REPORT OF

THE WORKING GROUP ON

MINERAL EXPLORATION AND DEVELOPMENT

(other than Coal and Lignite)

FOR

THE ELEVENTH FIVE YEAR PLAN

OVER VIEW

VOL - I

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1.0 REVIEW OF THE ACTIVITIES OF THE X^{th} PLAN

1.1 Geological studies carried out in past half-century have delineated vast area suitable for hosting mineral deposits. However, most of the exploration activity in the country even in the post-independence era remained confined to the stretches traditionally known to be locales of mining activities. Industrialization has led to manifold growth of mineral sector and fast depletion of known and near surface deposits would be the unavoidable result. During the X^{th} Plan, the need to adopt modern exploration techniques and beneficiation technologies was felt, mainly to locate the concealed mineral deposits and utilize the low-grade ores, which were hitherto being discarded as waste.

1.2 The Indian landmass measures 3.28 million sq.km., of which 2.42 million sq.km is constituted of hard rock. Out of the total hard rock area, approximately 7,00,000 sq km (5,71,000 sq.km. for Schedule Minerals) has been identified to contain geological associations and surface shows indicative of possible mineral occurrences.

1.3 During the X^{th} Plan (2002-2007) major thrust has been accorded to exploration for high value minerals like gold, diamond and platinum group of elements (PGE). Efforts for augmenting resource base for those mineral commodities having key role in sustaining industrial growth were also continued. Application of state-of-the-art technology for exploration and integrated multi-disciplinary approach were introduced during this period.

1.4 During the X^{th} Plan period Geological Survey of India (GSI) added 12,177 million tonnes of coal, 941 million tonnes of lignite, 8.2 million tonnes of copper ore, 0.8 million tonnes of lead-zinc ore, 37.42 million tonnes of iron ore, 14.38 million tonnes of manganese ores, 5.70 million tonnes of bauxite, 1883 million tonnes of limestone, 42.49 million tonnes of gold ore and 5.56 billion cubic meters of coal bed methane (CBM), to the National Inventory mostly by way of new discoveries. On the basis of conceptual approach and application of multi-disciplinary data synthesis, several kimberlite/lamproite pipes have been discovered by GSI during the same period. Four of these pipes from Andhra Pradesh have been found to be diamond bearing. In Maharashtra, diamond was recovered from Wairagarh conglomerate. Similarly, Mineral Exploration Corporation Limited (MECL) has identified and added 10,651 million tonnes of coal and 4667 million tonnes of lignite to the total energy mineral resources of the country during the X^{th} Plan period. MECL has also augmented 137 million tonnes of base metal and 3.35 million tonnes of gold ore. In the same period National Mineral Develoment Corporation (NMDC) has identified few blocks for Prospecting License (PL) out of their Reconnaissance Permit (RP) area. Contribution on the part of the State Governments has been mostly towards establishment of additional resources of limestone and dolomite.

1.5 Planned efforts for locating minerals over the last 55 years have enhanced reserves for various minerals like mica, barytes, chromite (metallurgical), coal (thermal), lignite, bauxite (metallurgical), manganese, iron ore, and resulted in the country being placed among the top ten producers for these minerals. However, India continue to display significant shortfall in many crucial minerals like fertilizer minerals, diamond, nickel, copper, gold, platinum group and rare metals leaving the country import dependent in these commodities.

1.6 Amendments to the Mines and Minerals Development & Regulation (MMDR) Act and the Mineral Concession Rules (MCR) have been introduced to create congenial environment for attracting investment in the mineral sector. As a sequel to this, several Multinational Companies (MNC's) have taken up exploration activity in the country and at present an area of 3, 64,000 sq.km is under different kinds of lease to private agencies, including MNCs. The exploration efforts in these leaseholds are yet to bear fruit. However, the record of applications for conversion from RP to PL suggests that the success ratio of the State agencies is at par with these Companies. A total number of 202 RPs and 73 foreign direct investment [FDI] proposals from global majors expected to invest about one billion US $, have been approved till 31-12-2005.

1.7 It has become apparent that the Private agencies have chosen to concentrate their exploration activities in areas with surface shows as recorded in the reports of Geological Survey of India and also in areas adjacent to those where mining activities developed through the efforts of the State agencies are going on.

1.8 During the Xth Plan, GSI has implemented an information infrastructure (GSI Net & Portal) based on an open, state of the art technology platform. The said information infrastructure will comprise a GSI Intranet including local area network (LAN) at different Regional / Wing / Operational Offices and wide area network (WAN) connecting all these offices and an Enterprise Integrated Portal (EIP) that will be a centralized, web-base providing single point access to all the applications in the GSI Enterprise Application suite. During the period under review, LAN at all other regions except NER, at operations and Wings were completed; the proposal for WAN, IP telephony and video-conferencing is under scrutiny. Work on Central Data Center at Kolkata and Disaster Recovery Center at Hyderabad is in progress. Portal is on design-development stage and expected to go live shortly.

1.9 Modernization efforts proceeded during the Xth Plan and attempts had been made to make up the shortfalls in achievement during the IXth Plan period. Orders have been placed for helicopter and heliborne survey equipments that are likely to be supplied during the early part of the XIth Plan Similarly the administrative procedures for obtaining clearance for the replacement ocean going vessel have been completed and further procedure for procurement will be completed during the XIth Plan.

1.10 COPPER

1.10.1 There has not been any significant change in inventory of copper reserves over past five years in India as no major copper deposit was located during this period.

1.10.2 Hindustan Copper limited is sole producer of copper from mines. Production of copper metal in concentrate [MIC] from mines in last five years was meager and has remained less than 30,000 tonnes per year.

1.10.3 The capacity for production of primary copper in India has risen from a mere 47,500 tonnes per year till 1997 to approximately 8,97,000 tonnes in FY 2006-07.

1.11 ZINC & LEAD AND ASSOCIATED METALS

1.11.1 After aluminium and copper, zinc and lead are among the most widely used nonferrous metals in the world.

1.11.2 The Indian zinc-lead industry comprises two primary producers - Hindustan Zinc Limited (HZL) and Binani Industries Limited (BIL), both in private sector. HZL was earlier a Government of India enterprise and post disinvestment in April 2002, it has become a private sector and presently a group company of Vedanta Resources. HZL is a vertically integrated producer from mining to smelting with its major operations in Rajasthan, while BIL has a smelter located in the west coast.

1.11.3 The zinc and lead price movement at London Metal Exchange [LME] during the last 10 years [1996 to 2005] has been varying substantially. After declining to record low levels in 2002, the prices started showing improving trend in subsequent years.

1.11.4 The total primary zinc metal production capacity in India at the end of terminal year of the IXth Plan (2001-02) was 199,000 tonnes per annum (tpa). (HZL – 169,000 tpa, BIL – 30,000 tpa). There has been progressive capacity build up by HZL during the early years of the Xth Plan through de-bottlenecking and modernization in its operating zinc smelters. This was followed by commissioning of a new 170,000 tpa hydromet zinc smelter at Chanderiya, Chittorgarh district in Rajasthan which has been operationalised in 2005. With this capacity addition, HZL’s zinc production capacity has surged from 169,000 tpa to 411,000 tpa and it is now the sixth largest producer of zinc in the world.

1.11.5 During 2002 to 2005, world zinc consumption increased at an average annual compounded rate of 4.3%. India recorded an annual average growth of 8.3%. During 2002 to 2005, world lead consumption increased at an average annual compounded rate of 4.6%. India recorded an annual average growth of 7%.

1.11.6 The present per capita consumption of zinc in India is about 0.4 kg as against the world average of 1.3 kg. Consumption of zinc during 2005-06 was nearly 430,000 tonnes Per capita consumption of lead in India is about 0.24 kg. Consumption of lead during 2005-06 was nearly 239,000 tonnes. The lead demand is riding the automotive growth, mainly driven by storage batteries.

1.11.7 There was supply deficit of lead during the first four years of the Xth Plan, which was met mainly through imports. This is basically due to inadequate lead resources limiting primary metal production capacity build-up. The demand-supply gap can only be reduced either by enhancing primary metal production once new resources are identified or upsurge in recycling of secondaries.

1.11.8 In India, HZL is the major producer of cadmium and silver, which are recovered as by-products from the smelting of zinc-lead concentrates. It is estimated that the zinc-lead reserves of HZL contain nearly 27,600 tonnes of cadmium and 3,700 tonnes of silver. Estimated production of cadmium and silver in the terminal year of Xth Plan will be of the order of 470 and 60 tonnes respectively.

1.12 ALUMINIUM & ASSOCIATED METALS

1.12.1 The production of bauxite in India has increased from 5.06 million tonnes in 1991-92 to 11.69 million tonnes in 2004-05. There is an increase varying from 0.5 million tonnes to more than 1 million tonnes yearly. Presently there are five primary aluminium producers in the country with 7 smelters.

1.12.2 While Nalco, Balco and Malco operate one each, Hindalco has four smelters [3, Ex-Indal]. The production capacity of these smelters has increased from 610,000 tonnes in 1991-92 to 697,000 tonnes in 2001-02.The capacity is likely to be enhanced to 1.075 million tonnes by the year 2006-07 for which development and construction activities are underway. The production of metal has increased from 522,000 tonnes in 1996-97 to almost 1 million tonnes in the year 2005. After slow growth for over a long period, there has been all around growth of aluminium sector. Taking into account the population growth and per capita consumption increasing to 0.8 kg, it is expected that the domestic consumption would be around 0.92 million tonnes around 2007 by the end of Xth Plan.

1.13 CEMENT AND LIMESTONE

1.13.1 The industry has shown much improved performance and not only crossed the production target set by the Department. of Industrial Policy and Promotion but also almost reached the target set by the Working Group for Xth Five Year Plan.

1.13.2 During the Xth Plan in March 2001, the gross reserves of cement grade limestone were 95939 million tonnes. This situation has not shown any improvement in course of the Xth Plan. The gross reserves of cement grade limestone stood at 97430 million tonnes, i.e. an increase of 1490 million tonnes or 1.5% as on March 2006.

1.14 DIAMOND AND PRECIOUS STONES

1.14.1 A steady growth of diamond imports and exports has been established between 1994-95 to 2003-04. The imports have risen from Rs.4,960 crores in 1994-95 to Rs.32,251 crores in 2003-04. The export figures have risen from Rs.12,357 crores in 1994-95 to Rs.38,145 crores in 2003-04.

1.15 GOLD

1.15.1 Although in last few years there was significant ore resource augmentation but the country has not witnessed any radical change in gold production from primary gold ore.

1.16 PGE [Platinum Group of Elements]

1.16.1 Platinum is naturally occurring precious metal that is scarce in India. Although there is no production of platinum there is demand for the metal in the country.

1.17 DIMENSIONAL STONES

1.17.1 India is one of the largest producers of dimensional stones in the world. The Indian stone production is estimated at 31059 thousand tonnes. Indian Stone exports was approximately Rs.3,408 crores during 2003-04, with Granite alone accounting for Rs.2,653 crores.

1.17.2 Prior to 1987, the export of Indian processed granite products was hardly 10% of the total granite exports, but in recent years, the share of value added finished products has touched 75-80% of the total granite exports.

1.18 FERTILIZER MINERALS

1.18.1 The anticipated consumption of apatite and rock phosphate is estimated at 4475 thousand tonnes by 2006-07.

1.18.2 The total production of phosphorite at 11,84,000 tonnes in 2004-05 decreased by 18% from that in the previous year due to closure of Jharkhand mine for want of permission from the Pollution Control Board and poor lifting of ore at crushing plant of Jhamarkotra mine in Rajasthan. During 2005-06, the total production increased to 13,83,000 tonnes. The production of rock phosphate and apatite is estimated to reach 1.34 million tonnes by 2006-07. As a result, India will continue to rely on imports to meet its demand.

1.19 INDUSTRIAL & NON-METALLIC MINERALS

1.19.1 The domestic consumption of asbestos was about 86,000-90,000 tonnes per annum, almost entirely in asbestos-cement and asbestos-based products manufacturing. The production of asbestos at 5,619 tonnes in 2004-05 decreased by about 44% from that in the previous year.

1.19.2 Resources of chrysotile variety of asbestos are very much limited in India. So, there is an urgent need to go for detailed exploration of chrysotile.

1.20 RARE EARTH ELEMENTS

1.20.1 Though there are 30 rare earth elements comprising 15 naturally occurring elements of lanthanide series and a couple of actinides, India's exploitation of rare earths is confined to Monazite based lanthanides and the actinides thorium and uranium. There is plenty of scope for exploration for ores like xenotime, bastnesite etc, containing naturally occurring rare earth elements.

1.21 RESEARCH & DEVELOPMENT

1.21.1 NML, Jamshedpur, successfully developed a continuous and more energy efficient silico-thermic reduction process for magnesium production, which is far superior than the existing Pidgeon process.

1.21.2 JNARDDC completed a project related to the enhanced productivity of the Bayer Process. Adoption of developed parameters led NALCO to achieve a digestion efficiency of 88-90% for Pachpatmali Bauxite deposits.

1.21.3 A project on the development of the National Facility on Semi-solid forming in Indian Institute of Science [IISC], Bangalore is nearing completion. It would be the only facility of its own kind in the country with wide ranging industrial applications.

1.22 INFRASTRUCTURE

1.22.1 Though in general lot of infrastructure development has taken place during the Xth Plan, still lot more needs to be done to match the growing mining sector.

2.0 SUMMARY OF THE XIth PLAN

2.1 At present bulk of the mineral resources of the world are consumed by 20% of the global population residing in developed countries. It has also been established that the demand in these countries has reached a saturation level. Current trends indicate that demand of the remaining 80% of the world population would increase manifold in the coming years from the current low levels, which may lead to a crisis more serious than the 1970 oil-crisis. Thus for a developing country like India the need of the hour is to intensify activities of mineral search using modern techniques and equipments for preparing assets required for augmented levels of mineral production.

2.2 India's per capita consumption of minerals and its products is one of the lowest in the world. From the coal exploration activity in the pre-independence period, the growth driven demand for mineral resources in the post independence era has led to significant expansion and diversification of mineral exploration programmes. Although new discoveries were made, but these were not enough to fully compensate the requirements. Therefore, it is essential that the country continue to strengthen the resource base through vigorous exploration activities by Public/Private Sector agencies.

2.3 SURVEY AND EXPLORATION PROGRAMME

2.3.1 With the near exhaustion of surface proximal resources it has become necessary to apply multi-disciplinary approach for locating concealed mineral deposits. In addition to this, emphasis needs to be given to mine small deposits having low-grade with high tonnage adopting a concept of cluster mining. The beneficiation technology needs to be developed at par with the international state-of-the-art techniques for extraction of high-value and strategic minerals.

2.3.2 The challenges to locate deep-seated, concealed deposits assume importance in this context along with the need to systematically explore areas in which favorable geological ensemble has been identified through geological and specialized thematic mapping. The holistic understanding of geology is to be followed by applying sophisticated geochemical and geophysical techniques. The approach to cover the country by multi-elemental geochemical mapping with ultra-low level detection of 70 to 80 elements in regular 1 to 5 sq.kms grids, has paid rich dividends in countries like China. Efforts initiated in this direction during the Xth Plan would continue in right earnest in the XIth Plan.

2.3.3 In tandem with search for concealed deposits, it is imperative in the national interest to build up a more complete resource inventory by depth and extension probing in known areas of established ore occurrences, as most of the known mineralized tracts have been drilled up to shallow depths of 100 to 200 meters, to cater to the immediate needs of the exploiting agencies.

2.3.4 In physical terms it is proposed to carry out the following:

i)	Specialised Thematic Mapping	35,000 sq.km.
ii)	Geochemical Mapping	1,80,000 sq.km.
iii)	Geophysical Mapping	2,40,000 sq.km.
iv)	Multi-sensor aerial survey (TOASS)	70,000 sq.km.
v)	Heliborne Survey	46,000 sq.km area has been selected For coverage, the actual quantum would depend on the time schedule of procurement of equipments.

Marine Surveys - Remaining area of EEZ and 20000 Sq.km.

vi)	Large Scale Mapping	13,000 sq.km.
vii)	Detailed Mapping	172 sq.km.
viii)	Ground Geophysical Surveys	600 line km.

x) Exploratory Drilling

a. MECL 10,66,325 meters (4,79,700 meters for non-coal minerals and the remaining for coal and lignite)

b. GSI 4,29,000 meters (1,32,000 meters for non-coal minerals and the remainder for coal and lignite).

State Government and others: Only a few States have identified programmes.

xi) Matching chemical, petrological, mineralogical, geochronological and other laboratory studies.

xii) Generation of base line data for geo-environmental appraisal.

xiii) Beneficiation studies for upgradation of marginal ores.

The programme of airborne survey for large tracts will continue for the purpose of identifying potential signatures of mineralized properties. This will be followed by ground surveys, which is the only way to convert the prospects into targets deserving more thorough and intense exploration. Ground geophysical surveys in extension of known belts would continue for correct assessment of their geological potential. The above stated plan of action is to be specifically carried out for base metals, gold, diamond, PGE, rare metals (RM), rare earth elements (REE), strategic and ferrous minerals. Similar actions are planned by various State agencies to share the burden with GSI and MECL.

2.3.5 The need for improved techniques of data acquisition and interpretation as well as the importance of multi-disciplinary approach for exploration was felt by the Geological Surveys all over the world. The increased application of earth science data for societal purpose led to widening of the horizons. All these factors necessitated a well thought of modernization programme for which efforts started during the Xth Plan period and will continue in the XIth Plan period. Modern equipments have been procured and the process of procurement for multi-sensor airborne geophysical equipment and ocean going vessel and equipment for off-shore exploration will be completed during the XIth Plan. Projects have been drawn to utilize these modern equipments in the XIth Plan.

2.3.6 The level of funding for mineral exploration in India has been extremely meager in comparison with the global scene. India's share in mineral exploration during the IXth Plan was less than 1.0% of global spending (US $ 14,900 million) for the same period. In spite of deficient financial support the success ratio of India's performance in terms of exploration efforts in respect of ferrous minerals and bauxite has been commendable. In respect of gold and some strategic minerals, India does lag behind, but the picture could have been much better.

2.3.7 The expenditure on exploration activities in the developed countries is largely met by the Private Sector, while in India this funding comes mainly from the Government. With the recent liberalization of economic policies, it was contemplated that a major share of exploration spending will be borne by the Private Sector but till this time no significant overtures in the new direction are visible. Thus it may not be feasible to shift away the entire responsibility of mineral sector from the hold of Public Sector in one stroke, in view of the far-reaching societal impact and overall national interest towards resources build-up.

2.3.8 The Government should regard the mineral exploration activity as a scientific endeavor having great societal impact rather than considering the expenditure as plan investment meant for quick returns. At present, the science and technology component in the total funding scheme of the 'Industries and Minerals of Planning Commission is entirely directed towards R&D efforts in mining and metallurgy. It would be worthwhile to review the situation and bring the funding for mineral search and exploration largely under S&T and social causes.

2.3.9 The total cost towards such modernization during XIth plan has been worked out to the tune of Rs. 822 crores, which includes Rs 622 crores for high value equipments and Rs 200 crores for the remaining. In the XIth Plan the envisaged outlay for Private sector spending is not known. It is envisaged that around Rs. 2816 crores for all National and State agencies like GSI, MECL, State Governments would be required to implement the proposed programmes

2.4 MINERAL OUTPUT INDUSTRIES

2.4.1 COPPER

2.4.1.1 No significant change has happened in inventory of copper reserves over past five years in India, as no major copper deposit has been discovered during this period. According to IBM, as on 1.4.2005 India has an estimated copper resource of 1394.43 million tonnes containing 11.42 million tonnes metal.

2.4.1.2 95% of the total reserves are in the states of Jharkhand, Rajasthan and Madhya Pradesh. Remaining 5% copper ore is located in other states of Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Meghalaya, Orissa, Sikkim and Uttaranchal.

2.4.1.3 Not much exploration for copper has been done in recent past. There is ample indication of finding copper reserves at depth as well as unexplored area. It is proposed that in addition to GSI and MECL, PSU like Hindustan Copper Limited [HCL] primarily involved in copper mining, should also undertake exploration either independently or as a joint venture with overseas organizations.

2.4.1.4 The past few years saw the Indian copper industry taking remarkable strides towards the goal of self-reliance. Hitherto the indigenous production capacity of 47,500 tonnes of copper of HCL met 25 to 30% requirement of the country before economic liberalization, while the rest was imported.

2.4.1.5 During the year, the demand for copper in global market has been growing steadily. Demand in Asian Countries, i.e. China & India, is one major reason for driving copper prices upward in the global market, this trend is expected to continue in the near future.

2.4.1.6 Domestic demand is expected to grow at about 6% per annum while production is expected to increase by 15.1% per annum on account of new capacities being added by private players.

2.4.2 ZINC & LEAD

2.4.2.1 The zinc-lead reserve-resource status as on 1.4.2005 based on United Nations Framework Classification [UNFC] has been estimated. The reserve is around 126 million tonnes containing about 11 and 2.6 million tonnes of zinc and lead metals respectively. The remaining resources are estimated at 397 million tonnes with about 13 and 4.6 million tonnes of zinc and lead metals respectively. While the total all India resources are estimated at 522 million tonnes, about 89% of lead and 93% of zinc reserves are located in the State of Rajasthan.

2.4.2.2 Looking at the present scale of operations and mine expansion under execution, the resource position will become critical to meet the concentrate requirement for the zinc metal production capacity, which is projected at 9% compounded annual growth rate [CAGR] during XI^{th} Plan and beyond. Accordingly, perspective exploration plan is required to achieve new economic greenfield discoveries. Adequate funding, technological up-gradation, conducive regulatory framework, expeditious clearances of licenses, collaborative efforts by various government and private organizations will accelerate exploration and finally to mine development.

2.4.2.3 HZL is the only primary lead producer in the country. It has a total lead production capacity of 85,000 tpa at its two lead plants at Chanderiya, one of which has been operationalised in 2005 using eco-friendly Ausmelt technology with a capacity of 50,000 tpa. The secondary lead production in the country, in both organized and small scale sectors is estimated at 50,000 tpa.

2.4.2.4 Looking at the growth in the automotive, information and communication technology sectors, the demand for lead is poised to increase. This in turn will result in more recycling of batteries. This is expected to enhance the production of secondary lead to around 75000 tpa during the XI^{th} Plan period.

2.4.2.5 The zinc demand is riding the steel industry growth, mainly driven by the production of galvanized sheets.

2.4.2.6 Down-stream industry development, improvement in standard of living and consumer awareness is set to further increase the demand of zinc and lead in the forthcoming years. Based on these factors, coupled with global and domestic market analysis, the demand in the country during the XI^{th} Plan period is projected to grow at compounded annual rate of 8% for zinc and 10% for lead.

2.4.2.7 The zinc industry is expected to rise @ 8% CAGR during the XI^{th} Plan. The lead industry is poised to rise @ 10% CAGR during the 11^{th} Plan. There is significant upsurge expected in applications of lead storage batteries in defence, power, auto and IT-CT and other end user industries.

2.4.2.8 Cadmium, silver, antimony, bismuth, mercury, indium, arsenic and generally associated as minor/trace elements with zinc-lead-copper deposits. Based on content in the ore, these are concentrated at ore beneficiation stage and finally some of these are recoverable during refining of main metals.

2.4.2.9 It is estimated that cadmium and silver production will rise to about 750 tpa and 90 tpa respectively from 2008-09 in the middle years of XI^{th} Plan. This industry has taken up various measures to improve recovery efficiency through process flow-sheet modification, R&D projects for optimization of recovery of these metals both at beneficiation and smelting stages and recovery from wastes and residues.

2.4.2.10 Main **nickel** occurrence in India is found in the Sukinda Valley in Orissa in the overburden of chromite. The total resources of nickel in India are estimated at 189 million tonnes of which 42.1 million tonnes contains +0.9% Ni. Orissa hosts about 92% of the total resources.

2.4.2.11 The total resources of **tin** in the country are placed at 87.34 million tonnes containing about 0.7 million tonnes of metal. There is meager production of primary tin metal in the country and almost entire consumption is met by imports. Demand for tin plate for packaging industry in the country is growing and the consumption is expected to grow at a moderate level of 5% per annum.

2.4.2.12 The **tungsten** demand can only be met by imports as there is no indigenous production. However, due to its strategic importance following measures are suggested-

- Vigorous exploration to identify new economic resources and evaluation of existing potential reserves.
- Continue the efforts on effective utilization of scrap.
- R&D for flotation, solvent extraction, plasma smelting and refining of the metal.

2.4.3 ALUMINIUM

2.4.3.1 The overall resource position of bauxite in India is over 3 billion tonnes. India occupies 5th place with a share of 7% of world resources. Out of this 80% of resources are of metallurgical grade. Orissa and Andhra Pradesh account for more than 90% of country's metallurgical grade resources. The balance is distributed in Jharkhand, Chhattisgarh, Karnataka and Maharashtra. The resources of metallurgical grade bauxite are quite adequate.

2.4.3.2 Though there are more than 200 mines operating in the country, most of these are small open cast and manually operated. 15 major deposits account for 75% of the country's production. These are mostly the captive bauxite mines of the major alumina players in the country like Nalco, Hindalco, Balco, Hindalco (Indal), Malco and the mines of GMDC which are either fully mechanized or semi mechanized. Among these, the Panchpatmali bauxite mine of NALCO in Orissa accounts for about 40% of the country's production.

2.4.3.3 With the abundance of resources, Eastern Ghats region of Orissa and Andhra Pradesh would be the area of major bauxite mining activities in future. The large deposits of these areas, with reserves of more than 50 million tones, can be reserved for proposed export oriented alumina plants. Additional bauxite resources are required for the brownfield expansion of the existing alumina producers. The Chhattisgarh and Jharkhand deposits are small and could be reserved for Balco, Indal (Muri plant) and Hindalco.

2.4.3.4 The Production of alumina in 2004-05, has been 2.9 million tonnes. The production of alumina in 2005 by India refineries is 3.04 million tonnes. India, with 7% of world resources of bauxite, produces only 4.3% of global alumina production and its share in world trade is 3.5%. There is adequate scope for increasing production of alumina and its export.

2.4.3.5 Per-capita consumption of aluminium has been, steadily increasing in developed countries with new areas of application being invented.

2.4.3.6 Future growth rate is likely to be high in transport and construction industries, with stress for infrastructure, power sector also likely to grow. Packaging and Industrial machineries particularly automobile sector would have considerable growth. Overall growth is expected to be around 8%. As recycling would also increase to 20 to 30% and likely to increase further in due course to facilitate the down stream sector for availing metal at low cost, the demand and growth of primary metal would be between 5 to 8%.

2.4.3.7 This present production matches the growth plan of 8% projected by the Planning Commission. Continuing with this trend, it is likely to increase to 1.28 million tonnes and 1.5 million tonnes by 2012 and 2017 respectively. Various steps are to be taken for promotion of aluminium sector and facilitating its growth. Hence it is necessary to have yearly review of aluminium sector to assess the achievement and for taking remedial measures to meet the demand for solving the constraints faced.

2.4.3.8 It is expected that per capita consumption would rise up to 0.8 kg. 1 kg and 1.1 kg by end of Xth, XIth and XIIth Plans respectively. With optimistic assessment, the domestic consumption of 0.7 million tonnes of aluminium in 2001-02 would increase upto to 0.92 million tonnes by 2006-07. With 1 kg per tonne it is likely to be 1.28 million tonnes by 2011-12 and with 1.1 kg it may reach 1.5 million tonnes around 2016-17 by the end of XIIth Plan. However, realistic figure with slow growth would be respectively 0.8 million tonnes, 1.35 million tonnes and 1.5 million tonnes. This matches also the domestic demand after sectoral uses of semi-fabs and proposed growth rate of 5 to 8%. The export and import from present level of 15,000 tonnes to 200 to 300 thousand tonnes by 2006-07 and may reach to 400,000 tonnes in another 5 years time.

2.4.3.9 To meet these projected demands of XIth & XIIth Plan, there are already proposals for Greenfield investments as well a brownfield expansions from both the present Indian Companies as well as International Companies.

- Greenfield smelters of about 400,000 tpy capacity to be planned now for the future.
- Secondary recycling should be promoted to contribute 30% of domestic metal requirements.
- Import of scrap to be increased with low duty which in turn can be exported as value added item. This will increase both import and export simultaneously giving benefit to international trade.
- Where power is cheap abroad, smelters can be established to produce metal at low cost.

2.4.3.10 During the Xth Plan period only the proposed brown-field expansions of existing refineries have been converted to reality to achieve the capacity of 27.20 thousand tonnes of alumina. In the X Ith Plan there are proposals for expansions to meet the demand of respective smelters and surplus for export by Nalco and Indal.

2.4.3.11 The Country is today producing surplus alumina, which is being exported. This trend is likely to continue with the establishment of greenfield export oriented alumina refineries. As such with the surplus availability of alumina, the aluminium smelters in the country would not suffer.

2.4.3.12 Out of over 1.8 billion tonnes of metallurgical grade bauxite resources in the country, only 400 million tonnes have been operating leases, while additional about 400 million tonnes are being planned for development of mines for greenfield plants.The balance resources can be planned for utilization.

2.4.3.13 Grant of mining lease, environmental clearance, land acquisition, forest clearance, etc. have been the major constraints for development of new mines.

2.4.3.14 Import of scrap to be increased with low duty which in turn can be exported as value added item. This will increase both import and export simultaneously giving benefit in international trade. Where power is cheap abroad, smelters can be established to produce metal at low cost.

2.4.3.15 The constraints of red mud disposal would be the problem of future alumina plants. Utilization of this waste has to be taken care through R&D efforts. Caustic soda, from domestic sources may pose problems. Long-term contracts with caustic soda plants abroad also need to be explored.

2.4.4 CEMENT & LIMESTONE

2.4.4.1 Examining growth of GDP and cement consumption over the last 10 years has shown that the cement consumption is always higher with rare exceptions. During XIth Plan cement growth should be 2% over the GDP growth.

2.4.4.2 The total limestone requirement in the XIth Plan with the growth scenario of cement at 9%[2322.87 mt], 10% [2376.00 mt] and 11% [2432.10 mt] for the GDP growth of 7%, 8% and 9%.

2.4.4.3 Limestone availability for sustainable development of the cement industry in meeting the fast track demand growth of infrastructure development is thus not assured beyond 65 years.

2.4.5 DIAMOND & PRECIOUS METALS

2.4.5.1 India has very large skilled man power for diamond cutting and polishing (small & rough) and other precious stones. Indian production of diamonds as against the requirement for cutting and polishing industry is almost negligible (0.04%). This industry has to rely very heavily on import of diamonds. After value addition by cutting & polishing and manufacture of jewellery, major percentage of the finished products is exported.

2.4.5.2 The liberalization of our National Mineral Policy in 1993 has resulted in the entry of private entrepreneurs and Multinational Companies from overseas, for carrying out diamond exploration.

2.4.5.3 Based on the exploration practices and activities, which are multi-disciplinary in nature, new kimberlites / Lamproites may be discovered. This may result in establishing a new mine and if so production may be expected only by 2015. The production from such economically viable kimberlites / Lamproites discovered may only meet a fraction of the industry's requirement. Therefore, for a long time to come, India has to depend on imports of rough stones.

2.4.6 GOLD

2.4.6.1 As per UNFC, total resources (reserves and remaining resources) of gold ore (primary) in the country as on 1.4.2005 were estimated at 390.28 million tonnes. Out of these, 19.25 million tonnes are placed under reserve category and the rest 371.03 million tonnes under resource category.

2.4.6.2 Besides, the total resources of gold ore of placer type in the country as on 1.4.2005 were estimated at 26.12 million tonnes, all in the resources category.

2.4.6.3 Although in last few years there was significant ore resource augmentation, but the country has not witnessed any radical change in gold production from primary gold ore. In order to enhance the gold production, existing gold resources in other parts of the country have to be converted to reserves through detailed exploration and feasibility studies. This will help to open up new mines in the country with resultant increase in gold production. From the existing mines the annual production will remain between 3 and 3.5 tonnes during XIth plan period. The major producer will be the Hindustan Gold Mines Limited [HGML] from its three existing mines.

2.4.6.4 India has a traditional and stable market for gold consumption. The demand for ornamental sector is increasing owing to the increase in purchasing power of emerging middle class. There is demand for growing electronic sector also. A huge gap exists between demand and indigenous production, which is likely to continue. To bridge the gap thrust for gold exploration needs to continue in the country along with import.

2.4.6.5 The mining sector calls for improved method of narrow vein mining for their economic exploitation. Introduction of small scale mining culture in gold industry is a need of the day. Adoption of modern gold extraction technology is an immediate need to treat low grade and complex ore type. For augmenting gold reserves in the country further detailed explorations have to be taken up for the deposits where preliminary assessment up to a shallow depth has been completed.

2.4.6.6 Cluster mining of small gold deposits may also deserve consideration and should be encouraged.

2.4.7 PLATINUM GROUP OF ELEMENTS

2.4.7.1 Platinum is a naturally occurring precious metal that is so far not produced in India. However, there is demand of the metal in the country. The development of Indian platinum jewellery market is increasing steadily. The demand continues to grow with increasing consumer awareness.

2.4.7.2 In India import of platinum registered an increase of more than 50% from 2,234kg in 2002-03 to 3,352kg in 2003-04.

2.4.7.3 The demand for platinum will continue to rise with tighter emission controls, robust growth of diesel engines and emerging Indian market for platinum jewellery. The demand of palladium is expected to rise in auto-catalysts for petrol engines. Growth of rhodium will also be more in automotive industry.

2.4.7.4 At present facilities for ore beneficiation and extraction of PGE do not exist in the country. The metallurgical technique for extraction of platinum group elements from low grade ore is a closely guarded secret with a few enterprises in advanced countries. Technology has to be imported for extraction of PGE and this should be promoted.

2.4.8 DIMENSIONAL STONES & DECORATIVE STONES

2.4.8.1 India is one of the largest producers of dimensional stones in the world.

2.4.8.2 Indian Stone Industry accounts for a sales turnover of over Rs. 15,000 crores exports over Rs. 3,400 crores (2003-04) and provisional exports of Rs. 3,500 crores (2005-06) employs over 1.5 million workforce. The rural economy of many developing states like Madhya Pradesh, Uttar Pradesh, Orissa, and the North Eastern states is dependent on this industry.

2.4.8.3 Industry plays a vital role in the economy of states like Tamilnadu, Andhra Pradesh, Karnataka and Rajasthan.

2.4.8.4 India is the **Second** largest exporter of granite after China. Next in line are **Brazil and South Africa.** With all the progress in granite processing industry (value added finished products), India is yet far behind i.e. at 5th place in the world. India has abundant resources, technical know-how, large quarrying base and processing capacity and can safely ensure export growth @ 20% per annum during the XIth Plan period.

2.4.8.5 The exports and domestic production are complimentary and supplementary in every aspect and thus the domestic industry will also grow simultaneously with the development of exports. It is estimated that domestic industry shall grow @ 20% per year during the XIth Plan period. Indian stone is widely accepted world over and also in the domestic market. The demand is growing rapidly with the boom in the construction sector. Domestic consumption of granite is worth around Rs.7,000 crores. It is anticipated that the dimension stone industry for the domestic sector will also grow simultaneously with the development of export industry.

2.4.9 INDUSTRIAL MINERALS

2.4.9.1 The total resources of rock phosphate as per UNFC system in the country as on 1.4.2000 are placed at 289 million tonnes.

2.4.9.2 In India, most of the existing phosphatic fertilizer and phosphoric acid plants have been designed for high-grade imported rock phosphate, mainly from Morocco and Jordan. The Indian deposits are of low grade. Therefore, the fertilizer and phosphoric acid plants that may be set up as replacement to the existing plants will have to be designed to accept indigenous ores as a feed. Beneficiation of domestic low-grade ores would-be a step in the right direction.

2.4.9.3 Demand of phosphatic fertilizer will continue to rise due to growth in population and corresponding increase in demand for food grains. There is no substitute for phosphate in agriculture.

2.4.9.4 As per UNFC, the total resources of Potash as on 1.4.2000 are estimated at 21,815 million tonnes in the country.

2.4.10 HEAVY SAND MINERALS

2.4.10.1 India has over 7,000 kms coast-line and many favourable stretches of the beaches on both the western and eastern shorelines have large reserves of heavy minerals whose potential is yet to be fully exploited.

2.4.10.2 Beach Sand contains the important heavy minerals such as Titanium bearing minerals including Ilmenite, Rutile and Leucoxene, as well as Zircon, Monazite, Garnet and Sillimanite.

2.4.10.3 Policy on Exploitation of Beach Sand Minerals (Resolution of 6.10.1998) had its objectives to encourage exploitation of the minerals through a judicious mix of public and private sector participation (including foreign investment); to maximize value addition within the country; to up-grade the existing process technologies to international standards; to attract investments from within the country and overseas. The recent delisting of several atomic minerals and placing them with other major minerals, should further facilitate faster development of the beach mineral sector.

2.5 FISCAL MEASURES & INFRASTRUCTURE

2.5.1 In India royalty on major minerals is charged on unit of production basis as well as on ad-valorem (percentage of revenue) basis. The unit of production rates is applicable to 14 minerals (excluding coal, lignite & sand for stowing) and ad-valorem rates on the rest of the major minerals. At present the unit of production rates are varying from Rs.5 to Rs.800 per tonne while the ad-valorem rates vary from 0.12% to 15%.

2.5.2 Three systems of calculating royalty are prevalent in the world. These are (a) Quantity based or rate per tonne, (b) Ad-valorem or percentage of revenue and (c) Profit based or percentage of profit.

2.5.3 Indian Mining companies and manufacturers are living in a rapidly globalizing world and they have to compete with their foreign counterparts not only in the external markets but in the domestic markets as well. In such a situation, it would not be wise to set a royalty rate, which is out of tune with the rates in other countries. Furthermore, India has to compete with other mineral producing countries in attracting FDI in mining.

2.5.4 Taxation is a form of government intervention, which is necessary for optimal exploration, mechanization of mining operations, maintaining environmental standards and maximizing mineral returns. It is also necessary to achieve equality and international competitiveness through optimal mineral extraction policy.

2.5.5 Internationally the ad-valorem royalty system is more prevalent. In India there is unanimity among the states now in the **demand that royalty rates should be shifted from tonnage to ad-valorem**. The main problem with ad-valorem royalty is the determination of price or value on which the royalty rate is to be applied.

2.5.6 Development and growth of the mineral sector is dependent on availability of adequate infrastructure including roads, railway lines, port facilities, power, water and communication facilities.

2.5.7 Rural roads linking major mining projects and those linking national or state highways are generally constructed and maintained by large mining companies. However, in case of small and medium enterprise (SME) mines, generally un-surfaced roads cater to mineral traffic.

2.5.8 Road and rail links for the transportation of minerals from the mine areas to the nearest railhead, national or state highway are the primary infrastructural requirement before a mine is opened.

2.5.9 In most parts of the world, there is hardly any mining in the SME sector. Whereas, in India the mining operations are largely confined to the SME sector. The infrastructure requirements of the SME sector operations are different, mainly, because the economics of scale do not permit miners to put up their own infrastructure.

2.5.10 India has an edge over many countries in terms of strategic locational advantage, large domestic market, skilled manpower in steel making, availability of cheap iron ore, etc. At the same time it has some serious disadvantages such as inadequate port and rail network, lack of power, etc.

2.5.11 Ports constitute a crucial part of the transportation infrastructure of the country. The international experience with economic development has emphasized the infrastructure development near the coast by ploughing back the "gains from trade".

2.5.12 Some of the infrastructural bottlenecks at Indian ports are - Inadequate receiving capacity of about 15000 tonnes per tippler per day, inadequate stockyard capacity in ports to ensure enough quantity of iron ore stocks for the shipping system to work continuously at the optimum capacity, inadequate loading capacities, inadequate railway network to feed the port, inadequate draft to handle large vessels.

2.5.13 For a country of India's size, an efficient road network is necessary both for national integration as well as for socio-economic development.

2.5.14 An ambitious National Highway Development Programme (NHDP), involving a total investment of Rs. 2,20,000 crore upto 2012, has been established. The main elements of this programme are:

- Four-laning of the Golden Quadrilateral and NS-EW Corridors (NHDP I & II)
- Four-laning of 10,000 kms (NHDP-III)
- Two laning of 20,000 km (NHDP-IV)
- Six-laning of 6,500 kms (NHDP-V)
- Development of 1000 km of expressways (NHDP-VI)
- Other Highway Projects (NHDP-VII)
- Accelerated Road Development Programme for the North East Region

2.5.15 Several State Highways and link roads from specific mines to the NH or SH or the railhead would also need to be taken up to make it easier for the SME mine owners to transport their minerals.

2.5.16 Minerals, being bulk commodities, are transported over a long distance mainly by the railways, the world over. In India also, the mineral transportation from the mines to the ports or to the factories generally takes place by rail.

2.5.17 The following railway projects are under survey, which if taken up, will ultimately augment movement of minerals in India -

- Doubling of rail track from Hospet to Vasco
- Doubling of rail track from Rajagoda to Haldia
- Attiputtu-Puttur: (Construction of New Line)
- Doubling of rail track of Kirandul-Kottavalsa station
- Construction of Third line from Kharagpur to Panskura
- Doubling of rail track on Raipur-Titlagarh section

2.5.18 India currently has around 120,000 MW of installed power generating capacity as on March 2006. Thermal power plants comprise almost 80 per cent of this capacity, hydroelectric plants about 16 per cent, and the remaining account for nuclear plants. While a relatively smaller percentage is contributed by the non-conventional energy sources.

2.5.19 A large number of private power projects in India are in the pipeline. The Central Electricity Authority (CEA) has granted techno-economic clearances (TECs) to several such power projects, which total for around 30,000 MW.

2.5.20 Considering the targets for economic growth in India, significant power generation capacities need to be added to support mineral industry during XIth Plan.

2.5.21 Environment concerns are growing globally as well as within the country. The mineral development is one among a number of competing land uses. Due to lack of planning and other frameworks to balance and manage the possible land uses, there are problems and disagreements in the matter of control, use and management of such lands where mineral discoveries are noticed. Exploration and exploitation of mineral resources in such areas is warranted in national interest.

2.5.22 At present it is seen that inordinate delays take place in public hearing for grant of mining lease in a forest area since large number of authorities are involved in granting the clearance.

2.5.23 Identification of equivalent non-forest land for compensatory afforestation is a major constraint.

2.5.24 It has been noticed that the acquisition of land particularly, in tribal areas is very difficult. This is owing to the fact that due to non settlement of these areas the land acquisition is often rendered impossible.

2.5.25 A high level expert committee comprising experts from Ministry of Mines and Ministry of Environment and Forest may be constituted to work as a nodal agency to examine and approve mining projects coming under forest areas, which may ensure timely forest clearance.

2.5.26 The Supreme Court in its order dated 30 October, 2002 directed that the user agency shall also pay for the Compensatory Afforestation Fund (CAF), the net present value (NPV) of the forest land diverted for non-forest purposes at the rate of Rs.5.80 lacs per hectare to Rs.9.20 lacs per hectare depending on the quantity and density of the forest land converted to non forest use.

2.5.27 The basic concept behind charging NPV is that forest areas give intangible benefits in the form of release of oxygen, soil and water conservation resulting into lesser floods and consequently lesser national loss in river plains.

2.5.28 As there is symbiotic relationship between the tribal people and the forest, employment to the tribal people and their rehabilitation with the funds available under Compensatory Afforestation Fund Management & Planning Authority [CAMPA] should be on priority list.

2.5.29 Indian Bureau of Mines (IBM) has identified 297 abandoned/orphaned mines and has prepared a project proposal for reclamation/rehabilitation of 106 abandoned mine sites out of the above-mentioned 297. Of the above 106 sites, 87 are open cast mines and 19 are underground sites varying in size from 281.6 hectare to less than 1 hectare.

2.5.30 Soil strata are inverted due to open cast mining making the area not only refractory for vegetation growth, but also very fragile and unstable due to bouldery material at the top and the finer material at the bottom of an overburden.

2.5.31 To overcome the soil degradation issue, it should be made mandatory for all open cast mines to store and stock the top soil at a separate place and then replaced it as soon as the mined area is back filled.

2.5.32 To assess the socio economic impacts of mining in the country, it is imperative to refer to socio-economic profile of the area and inhabitants of mining belts. The demographic profile of local community particularly scheduled castes, scheduled tribes, dwellers of forest and migratory population have to be evaluated.

2.5.33 Over indulgence by incoming mining community often affects their cultures, customs and traditions. Positive impacts of mining on the other hand opens up new vistas of infrastructural and community development, improves their capabilities for gainful employment, promotes new vision for socio-cultural and community growth and broadening of their traditional outlooks.

2.5.34 Investable surplus must be created from every mining project in India, which can be ploughed back into local economy.

2.5.35 Socio-economic Impact Assessment (SIA) is either not done, or if done by the mining company itself, has no credibility in the eye of local people. It should be done by local administration or the NGOs working in those areas. SIA should be compulsorily done by some reputed and credible agency and approved by the same authority approving the proposal at the Central Level.

2.6 HUMAN RESOURCE DEVELOPMENT

2.6.1 In order to strengthen the infrastructure for R&D and human resource development in the mineral sector during the XI^{th} Five Year Plan document, it is for the first time that a separate Sub-Group has been constituted.

2.6.2 The approach paper for XI^{th} Five Year Plan envisages a target of 9% growth in GDP and in order to achieve this level of growth, the mining sector is expected to grow @ 10% per annum during the XI^{th} Plan.

2.6.3 The contribution of mineral production (mining and quarrying) to the GDP is estimated at 2.04% in 2005-06. The mining and quarrying sector has a share of 10.74% in the overall index of the industrial production (IIP). This sector registered an average growth rate of 5.5% in the first two years of the X^{th} Plan.

2.6.4 To ascertain growth of mineral sector [except coal, lignite, petroleum (crude) and atomic minerals], enhanced production of metallic minerals, which contribute presently about 12% of the total value of mineral production, is to be ensured. Hence, it is necessary to strengthen infrastructure for research & development and human resource development.

2.6.5 There is need to provide impetus on formulating R&D projects specifically for exploration and mining of deep-seated and concealed mineral deposits by interfacing between research institutions, industry and academia.

2.6.6 Considering need for strengthening institutional mechanism for a dedicated research & development, consultancy and training, it is proposed that a national agency should be created for undertaking, facilitating, coordinating and monitoring a multi-laboratory, multi-disciplinary R&D in the field of mineral exploration, mining and mineral development, mineral processing, nonferrous metals with a view to ensure optimum utilization of available resources and a greater synergy.

2.6.7 It is recommended that an autonomous body in the name of National Council of Geo-scientific & Mineral Research and Training (NCGMRT) be established as a Society under Registration of Societies Act, 1860 under the ambit of Ministry of Mines on the pattern of The Council of Scientific & Industrial Research (CSIR) during XI^{th} Five Year Plan. The council initially may have only seven constituent Centres each specialized in different fields with a mandate to undertake projects on commercial model in India and abroad. The proposed centers are as follows -

- Centre for Applied Geoscientific Services [CAGS]
- Centre for Ore Dressing, Testing and R&D [CORD]
- Centre for Mining Research, Design and Development [CMRDD]
- Centre for Rock Mechanics and Geo-technical Engineering [CRGE]
- Centre for Research & Development in Aluminium and Base Metals [CRDAB]
- Centre for Advanced Training in Geo-scientific Management [CATGM]
- Centre for Research in Miners' Health and Hygiene [CRMHH]

2.6.8 The area of operations of NCGMRT may cover Geo-scientific Investigations, Exploration for Minerals and Energy Resources, Development of Mining Technology, Rock Mechanics, Geo-environmental Studies, Mineral Beneficiation, Aluminium, Base Metals and Precious Metals, Material Research and Process Development and Miners' Health, Safety & Hygiene.

2.6.9 To meet the requirement of growth envisaged, thrust areas have been identified in four broad disciplines, namely exploration, mining, mineral processing and metals and products development, nucleus for which is already available with R&D organizations under Ministry of Mines (NIRM, JNARDDC, NIMH), GSI, IBM and NFTDC.

2.6.10 It is now required to put together multiple projects under each mission within the 'Centre of Excellence' concept and concurrently develop the human resource. Mission mode projects would create leadership level HR as well as large number of knowledge workers.

2.6.11 For providing impetus to research in detailed exploration, an 'Advanced Centre for Studies in Mineral Exploration' be established, which may undertake advanced studies / research for deep-seated and concealed mineral deposits by holistic understanding of geology and crustal evolution leading to tectonic and metallogenic modelling.

2.6.12 In order to fill up the gap in research for underground mining technology, an 'Advanced Centre for Studies in Underground Mining' is proposed in order to synchronize research & development for deep-seated deposits.

2.6.13 In order to undertake research and development on lean grade ores and to ensure effective techniques for utilization of wastes, by-products and co-products, it is proposed that an 'Advanced Centre for Studies in Mineral Processing' be established.

2.6.14 Similarly, in order to provide greater impetus to the development of materials and development of processes for downstream industry, an 'Advanced Centre for Interdisciplinary Research in Materials and Systems' be created for undertaking interdisciplinary research in materials and systems for development of multiple materials.

2.6.15 Considering priorities identified for R&D, a National R&D Fund for Mineral Development is proposed during the XI^{th} Plan for which a provision of Rs.700 crores is recommended.

2.6.16 The most important asset of the mineral sector is its human resource base. The shortage of professional skills is a pressing concern for the high technology mineral and metal sector. In order to ensure the success of modernization process, it would be necessary to ensure availability of trained manpower in line with thrust areas identified.

2.6.17 Despite availability of professionally qualified and skilled manpower and a well-established network of R&D institutions in India, desired investment and efforts in updating the knowledge and skills of our technical manpower has not been adequate and this has adversely affected their creative abilities and realization of the gains for the system. Thus, there is a need to re-engineer our human assets to enhance the level of performance and productivity.

2.6.18 The universities and R&D institutions in India are generally in position to meet the requirements of education and training. Apart from demand – supply gap that is envisaged for human resource, which is seen generally in quantitative terms, there are significant gaps such as lack of (a) interdisciplinary R&D, (b) knowledge integration for technology development, (c) inter-related R&D between mineral sector and construction and infrastructure sectors etc. Thus, there is a strong need to look at fundamental issues governing R&D and human resource development for the mineral sector ranging from revision of course curricula in line with modern developments, interdisciplinary R&D in thrust areas, continuing education and training on one hand, knowledge integration paradigms and national mission programmes on the other hand, in order to meet the ambitious growth plans for the mineral sector.

2.6.19 An important area that requires urgent attention from all concerned in mineral and nonferrous metal sector is the need to institutionalize systems to create, nurture talent and skills in several knowledge domains. Creation of Centres of Excellence is to be first initiated which will require human resource at the level of leadership in R&D in specialized fields and at the same time, knowledge workers in the respective knowledge domains.

2.6.20 Considering need to have trained manpower in the field of exploration, the present GSI training infrastructure should be modified in respect of faculty development, curriculum development and introduction of new certificate/diploma/degree courses and upgradation of infrastructure to an international standard. A world-class fully residential infrastructure needs to be created for education and training in the multidisciplinary fields like exploration, mining, mineral processing and nonferrous metals. Courses are presently of very general nature. With a basic work force with minimum masters degree at entry level this carries little meaning. Courses on the other hand should be specific targeting to develop skills in areas immediately required.

2.6.21 Special training courses need to be organized catering to the requirement of PSUs, MNCs and R&D institutions with/without collaboration of Universities and professional organizations. The institute may be linked to UGC and AICTE system for providing degree / diploma.

2.6.22 To ensure front line scientific research in earth sciences, a continuous series of training programmes by way of workshops, summer schools, advanced short courses in selected topics are required to be encouraged. Contact programmes need to be initiated particularly in institutions where infrastructural and instrumental facilities are available. Interdisciplinary teams must be motivated to prepare instructional materials for dissemination. Refresher courses in modern trends in earth sciences with basics in physics, chemistry, mathematics and computer applications, mostly of remedial nature, should be formulated and distributed to various institutions / universities largely through video-lectures and correspondence materials.

2.6.23 In order to attract suitable talent and to train them in the knowledge domains required, it would be appropriate to introduce a National Mineral Fellowship Scheme through Ministry of Mines, Govt. of India. The fellowship may be given to pursue PhD or Post –Doctoral or Advanced Research at any centre of excellence and the candidate may be simultaneously registered in a university system, say Indian Institutes of Technology [IITs], Banaras Hindu University [BHU] or Indian School of Mines [ISM].

2.6.24 In order to ensure speedy development of northeast region, Special Fund for Capacity Building of HR and R&D needs be established exclusively for north-east region and for this purpose an amount of Rs. 50 crores be earmarked during the XI^{th} Five Year Plan.

3.0 RECOMMENDATIONS

3.1 SURVEY AND EXPLORATION

3.1.1 During XIth plan intensive exploration for additional resources in known areas, in the potential region, unexplored inaccessible territories and ocean beds should be taken up. A special thrust is also required for the mineral exploration and development activities in North-East and other remote areas in the Himalayas, coastal and desert regions, areas those are covered by vast expanse of Deccan Traps and thick alluvium. At the stage of resource identification emphasis should be more on extensive coverage of large areas rather than intensification of activity in small blocks that should be done at the stage of detailed exploration.

3.1.2 There is a need to locate "concealed/hidden" ore bodies on the basis of conceptual studies through modern and sophisticated exploration techniques including application of geochemical, airborne geophysical surveys, remote sensing techniques and synthesis of multi-parametric data.

3.1.3 Rigorous exploration efforts are required for deficient minerals for which the country is dependent on import. Emphasis has to be given to high value minerals such as gold, copper, lead, zinc, diamond, etc. by identifying targets for cluster mining. Technologies for low-grade, large tonnage; high-grade, low tonnage; PGE deposits and high-tech minerals should be developed.

3.1.4 The life indices worked out for base, noble, rare metals and fertilizer, refractory, strategic minerals give a dismal picture This deficit and scarce mineral group requires immediate attention.

3.1.5 Beneficiation technology has to be improved for the recovery of metals from the low grade ores, mine rejects / old dumps and also for the optimum recovery of high value minerals as the by-products from the mining of other minerals.

3.1.6 Panning of minerals from the river alluvium may be brought under the ambit of a government policy for the systematic exploration and recovery of gold and other heavy minerals in an organized manner.

3.1.7 Reserves under proved plus probable category are much less in comparison to the resources for most of the minerals. Therefore, programmes need to be taken up by State agencies for upgrading resources established to reserves.

3.1.8 The National Mineral Policy 1993 initiatives were expected to increase foreign direct investment (FDI) in exploration/mining sector. As on 31/12/2005, 202 proposals of Reconnaissance Permit (RP) over an area of 278,774 sq. km. have been approved which are expected to bring around US $ 1 billion. The same trend is expected to continue during the XIth Plan.

3.1.9 In order to facilitate exploration by multinational and national Private Organizations, certain bottlenecks need to be removed. Issues like single window clearance, dissemination of the data, proper interpretation of MMDR & MCR acts and difficulties posed by Forest Act need consideration. In addition, a Central Regulatory Authority could be constituted to oversee all the above aspects including extending appropriate advice about availability of mineral wise freehold areas in each State.

3.1.10 In the post liberalization era, the role of the government agencies has become very important in promoting foreign investments and intensifying the exploration activities in the free hold areas to generate a strong data base for the fulfillment of the future demands of the prospective investors in mineral sector.

3.1.11 However, the reconnaissance surveys carried out by multinational companies in the last 8-10 years has not resulted in any major economic discovery. Perhaps the adopted technology was best suited for locating near surface deposits. In order to discover deep-seated resources, it is necessary to re-look and reorient the exploration strategy, particularly in the tropical and sub-tropical regions of India. Moreover, the interest of multinational companies has been confined to exploration and development of lead-zinc, copper; diamond and sometimes gold.

3.1.12 The onus of exploration for the other 58-59 minerals, covered under National Mineral Inventory should therefore continue with State agencies and diversion of efforts and resources for mineral exploration is needed. Adequate financial and man-power support should be provided to the State agencies.

3.1.13 Highest priority was accorded to industry and mineral sector from second to fifth Five Year Plans and 20-23 percent of total plan outlay was provided to this sector. From sixth Five Year Plan onwards there is declining trend in terms of allocation of outlays. In the ninth Five Year Plan only 7.6 percent of total Public Sector Plan outlays were provided to this sector. As the gestation period of mineral exploration is very large ranging from 10 to 15 years, effect of this is likely to be felt only after 10/15 years. This issue needs serious attention.

3.1.14 Currently, Indian spending on exploration stands at meager 0.7 to 0.8% of global spending, which should at least be raised to 4.5% of the global spending in view of the size, population and geological potential of the country.

3.1.15 During the XIth Plan period enhanced investment in mineral exploration and exploitation could be expected from multinational and national private organizations. The State exploration agencies need to be supported for ensuring a balanced growth in the exploration sector in the foreseeable future. This should also include adequate thrust on upgradation of their capability through modernization of equipment and acquiring of state-of-the-art technology and expertise through training in all related field of mineral exploration.

3.1.16 In order to encourage private sector initiative, the State DMG's may have to play a more participative role in some of the activities related to regional reconnaissance

/ prospecting exercises in their respective states, besides their routine administrative responsibilities.

3.1.17 Currently, the Government's support to mineral exploration is of the order of about 97% while that of the private sector is only 3%. This is due to the lead role being played by Government in mineral production, accounting for 90% of the value of mineral production in the country, as also to the reservation of several minerals and mineral deposits for exploitation through Government sector.

3.1.18 Since mineral exploration is fundamental to the economic development of the country, it is necessary that allocation of funds for mineral exploration through the Ministry of Mines should be substantially stepped up. Similar efforts should be made by the various State Governments for the activities conducted by the State Directorates of Mines and Geology. In this connection, the following are suggested:-

a) A mechanism for recovery of exploration cost should be evolved such that the same can be charged from the prospective lessee while granting a mining lease. The charge should be reimbursed to the exploration agency.

b) The preliminary geological data available with GSI and State Directorates may be made available at reasonable prices. The prospecting/exploration data containing more details of the deposits which can form the basis of mine development may be made available by MECL, GSI & State DMG's only on payment of cost involved. The Govt. organizations should ensure such data to be user friendly and available in time.

c) At present, the Science and Technology (S&T) component in the total funding scheme of the 'Industries and Mineral' of Planning Commission is entirely directed towards R&D efforts in mining and metallurgy (i.e. post exploration, mineral development). It would be worthwhile to review the situation and bring the funding for mineral search and exploration under S&T.

d) Possible creation of one time exploration fund for promoting mineral exploration by the concerned Ministry / Department. / Or
Production linked contribution by the mining & mineral-based industry where the exploration has been carried out by Central/State agency.

3.1.19 Based on the broad assessment and considering the priorities define in the approach for the XIth Plan period for mineral exploration and related activities, the following allocations of funds is recommended:-

	(Rs. in Crores)
Geological Survey of India	2100
Mineral Exploration Corporation Ltd.	316
State Govt. agencies	400
Total	**2816**

3.2 MINERAL OUTPUT INDUSTIRES

3.2.1 COPPER

3.2.1.1 For High Volume and Multi-metal Extraction, exploration and development activities should be based on poly-metallic occurrences.

3.2.1.2 SX-EW (Solvent Extraction and Electro Winning) Technology: Considering the nature of deposits, SX-EW should be adopted in place of conventional froth floatation.

3.2.1.3 The cost of production by SX-EW process works out to as low as 60% of that through Conventional Pyro-metallurgical route. This process also obviates environmental problems associated with sulphur capture and dust emissions which is common in smelters.

3.2.1.4 GSI, MECL and PSU's like Hindustan Copper Limited should also undertake exploration either independently or as a joint venture with overseas organizations.

3.2.1.5 In order to update technology and develop new technologies, strengthening of R&D department/organization with adequate budgetary support is necessary.

3.2.1.6 In the present high copper prices scenario, HCL may explore the possibilities of reopening the closed mines.

3.2.2 ZINC AND LEAD

3.2.2.1 For significant growth of Indian zinc-lead industry some of the key points requiring specific attention are as under:

- Market Development and development of newer applications
- Infrastructure development
- Focus on safe & eco-friendly recycling
- Creating capacities with focus on global cost competitiveness and value addition
- Focused R&D efforts for recovery of minor/trace metals and development of cost effective new applications
- Growth strategy for identification and development of resources of other metals like nickel, tin, tungsten etc.

3.2.2.2 Single window clearance for grant of permission from RP/PL/ML enabling environment and specific infrastructure like power, water, roads etc should be provided.

3.2.2.3 Facilities like Geo-scientific data availability, rationalization of tenements system/grant of larger areas under RP/PL/ML, license security, preferential rights to reserve areas should be improvised..

3.2.2.4 Relaxation of environmental site clearance for PL – not involving any damage to flora and fauna should be allowed.

3.2.2.5 Royalty rates should be in line with international competitor countries. Part of the royalty to be allocated towards infrastructure/ community development and also for funding fresh exploration.

3.2.3 ALUMINIUM

3.2.3.1 With the abundance of metallurgical grade resources, there is a scope for increasing mining of bauxite of this grade. The refractory and chemical grade bauxite can be preserved for future use. There is adequate scope for increasing production of alumina and its export.

3.2.3.2 Growth is expected to be higher in consumption of downstream products and semis, particularly for sheets, extrusions and castings. To meet this growth, primary producers and potential downstream producers together with new players have to consolidate, strengthen and expand their manufacturing process. R&D efforts for cost reduction and better quality are to be introduced for remaining competitive in both domestic as well as international market.

3.2.3.3 The recycling process need to be increased to meet the growing demand. This area is to be addressed for increasing production at low cost, energy saving, and ensuring availability for domestic consumption.

3.2.3.4 Greenfield smelters of about 400,000 tpa capacity to be planned now for the future.

3.2.3.5 Import of scrap to be increased with low duty, which in turn can be exported as value added item.

3.2.3.6 Smelters can be established to produce metal at low cost in the foreign countries where power is cheap.

3.2.3.7 Tolling of low alumina and getting back metal after smelting abroad where power is cheaper, can also be planned.

I. To make primary metal available for domestic consumption at a competitive cost, excise duty for domestic aluminium and custom duty for imported aluminium could be reduced to make it at par and matching with international price so that the option can be used when metal is not available for some reason.

II. Capacity development would be required for foils, extrusions and rolled products besides reorganizing castings.

III. The duty can be further reduced for extrusions used in building and structural areas to reduce consumption of wood from environmental considerations. Similarly, the tubes used for irrigation should get preference.

IV. Attention has to be given for development of semi-fab production by improving quality and reducing cost.

a) Small deposits with less than 50 million tonnes can be earmarked for brown-field expansions of existing refineries.
b) Large deposits to be planned for future greenfield projects for which capacity of mine should be minimum 3.0 million tones per annum.
d) The Gandhamardan Bauxite deposit of Orissa having reserves of more than 200 million tonnes still remains virgin after Balco withdrew. It can be planned for development.
e) In Gujarat and Chhattisgarh, where chemical and refractory grade bauxite are mined, inferior grade which can be used as metallurgical grade is considered as waste and is not utilized properly. Gujarat also has sufficient resources of Metallurgical grade for future use.

3.2.3.8 The constraints of red mud disposal would be the problem of future alumina plants. Means to utilize this waste has to be established through R&D efforts.

3.2.3.9 Strategic importance of gallium and vanadium make it imperative for development of indigenous technology and also collaboration with foreign countries for development of refining and production of these metals along with magnesium, titanium and silicon.

3.2.4 CEMENT AND LIMESTONE

3.2.4.1 There has not been substantial increase in total reserves of limestone during X^{th} plan period. The need to identify potential limestone deposits for greenfield projects, preferably away from the existing clusters is therefore paramount.

3.2.4.2 The availability of potential limestone deposits of hill states and northeastern states is restricted due to Forest Conservation Act. Efforts have to be made to release the deposits for exploitation on selective basis. This can achieve quantum jump in the industrial development of the north-eastern states.

3.2.4.3 Marginal grade limestone should be utilized. This will improve the life of mine and mine environment by drastically reducing the waste dumps presently lying in the existing quarries and occupying precious land.

3.2.4.4 In order to ensure rational utilization of reserves of various grades available in the mining lease area and to assess the shortfall, if any, for expansion of existing cement plants, periodic re-assessment of captive limestone reserves has to be made mandatory.

3.2.4.5 The Royalty rates of limestone need be rationalized following one standard norm.

3.2.5 DIAMOND AND PRECIOUS STONES

3.2.5.1 It is essential to continuously review the diamond import and export policy so as to continuously make available the roughs to the industry and to facilitate the export of finished products.

3.2.5.2 All out efforts need to be made to increase production of rough diamonds from India to partly meet the requirement of Indian diamond industry. Exploration activity in different states is required to be boosted for discovering new economically viable kimberlites / lamproites for conversion in to mines and leading increase of indigenous production. This needs introduction of superior technology for exploration.

3.2.6 GOLD AND PRECIOUS METALS

3.2.6.1 A huge gap exists between demand and indigenous production, which is likely to continue. For the purpose of bridging the gap thrust for gold exploration will continue in the country along with import.

3.2.6.2 The mining sector calls for improved method of narrow vein mining for their economic exploitation. Adoption of modern gold extraction technology is an immediate need to treat low grade and complex ore type.

3.2.6.3 MNCs have to be inducted for this purpose with application of state-of-the art technology.

3.2.6.4 Cluster mining of small gold deposits may also deserve consideration and should be encouraged by providing some form of incentive.

3.2.6.5 To augment gold production in the country during XIth plan period Chigargunta and Bisanattam mines in Kolar Gold Field [KGF], which were abandoned, deserve active consideration for reopening.

3.2.6.6 Introduction of new technology by HGML and detailed exploration in new areas shall be carried out by HGML.

3.2.7 DIMENSIONAL AND DECORATIVE STONES

3.2.7.1 Suitable handling facilities in port infrastructure should be provided at major ports like Chennai, Tuticorin, Cochin, Mangalore, Karwar, Kandla, Mumbai, Jawaharlal Nehru Port Trust [JNPT] near Mumbai, Vizag.

3.2.7.2 There is a strong need for well-planned, concerted and dedicated efforts towards export promotion of Indian stones in the International market. The emphasis needs to be on popularization of Indian stones in the traditional markets and exploring new markets.

3.2.7.3 As in the case of major minerals, there is a case for steady and stable uniform rates of royalty across the States.

3.2.7.4 Stone quarries should be provided a status of small-scale industry and all the facilities extended to other SMEs should be extended to stone quarrying units.

3.2.7.5 Setting up a National Stone Technological Upgradation and Development Fund for sustainable development of Indian dimensional stone sector by imposing access of 2% of the royalty payable by quarry owners for marble, granite, sandstone, slate, flaggy limestone/ dimensional limestone and quartzite.

3.2.7.6 To constitute a separate Export Promotion Council for dimensional stones considering immense potential for boosting exports.

3.2.8 INDUSTRIAL/NON-METALLIC MINERALS

3.2.8.1 The reserves of chemical and fertilizer grade rock phosphate in India are very limited. Therefore exhaustive exploration is necessary for conversion of remaining resources into reserves.

3.2.8.2 The resources of chrysotile variety of asbestos are very much limited in India. There is an urgent need to go for detailed exploration, as the internal demand for asbestos in the country cannot be met from indigenous production.

3.2.8.3 Intensive search is needed for locating deposits of massive non-crystalline dolomite.

3.2.8.4 India's resources of gypsum are large and sufficient to meet increased demand. The production of gypsum wallboard needs to be encouraged.

3.2.8.5 Keeping in view the demand in development of oil wells, concerted efforts are necessary to boost up the export of barytes and its micronized products from the country.

3.2.8.6 It would be necessary for Indian mica industry to manufacture and export fabricated and value-added mica-based products, such as mica paper, micanite sheets and mica-based paper.

3.2.9 HEAVY SAND MINERALS

3.2.9.1 With the deletion of ilmenite, rutile and leucoxene from the list of prescribed substances under the Atomic Energy Act, 1962, these minerals should be added in Part

C of the First Schedule of the Mines & Minerals (Development & Regulation) Act, 1957 (MM(DR) Act) and they should be placed at par with other schedule minerals.

3.2.9.2 The process technology should be upgraded to international standards.

3.2.9.3 Procedural requirement to obtain license from Directorate General of Foreign Trade [DGFT] for export of ilmenite needs reconsideration.

3.3 FISCAL MEASURES

3.3.1 Suggestions on Rationalization of Taxes & Tariff Structure of Mineral Sector in India

3.3.1.1 Need & necessity of Government intervention through taxation - Taxation is a form of government intervention, which is required for optimal exploration, mechanization of mining operations, maintaining environmental standards and maximizing mineral rents.

3.3.1.2 The Department of Revenue, Ministry of Finance through its representative in Sub Group III has conveyed the following stand that the, "Fiscal measures have to be considered in the context of budget based on overall revenue and expenditure needs and based on national priorities as determined by the Government. Thus the duty structure and concessions for a particular industry should not be made part of policy making by the individual Ministries and should ideally be left to Ministry of Finance which is entrusted with the responsibility of making budget for the Government."

3.3.1.3 In the light of above observation of the Department of Revenue of the Ministry of Finance, no specific suggestions or recommendations on duty structure and concessions as applied to mining sector in India are proposed.

3.3.1.4 Internationally the ad-valorem royalty system is more commonly used. In India there is unanimity among the States that royalty rates should be shifted from tonnage to ad-valorem. Therefore, it is recommended that royalty rates in India should be shifted from tonnage to ad-valorem basis.

3.3.1.5 The following recommendations of the multi disciplinary committee on taxation constituted by the Ministry of Mines and submitted to the Ministry of Finance, (July 2000) deserve consideration: -

(a) **Rate of annual depreciation for mining plant and equipment** should be increased to 100% in order to encourage investment in mining sector as per practice existing in a large number of mineral rich countries and notably in African countries.

(b) **All expenditure incurred prior to commercial production** including the expenditure incurred on site and deposit acquisition should be eligible for amortization over the minimum mining lease period of 20 years or a lesser period at the option of the lessee.

(c) For **reclamation of mined out area**, the mining companies may be allowed to earmark a percentage of book profits each year to met rehabilitation cost in future and set it aside as a special reserve in their books.

(d) **Import-duties on mining equipments may be reduced** - For equipments used for gold and diamond mining operations no duty should be applicable while for other mining operations the duty should be at par with imports for coal mining equipments.

(e) **Nil levy of excise duty for concentrate produced in the leaseholds and low excise duty structure for concentrates produced outside leaseholds** may be devised. This is as per recommendation of Mineral Development Council (MDC), which has suggested that the concentrates produced within lease area may be exempted from levy of excise duty in the same manner as ores and minerals.

3.3.1.6 It will be useful and worthwhile to workout the total cost of mineral production in India as a percentage of total variance of revenue. It is therefore suggested that such a study may be carried out at the earliest and the data may be provided to the mineral planners.

3.3.2 Suggestions on Infrastructure Development in Indian Mineral Sector

3.3.2.1 In order to undertake the task of building the infrastructure in mining areas, it is recommended that Mineral Development Fund (MDF) should be set up in each State having stake in major mining activity by earmarking 15% of the annual royalty collections for the fund.

3.3.2.2 It would be necessary to enlarge the mandate of the mineral development corporations and State Industrial Development and Investment Corporations to include planning, promotion and financing of mining infrastructure.

3.3.2.3 Since, Government has decided to go in for privatization of infrastructure, it is recommended that financing of new ports – rail – roads infrastructure should be considered under Ministry of Commerce scheme for balancing of critical infrastructure, which envisages 50% contribution by the Central Government.

3.3.2.4 The railway projects, the national highways and the port projects within the existing schemes of the Government of India can be taken up as Public Private Partnership (PPP) projects.

3.3.2.5 The capital cost of water and power projects (to access the main grid) for the small & medium enterprises [SME] sector may have to be borne by the State Government through outright grants from the Mineral Development Fund. A conscious decision could be taken by the State Government to make electricity available to the mine sites, especially for small and medium size mines.

3.3.2.6 Development of high quality roads connecting priority sector mines to loading stations is urgently required and State Governments should earmark revenue from their royalty earnings for such infrastructure development in mining sector.

3.3.2.7 Power supply grid system in the country needs to be strengthened particularly in the mining belts of India.

3.3.2.8 New railway lines in the eastern sector as well as in Karnataka connecting mining areas to ports will have to be undertaken to support exports and for reducing cost structure of various steel plants.

3.3.2.9 Development of dedicated freight corridors for transport of iron ore by railways from the mine-heads to various ports needs to be promoted along with private promoters.

3.3.2.10 Ports should invest in additional tipplers to augment their receiving capacities.

3.3.2.11 Additional stockyard capacity at ports needs to be installed.

3.3.3 Sector Specific Recommendations

3.3.3.1 Iron Ore

3.3.3.1.1 The total traffic projection for the steel sector by 2019-20 includes 230 million tonnes by railways and 100 million tonnes by road.

3.3.3.1.2 The Indian steel plants and Iron Ore mines therefore need to be integrated with the ongoing programmes of National Highway development and also with the proposed rural road development schemes.

3.3.3.2 Bellary-Hospet Sector

3.3.3.2.1 Bellary-Hospet Sector, the existing iron ore production of about 35 million tonnes is expected to go up to more than 45 million tonnes by 2011-2012. In order to meet the infrastructure requirements for the increase in production / demand in iron ore both for domestic and export market, following infrastructure would be needed.

3.3.3.2.2 Railways - It is necessary to strengthen and improve railway carrying capacities to all these ports. This can be achieved by the increase in rake capacity, electrification of all the routes, doubling of tracks, wherever necessary and ensuring availability of wagons. In addition, it would be desirable to provide suitable rail linkages to some of these large mines.

3.3.3.2.3 Ports - A decision has already been taken to close down Chennai port for export of iron ore due to environmental reasons. It is therefore, necessary to develop alternative port /ports to handle the current exports from Chennai as well as to meet future export demands.

3.3.3.2.4 As part of hinterland of Bellary-Hospet Sector, a private sector port at Krishnapatnam in Andhra Pradesh is being developed. Iron ore loading facilities in this port should be suitably designed to handle part of the cargo, which is expected to move from Bellary-Hospet area through this port.

3.3.3.2.5 In case of new Mangalore port, conversion of metre gauge railway line would also be required.

3.3.3.2.6 It would also be worthwhile to make expeditious efforts to develop an all – weather port at Tadri or Belekeri with a draft of 18 meters as a long-term solution.

3.3.3.2.7 The above project is critically dependent on the construction of railway line between Hubbli and Ankola – a distance of 172 kms. The construction of this railway line will reduce the lead from Bellary-Hospet by 200 kms. These railway lines and the port projects deserve to be taken up on fast track.

3.3.3.3 Bailadila-Vaizag Sector

3.3.3.3.1 Construction of a new railway line to link Bailadila Sector (Jagdalpur) to Raipur needs to be taken up on priority.

3.3.3.3.2 Railway - To ensure and sustain the movement of increased tonnage by railway, it is necessary to strengthen the existing railway facilities.

3.3.3.3.3 The load carrying capacity of this means of ore transport needs to be enhanced keeping in view the movement of bauxite envisaged from Andhra Pradesh quarries.

3.3.3.3.4 Port - In order to remain competitive in global market, the size of ships and loading rates should be reviewed and suitably regulated to match India's competitive edge in Iron ore trade.

3.3.3.4 Orissa / Jharkhand – Haldia / Paradip Sector

3.3.3.4.1 About 30% of India's Iron ore resources are located in the states of Orissa and Jharkhand. The prospects of growth of iron ore mining in this region is expected to be high in view of several new steel plants of Posco, TATA and Mittal Steel being proposed.

3.3.3.4.2 Railway - The expeditious construction of Daitari – Banspani railway line will reduce distance between iron ore mines to the port by 313 km.

3.3.3.4.3 It is, therefore, recommended that Ministry of Railways should develop product- specific railway freight corridors jointly with rail users – MNCs / private companies / or / PSUs.

3.3.3.4.4 Road - Some of the road routes critical to Indian mining sector in this region are:

- Rajamunda-Barbil (NH215) - 60 kms
- Barbil-Panikhole (NH215) - 189 kms
- Chandikhole – Paradip (NH5A) - 77 kms
- Jamshedpur – Haldia (NH) 33, NH6, NH41) - 200 kms
- Jaint garh – Chaibasa – Haldia(NH 75E) - 100 kms

3.3.3.4.5 Port -Two major ports that handled, the iron ore exports from this sector are Haldia and Paradip. During 2004-05 the quantity exported was about 5 million tonnes and 9 million tonnes from Haldia and Paradip respectively. At present Haldia can handle a ship of about 35,000 DWT while Paradip can load a vessel of about 70,000 DWT due to draft limitations.

3.3.3.4.6 In view of the increase in demand of iron ore loading in Haldia and Paradip ports, immediate action is required for deepening of approach channel and turning basin and construction of iron ore berth to receive bigger ships.

3.3.3.4.7 Several new port projects namely Dhamra and Posco's captive port projects should be implemented expeditiously to handle additional iron ore from the region in order to reduce freight costs from India to iron ore importing countries.

3.3.3.4.8 Proposal for development of a dedicated port in Orissa by Jharkhand Government should be given priority in order to support mineral based exports from Jharkhand.

3.3.3.4.9 Posco's own port proposed at Jatadhari near Paradip should be developed expeditiously.

3.3.3.5 Goa Sector

3.3.3.5.1 Total iron ore production in 2004-05 from this region was 22 million tonnes. In addition to local production, about 2.5 – 3 million tonnes of iron ore is moved from Karnataka region through Mormugao port. In 2004-05, total quantity of iron ore handled at Mormugao was 24.72 million tonnes.

3.3.3.5.2 Railway - The railway capacity from Bellary-Hospet to Goa should be suitably increased to meet the growing movement of iron ore.

3.3.3.5.3 Port - The main infrastructure at Mormugao port is barges, mechanical ore loading facility and transhippers, which should be maintained, replaced and suitably enhanced to take care of growing export demand.

3.3.3.6 Dimensional & Decorative Stones

3.3.3.6.1 Handling facilities at major ports viz. Chennai, Tuticorin, Cochin, Mangalore, Kaswa, Kandla, Mumbai, JNPT and Vizag need to be improved for the export of dimensional stones.

3.3.3.6.2 Adequate railway transport network including container facilities and railway sidings should be extended at prominent centers producing stones.

3.3.3.7 Bauxite & Alumina

3.3.3.7.1 The Greenfield alumina plants and bauxite mining would require strengthening of infrastructure development of road and rail network in prospective areas.

3.3.3.8 Limestone and other industrial minerals

3.3.3.8.1 Bulk handling of limestone and rock phosphate both for domestic consumption, exports and imports is made by rail and road network. Road network is a serious bottleneck in northeastern states where limestone is exported through road network to neighboring countries. Therefore, efforts should be made to strengthen the existing road and rail network connecting mines to the consuming centres.

3.3.4 Suggestions on Measures to harmonize Mineral Development with Environment & Forests, Tribal Policy & Law

3.3.4.1 Measures

3.3.4.1.1 A high level expert committee comprising experts from Ministry of Mines and Ministry of Environment and Forest may be constituted to work as a nodal agency to examine and approve such mining project.

3.3.4.1.2 A copy of lease application should be sent simultaneously to all the scrutinizing agencies to work on parallel fronts.

3.3.4.1.3 Environmental clearance should not be required for prospecting license as the level of indulgence in the forest and waste generation is minimal in such cases.

3.3.4.1.4 One time in principle approval should be accorded for transfer and dereservation of entire forest land involved and deforestation should be approved in phases depending upon the requirement of the user agency.

3.3.4.1.5 Mineral rich states should create land bank of non-forest areas to be mutated in favour of forest department for compensatory afforestation and onus of non-forest land available, its mutation and transfer in the name of forest department should lie with the revenue department of the concerned state. The lessee should be responsible for depositing the required fees only.

3.3.4.1.6 It is preferable to demarcate mineral bearing areas as ‘Mining Land’ in all the revenue records as it is being done for the ‘Forest Land’.

3.3.4.1.7 It is suggested to modernize the present system and make provision for on-line application for mineral concessions.

3.3.5 Suggestions on Assessment of Net Present Value (NPV)

3.3.5.1 The basic concept behind charging NPV is that forest areas give intangible benefits in shape of release of oxygen, soil and water conservation resulting into lesser floods and consequently lesser national loss in river plains. Hon'ble Court may be approached to reconsider it for a very small forest area and especially for those areas which are though recorded as forest, but are devoid of forest cover. For such areas only the provision of compensatory afforestation should be there.

3.3.5.2 While the final decision on the liability of mining lessees for use of forest land would be taken by the Hon'ble Supreme Court, the Committee would like to make two recommendations that would lighten the burden on the lessees.

3.3.5.3 The NPV should be payable in installments proportionate to the land broken in accordance with the pre-submitted mining plan to reduce one time burden on the lessee.

3.3.5.4 The lessee should not be asked to pay NPV each time a lease is renewed as the intangible benefits have already been accounted for in previously paid NPV. Thus duplication of payment of NPV should be avoided.

3.3.5.5 Once the Hon'ble Court has passed orders in this regard all "forest" land must be notified in the Official Gazette so that there is no scope for subjectivity in interpretation. It is also recommended that clear and transparent guidelines may be formulated and circulated among entrepreneurs so that their confidence level is increased.

3.3.5.6 CAMPA should be accountable for the funds and its financial control. CAMPA should have representatives from the industry of concerned state.

3.3.5.7 As there is a symbiotic relationship between tribal people and forests, their employment and rehabilitation should be on priority basis.

3.3.6 Status of Rehabilitation and Reclamation of abandoned mines.

3.3.6.1 Indian Bureau of Mines (IBM) has identified 297 abandoned/orphaned mines in the country. It has put up a project proposal for reclamation/rehabilitation of 106 abandoned mine sites out of the total 297 sites. Of these 36 sites belong to Public Sector Undertakings, 25 to major private companies and 45 sites to other small private companies. Of these 106 sites, 87 are open cast mines and 19 are underground sites varying in area from 281.6 hectare to less than 1 hectare. Out of these 16 may be reopened.

3.3.6.2 The impact at these sites include unused pits and shafts, altered landscape, unusable land due to loss of soil, low pit, tailings/waste dumps, ground water depletion and soil contamination.

3.3.7 Suggestions on Rehabilitation & Reclamation of abandoned mines

3.3.7.1 To overcome the soil degradation issue, it should be mandatory for all open cast mines to store and stock the top soil at a separate place and it should be replaced as soon as the mined area is back filled with.

3.3.8 Suggestions on Socio Economic Impact of Mining on Local Life and Improving their Living Standard

3.3.8.1 To the extent feasible and possible the local value addition to mineral produce (through setting up of mineral based industries and ancillary industries) must be promoted for the benefit of local population.

3.3.8.2 The local human resource should get custom tailored training for utilizing their talents in mining project.

3.3.8.3 The areas presently under mining or to be brought under mining are generally forest areas and people dwelling in and around these areas depend much on these forests for their livelihood. Therefore, a mining proposal in these areas attracts much resistance against these proposals. Such a resistance should be won over through effective publicity campaigns highlighting benefits of the project accruing to them.

3.3.8.4 Socio-economic Impact Assessment (SIA) should compulsorily be done and approved by the same authority approving the proposal at the Central Level and it should be done by some reputed agency.

3.3.8.5 Rehabilitation of mined areas should not only concentrate on afforestation, but viability of development of fisheries, eco-tourism, water sports, etc. should also be explored for economic upliftment of the local people.

3.4 HUMAN RESOURCE DEVELOPMENT

3.4.1 Human Resource Development in the area of mineral exploration technology for locating deep-seated and concealed ore deposits is of vital importance for economic development. Hence, it would be necessary to reorient geoscience curricula and making training interdisciplinary in nature. For this purpose, there is need to set up Centres of Excellence for advance studies in the field of exploration.

3.4.2 There is also need to introduce continuing education / training programme / degree / diploma course for geologists in the field of mineral exploration under the training setup presently under GSI.

3.4.3 Considering need to have trained manpower in the field of exploration, geology, geophysics, drilling, mining, mineral processing and metallurgy, the present infrastructure GSI training institute at Hyderabad should be reorganized and strengthened in order to diversify its infrastructure for training in multidisciplinary fields, and upgradation of the present training infrastructure to an international standard. Therefore, a fully residential world-class infrastructure needs to be created for education and training in the entire field of geosciences, mining, mineral processing and metallurgy. The institute should be linked to UGC and AICTE system for providing degree / diploma.

3.4.4 As a result of increasing mining activity, the shallower mineral deposits are getting exhausted. This is causing the shift of mining activity to deeper horizons of the earth. In order to address issues relating to technology for deep mining, an Advanced centre for studies in underground Mining need to be established at Indian School of Mines during XI Plan. The centre may undertake in R&D in various aspects of deep mining, which will serve as input for the development of future human resources for mineral industry:

3.4.5 The following measures are being suggested to strengthen HR creation and continuous education programmes in academic institutions.

- To create an awareness among educational institutes that mineral sector has ample scope to give employment to graduates; to improve chances of ultimate employment for students by giving financial support while they study and access to good projects related to mineral exploration; to identify good centres of education to conduct short- term courses and summer training to interested students in mineral exploration. GSI can take up a special summer programme every year for students enrolled in geosciences courses. Government funding for these programmes should be liberally available as this is the fountain of HR for future.

- To introduce special orientation courses to existing faculty members of colleges and universities on mineral exploration. It is important to bring in courses for already employed personnel in the mining and mineral processing industry who do not have mining engineering or exploration sciences background. Govt. of India should fund this continuing education, as this is the key to upgrading the skills of both educators as well as existing mining industry personnel.

- To modernize & update curricula and degree programmes by geo-science department in order to make courses more relevant to the growing need of industry especially relating to computer science education requirement of service companies. Similarly, some business education should be included in geo-science curricula. Also to meet the needs of the global economy, department should expand international exchanges to provide students with international experience and exposure.

3.4.6 There is a strong need for increased University-Industry Interaction. Increased University – industry interaction is more difficult to be achieved in practice, though there has been some success in the recent past in ISM and the IITs.

3.4.7 To create adjunct faculty positions for industry personnel and concurrently sabbatical chairs for academicians in industry; this can be made part of the National Mineral Fellowship Award programmes; This interface is crucial for setting up R&D programmes in industry and the faculty members on sabbatical to industry are the best nucleus for starting in – house R&D schemes in industry.

3.4.8 Development of softer skills – leadership qualities, which has now become a need of the hour, in which mineral industry has always been lagging behind other sectors; a management and leadership initiative programme has to be specifically designed for the mineral sector.

3.4.9 Creation of centres of excellence is to be first initiated which will require human resource at the level of leadership in R & D in specialized fields and at the same time, knowledge workers in the respective knowledge domains. The thrust areas are chosen such that knowledge integration takes place and the centres of excellence have to perform the role of both specialized knowledge creation as well as knowledge integration to solve practical problems.

3.4.10 Thrust areas identified are to be treated like national mission projects such as the space or nuclear programme. For each of the four major areas, namely exploration, mining, mineral processing and metals and products development, a nucleus is already available with R&D organizations under Ministry of Mines (NIRM, JNARDDC, NIMH), GSI, IBM, ISM, NFTDC, ITBHU, etc. For each area, R & D thrust areas have also been identified. It is now required to put together multiple projects under each mission within the centre of excellence concept and concurrently develop the human resource. Mission mode projects would create leadership level HR as well as large number of knowledge workers.

3.4.11 In order to attract talent and train them in the knowledge domains required, it is appropriate that a National Mineral Fellowship Scheme be introduced by Government of

India. This fellowship programme can be administered by proposed NCGMRT under the Ministry of Mines through its seven centers. These centers would be –

3.4.12 The national mineral fellowship should be on the lines of Humboldt fellowship in Germany or Brain Pool in South Korea. The fellowship value should be enough (i.e. at least Rs 2.5 lakhs per annum or Rs. 10 lakhs for four years) and the cost of fellowship for 500 awardees spread over in 5 years will be Rs 50 crores). At least 100 awardees be given this fellowship to kick start the programme. Therefore, in order to ensure sustainable human resource development during the XI^{th} Five Year Plan, it is recommended an amount of Rs. 50 crores be approved under the scheme.

3.4.13 To ensure front line scientific research in earth sciences, a continuous series of training programmes by way of workshops, summer schools, advanced short courses in selected topics, are required to be encouraged. Contact programmes need to be initiated particularly in institutions where infrastructural and instrumental facilities are available. Interdisciplinary teams must be motivated to prepare instructional materials for dissemination. Refresher courses in modern trends in earth sciences with basics in physics, chemistry, mathematics and computer applications, mostly of remedial nature, should be formulated and distributed to various institutions / universities largely through video-lectures and correspondence materials.

3.4.14 North East Region Fund for capacity building of HR and strengthening of R&D should be established exclusively for the north east region and for this purpose an amount of Rs. 50 crores be earmarked for the XI^{th} Five Year Plan.

4.0 REQUIREMENT OF FUNDS

4.1 To sustain the 9% growth in GDP as envisaged in the approach paper, the investment required for the growth and development of the mineral sector during the XIth Plan would be of the order of Rs.19100.00 crore as per the details given below –

	Rs. [in crore]
1. Survey and Exploration [GSI, MECL & State DMGs]	2816.00
2. Modernisation Programme [GSI, MECL & State DMGs]	822.00
3. S&T Programmes [of Ministry of Mines]	110.00
4. R&D, HRD and NER	750.00
5. Development and Infrastructure [Rail, Road, Ports]	14600.00
TOTAL	**19098.00**
SAY	**19100.00**

PREFACE

Working Group on Mineral Exploration and Development (other than coal and lignite) was constituted under the chairmanship of Secretary (Mines), Govt. of India to formulate XI[th] Five Year Plan document vide Planning Commission O.M. No. I&M-3(24)2006 dated 6.3.2006. The terms of reference of the working group is at **Annexure-I.** The working group in its first meeting held on 20.4.2006 constituted following four sub-groups with defined terms of reference:

1. Sub-Group I : Mineral Exploration & Development
   Chairman: Sh. P.M. Tejale, DG, GSI
   Member Secretary: Dr. S.K. Haldar, Director (Tech), MECL

2. Sub-Group II : Mineral Output Industries
   Chairperson: Ms. Ajita Bajpai Pande, Joint Secretary, MoM
   Member Secretary: Shri R.K. Sharma, Secretary General, FIMI

3. Sub-Group III: Fiscal Measures, Infrastructure Development and Environment
   Chairman: Dr. Pradeep Kumar, Addl. Secretary, MoM
   Member Secretary: A.K. Srivastava, Suptdg.Mining Geologist, IBM

4. Sub-Group IV : Research & Development and Human Resource Development
   Chairman: Shri V.K. Thakral, Joint Secretary, MoM
   Member Secretary: Shri K.P. Lall, Advisor (TPPC)

In view of the importance of Human Resource Development and R&D in the field of Geology and Mining Sector, a new sub-group IV was constituted with terms of reference at **Annexure-II.**

All the sub-groups held several meetings and deliberated on their respective terms of reference. The sub-groups co-opted several members and their input helped immensely in finalising the report of the Working Group.

Ministry of Mines, Govt. of India has been encouraging greater investment in exploration and exploitation of minerals. After the formulation of the National Mineral Policy in 1993, the Government had taken a series of new policy initiatives for the growth in the mineral sector, with a view to accelerating investment in the mining sector. Further, the mineral policy stressed that the Central Government, in consultation with the State Governments, shall continue to formulate legal measures for the regulation of mines and the development of mineral resources to ensure basic uniformity in mineral administration so that the development of mineral resources keep pace, and is in consonance with the national policy goals. A major initiative has been in simplifying procedures to introduce transparency and reduce delay in granting different types of mineral concessions.

Recognizing this need and to further improve the investment climate for mining in the country, the Planning Commission has constituted a High Level Committee under the chairmanship of Shri Anwarul Hoda, Member, Planning Commission, to review the National Mineral Policy and recommend possible amendments to the MMDR Act. The terms of reference of the Hoda Committee include review of the National Mineral Policy 1993 and MMDR Act 1957 and suggest the change need for encouraging investment in public and private sector in exploration and exploitation of minerals and existing Government procedures for grant of mineral concessions in order to streamline and simplify procedures to review the procedures for according clearance to mineral exploration and mining projects under Forest [Conservation] and Environment [Protection] Act 1986 and suggest ways for speeding them up, prioritize the critical infrastructure needs of the Indian mining sector and ways to facilitate investment to meet these needs, identify ways of augmenting state revenues and other issues relating to value addition and restriction on export of iron-ore and policy on beach-sand minerals.

Taking into consideration the overall national perspective in conjunction with short term and long term demand projections, the exploration programmes are to be planned. With the near exhaustion of target areas delineated on the basis of ancient workings, surface indications etc, there is a need to locate concealed/hidden deposits through conceptual models and advanced 'state-of-the art' technologies for exploration.

The liberalization of policy and entry of MNCs and big domestic companies in mining sector has brought changes in investment scenario and use of advanced technology in mining sector. Though MNCs have shown interest so far in high value (diamond and gold) and value based minerals only, however, the national interest is in the development of mining industry as a whole. The low volume and high value scarce resource bases need special attention.

The recommendations contained in the report need consideration so that the development and growth of the mineral sector as a whole progress as per the envisaged growth rate during XIth Plan.

I would like to express my sincere thanks to the members of the working groups, Chairman and Convenors of the sub-groups, committees and co-opted members from State and Central Govt. organizations, PSUs and industry for their cooperation and valuable suggestions in finalization of this report.

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Ministry of Mines
&
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Working Group on Mineral Exploration &Development

(A.K.D. Jadhav)
Secretary
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Working Group on Mineral Exploration & Development

REPORT OF

THE WORKING GROUP ON

MINERAL EXPLORATION AND DEVELOPMENT

(other than Coal and Lignite)

FOR

THE ELEVENTH FIVE YEAR PLAN

SURVEY AND EXPLORATION

VOL - II

GOVERNMENT OF INDIA

PLANNING COMMISSION

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CHAPTER-I

STATUS/REVIEW OF SURVEY AND MINERAL EXPLORATION ACTIVITIES IN THE COUNTRY

1.1.0 INTRODUCTION

1.1.1 Mineral assets of any country play a direct role in the growth and prosperity of a country and its people. It is therefore, unavoidable that substantial investments are made for exploration of these assets through different agencies having the skills to do the job. Consumption of minerals and their required production has been consistently high in developed countries. Statistics demonstrates that 20% of world population residing in Europe, North America, Japan and other developed countries consume bulk of the mineral resources. Analysis of current data, however, establishes that the demand in these countries has reached a saturation level. Current trends indicate that demand of the remaining 80% of the global population would increase manifold from the current low levels in the coming years, which may lead to a crisis more serious than the 1970 oil-crisis. This being the background, developing countries including India continue prioritizing the vital activity of updating the National Geoscientific Information and knowledge base for the purpose of identifying new geological domains potential for housing additional mineral resources. It is also needed to intensify activities of mineral search using modern techniques and equipments to prepare assets required for augmented mineral production keeping in view the future needs of the country.

1.1.2 India having 2.4% of the global area, sustains 16% of the world population. Our per capita consumption of minerals and its products is one of the lowest in the world. In the pre-independence period the major activity was restricted to coal. In addition, the country's mineral exploration strategy was limited to the selected major minerals, that too, confined to better grade and large ore deposits occurring at or near the surface of the earth's crust. In the post independence era, the demand for growth has driven the demand for mineral resources leading to significant expansion and diversification of mineral exploration. New discoveries though made were not enough to fully satisfy the demand. It is understood that India does not have the necessary economic power to survive solely on import of a host of strategic mineral resources. Therefore, it is essential that the country continues to strengthen the resource base through vigorous exploration activities by Public/Private Sector agencies.

1.1.3 It is a fact that the mineral production in India in the post independence period has grown in quantity as well as in value. The Table-1.1 on growth of mineral production figures indicate the factual position. The growth rate in the energy sector is eight to ten fold and there is steady growth even in metallic sector, except in gold where there is reverse trend. Since independence, the value of mineral production increased from a level of Rs. 58 crores in 1947 to Rs.47130 **crores in 2004-05** (excluding crude petroleum & natural gas) amounting to a growth of 800 times in about 58 years. Though a significant part of the increase is a reflection of the increase in price of commodities, a substantial growth in production has also happened, driven by demands arising out of population growth and development of the economy. This upward trend in mineral production could not have been achieved without matching discoveries of mineral deposits by the different exploration agencies.

1.1.4 Different minerals are usually hosted in different geological set ups, created by variable geological processes. It is, therefore, easy to appreciate that even a country with extremely diverse geological set ups cannot be endowed with all minerals required for the development of the country. It is also true that it requires intense exploration efforts to identify the diverse geological set ups and the possible minerals likely to be hosted in them. India lacks adequate resource base in respect of a number of minerals, for which the country has to depend largely on imports. Therefore, the need for pursuing exploration efforts with modern concepts and tools for possible breakthrough, mainly in locating concealed/deep seated mineral deposits and deficient and non-existent commodities remains priority for any plan. It is also necessary to divert due attention to low grade ores in order to convert yester-year's waste into tomorrow's ore with the help of technological innovations.

1.1.5 The National Mineral Policy announced in 1993 and the amendment of the Mines and Minerals Regulation & Development Act, 1957, in 1994, are radical steps taken in the wake of economic and industrial reforms. Such policies/regulations were followed by (i) guidelines for Prospecting Licences (PL) for large areas in 1969; (ii) amendment of MMRD Act w.e.f. 20.12.99 (with prominence to 'development' over 'regulation') (iii) amendment of MCR, 1960 w.e.f. 05.05.2005, (iv) amendment of MCDR, 1988 w.e.f. 18.1.2000. In order to give further boost to private investment in the mineral sector, Planning Commission has set up a High Level Committee to review the National Mineral Policy and recommend possible amendments to Mines & Minerals Development & Regulation (MMDR) Act, 1957. The committee has submitted the report for consideration of the Government. It is hoped that these changes in economic policies and regulations will create a conducive and compatible environment to attract capital investment and technology transfer by the private sector including foreign companies, both in high risk field of mineral exploration and in the mining and metallurgical industries, considering India's high geological potential for new mineral discoveries.

1.2.0 GEOLOGICAL DATABASE TOWARDS MINERAL PROGNOSTICATION IN INDIA

1.2.1 India has a total land area of 3.28 million sq. km. of which 2.42 million sq km. comprises hard-rock terrain, while the rest is occupied by a thick alluvial cover.

In view of the geological possibilities, only 20-25% of the hard-rock area (approximately 571000 sq km) holds potential for solid fuel and non-fuel schedule mineral resources. Besides the country has potential for minor minerals over large area. At present about 8000 sq. km. is under mineral lease, which forms about 50% of the total area of the known mineral prospects and deposits. Out of the leased area only a small part is under active exploitation and large areas under lease are still awaiting exploration. Thus, there is still a large area left for exploration covering the known mineralized areas and bulk of unknown areas having favourable geological condition for the localization of mineral prospects. However, considerable areas have been given for regional reconnaissance under RP mainly to private agencies, in some states, but these also pertain to traditionally known potential domains.

Indian Landmass – Geographical vis-à-vis Geological Setting:

The Geographical units from south to north in Indian landmass are:

- ❖ Peninsular India: Precambrian (Archaean – Proterozoic) shield area, restrictively overlain by the Gondwana, Deccan Trap and Tertiary to Recent Sedimentary Formations.
- ❖ Indo– Gangetic alluvial tract: Neogene-Quaternary sediments lying between the Peninsular areas and the Himalayas.
- ❖ Himalayan Region: Precambrian shield elements and a thick sequence of Phanerozoic rocks.
- ❖ Naga – Andaman fold belt: Tertiary fold belt which includes parts of Indo – Burma Range and Andaman – Nicobar island arc.

1.2.2 In India, all the major non-fuel mineral deposits are mainly confined to the Precambrian rocks, belonging mostly to the Archaean to Middle Proterozoic and rarely extending upto the late Proterozoic age. The spatial distribution of the ancient crustal segments is restricted in the cratonic areas, known as Dharwar-Aravalli craton, Singhbhum craton, Bastar craton and Bundelkhand craton etc. These cratonic areas are skirted by Proterozoic mobile belts, along which the cratons have coalesced to form a composite landmass of the Indian Peninsular shield area. The intra-cratonic basins were formed in the mid-Proterozoic as well as in late-Proterozoic age and the Proterozoic rocks have wide expanse, covering major part of Peninsular India and Lesser and Central Himalayan belts. The Deccan Trap, however, covers a large area (0.6 million sq. km.) of the Peninsular India. The metallogenic provinces in Precambrian terrain of Peninsular India are related to Archaean granite-greenstone belts, Proterozoic fold belts, including high grade granulite terrain, and thermally reactivated granite gneiss complexes and mid-to late-Proterozoic cover sediments.

1.2.3 The Phanerozoic rocks in India, except Deccan Traps, are mainly exposed in the Himalayas, as also in linear basin belts of Gondwana in Peninsular India and coastal areas. Most of the solid energy resources are located in the Gondwana and Tertiary basins. Potash, of low grade, is present in the evaporate basin of western India.

1.2.4 Holocene and Quaternary sediments and weathered profiles have concentrated a few metals (gold, tin) as placers. Laterite hosts enormous resources of bauxite, clays, nickel and titanium etc. A wide variety of heavy minerals of economic significance, including rare minerals, are found in beach sand and in near-shore conditions of east and west coasts of India.

1.2.5 The huge resources of dimension stones occur in the Archaeans to the Phanerozoics. The major part of the multi-coloured and black commercial granites, however, is restricted to the Precambrian terrain.

1.2.6 India has more than 7000 km. long coastline and the territorial waters cover more than 0.15 million sq.km. Seabed resources of these areas and the EEZ covering about 1.87 million sq.km. have also come to light in recent years. If legal continent shelf is taken in account total offshore area would become about 3.09 million sq km. This may also require exploration for resources.

1.2.7 A critical review of all these settings is definitely suggestive of India's exploration potential for natural resource endowments.

1.2.8 The Geological Survey of India has built up a national geoscience database in the form of 1:50,000/1:63,360 scale geological maps covering the entire country, using ground survey, aerial photographs and satellite imageries. The plan for preparation of geochemical and geophysical maps for the entire country has already taken off during the Xth Plan period. The database is continuously in the process of being updated as the new data are incorporated. For a faster coverage, procuring new set of equipments and helicopter is strengthening the continuing program of multi-sensor aerial survey. Plan for generation of such multi-parametric data sets is with the objective of having better insight into the potential of a geological target in terms of mineral resources by means of thorough analysis of the data with the help of advanced tools. Seabed survey and preliminary assessment of mineral resources are being carried out by GSI in the EEZ including territorial waters for the last three decades with its own Research Vessel and two Coastal Launches.

1.2.9 Creation of National Geoscience Information and knowledge base

- Coverage of 98.23% of the country (out of total mappable area of 3.146 million sq. km.) by geological mapping on 1:50,000/63,360 scale.
- Reconnoitary survey of 96% of Exclusive Economic Zone (2.02 million sq. km. in the surrounding ocean).
- Initiation of job of demarcating legal continental shelf.
- Airborne geophysical survey of above 2.18 million sq. km. of which 1.65 million sq. km. covered by magnetic surveys and about 0.53 million sq. km by multisensor surveys.
- Coverage of more than 1.08 lakh sq. km. in geologically critical areas of the country by large scale (1:25,000) thematic mapping.
- Geological mapping of more than 19000 sq. km. in Antarctica through participation in all the 24 scientific expeditions – GSI officers gave leadership in 8 teams.
- Path breaking research data in Petrology, Palaeontology, Geochronology, Geophysics and Geochemistry.

- Creation of large database/information necessary for infrastructure development, water resources, power projects, engineering projects, surface transport urban and rural development, environment assessment, coastal zone development, natural hazard evaluation, assessment mitigational measures.

1.3.0 AGENCIES INVOLVED IN EXPLORATION

1.3.1 The Central Government departments, various State Government departments, Central and State Undertakings etc. carry out investigations and search for minerals. With the opening up of mineral sector to private agencies, Multi National Companies (MNC's) have entered into survey and exploration since the IX plan.

1.3.2 The Ministry of Mines created after independence is responsible for survey and exploration of all minerals other than petroleum, natural gas and atomic minerals and for coordinating with different departments and agencies involved in exploration and development of minerals.

1.3.3 One of the Charter of functions and responsibilities of the **Geological Survey of India (GSI)** established in 1851 is mineral search and exploration, both on – and off – shore, as one of the specified tasks. This activity comprises multidisciplinary surface and sub-surface probes, through well defined stages (P-I, P-II, E-I and E-II) within the realm of Preliminary Exploration, as defined in the GSI Misc. Pub.58, 1981 and BIS booklet IS 12595, 1989. The accredited function of GSI in this field comprises search and prospecting for all minerals, except oil and gas and atomic minerals, leading to resource evaluation upto "Probable" category. Different stages of exploration by GSI are in conformity with the exploration in put for G4, G3, G2 (partly) stages of UNFC system. The resource estimation is also currently classified as indicated resource (332), inferred resource (333) and reconnaissance resource (334). It may be stressed that the mineral search and prospecting by GSI and other organizations derive substantial support and lead from the fundamental geo-scientific studies conducted by GSI through ground, airborne and marine surveys. Introspective analysis of the regional data-sets generated and continuously updated by GSI, in conjunction with remotely sensed information serve as basic clues for mineral prognosis.

1.3.4 Prior to the Xth plan period, the Government has introduced radical reforms in the economic and mineral policies. Currently, further liberalization is contemplated in the form of the New Mineral Policy under active consideration of the Government. This is anticipated to bring in further investments from Indian private sector and MNCs in the field of mineral exploration. It is also envisaged that GSI would continue to act as the principal national agency for generating basic as well as frontline advanced level data required and provide updated data on mineral information to prospective investors in order to facilitate investment decisions. These government agencies would also play the role of monitoring the work of the private exploration agencies. GSI has already published General Information Dossiers

(GID) and updating Detailed Information Dossier (DID) in respect of major minerals. In addition documents reviewing the status of exploration of different Schedule Minerals have been prepared and would supply the required data for prospective investors. It is foreseen that future role of GSI in mineral sector would reflect a judicious blend of national priorities towards planned development missions of the Government with quasi-commercial activities. It would collaborate with the commercial organizations in a time-bound, cost-effective and competitive manner to identify new targets, assess them properly to make them investment-worthy properties and augment the resource base of the country.

1.3.5 **The Indian Bureau of Mines (IBM)** established in 1948, is usually conducting regional mineral development studies, mining geological studies, and mineral reject studies. With the liberalization in mineral sector, changes were brought in their activities in order to get a comprehensive picture about the availability of resources in a mineralized belt, scope of augmenting production from the mineralized zones. The reoriented activities include project oriented conservation studies, studies on underground mines and mechanized mines and mineral utilization studies. To fulfill its charter of functions, **IBM** also undertakes regulatory inspection and study of mines and research on the beneficiation of low grade ores/minerals and on special mining problems and also publishes statistical information on mineral inventory, (both lease-hold and freehold areas), mineral production, export and import of minerals etc. **IBM** advises on all aspects of mineral industry, trade and legislation to the Government. **IBM** would act as a nodal agency to monitor the progress of work as well as details about the relinquishment of areas etc., by the RP/PL holders.

1.3.6 **The Mineral Exploration Corporation Ltd. (MECL)** was established in 1972 with the sole objective of reducing the gap between the discovery of the mineral prospect and its commercial exploitation. It carries out detailed mineral exploration as a follow up of the GSI's regional exploration. Its activities enhance the confidence level of resource estimation both in quantity and the quality to "Demonstrated" / "Proved" categories. In the present scenario MECL is not only carrying out the promotional and quasi-commercial exploration activities on behalf of the Government but is also competing with the domestic private players and with the MNCs in the mineral exploration.

MECL as a premier detailed mineral exploration agency of the Government has played a vital role in the development of mineral industry in India. MECL's efforts have proved vast deposits of bauxite on the East and West coast of the country which has resulted in coming up of giant domestic aluminium companies in those regions. The explorations of lignite in Rajasthan, Gujarat and Tamil Nadu have been very significant. The coal exploration by MECL for the Ministry of Coal both on promotional and contractual basis has added sizeable reserves in the country's mineral inventory.

Inspite of the valuable contribution of MECL in mineral exploration the company witnessed a downfall upto the IXth Plan. The concerted dedicated efforts of the company have helped it to overcome the pressures of disinvestment and liberalization policies of the Government. The company stood upto the expectations and faced the upcoming challenges in mineral exploration. The company has been able to register profits in the Xth Plan after incurring heavy losses upto the IXth Plan.

Encouraged by the turn around performance of MECL and the boom in the mineral sector internationally the Government of India has decided to strengthen MECL by approving the long pending financial restructuring package for MECL.

MECL has been adopting to the needs of exploration with the modern developments. In addition to the conventional drilling activities, MECL carries out geophysical and geochemical surveys and remote sensing studies. MECL has also stood up to the demands of drilling for CBM for a number of clients and is moving ahead in this field at a steady pace.

1.3.7 National Geophysical Research Institute (NGRI), since its inception in 1964, has been actively engaged in developing various geological, geophysical and geochemical technologies oriented for mineral exploration. In this direction, NGRI has introduced and implemented air-borne geophysical techniques and covered several mineralized belts. The data on the air-borne geophysical surveys of the mineralized belts has been fruitfully utilized by the other agencies involved in mineral exploration.

1.3.8 Since 1949 survey & exploration for atomic minerals is being done by Atomic Minerals Division (AMD) now renamed as Atomic Minerals Directorate for exploration and research. It is also building up resource position of rare metal and rare earth elements. The new mineral policy has spared the atomic minerals from its purview due to strategic and defense consideration as a result the atomic minerals continue to be under the control of the Government.

1.3.9 Besides the Central Govt. agencies mentioned above, almost all State Governments have Directorates of Mines & Geology (DMG). Generally the exploration efforts of DMG's are concentrated on surface shows. The concept oriented search for concealed deposits occupy low or no priority due to lack of infrastructural facilities. They monitor the mining activities in the State, co-ordinate with Central Government and advise the State Government in the matters related to the mineral industry. The role of the State DMGs has increased as a result of the decentralization of the power to award mining lease which has been transferred from the Central to the State Governments by the amendments of the legislations.

1.3.10 The exploration by State Governments is mainly confined to the freehold and the leasehold areas of the State Mineral Development Corporations. The exploration activity in the private leasehold areas is very negligible and the efforts are mainly directed towards development of immediate extensions of the working mines.

1.3.11 Jawaharlal Nehru Aluminium Research Development & Design Centre (JNARDDC) was established in the year 1987 with objective of providing and developing technical know how for the basic engineering processes involved in the production of alumina and aluminium based industry. It has also been providing technological support for setting up alumina refinery in the country since its inception.

1.3.12 The Public Sector Undertakings (PSU) such as HCL, NALCO, NMDC, MOIL, CIL, SCCL, SAIL, KIOCL, NLC, the joint venture companies of the Government such as HZL and BALCO and the private sector companies like TISCO, CHOWGULES'S, DEMPO'S, SESAGOA, SALGAOKAR, HINDALCO, ESSAR, JINDALS etc. are conducting exploration mostly in their leasehold areas towards planning and development of mines. These are only to enhance confidence level of reserves in their specific areas rather than to add to mineral inventory. Moreover, the exploratory data is generally confined to comparatively shallow depths and there is seldom, if any, attempt to probe the deep seated deposit in their operational area.

1.4.0 Thrust of Exploration and priorities accorded in Plan periods (1947-2005) till the Xth Plan

1.4.1 During **First Five Year Plan (1951-56),** Coal exploration was intensified with a modest beginning, systematic regional exploration by GSI gained momentum and fresh plan of production - linked exploration programmes were drawn up.

1.4.2 Thrust in power, steel and agriculture necessitated massive exploratory inputs for coal, limestone and iron ores, manganese and base metals in the **Second Five Year Plan (1956-61).** Base metal exploration always remained the highest priority since then, though priorities in other sectors changed.

1.4.3 During the beginning of the **Third Five Year Plan Period (1961-66)**, emphasis was given for bauxite exploration and substantial resources were established in Madhya Pradesh and Maharashtra. Discovery of bauxite in Amarkantak and Phutka Pahar area in Madhya Pradesh led to the setting up of Bharat Aluminium Corporation (BALCO). Discovery of phosphorite was a major breakthrough. For the first time in the world sedimentary phosphorite horizons were located in the Precambrian rocks of Udaipur District of Rajasthan. Large resources were established by GSI in Rajasthan, Mussoorie area of Uttar Pradesh and Jhabua area of Madhya Pradesh.

1.4.4 During the **Second and Third Five Year Plans**, the GSI set up ‘Coal Public Sector Unit’ (for supporting the public sector agency in their exploration efforts). Intense exploration activities in the early years of the Second Five Year Plan were initially concentrated in South Karanpura and Ramgarh Coalfields and these efforts led to the development of several new mines. The regional exploration by GSI also led to the discovery of vast multi-seam quarriable reserves of coal in the eastern part of the Singrauli Coalfield, which culminated in the development of large open cast mines.

1.4.5 The **Fourth Five Year Plan (1969-74)** witnessed significant discoveries of base metal belts. Major base metal deposits were located in Singhbhum, Khetri and Malanjkhand. In the Singhbhum belt, new copper deposits came to light in Turamdih, Ramchandra Pahar, Nandup and Dhadkidih. Discovery of Rajpura-Dariba lead-zinc belt in Rajasthan was also a major achievement. A belt of lateritic nickel-cobalt association was deciphered in Orissa. In early seventies coal exploration again gained prominence and highest priority was assignment to it. During this period, airborne geophysical surveys were introduced in the mineral search activities of GSI. The exploiting agencies in public sector viz., HCL, HZL etc., were established for mine development and enhanced production.

1.4.6 The **Fifth Five Year Plan period (1974-79)**, witnessed the major discovery of East Coast bauxite from the states of Andhra Pradesh and Orissa, thereby bringing the country in the front-line in world inventory on bauxite. Massive exploration efforts made under the leadership of GSI led to the enhancement of reserves by seven times within 18 months in the 1974-76 period. This was followed by the exploration and establishment of substantial reserves for manganese ore in Madhya Pradesh, Maharashtra and Orissa, besides chromium ore in Orissa. These were considered as 'critical minerals' for the development of steel and alloy industries. The Tin belt of Orissa - Madhya Pradesh found place in the Mineral Map of India. Exploration for metallurgical coal and refractory raw materials in free hold and leasehold areas also received thrust and priority.

1.4.7 During the **Sixth Five Year Plan period (1980-85)** emphasis was laid on exploration of the ores of base metals, manganese, chromium, tin, tungsten, besides fertiliser minerals, including those of phosphorous and potash. The thrust was also assigned to exploration for gold and diamond. These activities resulted in locating new blocks in Rajpura-Dariba lead-zinc belt of Rajasthan. Discovery of gold deposit at Chigargunta in Andhra Pradesh, proved the southern extension of the Kolar Gold Field. A tin prospect was also established in Tosham in Haryana. Massive exploration efforts were directed towards locating potash deposits in the covered terrain of Western Region. Trillion tonnes of halite resources were established in Sri Ganganagar District.

1.4.8 In the **Seventh Five Year Plan period (1985-90)** efforts were made to enhance the resources of base metals, tin, tungsten, fertilizer and refractory minerals, precious metals, diamond, rare metals and rare-earths. Efforts were made in obtaining latest available technology in the exploration of tin and tungsten by collaborative studies with BRGM of France. The planned efforts in mineral exploration led to the discovery of new prospect in the Rajpura-Dariba belt, Ghugra and Kayar in Rajasthan; gold deposits of Kempinkote, Wandalli, Uti, Champion East Lode and Mysore Mine Block in Karnataka, potash deposits of Marwar Bas in Rajasthan, extension of copper deposits in Khetri belt in Rajasthan and in Malanjkhand, Madhya Pradesh.

1.4.9 During the **Eighth Five Year Plan period (1992-97),** highest priority was accorded for high value and high-tech minerals. Accelerated exploration programme to improve the resource position of marginal, poor or deficit categories of minerals were also given greater attention. The commodities, which enjoy unlimited demand and have potential for export also, received attention. The search for basemetals, gold, tin, tungsten, molybdenum, platinum group of elements, diamond, rock phosphate and low silica dolomite got priority. In view of having attractive export market, preliminary assessment of decorative / dimension stones was taken up all over the country for the first time on regional scale.

1.4.10 New gold deposits were identified in Ajjanahalli, Chinmulgund, Hira-Buddini and G.R. Halli in Karnataka. In the Dona area, Andhra Pradesh, gold prospects were identified and explored. The Bhukia area in Banswara district, Rajasthan was included in the Gold Map of India. This is a significant breakthrough, as except for southern states and a few small occurrences in central and eastern parts of the country, gold prospects were not known in other parts. New kimberlite bodies, identified in the eastern part of Madhya Pradesh, led to the opening up of a new diamond field having great potentiality. Manganese and Chromite ore reserves were augmented in Orissa. In the Harur-Uttangarai belt of Tamil Nadu, molybdenum deposits were discovered. Low silica dolomite was located in Madhya Pradesh and limestone potential areas were identified and explored in Meghalaya and Arunachal Pradesh.

1.4.11 In the Coal Sector an additional reserve of 8,372 million tonnes of coal has been estimated by GSI in the coalfields of Andhra Pradesh, Bihar, M.P., Maharashtra, Orissa and West Bengal. In addition, reserves have been augmented by 1,706 million tonnes due to reassessment. The significant prospects include Sohagpur CF (Madhya Pradesh) having high grade coal with coking propensity, Talcher and Ib River fields (Orissa), Korba CF (M.P.), Birbhum CF (West Bengal) and Auranga CF (Bihar). Godavari Valley CF of Andhra Pradesh also added to the reserves substantially. MECL continued detailed exploration for coal in Jharia, Raniganj, East and West Bokaro, Karanpura, Talchir, Hasdo-Arand, Rajmahal, Pench - Kanhan Valley, Wardha valley, Godavari valley coalfields besides North Eastern States and upgraded nearly **15000** mt of coal reserves. In addition it has taken up priority regional exploration in Talchir, North Karanpura (Rohne-Rautpara) and Godavari valley coalfields and identified a reserve of **6500** million tonnes. State Directorates of Mines & Geology of North Eastern States also carried out investigations and identified a few coalseams, which are of local significance. DGMs of Bihar, (Ithkori CF), Maharashtra (Nagpur and Chandrapur dist), and Orissa (Talchir CF and IB valley CF) carried out exploration work and estimated about 490 m.t. of various grades of coal.

1.4.12 More than 422 million tonnes of lignite has been assessed by GSI in the major lignite belts along east-coast of Tamil Nadu (Lalpettai - Neyveli - Mannargudi areas) and west-coast of Gujarat (area between Rajpardih and Vastan). Other promising areas are in east of Nileswar in Kasargod district of Kerala, Tiruchirapalli of TN, Bikaner in Rajasthan.

1.4.13 **The Nineth Plan Period** (1997-2002) witnessed thrust for search of energy minerals, gold, diamond, rare metals, molybdenum and basemetals etc. Preliminary assessment of decorative/dimension stones on regional scale was taken up all over the country and huge resources established. In Bhukia area, Rajasthan, gold resources were established. Resources of PGE ore has been established for the first time in the country from Baula-Nuasahi area of Orissa. Resource of rare metal (cesium ore) was established in Purulia district, West Bengal and molybdenum resources were established from Harur-Uttangarai belt of Tamil Nadu. Resources of iron ore and manganese ore were augmented in Orissa. Besides high value and high tech minerals, exploration for energy and other minerals continued for the augmentation of the resources. GSI and MECL together added 31.61 mt of lead-zinc ores in Rajasthan. South Sindesar ridge/Sindesar Khurd and Latio-ka-khera (E) in Dariba-Bethumni belt and Kayar in Ajmer have been the significant lead-zinc findings in Rajasthan. Singhana-II, Surhari and Kalapahar in Rajasthan, Dhadkidih in Jharkhand and Kallur in Karnataka were the important copper prospects explored during IX Plan period. HZL, HCL, State DGMs of Rajasthan, West Bengal, MP, Karnataka, UP and Jharkhand also carried out base metal exploration. ACC-RIO TINTO Exploration Ltd., BHP Minerals in association with HZL and Phelps Dodge were the private sector players engaged in the base metal exploration.

For the energy sector exploration continued with a thrust for augmentation of coal, lignite and coal-bed methane resources. GSI established 1015 mt of coking and superior quality coal from Sohagpur, Raniganj, Tatapani-Ramkola etc. coalfields, 5088 m.t. of power grade coal in Talcher, Ib river, Auranga, Rajmahal, Mand-Raigarh, Wardha and Godavari Valley Coalfiedls, 111 m.t. of lignite in Gujarat and Tamil Nadu and 14 trillion c. ft. (974 b.c.ft) of Coal Bed Methane prognosticated in deeper parts of Jharia, Bokaro, Raniganj and North Karanpura coalfields of Damodar Valley. MECL established 14,290 m.t. of coal reserves and 25,338 m.t. of lignite reserves during the IX plan period. DGM, Kerala also contributed 1.15 m.t. of lignite reserves.

1.4.14 Economic reforms and liberalisation measures were announced in the mineral sector to provide opportunities to private sector for participation and involvement in natural resource build up by way of technology transfer and upgradation / sophistication to improve productivity. A total of thirteen mineral commodities were thrown open to private investment. Foreign investment was allowed jointly with Indian partners. The minerals having exportable surplus resources like iron, manganese, chromite, bauxite and deficient noble and strategic minerals, diamond and high tech rare metals and rare earths have evoked their interest and attention. The leading multinational mining agencies apart from other Indian Companies showed interest. Most of the private investment in exploration was in the States of Rajasthan, Karnataka, Andhra Pradesh, Madhya Pradesh, Orissa and Chhattishgarh.

1.4.15 In the changing and liberalised scenario, the need for reliable geoscientific data base with constant refinement was felt and high quality data base has been generated by the national agencies like GSI, MECL, NRSA, NGRI and IBM etc. This data helped investment decisions in mineral exploration/mining in India.

1.5.0 STATUS OF EXPLORATION.

1.5.1. OVERALL STATUS :

GSI continues its activities in the assessment and regional exploration of gold, diamond, basemetal along with coal and other mineral resources. The data base thus, created forms the base for the future development of the minerals and the mineral based industries.

MECL carries forward the regional exploration done by GSI by detailed exploration thereby enhancing the level of confidence of the reserves. Based on the findings of GSI and MECL the Government identifies and allots the blocks for mining and captive mining purposes to private / public sector organizations.

The position of India in minerals like bauxite, dolomite, iron ore, limestone and manganese is quite comfortable. **In 2003, India ranked within the first ten of the world** in terms of quantum of production for the following minerals–

⇒	Mica blocks and splittings	(Eighth)
⇒	Barytes	(Second)
⇒	Coal-lignite	(Third)
⇒	Chromite	(Second)
⇒	Iron Ore	(Fourth)
⇒	Bauxite	(Sixth)
⇒	Manganese Ore	(Eighth)
⇒	Kyanite/Silimanite/Andalusite	(Fourth)
⇒	Talc/Steatite/pyrophyllite	(Third)
⇒	Magnesite	(Nineth)

Although the country is more or less self reliant in respect of few minerals, a significant gap exists in respect of large number of critical minerals and metals for which the country is partly or largely dependent on imports.

1.5.2 **GAP AREAS IN EXPLORATION:**

There is an urgent need to refine the strategy for the exploration and discovery of the minerals such as gold, silver, diamond, copper, lead, zinc, nickel, tungsten, molybdenum, PGE etc. in which the country is deficient. On the other hand survey & exploration has to continue for the minerals such as bauxite, dolomite, iron ore, limestone and manganese for augmentation of the existing resources. Besides the conventional mineral exploration in the known mineralized belts vast tract of the areas which are otherwise not known for mineral occurrences such as the Himalaya, Indo-gangetic plains, Deccan Traps and deserts required a special approach towards systematic mineral exploration.

The vast coast line upto the EEZ (Exclusive Economic Zone) has been by and large been unexplored for the mineral wealth. GSI should be strengthened so that it can speed up its endeavours in this field. Services of other exploration agencies may also be utilized to reap the benefits for national development.

The beneficiation technology may be upgraded for the better recovery from the low grade ores and the mine rejects.

Table – 1.1

GROWTH OF MINERAL PRODUCTION IN THE COUNTRY

(1948 -2004)

Mineral/Ore	Unit	1948	1958	1968	1978	1988-89	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
Coal	Th.tonnes	30334	46036	70613	101340	194375	292270	299996	313696	327787	341272	361156
Lignite	Th.tonnes	73	19	126	3613	12589	23419	21847	24247	24813	26018	27958
Natural Gas	m.cu.m	--	--	601	1721	9250	25706	26884	27860	28038	29964	30908
Petroleum (Crude)	Th. tonnes	255	440	5853	11271	32040	32722	32011	32426	37032	33044	33373
Bauxite	Th.tonnes	23	169	2131	1663	4395	6610	6854	7993	8688	9867	10924
Chromite	Th.tonnes	23	64	206	766	926	1418	1696	1972	1549	3069	2905
Copper Ore	Th.tonnes	327	111	484	2132	5132	4230	3121	3498	3418	3071	2903
Dolomite	Th.tonnes	83	177	1284	2003	2261	2922	2875	3032	3251	3630	4051
Gold	Kg	5612	3291	3588	2774	2011	2683	2442	2615	2810	3153	3457
Iron Ore	Th.tonnes	2329	9055	27051	39288	49911	72230	73475	80587	86226	99072	122838
Lead Conc	Tonnes	1346	3341	3365	16834	40485	62842	62865	54487	52386	59107	73069
Limestone	Th.tonnes	4056	10533	21030	31061	65314	113213	127891	127338	130912	155744	153390
Manganese Ore	Th.tonnes	541	1379	1610	1619	1386	1538	1565	1595	1587	1678	1776
Silver	Kg	398	3416	2026	12138	38928	55409	53627	46150	57675	59502	37870
Zinc. Conc	Tonnes	--	7391	12839	66026	121993	349934	359924	366095	398837	486162	590276
Tin Conc.	Kg	-	-	-	570	25137	39391	22812	12979	13887	10630	15576

Source: IBM Year Book, 2005

CHAPTER–II

REVIEW OF NATIONAL MINERAL INVENTORY
(Items-1 &2 of Terms of Reference)

2.1.0 INTRODUCTION

2.1.1. Minerals have been in use since the earliest period of human civilisation. Whatever produced was utilised and there was no need for any systematic inventory. Major changes in the pattern of mineral consumption came about with the industrial revolution and mineral products. Growth of Industries was based on minerals and mineral products. With the result, the economy of most industrial countries became mineral dependent. It was during the World War II, that the awareness of mineral resources and the need to continuously inventory them became a reality. In India, activities in this direction were initiated in the year 1968, when the task of preparation of inventory of mineral resources was included in the charter of functions of the Indian Bureau of Mines. Since then inventory of important minerals of India are being prepared and updated at regular intervals. The National Mineral Policy of 1993 of Government of India also has laid emphasis on the preparation and updation of National Mineral Inventory and responsibility of this task has been vested in the IBM.

2.2.0. BRIEF HISTORY OF PREPARATION OF MINERAL INVENTORY

2.2.1 The first National Mineral Inventory (NMI) was released by IBM in 1971 covering 17 important minerals. It was increased to 47 minerals of importance for the core industries like Iron & Steel, Cement, Chemical, Fertilizer, etc. by 1974. The sources of data were the exploration agencies including Geology Survey of India, State Directorates of Mining &Geology, the individual mining organisations both in the public and private sectors. The data included the information on location of deposits, geological set up, lease status, details of exploration, chemical and physical characteristics of ores/minerals, etc. Similarly, data on reserves of various categories was also collected. Subsequently updation of National Mineral Inventory at 5 years intervals was formalised and National Mineral Inventory as on 1.1.1985 was released in July, 1987 with incorporation of additional features such as adoption of reserves classification as per GSI Bulletin MISC. Publication No. 58 of 1981. The 5 yearly National Mineral Inventory updation as on 1.4.90 was taken up and certain problems and gaps were identified. The important issues were assessment of recoverable reserves, lack of end-use grade classification, lack of standard formats for reporting exploration activity, untimely receipt of information and data, lack of information on nature of land, forest or otherwise, etc. The new features of the National Mineral Inventory as on 1.4.90 were changed over, from calendar year to financial year basis, inclusion of decorative granite, marble, systematic assessment of recoverable reserves based on due scrutiny of data on recovery factors, inclusion of conditional resources for the first time and adoption of end use of classification in respect of 47 minerals. Subsequently five yearly updation of inventory as on 1.4.95 pertaining to 61 minerals was carried out. The last updation was done as on 1.4.2000 as per Indian system covering 64 minerals which was completed on 31.3.2002. GSI was entrusted with the responsibility of national mineral inventory for coal and lignite.

2.2.2. Subsequently, in accordance with the decision taken in Geneva Conference of UNECE in November, 1999, where both the Government and the Industry from India represented, process of implementation of the United Nations Framework Classification (UNFC) for minerals, which is universally acceptable and understandable, was started. In May, 2000, Government of India constituted Task Force to formulate field guide lines in quantitative terms as per UNFC for having a uniform interpretation in the country. In August, 2000, Task Force submitted its field guidelines. This was further discussed in a Seminar at Agra in December, 2000. Further consultations with all the Government agencies and industries were held and in February, 2001, a final version of field guidelines was submitted to the Government. In May, 2001, a decision was taken by the Government on the strategy for implementation of UNFC, which were further put for consultations between May, 2001 to January, 2003 to ensuring the workability of the strategy. In the Conference of Central and State Ministers of Mines, held in January, 2003, the final stamp of approval was done for adoption of UNFC and implementation of strategy.

A two-fold strategy for implementation of UNFC was adopted. The first was for already generated resource data and the other was for future exploration and resource estimation. As per the first strategy, the available resources in NMI as on 1.4.2000, prepared by IBM, were manually codified as per UNFC, covering 64 non-coal, solid minerals. The NMI database maintained by IBM was modified in collaboration with BRGM, France by October, 2003 and generation of summary output for resources as on 1.4.2000 was completed by November, 2003. The CMPDI had been given the responsibility to implement the UNFC in the inventory of coal and lignite.

2.2.3. As a part of implementation of the second strategy of adoption of UNFC, IBM had organised extensive training programme on UNFC for the concerned Central and State agencies. Besides, concerned industries and individuals were also covered. GSI and MECL also imparted in-house training to their officers.

Amendments in MCDR, 1988, were also made to make statutory for all non-coal major mineral mines to report to IBM their reserves/resource data as per UNFC and also for ML applicants to submit plan accordingly. The amendments were modified by Gazette Notification No.185 dated 17.4.2005.

2.2.4. The mineral inventory is a comprehensive document covering all aspects of mineral deposits. The structure of National Mineral Inventory prepared by Indian Bureau of Mines covers the detailed information on various items and deposit-wise mineral inventory. The present structure of the National Mineral Inventory (NMI) covers mineral prospects/deposits/mines in freehold and leasehold areas, their status, infrastructure, geology & exploration, ore characteristics, reserve/resource estimation, details of feasibility, details of mining along with production data, etc.

2.3.0 CLASSIFICATION AND CATEGORISATION OF RESERVES / RESOURCES

2.3.1. Initially classification of reserves/resources was limited to the categories of Measured, Indicated and Inferred, basically depending on the mode of exploration. Although this was being followed, there was no uniformity in terms used by exploration agencies. To overcome this difficulty and also keeping in view the progressive trend both in technological and economical spheres of the country, the Geological Survey of India in the year 1981 came out with a standard system of classification (GSI Misc. Publication No. 58, June 1981) and recommended classification of mineral resources based on both geological assurance and economic viability of the mineral deposit. The Indian Bureau of Mines, keeping in mind the classification suggested by GSI in general, and the actual data received from various agencies on reserve/resource estimation and exploration in particular, made slight modification in the scheme suggested by GSI and adopted the modified scheme in the National Mineral Inventory from 1985 onwards till the updation as on 1.4.2000.

2.3.2. Depending on the degree of geological assurance and economic feasibility, the mineral resources were divided into two types, namely, “identified” or “discovered” and “undiscovered” mineral resources. The identified or discovered mineral resources were categorised into proved, probable and possible categories and the undiscovered mineral resources were divided into prospective and prognostic categories.

2.3.3. In January, 2003, the Government of India decided to adopt the United Nations Framework Classification (UNFC) to Indian mineral sector. United Nations Framework Classification (UNFC) is a system classifying the estimates based on three digit codes representing 3 axes, namely, Geological assessment, Feasibility assessment and Economic viability. The main objective of this classification is to create an instrument that will permit reserve/resources of solid fossil fuels and mineral commodities to be classified on an internationally uniform system based on market economy criteria. The system has been designed to allow incorporation of existing terms into it in order to make them comparable and compatible, thus enhancing international communication. The three-digit code system of the classification directly reflects the procedures used in the practice to investigate and evaluate mineral reserves/resources and accommodates the results of these investigations and evaluations, i.e. the reserves/resource figures quoted in the respective reports and documents.

The three axes of this classification are Economic axis (E), representing codes (1, 2,3) in order of descending economic viability; Feasibility axis (F) with codes (1,2,3) in order of decreasing feasibility and Geological axis (G) having codes (1,2,3,4) in order of decreasing geological certainty. The system uses eight terminologies. Each terminology is represented by three-digit codes

(EFG). For example, the highest category will be (111) i.e. economically viable, feasibility study completed and geologically explored in detail whereas lowest category will be represented by (334) i.e. potentially economic, no feasibility done and reconnoitered. As per this system, there are eight standard terms and corresponding ten standard codes.

S. No.	Terms	Codes
1.	Reconnaissance Mineral Resources	334
2.	Inferred Mineral Resources	333
3.	Indicated Mineral Resources	332
4.	Measured Mineral Resources	331
5.	Pre-feasibility Mineral Resources	221 and 222
6.	Feasibility Mineral Resources	211
7.	Probable Mineral Reserve	121 and 122
8.	Proved Mineral Reserve	111

Guidelines have been formulated, reflecting type and quantum of work required to be carried out according to the nature of deposit so that uniformity is maintained while assigning the codes and terminologies.

2.4.0. END-USE GRADE CLASSIFICATION OF THE MINERAL RESOURCES

2.4.1. In the National Mineral Inventory upto 1985, due to non-availability, in general, of the data on chemical constituents and physical characteristics, only some critical constituents were considered for classifying reserves according to end-use grades. In order to evolve standard guidelines for classification of minerals according to end-use grades, an Expert group was constituted by the Ministry of Mines to draw requisite guidelines for field Geologists and Mining engineers to classify mineral resources according to their industrial application. The report of the Expert Group was published by IBM in December, 1989. This Group had standardised grades of various minerals for different end-use applications for the purpose of reserve estimation. More than a decade had been passed since these end-use grade classifications were adopted. Changes in specifications due to newer uses of minerals in their physical and chemical forms and in technologies are the inevitable phenomenon. Therefore, it was felt necessary to review afresh these specifications. Three Committees were constituted under the Chairmanship of Controller General, Indian Bureau of Mines to consider independently each group of minerals, namely (i) Metallic Minerals (Ferrous Group), (ii) Metallic Minerals (Non-Ferrous Group), and (iii) Non-Metallic Minerals (Industrial Minerals Group). In April, 2005, representative from all the major exploration and user industries from Central and State Government Departments, Central and State Undertakings and private organizations were drawn. They discussed, analysed and finally cleared the documents on end-use grade classification which has been adopted in the National Mineral Inventory as on 1.4.2005.

2.5.0 PRESENT STATUS OF NATIONAL MINERAL INVENTORY (NMI)

2.5.1 The National Mineral Inventory of 64 important minerals as on 1.4.2000 was completed in March, 2002. For getting the feedback from the mining industry, exploration and exploitation agencies both private and government, the IBM organised National Conferences on these important minerals. Subsequently, in view of the Govt. of India's decision to adopt United Nations Framework Classification to Indian Mineral Industry, the National Mineral Inventory was converted as per UNFC in 2003.

Further the quinquenial updation of NMI as on 1.4.2005 was taken from the Annual Programme 2005-06 and the target for completion of updation as on 1.4.2005 is 31-3-2007. Presently provisional figures as on 1.4.2005 are available for 42 minerals.

2.5.2. The Table-II-1 gives the mineral-wise details on number of deposits under freehold, public sector leasehold, private leasehold, partly leasehold and total number of deposits. As such the NMI presently comprises total 16,000 deposits of which 8,000 are in Freehold areas, 800 in public sector leasehold, 7,100 private leasehold and 100 in partly leasehold.

2.5.3. Summarised account of mineral resources of 64 minerals contained in the NMI are given in Table-II-2 incorporating the details on Total Resources in Freehold, Total Resources in leasehold including partly leasehold and Total All-India Resources. These 64 minerals have been grouped into 7 groups such as Metallic Minerals – Ferrous Group; Metallic Minerals–Non-Ferrous Group, Precious and Semi-Precious Minerals, Strategic Minerals, Fertilizer Minerals and Non-Metallic Minerals. The detailed account of resources in Reserve Category, Remaining Resource Category and gradewise availability of the mineral resources, their distribution in freehold areas, leasehold areas and the details on exploration activities have been covered in the mineral-wise reviews in **Annexure-II** .

2.6.1. INDIA'S MINERAL RESOURCES AS COMPARED TO WORLD RESOURCES

2.6.2. The position regarding Total Resources in respect of important minerals is given in Table-II-3 with percentage share of Indian resources in the total world reserve base.

2.7.0. STATUS OF MINERAL RESOURCES AVAILABILITY IN INDIA

2.7.1. The status of total resources, estimated domestic production during 2006-07 and life indices of important minerals beyond 1.4.2007 based on estimated current level of production are given in Table-II-4. However, it is to be appreciated that the basic data on individual mineral resources has been collected by different organisations based on different parameters of estimation of resources. In view of this, the status of Total Resources vis-à-vis life of mineral deposits may be viewed irrespective of the techno-economics of the deposits.

2.8.0. DATA DISSEMINATION

2.8.1. The entire mineral inventory has been fully computerised and summary output reports have been generated. Presently only 3 types of standard output are generated - (i) The district-wise, category-wise, grade-wise and sector-wise resources/reserves of all the minerals; (ii) Deposit-wise summary information showing location, resources/reserves, grades and status of each deposit; (iii) Deposit-wise detailed information showing data on geology, exploration, reserves, grade, chemical analysis, physical characteristics, infrastructure, etc. These reports cover mineral-wise information on all-India as well as state-wise and district-wise parameters. Total Resources and Reserves by grades and categories. The leasehold areas have been further classified into private, public, captive and non-captive. The Handbook on National Mineral Inventory as on 1.4.2000 has been published by the Indian Bureau of Mines as a ready reference to mineral inventory. Besides, the deposit-wise detailed information output sheets for freehold areas are disseminated to interested public on nominal charges.

2.9.0. MEASURES FOR USER'S FRIENDLY INVENTORY

2.9.1. Mineral inventory plays a crucial role in evolving overall development strategy for judicious management of country's mineral resources. The information on mineral resources plays a vital role for identification of areas for exploration, application for mining leases, planning for mineral based industries, formulation of mineral trade policies, development of infrastructure, identification of priority sectors in mineral exploration, etc.

2.9.2. The database used to be handled manually since 1971 where the mineral inventory was first prepared till the updation of inventory as on 1-1-1980. It was real challenging task to handle such a huge data manually. Computer technology in the form of personal computer (PC) came in a big way to make the mineral inventory user's friendly. IBM started computerisation of its NMI database since 1985. Since then all the subsequent updation of National Inventory used the latest and updated technology. NMI databases were shifted from DOS based PC's to UNIX based mini server to VAX/VMS server with ORACLE RDBMS. Further introduction of latest high speed window NT based server with latest version of ORACLE RDMS i.e. Oracle **8.X** computer technology in the NMI database in collaboration with BRGM (France) for 1.4.2000 and 1.4.2005. NMI updation improved processing speed, increased volume of activities and faster retrieval of information.

2.9.3. Through Local Area Network and Wide area Network connecting the various offices of IBM and the Ministry of Mines, instant data retrieval has been facilitated. Mineral-wise updated reserves/resources as on 1.4.2000 are also available on IBM Website.

2.10.0 UNITED NATIONS FRAMEWORK CLASSIFICATION (UNFC) FOR MINERAL RESERVES / RESOURCES

2.10.1. The main objective of the UN framework classification is to create an instrument that will permit reserves/resources of solid fossil fuels and mineral commodities to be an internationally uniform system, so that the investment decisions in mineral industry are facilitated.

2.10.2. The UNFC consists of a three dimensional system with three axis criteria, namely Geological assessment, Feasibility assessment and Economic Viability Evaluation. It is a three-digit code-based system. The economic viability axis representing the first digit, the feasibility axis the second digit and the geological axis the third digit. The three categories of economic viability have codes 1, 2 and 3 while four stages of geological assessment are represented by four codes i.e. 1 (detailed exploration), 2 (general exploration), 3 (prospecting) and 4 (reconnaissance). Thus the highest category of resource under UNFC system will be the proved reserve with a code of (111) and the lowest category will be the Reconnaissance Resource with a code of (334).

2.10.3. World wide, the reactions to the suggestion to adopt UNFC system have been varied largely based on their individual socio-economic status. The countries which are emerging in the field of industrial economy and want to attract investors for exploration and mining have gone ahead to adopt UNFC system as many of them did not have any well established pre-existing system of resource/reserve classification. The advanced nations with strong economic base are more focussed on building up of a knowledge society and are mainly inclined towards global resource inventory and assessment of global market trends. These nations are not too keen to impose a new resource classifications system in their domestic sector because there are already well founded pre-existing systems of classification with sufficiently expressive of the category and confidence level of reserve/resource estimation. So far about fifty countries have adopted UNFC.

2.10.4. In India, the classification of mineral resource/reserves was standardised way back in 1981 (GSI Misc. Pub.No.58) and was further refined by BIS (vide IS 1209 : 1989). This system was originally based on USGS/USBM and USSR systems and was adopted with some modifications for preparing National Mineral Inventory (NMI) by IBM. The basic approaches of NMI, which include 150,000 reserve/resource figures and brought out at every 5 years interval since 1971, are (i) geological i.e. assurance of appraisal and (ii) techno-economic viability i.e. mainly mineability and useability. In this classification, the stages of exploration considered include reconnaissance (P-I and P-II stages) by GSI, regional exploration (R-I and E-II stages) by GSI and detailed exploration by MECL and others. Similar classifications system are still used by many advanced countries like USA, Canada, UK, Russia, etc.

2.10.5. With the adoption of UNFC to the Indian Mineral Sector, the National Mineral Inventory is now updated and available in accordance with the UNFC.

2.11.0. **ANALYSIS OF NATIONAL MINERAL INVENTORY**

2.11.1. A study of the National Mineral Inventory data reveals that in case of a wide variety of mineral commodities in the categorisation of resources/reserves and grouping thereof, no uniform system appears to have been followed. The basic confidence level required for each category of resource/reserve decides about the variations likely to take place in the existing resources and availability thereof. Hence the data in case of large number of minerals under NMI are required to be taken for broad considerations only.

2.12.0. **BALANCE LIFE OF MINERAL INVENTORY**

2.12.1. The total resources considered for working out life indices of important minerals requires a cautious approach. For a better appreciation, the entire group of mineral commodities have been classified based on indigenous availability as "Abundant Minerals", "Adequate Minerals", "Deficit Minerals" and "Scarce Minerals". Considering the present and anticipated production levels, exports, imports, etc., the balance life of present mineral resource which include Proved Reserve, Probable Reserve, Feasibility Resource, Prefeasibility Resource, Measured Resource and Indicated Resource categories have been broadly worked out. The details are given in Tables-II-5, II-6, II-7 and II-8.

2.13.0. **FUTURE DEVELOPMENT AND CONSERVATION**

2.13.1 The mineral resources are finite and exhaustible hence the conservation of mineral resources is essential. Keeping in view the national approach regarding data generation of mineral resources due emphasis may be given on low volume high value minerals like gold, diamond, base metals and platinum group of minerals.

2.13.2 With the near exhaustion of surface proximal resources it has become necessary to have multi-disciplinary approach for locating concealed mineral deposits. In addition to this, emphasis may be given to mine small deposits having low grade with high tonnage adopting a concept of cluster mining. The beneficiation technique need to be developed at par with the international state of the art techniques for extraction for high value and strategic minerals.

TABLE-II-1

LIST OF MINRALS COVERED IN THE NATIONAL MINERAL INVENTORY SHOWING THE MINERAL-WISE NUMBER OF DEPOSITS AS ON 1.4.2005/1.4.2000*

Sl. No.	MINERAL NAME	Freehold	Leasehold public	Leasehold private	Partly leasehold	Total
1.	Andalusite	10	0	0	0	10
2.	Antimony	4	0	0	0	4
3.	Apatite	21	3	0	0	24
4.	Asbestos	122	1	68	0	191
5.	Barytes	163	4	86	1	254
6.	Bauxite	540	26	265	12	845
7.	Borax	6	0	0	0	6
8.	Calcite	113	1	64	0	178
9.	Chromite	68	17	17	0	102
10.	Chinaclay	642	15	411	2	1072
11.	Cobalt	6	5	1	0	12
12.	Copper	223	14	1	1	239
13.	Diatomite	9	1	0	0	10
14.	Diamond	48	3	0	1	52
15.	Dunite	9	7	11	1	28
16.	Emerald	18	0	2	0	20
17.	Felspar	152	18	382	0	553
18.	Fireclay	469	23	357	2	851
19.	Gold	207	12	0	5	224
20.	Iron ore (Haematite)	335	49	525	3	912
21.	Iron ore (Magnetite)	104	3	37	0	144
22.	Kyanite	94	6	13	0	113
23.	Lead-zinc ore	110	4	5	1	120
24.	Magnesite	98	13	26	0	137
25.	Manganese ore	260	29	328	4	621
26.	Molybdenum	27	2	0	0	29
27.	Nickel ore	17	2	1	0	20
28.	Perlite	2	0	1	0	3
29.	Potash	20	0	0	0	20
30.	Platinum group of metals	27	1	0	0	28
31.	Pyrite	12	2	0	1	15
32.	Rock phosphate	54	13	1	1	69
33.	Rock salt	0	1	0	0	1
34.	Ruby	8	3	0	0	11
35.	Sapphire	4	1	0	0	5
36.	Sillimanite	31	8	1	1	41
37.	Silver	13	14	7	1	35

Sl. No.	MINERAL NAME	Freehold	Leasehold public	Leasehold private	Partly leasehold	Total
38.	Sulphur	2	9	0	0	11
39.	Tungsten	38	0	0	0	38
40.	Vanadium	24	3	0	0	27
41.	Vermiculite	35	2	11	0	38
42.	Wollastonite	6	1	4	1	12
43.	Ballclay	13	3	75	-	91
44.	Bentonite	45	1	20	8	74
45.	Corundum	80	3	10	-	93
46.	Diaspore	9	4	42	-	55
47.	Dolomite	214	24	378	-	616
48.	Fluorite	14	13	3	1	31
49.	Fuller’s Earth	26	1	12	1	40
50.	Garnet	56	5	55	-	116
51.	Granite Dimension stone	483	81	284	22	881
52.	Graphite	168	9	160	2	339
53.	Gypsum	438	63	25	-	526
54.	Limestone	1336	101	1415	4	2857
55.	Marble	51	7	48	-	106
56.	Mica	45	1	153	-	199
57.	Ochre	50	-	134	-	184
58.	Pyrophyllite	14	6	67	-	87
59.	Quartz – Silica Sand	530	41	1149	1	1721
60.	Quartzite	52	2	87	-	142
61.	Talc/Steatite/Soapstone	287	1	483	-	771
62.	Tin ore	23	2	-	-	25
63.	Titanium minerals	103	7	-	-	110
64.	Zircon	-	5	-	-	5

TABLE-II-2 : NATIONAL MINERAL INVENTORY AT A GLANCE
(AS ON 1.4.2005/1.4.2000)*

S.No.	Mineral	Unit	Total Resources in freehold	Total Resources in leasehold (including partly leasehold)	Total All India Resources
1.	**METALLIC MINERALS (FERROUS GROUP)**				
	Chromite	'000 tonnes	71136	160984	232120
	Iron Ore (Haematite)	'000 tonnes	5705829	8924501	1463331
	Iron Ore (Magnetite)	'000 tonnes	10118007	501474	10619481
	Manganese Ore	'000 tonnes	75038	305429	380467
2.	**METALLIC MINERALS (NON-FERROUS GROUP)**				
	Bauxite	'000 tonnes	2227404	1079359	3306763
	Copper Ore – Metal	'000 tonnes	751625 4884	642801 6534	1394426 11418
	Lead-Zinc Ore	'000 tonnes	352817	169763	522570
	Lead Metal	'000 tonnes	3707	3500	7207
	Zinc Metal	'000 tonnes	8990	15269	24260
	Lead+Zinc	'000 tonnes	118	-	118
	Antimony - Ore - Metal	Tonnes	10588 174	- -	10588 174

S.No.	Mineral	Unit	Total Resources in freehold	Total Resources in leasehold (including partly leasehold)	Total All India Resources
3.	**PRECIOUS & SEMI-PRECIOUS MINERALS/METALS**				
	Gold: Primary Ore Metal	'000 tonnes Tonnes	333393 358	56690 133	390289 491
	Gold: Placer Ore Metal	'000 tonnes Tonnes	26121 6	- -	26121 6
	Diamond	Carats	3372314	1209599	4581913
	Garnet [(1)] *	'000 tonnes	36176	15560	51736
	Corundum [(2)]	Tonnes	32874	57	32932
	Silver : Ore Metal	'000 tonnes Metal	34902 746	195982 10778	230883 11524
	Emerald	Kg	NOT ESTIMATED		
	Ruby	Kg			
	Sapphire	Kg			
4	**STRATEGIC MINERALS & METALS**				
	Cobalt	Mil. Tonnes	14.01	30.9	44.91
	Molybdenum : Ore Metal	'000 tonnes Tonnes	11287 7620	8000 5020	19286 12640

S.No.	Mineral	Unit	Total Resources in freehold	Total Resources in leasehold (including partly leasehold)	Total All India Resources
	Nickel	Mil. Tonnes	90.66	98.05	188.71
	Tin (3) : Ore*	'000 tonnes	83703	3512	87215
	Metal	'000 tonnes	101	1	102
	Titanium Minerals	'000 tonnes	331411	43820	375231
	Vanadium : Ore	'000 tonnes	18529.2	6318.6	24847.8
	Metal	'000 tonnes	54.62	10.77	65.39
	Tungsten : Ore	'000 tonnes	87387	-	87387
	Contained WO^3	'000 tonnes	142	-	142
	Platinum Group of Metal	Tonnes	14.2	-	14.2
	Mica*	Tonnes	10737	49152	59890
5.	**FERTILIZER MINERALS**				
	Apatite	'000 tonnes	20382	6483	26864
	Rock Phosphate	'000 tonnes	171966	137255	309221
	Gypsum (4) *	'000 tonnes	1151612	91644	1243257
	Sulphur	'000 tonnes	210	-	210
	Potash	Mil. Tonnes	21815	-	21815
	Pyrite	'000 tonnes	60383	1614018	1674401

S.No.	Mineral	Unit	Total Resources in freehold	Total Resources in leasehold (including partly leasehold)	Total All India Resources
	NON-METALLIC MINERALS				
6.	Sillimanite	Mill. Tonnes	48.16	15.33	63.49
	Talc-Steatite [(5)] *	'000 tonnes	58085	211231	269317
	Vermiculite	'000 tonnes	-	-	2444
	Wollastonite	'000 tonnes	9125	11117	20242
	Zircon [(6)] *	'000 tonnes	-	1789	1789
	Ballclay [(7)] *	'000 tonnes	8463	60810	69273
	Pyrophyllite [(8)] *	'000 tonnes	915	17278	18194
	Ochre [(9)] *	'000 tonnes	16813	41467	58280
	Diaspore [(10)] *	'000 tonnes	1.28	2574.8	2576
	Andalusite	Tonnes	18450	-	18450
	Diatomite	'000 tonnes	2251	633	2885
	Rock Salt	'000 tonnes	13530	-	13530
	Granite [(11)] *	Mill Cu. M.	25092	12533	37625
	Marble [(12)] *	Mill. tonnes	600	1191	1791
	Asbestos	'000 tonnes	10890	10891	21781
	Barytes	Tonnes	31830348	41845450	73675798

S.No.	Mineral	Unit	Total Resources in freehold	Total Resources in leasehold (including partly leasehold)	Total All India Resources
	Bentonite [13] *	‘000 tonnes	421193	105461	526655
	Borax	Tonnes	74204	-	74204
	Calcite	‘000 tonnes	-	-	15766
	Chinaclay (*)	‘000 tonnes	1896048	406378	2302426
	Dolomite [14] *	‘000 tonnes	5001743	2082466	7084209
	Felspar	‘000 tonnes	26581	43561	70142
	Fireclay [15] *	‘000 tonnes	523390	171636	695027
	Fluorite [16] *	Tonnes	9140350	3635584	12775934
	Fuller’s Earth [17] *	‘000 tonnes	187216	69435	256652
	Graphite [18] *	‘000 tonnes	152369	6898	159267
	Kyanite	‘000 tonnes	-	-	102598
	Limestone [19] *	‘000 tonnes	150549039	19909617	170458657
	Dunite	000 tonnes	-	160236	160236
	Magnesite	‘000 tonnes	202364	166293	368657
	Quartz-Silica Sand [20]	‘000 tonnes	1634523	1275037	2909562
	Quartzite [21]	‘000 tonnes	120427	962449	1082876
	Perlite [22]	‘000 tonnes	2578	-	2578

TABLE – 11 – 3

RESOURCES OF IMPORTANT MINERALS IN INDIA AS ON 1.4.2005/1.4.2000*
WITH PERCENTAGE SHARE IN WORLD RESOURCES

Sl. No.	Mineral	Total Resources (Million tonnes)	Reserves (Million tonnes)	% of various grades in Total Resources	Percentage share of Indian Resources in World
A.	**METALLIC MINERALS**				
1.	Iron ore (i) Hematite (ii) Magnetite	 14696 10614	 7020 207	 High Gr. – 14.5% Med. Gr. – 45.54% Low Gr. – 23.68% Met. – 20.58% Coal Washery – 0.078%	6.8
2.	Bauxite	3306	914.7	Met. – 83.0% Chem. 0.4% Refr. – 2.11%	10.0
3.	Copper ore Metal	1394.4 11.42	369.5 4.38	-	–
4.	Manganese ore	380.3	141.9	B.F – 34.22% Fe Mn – 6.65% Battery – 0.14%	7%
5.	Lead-Zinc ore (i) Lead Metal Content (ii) Zinc Metal Content	522.6 7.2 24.2	125.7 2.6 11.1	– – –	N.A 5.1 5.27
6.	Chromite	232	66	Met. 18.36% Charge Chrom–23.7% Ref. – 1.79%	13%
7.	Gold Primary ore Metal Placer ore Metal	 390 491 26.1 6	 19.25 85 – –	 – – – –	 N.A Negligible N.A
8.	Tin Ore Metal	 87.2 0.10	 12.7 **Negligible**	 – –	 N.A
9.	Tungsten Ore WO_3	 87.4 0.14	 – –	 – –	 N.A

Sl. No.	Mineral	Total Resources (Million tonnes)	Reserves (Million tonnes)	% of various grades in Total Resources	Percentage share of Indian Resources in World
B.	**NON-METALLIC MINERALS**				
1.	Limestone	170458	12222	Chem.-3%; B.F – 8.75% Cement Portland (55.45%)	N.A
2.	**Silica Minerals** (i) Quartz-Silica Sand (ii) Quartzite	2909 1083	625 173	Glass Gr. - 9.1%; Foundry – 15.68% Ref. – 24.11%, Flux – 5.61%	N.A
3.	Kaolin (China clay)	2302	180	Ceramic & Pottery – 16% Insecticide – 1.5%	N.A
4.	Fireclay	695	48	Refr. NP – 10.6% Ref. Pl. 12.9%	N.A
5.	Magnesite	368	128	Beneficiable/low - 43.45%, Med. Gr.– 8.9%	-
6.	Dolomite	7084	992	BF/Sinteming – 28.16%; Refr. – 5.46%; SMS (LD) – 1.84%	N.A
7.	Gypsum	1243	84	Cement & Paint – 5.1%, Fertilizer/ Pottery – 77. 18%, Soil Recl. –1%	N.A
8.	Steatite/Talc/Soapstone	269	130	Paper & Tex. 12.27%; Cosmetic – 28.14%	N.A
9.	Rock Phosphate	309	53	Chem. & Fert. – 6.83%; Blendable – 9.24%; Soil Rec. – 11.66%	-
10.	Pyrite	1674	57	Soil Recl. – 0.360% Beneficiable – 3.60%	N.A
11.	Ilmenite	-	-	-	-
12.	Barytes	73.7	34	Chem. 3.11%; Oil Well drilling – 40.18	
13.	(a) Kyanite (b) Sillimanite	102.6 75	1.5 15	- Massive – 5.1%; Granular – 87.4%	N.A N.A
14.	Felspar	88	34	Pottery Ceramics – %; Glass - %	N.A
15.	Calcite	16	9.6	Glass/Ceramic –8.2%; Chem. – 17.74%	N.A

Sl. No.	Mineral	Total Resources (Million tonnes)	Reserves (Million tonnes)	% of various grades in Total Resources	Percentage share of Indian Resources in World
16.	Asbestos	21.89	6.15	Amosite – 20.49%; Tremolite – 19.28; Chrysotile – 0.38%	N.A
17.	Graphite	159	4.8	10-40%; FC – 12.25%	-
18.	Fluorite	12.77	2.23	Usable – 72.42%	-
19	Pyrophyllite	18.19	12.15	Ceramic-9%; Refractory – 21%; Insecticide – 46%	N.A
20.	Diamonds (Million Carats)	4.58	1.20	Gem –16.5%; Ind. – 18.35%	-
21.	Mica (Tonnes)*	59890	15.3	-	Very large
22.	Wollastonite	20.24	8.5	Marketable –52.48%	N.A
C.	**MINOR MINERALS**				
1.	Granite * (Million Cu. m.)	37624	1180	Coloured granite – 90%	N.A
2.	Marble *	1791	4.7	Off Colour – 38%	N.A
3.	Bentonite *	526.6	24.24	Foundry - 9.6% Drilling – 1.77 %	N.A
4.	Fuller's Earth*	256.6	58.2	-	N.A.

TABLE – II – 4
LIFE INDICES OF IMPORTANT MINERALS

Unit in 000 tonnes

Sl. No.	Mineral	Total Resources on 1.4.2000/1.4. (Resources considered for life index in Paranthesis)	Total Balance Resources as on 1.4.2007 (Resources considered for life index after depletion of production from 2000-01 to 2006-07/2005-06 to 2006-07.	Estimated domestic production during 2005-06	Life index beyond 1.4.2007
1.	**2.**	**3.**	**4.**	**5.**	**6.**
1.*	Asbestos	21781 (11285	21763 (11267)	6.31	Very large
2.	Bauxite (i) All grade (ii) Refractory	 3306763 (2221549) 69864 (60496)	 3269525 (2184311) 69223(59855)	 13142 97	 166 Very large
3.*	Ballclay	69273 (28115	62996 (23838)	593	40
4.	Barytes	73676 (65805)	70046 (62174)	1238	50
5.*	Bentonite	526655 (276765)	- Not estimated -		
6.	Calcite	15998(11579)	15354(10945)		
7.	Chromite (i) All grade (ii) Refractory	 232120 (146483) 4161 (2221)	 220532 (134895) - Not estimated -	 4090	 33
8.	Copper ore	1394425 (659789)	1385094 (650458)	3293	200
9.	Chalk	- Not estimated -			
10.*	Corundum	33 (1.77)	- Not estimated -		
11.*	Diaspore	2576 (1128)	2466 (1018)	24	42
12.	Diatomite	2885 (634)	- Not estimated -		
13.*	Dolomite	7084259 (1920204)	7060223 (1896168)	4841	391
14.	Diamond Gem & Industrial	4582 (3029) Unit – 000 Carats	4333 (2780)	83	33
15.*	Fireclay	695027 (162948)	691094 (159015)	628	253
16.*	Felspar	70142 (31895)	67974 (29727)	419	71
17*	Fluorspar	12776 (10950)	12675 (108491)	13	834
18*	Fuller's Earth	256652 (970)	- Not estimated -		
19*	Graphite (i) All grade (ii) 40% Fc	 159267 (11566) 282 (249)	 158524 (10823) - Not estimated -	 106	 102

Sl. No.	Mineral	Total Resources as on 1.4.2000/1.4.2005 (Resources considered for life index in Paranthesis)	Total Balance Resources as on 1.4.2007 (Resources considered for life index after depletion of production from 2000-01 to 2006-07/2005-06 to 2006-07.		
1.	**2.**	**3.**	**4.**		
20.*	Gypsum	1243257 (815830)	1220987 (793560)	3994	199
21.*	Garnet (all grades except gem)	51730 (25280)	48422 (21972)	661	33
22.*	Granite	37624611 (4536517) Unit – 000 cu. m.	- Not estimated -		
23.	Gold ore Primary Placer	 390289 (131571) 26121 (2552)	- Not estimated -		
24.	Iron ore Haematite & Magnetite Unit – Million tonnes	25250 (15946)	24795 (15432)	160350	97
25.*	Kyanite	102491 (7196)	102443 (7148)	8.7	825
26.*	Kaolin	2302426 (833038)	2296138 (826750)	1017	813
27.	Lead-Zinc ore	522579 (316879)	510072 (304372)	4414	69
28.*	Limestone	170458657 (48293810)	169377000 (473212397)	181419	260
29.	Manganese ore	380467 (21534)	372895 (207775)	2672	78
30.*	Magnesite	368657 (241504)	366235 (239082)	428	558
31.*	Mica	59890 (15.3) Unit – Tonnes	- Not estimated -		
32.*	Marble	1791309 (287221)	- Not estimated -		
33.*	Ochre	58279 (31439)	52966 (26126)	908	29
34.*	Pyrophyllite	18194 (12951)	16713 (11470)	303	38
35.	Rock Salt	13530	- Not estimated -		
36.	Potash	21815 (18412) Unit – Million tonnes	- Not estimated -		

37.	Rock Phosphate & apatite – all grade	336086 (152170)	332288 (148372)	1340	110
38.	Silver ore	230883 (156371)	- Not estimated -		
39.*	Sillimanite	63495 (43665)	63311 (43481)	32	Very large
40.*	Silica Minerals	3992438 (1559858)	3972898 (1540315)	2576	597
41.	(i) Sulphur (ii) Pyrite	210 (nil) 1674401 (147045)	- Not estimated -		
42.	Steatite	269317 (138047)	266929 (135659)	843	161
43.	Slate	- Not estimated -			
44.	Tin ore	87215 (581521)	87215	26 Tonnes	Large
45.	Tungsten ore	87387 (45623)	87387 (45623)	- Not estimated -	
46.*	Vermiculite	2662 (159)	2592 (129)	3.7	35
47.	Wollastonite	20242 (16068)	19693 (15519)	194	80
48.	Zircon	1789 (1789)	- Not estimated -		

TABLE – II-5
ABUNDANTLY AVAILABLE MINERALS
(Figures in thousand tonnes in case not indicated exclusively)

Mineral	**Country's available resources**		**Production**		**Export**		**Import**		**Life at present rate of production**	**Remarks**
	1.4.2000 1.4.2005	**% of world**	**2004-05**	**% of world**	**2004-05**	**2005-06**	**2004-05**	**2005-06**		
FUEL MINERALS										
1. Coal	247847	31	382137	7	1374	--	26127	--	>100 yrs for non coking only	Production increasing Import of Coke & low ash coal increasing
2. Lignite	36009		30341							
METALLIC MINERALS										
3. Iron Ore (million tonnes)	25250 (15946)	6.8	142711	10	87185	84045	485	611	97	Production and export increasing
4. Bauxite	3306763 (2221549)	10	11697	7	1016	2355	56	45	166	Production increasing - Refractory grade imported - Alumina export as value added is increasing - Metallurgical grade is abundant
5. Titanium Minerals	375.23	29	652	4	473	438	0.56	6.8	100 yrs	--
NON METALLIC MINERALS										
6. Limestone (million tonnes)	170459 (169377)	--	161462	--	319	326	1159	1513	260 yrs except low silica high grade	- Production increasing - Low silica grade being less is imported - Abundant for cement and B.F.grade
7. Dolomite (million tonnes)	7084 (1920)	--	4309	--	--	--	1.23	2.7	390 yrs except refractory grade	- Production increasing - Import increasing for refractory grade - Abundant for met. grade
8. Barytes	73676 (65805)	10	1161	16	483	555	0.5	0.26	50	Production decreasing, export increasing

9. Bentonite (million tonnes)	527	--	--	--	290	465	0.8	1.6	Not estimated	Resources are large
10. Fireclay	695027 (162948)	--	559	--	-	--	Bricks Importerd	--	250	Production increasing
11.Fuller's Earth (million tonnes)	257 (1)	--	--	--	134	82	2.2	2.9	NE	Resources are large
12. Kaolin (Chinaclay)	2302426 (8330356)	--	905	4	66.7	65.2	31	41	800	Production increasing
13. Magnesite	36865 (215347)	21	381	2	2	1	14.6	10.6	558	Production increasing
14. Sillimanite	63495 (43665)	--	29	--	0.16	0.35	--	0.10	NE	Resources are large
15. Silica sand & Quartz	2910 (1035)	--	1905	--	49.54	40.8	10.9	3.7	230	Production increasing
16. Quartzite	1083 (525)	--	388	--	83.7	102.2	0.2	0.06	200	Production increasing
17. Garnet (Abrasive.)	51730 (25280)		1588	--	174	--	--	--	33	Production increasing
18. Calcite	15998 (11579)	--	84	--	0.53	1.13	53.17	75.3	116	Production increasing
19. Felspar	70142 (31895)	--	373	2	467	469	2.2	6.03	70	Production increasing
MINOR MINERALS / ROCKS										
20. (i) Marble	1.8	--	--	234	341	333	182.6	271.7	Large	Production and export increasing
(ii) Granite	37.6	--	--	2468	2191	2147	18.9		Large	- do -
(iii) Slate	--	--	4	159	124	128	--		Large	- do -

TABLE – II-6 - ADEQUATELY AVAILABLE MINERALS

(Figures in '000 tonnes in case not indicated exclusively)

MINERAL	Country's Total Resource as on 1.4.2000/1.4.2005 (Resources considered for life index in parenthesis)	% of world	Production		Export		Import		Life index at present production	Remarks
			2004-05 (000 t)	% of world	2004-05	2005-06	2004-05	2005-06		
METALLIC MINERALS										
21. Manganese ore	380467 (215347)	7	2379	9	318	237	241	13.3	78	-
22. Chromite	232120 (146483)	13	3640	20	1116	693	2.52	5.1	33	-
NON-METALLIC MINERALS										
23. Ball Clay	69273 (28115)	N.A.	528	-	2.8	4.4	37	111	40	Production increasing
24. Mica	59.89 (0.015)	N.A.	4	1	98	80	0.8	0.77	Resource assess-ment not done fully	Production of crude mica decreasing.
25. Gypsum	1243257 (815830)	N.A.	3555	3	96	83	31.8	72.5	199	Export decreasing and production increased
26. Graphite	159267 (11566)	-	100	6	1	1.2	6.2	7.9	102	Production fluctuating

27. Steatite	269317 (138047)	-	750	-	59	47	0.52	0.80	161	Production and export increasing.
28. Wollastonite	20242 (16068)	-	173	24	5.7	18.5	-	-	80	Increasing production and exports
29. Ochre	58279 (31439)	N.A.	808	-	1	-	1	-	29	Production fluctuating
30. Vermiculite	2622 (159)	N.A.	3	0.6	-	-	-	-	35	Production increasing
31. Pyrophyllite	18194 (12951)	N.A.	270	16	-	-	-	-	38	Production increasing
32. Salt Rock	13530	-	-	-	-	-	-	-	-	

TABLE – II-7

DEFICIT MINERALS

(Figures in ‘000 tonnes in case not indicated exclusively)

MINERAL	Country’s Total Resource as on 1.4.2000/1.4.2005 (Resources considered for life index in parenthesis)	% of world	Production		Export (tonnes)		Import (Tonnes)		Life index	Remarks
			2005-05 (000 t)	% of world	2004-05	2005-06	2004-05	2005-06	200	
METALLIC MINERALS 33. Copper ore	1394425 (659789)	1.21	3293	-	18990		-	-	-	-
34. Lead-Zinc ore	522579 (316879)	-	4414	-	261361	443485	-	-	69	-
35. Pyrite	1674000 (1674000)	-	-	-	3	-	1003	-	-	-
NON-METALLIC MINERALS 36. Apatite	26865 (19908)	0.67	1340	-	1	-	2312		110	
37. Rock Phosphate	309221 (132262)			-						-
38. Asbestos	21781 (11285)	-	6.3	-	2	0.3	183	-	Large	-
39. Fluorite	12776 (10950)	2.6	12.8	-	0.6	-	100	-	large	-
40. Kyanite	102491 (7196)		8.7	-	-	-	97	-	NE	-

TABLE – II-8

SCARCE MINERALS
(Production figures in thousand tonnes in case not indicated exclusively)

Mineral	Country's available resources		Production		Export Tonnes		Import Tonnes		Life at precent rate of producer	Remarks
	1.4.2000 1.4.2005	% of world	2004-05	% of world	2004-05	2005-06	2004-05	2005-06		
METALLIC MINERALS										
41. Gold Ore Metal (t)	416410 (134123) 497	0.55%	3.5 tonnes	Negligible	--	28.8	--	--	-	Mostly imported
42. Silver ore Metal (t)	231 11523 (Poor Gr.)	20%	10.9 tonnes	--	--	0.006 3 t	--	--	--	Mostly imported
43. Gallium	N.A.	--	Negligible	--	--	--	--	N.A.	--	Mostly imported
44. Magnesium	N.A.	--	--	--	--	--	--	--	--	--
45. PGM (t)	14.2	0.01	Nil	--	--	--	--	--	--	Imports only
46. Antimony Tonnes Metal Tonnes	10588 174	Negligible	Nil	--	--	--	440	445	--	Domestic demand met by import of metal, alloys and conc.
47. Molybdenum ore (Million Tonnes) MoS2	19.2 12639	Negligible	Nil	--	--	--	--	--	--	Domestic demand met by import of metal, alloys and conc.
48 Nickel Ore (Million Tonnes)	188.71	--	Nil	--	10	22	37	--	--	Domestic demand met by import of metal, alloys and conc.
49 Tin Ore (Million Tonnes)	87.3	--	Nil	--	5	--	--	630	--	Domestic demand met by import of metal, alloys and conc.
50 Tungsten Ore (Million Tonnes) Metal (Tonnes)	87.387 142094	Negligible	Nil	--	3.90	1.58	2.58	104	--	Domestic demand met by import of metal, alloys and conc.

TABLE – II-8

SCARCE MINERALS
(Production figures in thousand tonnes in case not indicated exclusively)

Mineral	Country's available resources		Production		Export Tonnes		Import Tonnes		Life at precent rate of producer	Remarks
	1.4.2000 1.4.2005	% of world	2004-05	% of world	2004-05	2005-06	2004-05	2005-06		
51. Vanadium Ore (Million Tonnes) Metal (Tonnes)	24.85 65390	Negligible	Nil	--	--	--	--	--	--	Production of vanadium sludge reported.
52. Cobalt Ore	44.91 (Million Tonnes) low grade with nickel	Negligible	Nil	--	84	443	8072	8313	--	Domestic demand met by imports of metals, alloys and concentrates.
NON METALLIC MINERALS										
53. Diamond	4581913 Carats	Low	78315	Low	NA	--	--	--	--	Mostly imported
54. Potash (Million Tonnes)	21815	-	Nil	--	--	--	--	--	--	Mostly import
55. Native sulphur	210,000 tonnes	Negligible	Nil	--	--	--	--	--	--	Only import
56. Borax	74204 tonnes	Negligible	**Nil**	--	--	--	--	--	--	Only import

Annexure - II

MINERAL-WISE REVIEWS

The mineral wise review under the various groups as per Table II-2 are given below :

I. METALLIC MINERALS (FERROUS GROUP)

(i) Iron ore (Hematite)

All India total resource are 14,630 million tonnes as 1-4-2005 (provisional). Out of these, the resources under Reserve Category are 7004 million tonnes. Out of these reserves under proved category are 73%. Under the reserve category, 43% are lump (high medium, low and unclassified grades), 41% are fines (high, medium, low and unclassified grades), 15% are lump/fine (high, medium, low and unclassified grades) and balance are in Black iron ore, other unclassified and not known grades.

Out of 14,630 million tonnes of total resources 61.0% are in lease hold areas and 39% are in freehold areas). Further, 56% are in public sector, 44% are in private sector, about 37% are in captive and 63% are in non-captive areas.

(ii) Iron ore (Magnetite)

All India total resources of magnetite are 10,619 million tonnes as on 1-4-2005 (Provisional). Out of these, Reserves are only 207 million tonnes (1.89%) and 10,412 million tonnes are Remaining Resources. Out of the total resources, 20.6% are of metallurgical grade, 8 million tonnes are of Coal-washery grade and the balance is of foundry, others, unclassified and not known grades. Out of total resources, 95.27% are in freehold and remaining 4.73% (501.47 million tones) are under leasehold with 85.86% in public and 14.14% in the private sector.

(iii) Manganese ore

All India total resources of manganese ore as on 1.4.2005 are 380 million tonnes. Out of these 37.29% are in Reserve Category and balance 62.71% in Remaining Resource Category. Out of the total resources, the BF grade are 130.2 million tonnes, medium grade 31.63 million tonnes, Ferro-manganese grade 25.3 million tonnes and the balance are of Fe-Mn, low, mixed, unclassified and not known grades. The freehold resources are 75 million tonnes and the leasehold are 305 million tonnes. Out of the leasehold, 48% resources are in public sector and 52% in private sector. In the public sector, 1.19% are in captive and 98.8% in non-captive. In the private sector 7.99% are in captive and 92.01% in non-captive.

(iv) <u>Chromite</u>

The all India total resources of chromite are 232.12 million tonnes as on 1-4-2005 (Provisional), of which 28.48% are Reserve and 71.52% are Remaining Resources. Gradewise, 18% are metallurgical, 1.79% refractory, 23.69% are charge chrome, 18.28% beneficiable and the balance 38.24% are low, ferrochrome, others, unclassified and not known grades. Bulk of the resources i.e. 93.38% are located in Orissa.

Out of the total resources 71.13 million tonnes are in freehold and 161 million tonnes are in leasehold. Out of the 161 million tonnes of resources in leasehold, 33.67% are in public sector, and 66.33% in private sector.

Chromite deposits associated with Iron Ore Group are most important. Among them two belts namely Sukinda Ultramafic Belt and Nausahi Utramafic Belt of Orissa contain about 97% of total Indian resources of Chromite.

II. METALLIC MINERALS (NON-FERROUS GROUP)

(i) <u>Bauxite</u>

The all India total resources of Bauxite as on 1-4-2005 (Provisional) are 3,306 million tonnes. Out of these, 915 million tonnes are under Reserve Category and the balance 2,392 million tonnes under Remaining Resource Category. Gradewise, 0.4% are chemical grade, 2.1% refractory grade, 83.39% metallurgical grade and balance 14.1% are of chem-refractory, mixed, metallurgical, mixed abrasive, unclassified and other mixed grade.

Out of the total resources 67.35% are under freehold and 32.65% are under leasehold. Out of the lease hold resources of 1079 million tonnes, 41.94% are in public sector and 49.06% in private sector. Out of the total resources, 54.34% are in captive and

45.66% in non-captive sector. Out of the public sector resources of 453 million tonnes, 300 million tonnes are in captive area.

The major producers are National Aluminium Company with a largest open cast mine in India, Hindustan Aluminium Company and Bharat Aluminium Company. Major deposits are in East Coast falling in Visakhapatnam and East Godavari districts of Andhra Pradesh and Phulbani, Sundergarh, Bolangir, Sambalpur, Kalahandi, Keonjhar and Koraput districts of Orissa. Other important bauxite occurrences are located in Bilaspur, Surguja and Raigarh districts of Chhattisgarh, Satna, Balaghat, Rewa and Jabalpur districts of Madhya Pradesh, Lohardaga and Gumla districts of Jharkhand, Kolhapur, Raigad, Satara, Sangli, Sindhudurg, Ratnagiri and Thane districts of Maharashtra, Kutch, Jamnagar, Junagarh, Amreli, Bhavnagar, Sabarkantha, Surat, Valsad and Ahmedabad districts of Gujarat State.

(ii) <u>Copper ore</u>

The all India total resources of Copper ore as on 1-4-2005 (provisional) are 1394 million tonnes, with a metal content of 11.41 million tonnes. Out of these, 369.5 million tonnes of ore with a metal content of 4.4 million tonnes is under Reserve Category and the balance in Remaining Resource Category. Gradewise 28.031 million tonnes are with (+) 1.85% Cu, 622 million tonnes with 1.0 to 1.85% Cu; 604 million tonnes with 0.5 to 1.0% Cu and 140 million tonnes with less than 0.5% copper. Out of the total resources, 751.6 million tonnes ore with 4.88 million tonnes metal content is in freehold and 642.8 million tonnes of ore with 6.53 million tonnes metal is in leasehold sector.

Hindustan Copper Ltd. is the only public sector undertaking producing copper in the country. Most of the copper deposits under mining have been explored in detail. Exploration activities have also led to discovery of small prospects in Western, Eastern, Southern and Central Pre-cambrian shield areas of the country.

(iii) <u>Lead-zinc ore</u>

The all India total resources of Lead-zinc ore are 522 million tonnes with 7.2 million tonnes of lead metal and 24.25 million tonnes of zinc metal. Out of the total resources, 126 million tonnes with 2.6 million tonnes of lead metal and 11.0 million tonnes of zinc metal are under Reserve Category. Gradewise 86.82 million tonnes are with +10% lead and zinc, 144.67 million tonnes with 5-10% lead and zinc and 291 million tonnes with less than 5% lead and zinc metal.

Out of the total resources, 352.82 million tonnes with 3.7 million tonnes of lead metal and 8.99 million tonnes of zinc metal are in freehold sector. In the leasehold, the total resources are 169.7 million tonnes with 3.5 million tonnes of lead metal and 15.26 million tonnes of zinc metal. Out of the total resources in leasehold, 7.94 million tonnes are in public sector and 161.82 million tonnes in joint public and private sector.

The important leasehold deposits are Devpura, Dodwas (South), Rampura Agucha in Bhilwara district, Balaria, Bamnia, Baroj, Bora, Mochia, Paduna, North Rajpura Dariba, Sonaria, Ruparia and Zawarmala in Udaipur district of Rajasthan. Hindustan Zinc Ltd. (HZL) is the only JV sector producing lead-zinc in the country.

Most of the lead-zinc deposits of the country occur in the Proterozoic fold belt, in the Western Indian Shield. In the Pre-cambrian shield of Western India as well as in other shield areas, several small and medium sized lead-zinc deposits have been identified and explored by GSI in detail.

III. PRECIOUS METALS AND MINERALS

(i) Gold

The all India total resources of gold ore as on 1-4-2005 (Provisional) are 390 million tonnes of primary ore with 491 tonnes of metal and 26 million tonnes of placer ore with about 6 tonnes of metal. Out of the total primary ore 19 million tonnes with 85 tonnes are under Reserve Category and balance 371 million tonnes with 406 tonnes metal are under Remaining Resource category. All the placer ore resources are under Remaining Resource Category. Out of the total primary ore, 333.4 million tonnes with 358 tonnes of metal are in freehold and 56.7 million tonnes with 133 tonnes metal are in leasehold. All the placer type ore deposits are in freehold. Out of the leasehold 56.34 million tonnes with 129 tonnes metal is in public sector and 0.35 million tonnes with 3 tonnes metal is in private sector.

(ii) <u>Silver</u>

The all India total resources of silver ore as on 1-4-2005 (provisional) are about 231 million tonnes with a silver content of about 11524 tonnes. Out of the total resources about 116 million tonnes of ore with 7955 tonnes of silver is in Reserve Category. Out of the total resources 34.9 million tonnes with 746 tonnes of silver metal are under freehold and 195.98 million tonnes with 10778 tonnes of silver metal are in leasehold.

In India, there are no native silver deposits except the small and unique Bharak deposit of silver in Rajasthan. This mineral occurs as an associate with most of copper and lead-zinc minerals. The important deposits where this mineral occurs are Zawar group, Dariba group, Bamina Kalan, Sindesar Khurd, Rampura Agucha, Sargipalli, Bandalamottu, Ghugra, etc. Silver is recovered as co-product from Hutti Gold mines in Karnataka during refining of Gold and at Vizag Zinc smelter, Andhra Pradesh from lead concentrates.

(iii) <u>Diamond</u>

The all India total resources of diamond as on 1-4-2005 (Provisional) are 4.58 million carats. Out of these, 1.2 million carats are under Reserve Category and the balance 3.38 million carats under Remaining Resource Category. Out of the total resources, 7.56 lakh carats are of gem variety, 8.4 lakh carats are of industrial grade and the balance 2.98 million carats are unclassified. Out of the total resources 3.37 million carats are under freehold and 1.20 million carats under leasehold. All the leasehold resources are in public sector.

In India, diamond deposits occur in three types of geological settings viz. Kimberlite, conglomerates and alluvial gravels. At present only Majhgawan Diamond pipe in Panna district of Madhya Pradesh is under exploitation by NMDC.

IV. STRATEGIC MINERALS/METALS

(i) <u>Tin</u>

The all India total resources of tin ore are placed at 87.215 million tonnes with a metal content of 102224 tonnes. Out of the total resources 12,692 tonnes of ore with 34.6 tonnes of metal are placed in Reserve Category and the balance in Remaining Resource Category. Out of the total resources, 83.7 million tonnes are in freehold and 3.51 million tonnes are in leasehold. Out of leasehold, 99.96% are in public sector. Identified tin deposits includes Bodawada Katekalyan, Bastar district of Chhattisgarh and Tosham deposit in Haryana.

(ii) <u>Tungsten</u>

The all India total resources of tungsten ore as on 1-4-2005 (provisional) are 87.4 million tonnes with WO_3 content of 142,094 tonnes. All the resources are under Remaining Resource category. All the resources are in freehold. In Karnataka, scheelite occurs in association with auri-ferrous bodies in Kolar and Hutti Gold field.

(iii) <u>Nickel ore</u>

All India total resources as on 1-4-2005 (provisional) are of the order of 188.71 million tonnes, all under Remaining Resources category. Out of the total resources 90.66 million tonnes are under freehold sector and 98.05 million tonnes under leasehold sector. Under leasehold 39.97 million tonnes are under public and 58.08 million tonnes under private sector. Out of the total resources 42.13 million tonnes are of 0.9% Ni; 93.53% are of 0.5 to 0.9% Ni and remaining of unclassified grade. Out of total resources 17,4.85 million tonnes are in Orissa, and the balance in Jharkhand, Nagaland and Karnataka.

(iv) <u>Cobalt</u>

All India total resources as on 1-4-2005 (Provisional) are of the order of 44.91 million tonnes, all under Remaining Resource Category. Out of the total resources 14.01 million tonnes (31%) are in freehold and 30.9 million tonnes are in leasehold. These resources are distributed in Singhbhum district of Jharkhand, Jajpur and Cuttack districts of Orissa, Jhunjhunu district of Rajasthan, Tuensang district of Nagaland and Hoshangabad district of Madhya Pradesh. There is no commercial indigenous production of Cobalt. The demand is met through imports.

(v) <u>Molybdenum</u>

All India total resources of molybdenum ore as on 1-4-2005 (provisional) are 19.28 million tonnes in which the contained MoS2 is 12,639 tonnes. Out of total resources of ore 1.5 million tonnes (7.78%) with a metal content of 1,050 tonnes are under Reserve category and the balance 92.22% ore are under

Remaining Resources category. Out of the total resources 8 million tonnes of ore with 5020 tonnes of MoS_2 are under leasehold all in public sector.

Molybdenum is generally found to be associated with copper, lead and zinc ores. In India by-product concentrates of molybdenum are produced intermittently from uranium ore of Jaduguda mine of Uranium Corporation of India Ltd. In Jharkhand.

(vi) Vanadium

All India Total Resources of Vanadium ore as on 1-4-2005 (provisional) are 24.85 million tonnes with 65390 tonnes of metal. Out of these 25.43% of ore is under Reserves category and the balance in Remaining Resource category. The freehold resources are 18.52 million tonnes with 54,620 tonnes of metal and 6.31 million tonnes with 10770 tonnes of metal in leasehold, all under public sector. Out of the public leasehold 90.52% are in captive and 9.48% in non-captive sector.

(vi) Titanium Mineral

The all India total resources of titanium mineral are 375.23 million tonnes as on 1-4-2005 (provisional) of which ilmenite is 318.18 million tonnes, rutile is 12.92 million tonnes, leucoxene 0.1 million tonnes and titaniferrous magnetite 40.68 million tonnes. Out of the total resources of titanium minerals, 22.84 million tonnes (6.08%) are under Reserve category and balance under Remaining Resource category. The freehold resources are 331.4 million tonnes (88.3%) and leasehold 43.81 million tonnes (11.7%). All leasehold resources are in public sector with 9.38% in captive and 90.62% in non-captive sectors.

IREL and KMML are two undertakings working on beach sands in the country and extracting titanium minerals.

V. FERTILIZER MINERALS

(i) Gypsum

All India resources are 1243.2 million tonnes as on 1-4-2000 of which Reserves is 7% and Remaining Resources are 93 per cent. Of the total resources 1243.2 million tonnes, fertilizer/pottery grade are 77.8%, cement/paint grade 5.1%, and soil reclamation grade 1%. The reserve of surgical plaster is very meagre and 16%

are unclassified/not known grade. The freehold resources are 92.6% and leasehold are 7.4% , of the total all India resources. Of the total leasehold resources 86.75% are in public sector and remaining 13.25% are in private sector. Out of the total leasehold public sector resources, 10% are captive and 90% are non-captive. Similarly, out of total leasehold private sector resources 8% are in captive and 92% are in non-captive sectors.

(ii) <u>Sulphur</u>

There is only one deposit reported from Puga Valley Schist Zone in Leh district having 21.6% (av.) "S" content. Total 17 boreholes were drilled in this deposit. A total of 210 thousand tonnes of resources were estimated. However feasibility of beneficiation of low grade sulphur has not been established. The deposit is located at a remote place. In the other deposit in Puga Valley, Jammu and Kashmir, associated with hot spring, 10 pits were sunk. However resource estimation has not been done.

(iii) <u>Potash</u>

The all India total resources of potash as on 1-4-2005 (provisional) are 21,815 million tonnes, all under Remaining Resource Category. Gradewise 1,946 million tonnes are glauconite 16,164 million tonnes are polyhalite, 2,477 million tonnes sylvite and 1,228 million tonnes are unclassified. All the resources are in freehold. Deep seated bedded sylvite mineralisation has been located in Nagaur district of Western Rajasthan accounting practically for entire resources. GSI has carried out the exploration by drilling in Nagaur/Sri Ganganagar basin of Rajasthan and has estimated about six trillion tonnes of halite containing about 80% NaCl over an area of 40,000 Sq. km. Western Rajasthan holds good potential for potash deposits. The K-rich mineralisation is very deep seated with thickness of overburden ranging from 593 to 676 m and feasibility of mining is yet to be established. The underground brine in Runn of Kutch is also a potential source of potash.

(iv) <u>Magnesite</u>

The all India total resources of magnesite as on 1-4-2005 (provisional) are 368.6 million tonnes. Out of these 128 million tonnes are under Reserve Category and 246 million tonnes under Remaining Resource Category. Gradewise 2.20 million tonnes are high grades, 34.82 million tonnes are medium grade, 160.19 million tonnes beneficiable low grade, and the balance 173.27

million tonnes are high and medium mixed, medium and low mixed, others, unclassified and not known grade. Out of the total resources 31.78% are in freehold sector and 68.22% are in leasehold sector.

(v) Pyrite

The all India total resources of pyrite as on 1-4-2005 (provisional) are 1674.4 million tonnes. Out of these 56.72 million tonnes are under Reserve Category and balance 1617.7 million tonnes under Remaining Resource Category. Out of the total resources 6.02 million tonnes are soil reclamation grade, 61.6 million tonnes beneficiable grade, 1552.8 million tonnes low grade and the balance 53.9 million tonnes are unclassified and not known grades. Out of the total resources 60.38 million tonnes are in freehold and 1614 million tonnes in leasehold sector.

The most important deposits occur at Amjhore in Rohtas district, Bihar. Saladipura in Sikar district, Rajasthan is another promising deposit.

(vi) Apatite

The all India total resources of apatite as on 1-4-2005 (provisional) are 26.86 million tonnes, of which 6.14 million tonnes are reserves and the balance 20.72 million tonnes are under Remaining Resources Category. The gradewise breakup is 27.26% beneficiable, 43.39% soil reclamation, 1.44% chemical/fertilizer grade and remaining 27.91% of blendable, unclassified, others and not known grade.

Leasehold resource are 24.13% and freehold resources are 75.87% of the total all India resources. The leasehold resources are in public sector, out of which 70.41% in captive and 29.59% in non-captive sector.

(vii) Rock Phosphate

The all India total resources as on 1-4-2005 (provisional) are 309.22 million tonnes of which 17.12% are under Reserve category and 82.88% under Remaining Resource category. Gradewise total resources are chemical/fertilizer (6.83%), blendable (9.24%), soil reclamation (11.66%), beneficiable (30.26%), low grade (35.53%) and remaining 6.48% are under others, unclassified and not known grades.

Out of the total resources, 44.38% are leasehold and 55.62% under freehold. Out of total resources of 137.2 million tonnes are under leasehold, public sector accounting for 95.56% and remaining 4.44% in private sector. Under leasehold 6.95% are in captive and remaining 93.05% in non-captive sector.

Rock phosphate is an important fertilizer mineral, which is in short supply. Inspite of country's production of around one million tonnes, India is deficient in this mineral and bulk of the requirement are met by imports.

Phosphorites associated with Aravalli are located at Jhamarkotra, Maton and Kanpur in Udaipur district, Rajasthan. Jhamarkotra is the biggest deposit located so far. In Rajasthan, other phosphorite deposits are reported from Banswara, Udaipur, Jaipur and Jaisalmar districts. In Madhya Pradesh, important deposits are in Jhabua, Sagar and Chhattarpur districts. In Uttar Pradesh deposits are located in Lalitpur district. In Uttaranchal these are located in Dehradun and Tehri Garhwal districts. Phosphorite deposits are also located in Panchamahal district of Gujarat and Palamu district of Jharkhand.

VI. NON-METALLIC MINERALS

(i) Sillimanite

The total all India resources are 63.49 million tonnes as on 1-4-2000 and out of the total resources 24% are placed under Reserves and 76% are placed under Remaining Resources. Granular type forms 87.4% of the total resources, 5.1% in massive type and remaining 7.25% are quartz sillimanite rock/unclassified/not known grade. Of the total resources 48.16 million tonnes (75.85%) are in the freehold areas and 15.33 million tonnes are in the leasehold areas.

(ii) Asbestos

The all India total resources of asbestos as on 1-4-2005 (provisional) are 21.781million tonnes. Out of these, chrysotile variety is 83,468 tonnes, amosite variety 4.46 million tonnes, tremolite is 4.2 million tonnes and the balance of other mixed grades. Out of the total resources, 6.04 million tonnes are under reserve category and the balance 15.74 million tonnes, under Remaining Resource Category.

(iii) Bentonite

The total all India resources are placed at 526.65 million tonnes as on 1-4-2000. Out of the total resources 4.6% is in the Reserves and 95.4% are Remaining Resources. Of the total resources 80% are in the freehold and 20% in the leasehold.

(iv) Barytes

The all India total resources of barytes as on 1-4-2005 (provisional) are 73.67 million tonnes. Out of these 34.03 million tonnes are under Reserve Category and the balance 39.64 million tonnes are under Remaining Resource Category. Gradewise 3.11% are chemical grade, 40.18% are oil-well drilling grade, 0.6% paint grade and balance 56.11% are low, other, unclassified and not known grades.

Out of the total resources, 43.20% are in freehold and 56.8% are in leasehold sector.
India is having 10% of total world resources mostly concentrated in Mangampet area of Cuddapah district of Andhra Pradesh. Barytes deposits found in India are of vein or fracture fillings and bedded types. Bedded type of deposit is found only in Mangampet area. Presently there is no thrust on exploration of barytes after the discovery of Mangampet baryte deposits.

(v) Fluorite

The total all India resources of fluorite are 12.7 million tonnes as on 1-4-2000 of which 17% in Reserves and 83% Remaining Resources. Out of total resources 71% are in freehold and remaining 29% in leasehold.

(vi) Talc, Steatite and Soapstone

The total all India resources are placed at 269.3 million tonnes as 1-4-2000. Out of these paper and textile grade forms 12.25%, cosmetics grade 28.13%, insecticide grade 14.40% and remaining 45.12% form unclassified ceramic, not known and other grades. Of the total 48.2% are in Reserves category, and 51.8% are Remaining Resources. Out of the total resources 21.6% are in the freehold and 78.4% in the leasehold areas.

Major deposits of superior grade steatite are found in Bhilwara, Udaipur and Jaipur districts of Rajasthan, Jabalpur, and Jhabua districts of Madhya Pradesh and Durg district of Chhattisgarh. In

Uttaranchal extensive deposits of massive soapstone occur in association with dolomites in Almora and Pithoragarh districts. All these deposits account for 80% of Resources. Remaining 15% is accounted mainly by Andhra Pradesh, Bihar, Maharashtra, Kerala and Orissa. The remaining 5% is shared by other states.

(vii) **<u>Fuller's Earth</u>**

The total all India resources are placed at 256.65 million tonnes as on 1-4-2000. Almost all the resources are placed under Remaining Resources, accounting 99.9% and a meagre quantity is under reserves. The entire resources are in unclassified grade. The freehold resources are 73% and remaining 27% are in leasehold.

(viii) **<u>Graphite</u>**

The total resources of graphite in India are 159.2 million tonnes as on 1-4-2000. Out of which 3% are Reserves and 97% Remaining Resources. Out of total resources (0.2 million tonnes), +40% F.C. grade is 0.12%, 10-40% F.C. grade is 12.25% and remaining 87.5% are others, unclassified and not known, grades. In the freehold areas the resources form 95.7% and 4.3% are in the leasehold areas. Out of the total resources in leasehold (6.9 million tonnes), 54% is in leasehold private and 46% ;is in leasehold public. Of the total, resources in lease hold (6.9 million tonnes), 13% are in the leasehold captive sector and 87% are in the leasehold non-captive sector.

(ix) **<u>Limestone</u>**

The total all India resources are 170,458 million tonnes as on 1-4-2000. Out of these, 7.17% are Reserves and 92.83% are Remaining Resources. The grade-wise percentage of total resources under chemical grade is 3%, SMS (OH) grade 3.80%, SMS (LD) grade 0.14%, SMS (OH) and (LD) mixed grade 0.12%, B.F. grade 8.75%, Cement (Portland) grade 55.450%, Cement (Portland and white) grade 0.23%, BF and Cement mixed grade 0.7%, SMS, Chemical and paper grade 0.47% and Paper, others, Cement (White) not known and unclassified grades 26.14 per cent.

Out of the total resources 88.3% are in the freehold area and 11.7% is in the leasehold area.

(x) Dolomite

The total all India resources are placed at 7,084.2 million tonnes as on 1-4-2000. Out of which 14% are Reserves and 86% Remaining Resources.

In the resources, BF/sintering grade is 28.16%, SMS (OH) grade 3.91%, SMS (LD) grade 1.84%, SMS (OH) and (LD) mixed grade/BF and SMS (mixed) grade 4.72%, Refractory grade 5.46%, BF/SMS and refractory grade 0.15%, glass 2.46% and unclassified and others not known grade are 48.54%.

Out of the total resources 70.60% is in the freehold sector and 29.40% are in the leasehold sector.

(xi) Pyrophyllite

The total all India resources are placed at 18.19 million tonnes as on 1-4-2000. Out of which 67% are Reserves and 33% Remaining Resources. Gradewise 21% is in the refractory grade, 9.0% in the Ceramic grade, 46% in the insecticide grade and remaining 11% are in the insecticide and ceramic mixed, 11.5% resources unclassified/other and not known category. Out of the total resources 5% is in the freehold area and 95% is in the leasehold area.

(xii) Diaspore

Total all India resources of diaspore are placed at 2.57 million tonnes as on 1-4-2000.

Out of this 44% are Reserves and 56% Remaining Resources. Gradewise 3.1% are in the ceramic grade, 78% in the refractory grade and 17.9% in the unclassified and not known category. Out of the total resources 0.03% is in the freehold areas and 99.97% in the leasehold areas.

(xiii) Wollastonite

The all India total resources of Wollastonite as on 1-4-2005 (provisional) are 20.241 million tonnes, out of which 8.53 million tonnes are under Reserve Category and the balance 11.7 million tonnes in Remaining Resource Category. Gradewise 10.7 million tonnes are of marketable grade and the balance 9.54 million tonnes are of unclassified and not known grade. Out of the total resources 9.12 million tonnes are in freehold and 11.11

million tonnes in leasehold, mostly in private sector. Only a small quantity of 200 tonnes is in leasehold public sector.

(xiv) Andalusite

The total all India resources as on 1-4-2005 (P) are placed at 18.45 million tonnes. The deposits are of low grade and are in the freehold areas only.

(xv) Ball Clay

The total all India resources are placed 69.27 million tonnes as on 1-4-2000. Out of which 36% are Reserves and 64% Remaining Reserves. Gradewise 93% are in the ceramic/pottery grade, and 7% are in the other and unclassified category.

Out of the total resources 12% are in the freehold area and 88% in the leasehold area.

(xvi) China Clay

The total all India resources are placed at 2302.4 million tonnes as on 1-4-2000, out of which 7.85% are Reserves and 92.15% are Remaining Resources.

Gradewise 1.5% comes under insecticide grade, 0.29% under chemical grade, 16.4% comes under ceramic/pottery grade, 0.16% paper/filler, 0.41% rubber, 20.48% in mixed grade and others, unclassified and not known 60.56%.

Out of the total resources 82.35% are in the freehold area and 17.65% in the leasehold area.

(xvii) Fire Clay

Total all India resources are placed at 695.0 million tonnes as on 1-4-2000. Out of which 7.07% are Reserves and 92.90% are under Remaining Resources category. Gradewise 10.6% is in refractory non-plastics, 12.90%, semi plastic and refractory plastic, 10.87%; refractory unspecified grade and 65.61% are under unclassified, other and not known category.

Out of the total resources 75.37% are in freehold and 24.7% are in the leasehold area.

CHAPTER-III

REVIEW OF PERFORMANCE DURING XTH PLAN

3.1.0 THRUST OF EXPLORATION DURING THE TENTH PLAN PERIOD

3.1.1 During the Tenth Plan period, major thrust was accorded to exploration for high value minerals like gold, diamond, PGE in which the country is deficient, besides energy minerals. Exploration effort also continued towards augmentation of the existing resources in respect of those minerals having key role in sustaining industrial growth and potential for new investment opportunities from private sector.

3.1.2 During the Plan period attention was also paid on state-of-the-art exploration technology and an integrated multi-disciplinary approach to mineral exploration was introduced to discover concealed or hidden deposits matching with the resource availability.

3.1.3 The economic reforms and national mineral policy (1993), which envisaged increased flow of private and foreign capital in the mineral sector, continued to prevail during the Xth Plan period. With a target to make the anticipation a reality, MMRD Act, 1957 and MCR 1960, were amended, concept of Reconnaissance Permit (RP) prior to actual prospecting was introduced and more powers were given to the State. Unfortunately the desired and anticipated level of FDI had not materialized. In the liberalized scenario only a few of the multinationals and a few Indian Companies have come forward for investment. The investment was mainly for RP, with only a few conversion of RP to PL. Most of these investments were for gold, diamond, base metals and a few for nickel and platinum group metals. The RP to PL conversion has happened mainly in case of diamond.

3.1.4 In recent time 120 mineral investigations involving different stages of activity are taken up by GSI each year. MECL takes up promotional/contractual work in order to upgrade the status of the prospects in the leasehold and free hold areas covering over 30 blocks annually. IBM takes up project studies for evaluation of resources, beneficiation studies and conservation of wide spectrum of rocks and minerals. AMD pursues its objective by exploring and updating resource position of rare metals and rare earth elements through their annual programs. In addition the Public Sector Undertakings and the private sectors are engaged in mineral exploration in their RP/PL/ML areas.

3.1.5 The national agencies namely **GSI, MECL, NRSA, NGRI, IBM** etc. in addition to their engagements in exploration work, has also accorded top priority for creation of multi-thematic database for dissemination. Untiring efforts by national agencies have created sophisticated database, which helped private investment in mineral sector. Constant refinement of geoscientific database is under progress to facilitate quick growth in mineral sector.

3.2.0 SIGNIFICANT ACHIEVEMENTS IN MINERAL EXPLORATION DURING Xth PLAN

3.2.1 Some of the significant additional mineral resources established during the Xth Plan period (first four years) are encapsuled below mineral-wise. Table III-1 reflects augmentation of resources of major minerals as estimated by GSI during the Xth Plan, whereas reserves established by MECL, during the Xth Plan as well as total reserves established since inception are reflected in Table III-2A & B. A comparative study of the tonnage added to the national mineral reserves from 1955 to 2005 commodity-wise by GSI, is furnished in Table III-3. Feedback of some of the State Govts in augmentation of resources is also summarized in Table III-4.

3.2.2 BASEMETAL :

GSI has paid adequate attention to exploration for basemetal minerals and has established additional resources of 8.20 million tonnes of copper ore and 0.80 million tonnes of lead-zinc ore. The significant findings in basemetal exploration by GSI are summarized below:

- Basemetal (Pb, Zn) in Muariya Block, Betul district, Madhya Pradesh establishing a resource of 0.80 million tonnes of ore with grade varying from 12.30% Zn, 2.40% Pb and 1.76% Cu to 12% Zn, 3.6%Pb and 1.66% Cu.
- Basemetal (Cu) and associated gold in Dhani-Basri area, Dousa district, Rajasthan proving resource of 3.2 million tonnes of ore with grade varying from 1% Cu and 1g/t gold to 1.09% Cu and 1.56g/t gold.
- Basemetal (Cu) in Baniwala-ki-Dhani block, Sikar district, Rajasthan where resources of 5.00 million tonnes of copper ore with an average grade of 0.55% Cu have been established. In the same geological milieu other blocks have been taken up for exploration to establish low-grade bulk tonnage deposits.

Apart from these, encouraging results have been achieved in course of investigation for copper at Gangas, Rajsamand district, Rajasthan; for zinc and lead at Bhuyari block, Chhindwara district, Madhya Pradesh.

MECL carried out detailed exploration for copper ore resulting in establishing 35.13 million tonnes of copper ore in Jharkhand, Rajasthan, Maharashtra states and 1.37 million tonnes of zinc ore in Rajasthan state. Significant findings of MECL are as under:

1. Dhadkidih (OCP)	Eastern Sector: MECL carried out 2937 m of exploratory drilling in Dhadkidih (OCP) block, Eastern sector in Singhbhum copper belt, Jharkhand and estimated 7.10 million tonnes of copper ore with 1.01% Cu between section line V & XII covering 775 m strike length, 200 m vertical column [(+)150mRL & (-)50mRL] . Out of this, 2.26 million tonnes ore reserves with 0.94% Cu confined to 100m vertical depth from surface (ore/OB ratio being 1:6), over 360 m strikelength.
2. Nandup (East)	In Nandup (East) block, in Singhbhum copper belt, Jharkhand, 2400m of drilling was carried out . A total of 2.47 million tonnes. of ore reserves with 1.04% Cu were estimated, over 660m strike length.
3. Thanewasna (South) block	Carried out 2002 m of drilling. A total of 3.40 million tonnes of ore reserves with 0.74% Cu estimated, over 1000m strike length in 200 m vertical column [(+)170mRL & (-)30mRL] in a single lode.
4. Singhana Extension block II	3038 m of drilling for deeper level probing in 4 boreholes was done. A total 2.83 million tonnes of copper ore reserves with 0.82% Cu were estimated, over 1000m strike length, 470 m vertical column [(+)290mRL & (-)180mRL] with 0.3-0.5 g/t Au associated with sulphides.
5. Bhagal block	Carried out 4037 m of drilling in two phases (Phase I & II). A total of 9.23 million tonnes of ore reserves with 0.74% Cu were estimated, over, 1000m strike, 300m vertical depth (450mRL – 150mRL). Out of this, 4.80 million tonnes ore reserves with 0.78% Cu are available within 100 m vertical depth from surface having open cast potential.
6. Devtalai (Phase-I)	1700 m of drilling was done. A total 1.27 million tonnes. of copper ore reserves with 1.36% Cu were estimated, besides 422 kg of in-situ gold metal with tenor of 0.37 g/t Au.
7. Bayanbil	Carried out 2890 m of exploratory drilling in 22 boreholes. A total of 8.79 million tonnes of copper ore reserves with average grade of 1% Cu at 0.5% cut-off have been estimated over 800m strike length and upto 200mRL. In the deposit 5 copper lodes i.e. L1 to L5 have been delineated of which Lode L1 and L1A are most promising with average thickness of 11.72 m and 7.09 m respectively.

In addition, **MECL** carried out detailed exploratory drilling on behalf of M/s. Hindustan Zinc Limited for lead-zinc ore in Rampura Agucha, Sindesar Dariba South and Kayar blocks.

HZLcontinued wide ranging exploration activities from regional scale to production scale detailing within leasehold areas. In Kayar Lead-Zinc deposit a reserve of 4.9 million tonnes of ore containing 1.925% Pb and 11.70% Zn and 43 g/t Ag has been established. In addition 0.43 million tonnes of inferred reserve has been estimated. In Agucha area preliminary indication of mineralisation has been intersected in a borehole.

HCL continued their development exploration activities in the leasehold areas and detected 80m average width of ore zone with average grade of 1.30% Cu in Khetri mine and 100m width with 1.32% Cu in Kolihan mine.

DMG, Rajasthan has continued exploration and established 8 m wide zone containing 1% Zn in Navlakha- Tanliya in Ajmer district having copper values 2.98% to 4.50%. A 14m thick copper zone containing 1.9% Cu was found in Srinagar area, Ajmer district.

DMG, West Bengal obtained 0.20g/t Au in four samples and 2.22% to 2.43% Cu in three samples in Mahanadi, Shibkhola area, Darjeeling district.

RIO TINTO Exploration Ltd. carried out prospecting operation for base metal in Jhansi district, Uttar Pradesh.

BHP- KHANIJ Anivesana Pvt. Ltd. carried out prospecting operation by ground survey for base metal in parts of Jhansi, Mahoba, Hamirpur district,UP and Bharuch, Surat, Vadodara, Bhavnagar and Ahmedabad districts, Gujarat.

BHP Mineral Pvt. Ltd. carried out exploration for base metal in Deogarh, Dhenkanal ,Keonjhar, Sambalpur, Jaipur and Angul districts, Orissa and Narasigpur, Chhindwara, Hosangabad districts, MP.

Anglo American Exploration India Pvt. Ltd. carried out exploration for base metals by ground survey as well as ground geophysics in Prakasam, Nellore and Guntur districts, Andhra Pradesh, Midnapur & Purulia districts, West Bengal and Sikar, Jhunjhunu, Ajmer, Nagaur, Bhilwara and Pali districts, Rajasthan.

3.2.3 GOLD:

A total of 42.49 million tonnes gold ore has been estimated by **GSI** during the period between 2002-2005 in the states of Rajasthan (40.63 million tonnes), Andhra Pradesh (1.21 million tonnes) and Jharkhand (0.65 million tonnes). The Bhukia prospect in Rajasthan is of high tonnage low-grade category. Details of the prospects are given below:-

- 0.132 million tonnes ore with 2.09g/t Au in Dugocha North block, Udaipur district, Rajasthan.
- 0.216 million tonnes with 3.05 g/t Au in Dugocha Central block. Udaipur district, Rajasthan.

- 11.48 million tonnes of ore with 1.89 g/t Au in Bhukia East, Central block, Banswara district, Rajasthan.
- 13.60 million tonnes of ore containing 1.88 g/t Au in Delwara block, Banswara district, Rajasthan.
- A resource of 3.22 million tonnes of gold ore, with 2.36 g/t Au in Bhukia East block, Banswara district, Rajasthan.
- A resource of 3.6 million tonnes of gold ore with 2.30g/t Au in Timran Mata East block, Banswara district, Rajasthan.
- A resource of 3.33 million tonnes with 1.5g/t Au in Timran Mata West Block, Banswara district, Rajasthan.
- A resource of 2.46 million tonnes gold ore with 1.83 g/t in Bhukia North Central block, Banswara district, Rajasthan.
- A resource of 2.59 million tonnes with 1.5g/t in Bhukia South Central block, Banswara district, Rajasthan.
- 1.113 million tonnes of ore containing 1.16 to 6.28 g/t Au in Dona South block, Anantpur district, Andhra Pradesh.
- 0.098 million tonnes of ore averaging 3.85 g/t Au in Dona North block, Anantpur district, Andhra Pradesh.
- A resource of 0.4 million tonnes of gold ore with 3.1g/t Au in Parasi area, Ranchi district, Jharkhand.
- A resource of 0.25 million tonnes of gold ore with 3.85g/t Au in Pahardia block, West Singhbhum district, Jharkhand.

Dona East (Ph-II) MECL carried out 6904 m of drilling and 64 m deep pitting in three pits. 3.356 million tonnes of gold ore reserves with 3.66 g/t Au were estimated at 1.0 g/t cut-off over 650m strike length. The deposit is having open cast potential with ore reserves 7.768 million tonnes with 2.0 g/t Au with average width 21.53 m at 0.5 g/t cut off.

HZL: In Jagpura, nine lenses were explored of which one lens, which has 41% of total resources was found to be amenable to open pit mining.

DMG, West Bengal has identified encouraging values of gold in Kattara-Harinarayanpur, Midnapur district. The samples of the area indicated 0.2g/t to 0.408g/t of Au. In Rajgaon area 0.20g/t to 0.498g/t of Au values have been reported from primary samples.

DGM, U. P. has identified encouraging gold values in Bikrampur area in the range of 0.17g/t to 0.529g/t of Au.

DMG, Rajasthan : In Jajram Ka Khera, Chittorgarh district indication of gold was found (Au-0.1 to 0.20g/t, Ag 2.2 to 42.2 g/t). The surface samples of Chhachhundara- Jorawarpura- Sargaon village, Ajmer district have indicated 1.6 to 4.7g/t Ag, 0.13 to 0.65%Cu, 378 to 1010 ppm Co and upto 0.742 g/t Au.

RIO TINTO Exploration Ltd carried out prospecting operation of gold in Chhatarpur and Panna districts, M.P.

Geo Mysore Service Pvt. Ltd. was granted 25 RP blocks over a total area of 18,490 sq.km. mainly in the states of Chhattisgarh, M.P., Rajasthan, Andhra Pradesh and Jharkhand for reconnaissance activity by geochemical and ground geophysical study for gold, basemetal, Ni and PGE. Exploration carried out during the period has brought out a few potential prospects warranting further detailed work in PL stage.

The Hutti Gold Mine Company Limited did mining in Hutti mines area and Uti block and carried out exploratory mining in Hirabuddini block, Raichur district, Karnataka.

3.2.4 DIAMOND:

GSI discovered a number of kimberlite/ lamproite bodies based on conceptual approach and multidisciplinary application mainly in Andhra Pradesh, Karnataka and Orissa. Significant finds made during the current plan are listed below:-

- In Andhra Pradesh, two gem quality diamonds weighing 3.90 carats were recovered from pipe no. P-2 of Wajrakarur Kimberlite Field.
- A diamond weighing 0.02 carats was recovered from Bodesanipalli Kimberlite body (P-14) in Andhra Pradesh.
- In Andhra Pradesh, Ananatapur district two diamonds weighing 0.13 carat and 0.04 carat have been recorded from kimberlite pipe CC-4.
- In Mahboobnagar district, Andhra Pradesh within the Peninsular Gneissic terrain, three new kimberlite pipes (SK-1, SK-2 and SK-3) have been discovered.
- In Raichur district, Karnataka, two new kimberlite pipes have been discovered; one in Metti Malkapur (RK-2) and the other in Maliabad (RK-3).
- In Andhra Pradesh at Atmakuru and Penukonda blocks, Anantapur near Timmasamudram village four new kimberlite pipes (TK-1 to TK-4) have been discovered. In course of processing all the samples from TK-4, 42 diamonds weighing 8.15 carats were discovered by processing 49 tonnes of material.
- Near Nadigadda – Malkapuram, Kurnool district, AP, a kimberlite body was located on the left bank of Tungabhadra river.
- In Musi and Halia river basins,Nalgonda district,Andhra Pradesh apart from locating two carbonate rich lamprophyre at Chennaram and Somavarigudem, ten small lamproite dykes have been identified in Ramadugu area.

- In Orissa, near Sakri, Bargarh district, a lamproite dykelet has been discovered.
- A grain of 0.15 carat diamond was recovered from Wairagarh conglomerate, Chandrapur district, Maharashtra.

NMDC continued studies in Andhra Pradesh and samples were collected from four pipes: pipe 7-Venkatampalle, pipe10 in Anumpalle, pipe11 in Dibbasamipalle and in Chigicherla.Based on RP work a few blocks have been identified for exploration under PL.

DGM, U.P: Search for diamond in ancient paleo-channels of Baghain river continued.

DMG, Andhra Pradesh: Continued search for diamond in A.P.

DGM, Orissa continued intensive exploration in Dharambandha areas in Kalmidadar and 42 pieces of diamond with maximum and minimum weight of 0.22gm and 0.006gm has been produced from bulk samples of the area.

RIO TINTO Exploration Ltd. carried out exploration of diamond in parts of Tikamgarh and Chhaattarpur districts, Madhya Pradesh and Raipur, Mahasamund, Dhamtari and Bastar districts, Chhattisgarh. 25 kimberlite pipes have been discovered since the commencement of exploration programme. Some of them are diamondiferous. Based on the RP result one PL has been applied for 4.5 sq.km in Chhattarpur and Damoh districts, M.P.

BHP- KHANIJ Anivesana Pvt. Ltd. covered parts of Mahboobnagar and Ranga Reddi districts, Andhra Pradesh; Chhattarpur, Tikamgarh and Panna districts, M. P.; Bastar, Kanker, Durg and Jagdalpur districts, Chhattisgarh for diamond exploration.

BHP Mineral Pvt. Ltd. carried out exploration for diamond in Anantapur, Mahboobnagar and Ranga Reddy districts, Andhra Pradesh; Shivpuri, Datia and Guna districts, Madhya Pradesh and Kolar, Tumkur and Chitradurga districts, Karnataka.

DE BEERS India Surveys Pvt. Ltd. carried out exploration for diamond in parts of Kurnool, Prakasam and Anantapur districts, Andhra Pradesh; Kalahandi, Nawarangpur, Bolangir and Nuapada districts, Orissa; Rewa, Gwalior, Shivpuri, Datia, Tikamgarh districts, M.P.; Gulbarga district, Karnataka; Raipur, Mahasamund, Durg, Rajnandgaon, Kanker, Dhamtari districts, Chhattisgarh; and Chitrakut district, UP. Aero-geophysical survey was followed by ground geophysical and geochemical surveys. Based on the positive results a number of PL applications have been submitted for diamond exploration in Kurnool district, Andhra Pradesh.

3.2.5 PLATINUM GROUPS OF ELEMENT (PGE):

GSI traced two parallel mineralized veins for 200 m strike length at Bhimsain Killa Pahar, Maharashtra where borehole samples analysed 13-237 ppb Pt, 75-165 ppb Pd. and 0.1 – 1.3 ppb Ir.

GSI carried out investigation for PGE in Tavarekere-Masanikere-Magyathahalli areas of Davangere district, Karnataka. The meta-pyroxenite of Hanumalapura has indicated presence of promising mineralized zone of PGE.

DGM, U.P: In Ikona –Dangli areas, Lalitpur district, PGE mineralization has been recorded in 3.5 km X 70m zone where drill core samples have analysed platinum upto 2.78g/t and paladium upto 0.75g/t**.**

3.2.6 IRON ORE:

In Sundergarh district, Orissa, **GSI** has established a total of 37.42 million tonnes of iron ore (haematite) resources from Pureibahal and other blocks. To augment iron ore resources investigation has been taken up in Bellary-Hospet sector, Karnataka; Tomka-Daiteri sector, Orissa and Ghatkuri area, Jharkhand. Investigation has been taken up in the granulite terrain of Tamil Nadu for search of magnetite resources.

DGM, Jharkhand: Float ore with 60% iron and insitu ore with 60 to 65% iron located in Noamundi area, West Singhbhum district.

DGM, Orissa i) Ore body varying in thickness from 5m to 45 m with 40% to 64.17% Fe in Khandadham area, Sundergarh district. ii) Iron ore with 62.09% to 63.73%Fe in Raida 'C' block, Keonjhar district.

DGM, Chhattisgarh: Iron ore of about 20m thickness and grade varying from 62% to 67% Fe in Pharaspat-Hurnar-Iantiwadia-Manjhapara area, Dantewara district.

3.2.7 MANGANESE ORE:

GSI has added 14.38 million tonnes of manganese ore located in Orissa.The details are as follows:

- 6.7 million tonnes of manganese ore with 20% to 31.4% Mn in Sundergarh and Bolangir districts, Orissa.
- A provisional reserve of 0.9 million tonnes of manganese ore with 20%Mn in Champasar-Bharatbahal blocks, Bolangir district, Orissa.
- 0.22 million tonnes of manganese ore with 27.1% Mn in Lasdarda block, Kendujhar district, Orissa.
- 0.598 million tonnes of manganese ore with 30.72% Mn in Pacheri block, Kendujhar district, Orissa.

- An additional resource of 5.962million tonnes of manganese ore with average grade of 27% Mn in Pacheri- Lasarda sector, Kendujhar district, Orissa.

3.2.8 CHROMITE :

GSI carried out investigation for chromite in Kanchanbahalli – Bhusal sector, Dhenkanal and Jajpur districts, Orissa. Chromite float was reported over a strike length of one kilometer.

Nuggihalli schist belt	**MECL** conducted geophysical survey and preliminary prospecting work involving 2100m drilling in Gobballihalli-Balehalli-Penna Samudra Area. In Byrapur Mines area 0.01 million tonnes ore reserves with 41% Cr_2O_3 were estimated based on data, of one borehole, for depth continuity of lode in Mine block.

Directorate of Geology, Karnataka carried out exploration in Nuggihalli schist belt, Hassan district and a reserve of 0.1 million tonne having 3.6 m thickness and 41% Cr_2O_3 has been estimated.

DMG, Jharkhand: In west Singhbhum district within serpentinised ultrabasic rock chromite with 37% to 45% Cr_2O_3 and 15% to 22% Fe_2O_3 has been located.

DCI, Manipur: A probable reserve of 33,028 tonnes of chromite has been estimated in Lunghai, Thangrai, Phangrai, Sirohi and Gamnan area of Ukhrul district.

On behalf of M/s. Orissa Mining Corporation (OMC), **MECL** carried out drilling for Chromite ore at Kaliapani, base of Mohagiri, Sukrangi etc.

3.2.9 NICKEL:

Search for nickel was carried out by the **GSI** in Dhipsai-Rajnagar sector, East Singhbhum district, Jharkhand. Preliminary indication of nickel contents varying from 0.11 to 0.15% near Kustaghutu and 0.26% nickel in Tua Dungri hillock have been established. Investigation was also carried out in the fringe areas of Simlipal Complex and Notopahar area, Orissa.

DGM, Karnataka carried out sampling for nickel in laterite capping on ultramafic rocks in North Kanara district.

3.2.10 BAUXITE:

Investigation by **GSI** in Ratnagiri district, Maharashtra indicated presence of gibbsitic bauxite below laterite capping. Drilling has yielded 5.704 million tonnes of bauxite of all grades in the area. In Kadalia, Malangtoli, and Dunkujhori areas, Kendujhar and Sundergarh districts, Orissa, plateau capped by thick lateritic bauxite were demarcated and Kadalia block was selected for exploration by drilling. Small pockets of good grade bauxite have been proved in the area. In general SiO_2 content is high. XRD studies have indicated gibbsite as the major mineral along with boehmite, kaolinite, anatase, rutile, diaspore and hematite.

1. Serangdag (block)	MECL conducted 8800 m of drilling, 147 m of deep pitting and 1000 cu.m. excavation in Serangdag (West) block, Gumla, Jharkhand. A total of a 15.44 million tonnes. of bauxite reserves with 45.9% Al_2O_3 & 4.75% SiO_2 were estimated.
2. Jamirapat	MECL estimated 9.68 million tonnes of bauxite reserves with 48.66% Al_2O_3 & 4.11% SiO_2 in Serangdag block of Jamirapat plateau, Chattisgarh based on exploration inputs of 3524m of drilling.
3. Lanjigarh	MECL carried out detailed exploration for bauxite in Lanjigarh plateau, district Rayagada / Kalahandi, Orissa of East Coast bauxite belt on behalf of M/s. Sterlite Industries India Ltd. MECL carried out 4602m of vacuum suction drilling on 200m & 100m grid and 70m of deep pitting, covering plateau area of 5.90 sq.km. A total of 76.05 million tonnes of bauxite reserves with grade 47.11% Al_2O_3 & 2.07% SiO_2 were estimated. MECL has also done developmental drilling in Panchapatmali bauxite deposit of Orissa on behalf of M/s. NALCO.

Directorate of Geology, Orissa took up exploration work in Koraput and Kalahandi districts.

Bharat Aluminium Company Ltd. continued exploration work in Mainpat area, Surguja district, Chhattisgarh.

DGM, Madhya Pradesh: In Shajapur district a total seven blocks of ferruginous aluminous laterite has been recorded and a reserve of 16 million tonnes has been estimated.

DGM, Maharastra: In Kolhapur district a reserve of 0.57 million tonne has been estimated.

DGM, Chhattisgarh: Reserves of 0.15 million tonne of bauxite has been estimated in Kasra-Lunera block, Surguja district with Al_2O_3 ranging from 43% to 55.98%. In Kamlesharpur, Bijlahawa area, Mainpat, Surguja district a total of 0.15 million tonne of bauxite containing 42% to 56% Al_2O_3, in Kadampet block and Keraput–Juamunia block a total of 0.24 million tonne and in Kadampat and Pakhantoral blocks, Jaspur district a probable reserve of 0.57 million tonnes of bauxite has been estimated.

NALCO continued exploration work in Panchapatmali bauxite mines at Damanjodi, Koraput district, Orissa.

DMG, Kerala: A total of 5.2 million tonnes of bauxite has been estimated in Karindalam area.

3.2.11 RARE METALS AND RARE EARTH ELEMENT:

GSI has estimated a resource of 0.01 million tonnes of raremetal bearing pegmatite with 1.02% Cesium (Cs) and 0.02 million tonnes of aplite with 1.27% Cs in Belamu and 1131 tonnes of pegmatite with 0.65% Cs at Khatanga of Purulia district, West Bengal.

Beku Area	MECL carried out deep pitting & shallow trenching work in Beku Area involving 141 m of pitting and 862 cu.m. of excavation and estimated 0.178 million tonnes of ore reserves with 0.443% Cs, 0.062% Li and 0.102% Rb.

3.2.12 LIMESTONE/DOLOMITE:

GSI has estimated 1883.53 million tonnes of limestone of cement, SMS, LD and chemical grades from different blocks of Litang River Valley, Jaintia Hills district, Meghalaya.

DMG, Andhra Pradesh: Exploration of limestone in Bethamcherla, Banganapally, Peapully, Uyyalawada has revealed an inferred reserve of 1035 million tonnes limestone of which 568 million tonnes fall under reserve forest.

DMG, Karnataka continued limestone investigation for cement industries in Bhima basin, Gulbarga district and in Melanahalli village, Tumkur district. In Chennagiri taluk, Davanagere district, dolomite band of BF grade was mapped.

DGM, Tamil Nadu in Kanjamalaipathi and Asaveerankudihadu blocks, Perambalur district, carried out exploration for limestone by drilling and delineated an area of 80 sq km. In Pannamparai, Pudukunaru and Sathankulan villages, Tuticorin district limestone bands having CaO content varying between 31% and 40% were delineated.

CGM, Gujarat. Good quality dolomite deposit of approximately 37.10 million tonnes has been estimated around Nakamali, Dehwat Motisadlii and Tundva village, Vadodara district. In Veraval area, Junagarh district a total reserve of 33.43million tonnes of limestone with average thickness of 6.64m has been estimated.

DGM, Chhattisgarh: In Pousari Guma area, Raipur district a reserve of 13.02million tonnes of cement grade limestone has been established. In Chuchurangpur–Amlidih area, Raipur district a reserve of 43.03million tonnes of cement grade limestone and 45 million tonnes of low grade limestone have been established. In Chilhati area, Bilaspur district a reserve of 31.09million tonnes of cement grade limestone have been proved. A reserve of 50million tonnes of limestone of all grades has been estimated in Rajur – Kodma area, Bastar district.

DMG, Meghalaya: In Asakgere, South Garo Hills district, investigation for limestone was carried out by drilling.

DGM, U.P.: In Block-IV of Ghaghar district roughly 40 million tonnes of cement grade limestone, confined to top 30 to 40m, has been estimated .

DMG, Rajasthan: In Dhonkliwali Dhani area, Jaisalmer district, about 22.76 million tonnes of SMS grade and 212.4 million tonnes of cement grade limestone was proved .

- In Gothra area, Jhunjhunu district a total of 136.66million tonnes of cement grade limestone has been proved.
- A reserve of 81.00 million tonnes of cement grade limestone in Kanpura-Arniya Joshi area, Chittaurgarh district has been established.
- 60.29 million tonnes of limestone was proved in Jawali area, Jaipur district.
- 50 million tonnes of cement grade limestone were proved in Joga area, Jaisalmer district.
- 12.5 million tonnes of chemical grade limestone was proved in Sarsani area, Nagaur district.
- 169.81 million tonnes of SMS and 217.85 million tonnes of cement grade limestone proved in Sam area, Jaisalmer district.
- 25 million tonnes reserve of cement grade limestone were assessed in Tipu-Tekra area, Jodhpur district.
- About 20 million tonnes reserve of cement grade limestone were assessed in Khinsar-Hamirana area, Nagaur district.
- 15.75 million tonnes reserve of cement grade limestone was proved in Bairas, Nagaur district. A low silica dolomite reserve of 3.29million tonnes was also identified over 0.5 sq km.
- 15 million tonnes of limestone was assessed in Sarjaniydwas area, Nagaur district.
- A 6km long and 0.50 to 1.00 km wide limestone band was found between Bhat Kotri and Lasrawan villages of Chittaurgarh district. About 70 million tonnes probable reserve was assessed in Javda block of Bhat Kotri area.
- A 2.7km in length and 1.2km width low silica dolomite (SMS grade) was established from Sangath to Karanji Ka Gurha, Udaipur district.

DGM, Orissa: Five bands of crystalline limestone of which one band of 15m to 43m with 49.58% CaO, 3.44%MgO and 7.0% SiO2 has been established in Garramura and Chalanpara, Nuapada district.

DGM, Madhya Pradesh: A total of 19.4million tonnes of dolomite has been assessed in Nimgaon, Harda district.

- 2.7 million tonnes of dolomite in the inferred category has been estimated in Ramakona area, Chhindwara district.
- A total of 30 million tonnes of dolomite resource has been estimated in Dewas district.
- A total of 24million tonnes inferred resource of dolomite has been assessed in Halte (Damoh district) and Devendra Nagar (Panna district).
- A total resource of 180 million tonnes of dolomite has been estimated around Rampura and Khandlai village, Dhar district.
- The inferred resource of 10 million tonnes limestone is expected from villages Pagra, Jhiria and Kothar in Satna district.

DCI, Manipur: A probable reserve of 5.76 million tonnes of limestone was established in Ukhrul and Phungyar.

3.2.13 CLAY :

GSI has estimated 5.83 million tonnes clay from Kasargod district, Kerala.

DMG, Rajasthan: A clay bed of 6km x 3km x 3.5km was observed near villages Luniyass-Indawar-Baragaon area, Nagaur district. A bentonite bed in 2 sq.km area was found near villages Maliyon Ki Dhani, Bishala, Angore and Chhapri Talai in Barmer district. 3.6 million tonnes of bentonite has been estimated in Phusand village.

DGM, UP; Reserve of 2.5 million tonnes of clay in Ramgarh–Nandiha area, Sonbhadra district.

DGM, M.P. A reserve of 10,000 tonnes of clay in village Barkhera, Shajapur district.

DMM,**West Bengal**: 4.2 million tonnes of clay in Dalambhija area, Bankura district.

CGM, Gujarat: White to milky china clay pockets of 0.4m to 3m thickness located in Bhuj taluk, Kutch district.

DMG, Karnataka: Carried out search for clay in Chintamani taluk, Kolar district and identified 200m x 50m, 1000m x 200m and 500m x 70m clay zones in Tadigol, Sigepalya and Hulgumnahally areas respectively.

DGM, Kerala :

- A reserve of 2.9million tonne of China Clay in Arattuchira-Karamoodu area and 3.32 million tonne of clay has been estimated in Marthandamkuzhi-Sasthavattom area, Tiruvantapuram district.
- In Nellimoodu- Mangalapuram- Karamoodu area, 2.55 million tonne of clay has been estimated.
- In Kasargod district, 9.94 million tonnes of clay and 6.8 million tonnes of variegated clay have been estimated.

3.2.14 GRAPHITE :

GSI has mapped a 9 m graphite rich band alongwith some minor bands in Puvandi-Usilampatti area of Sivaganga district, Tamil Nadu.

DGM, Jharkhand : In Salbarwa block, Palamau district resources of 0.86 million tonnes of graphite down to 10m depth has been estimated by way of mapping on different scales and drilling. Fixed carbon content in graphite varies from 15% to 20% C.

DGM, Chhattisgarh: In Revantipur – Oranga area, Surguja district,a graphite mica schist zone of 2km length and 500m width has been located.

3.2.15 DIMENSION STONE:

DMG, Rajasthan: Massive sandstone suitable for block mining was found near Kasti and Seveki village, Jhalawar district.

- Yellow marble was located near Moolsagar, Jiyar, Mundari-Mayajal and Chundi, Jaisalmer district.
- Kota stone was located between Nala and Mandawar villages Jhalawar district.
- Blockable granite were located near Vispura, Kana, Chhada areas, Pali district.
- Dolomitic marble was found over an area of 1200m x 600m and 600m x 300m near Kaled and Todi area, Alwar district.
- Dolomitic marble was located near Chhale Ki Dhani, Kushalwali Dhani area, Sikar district.

DMG, Andhra Pradesh: 0.10 million cu. m of pink and multi-coloured granite was assessed in existing quarries from Bheemal areas and 50,000 cu. m of pink granite and 25000 cu. m of multi coloured granite has been assessed in the surrounding area from Nizamabad district.

DMG, Karnataka: A total of 30 million cu. m of sandstone and 0.3 million cu. m of pink granite have been estimated in Badami taluk, and 10 million cu. m ornamental varieties of sandstone has been estimated in Bilgi taluk, Bagalkote district.

- 1.2 million cu. m of dolerite and1.3 million cu m of granite gneiss have been estimated in Somwarpet taluk, Madkeri district. Additional 3.2 million cu. m of dolerite was also added to the inventory.
- 15.64 million cu .m of dolerite and granite have been estimated in Karkale taluk of Udipi district.
- 0.50 million cu. m of dolerite dyke has been estimated in Kollegal taluk, Chamrajnagar district.

DGM, Chhattisgarh: 0.10 million cu m of flagstone in Kharod and Kasmandih village and 0.8 million cu m of low grade limestone suitable for road metal have been estimated.

0.10 million cu m of high silica limestone has been estimated in Belanga-Tikampal, Rajpur and Retawad area.

DGM, Jharkhand: A dolerite (600m x 500m) was recorded in Sarath and Madhopur/Deoghar area and 0.75 million cu m dolerite dyke in Deoghar district.1.22 million cu m of granite has been assessed in Koderma district.

DMR, Meghalaya: Five dolerite outcrop of 15m x 20m length and 8m to 10m width have been located in Anogiri-Asananggre, West Garo Hills district.

DGM, Madhya Pradesh: 12.3 million cu m of flagstone have been assessed in Gwalior district and 0.75 million cu m of flagstone have been assessed in Atta, Chiware, Neguwan area of Sagar district.

3.2.16 HIGH MAGNESIAN FLUX :

DGM, Jharkhand: In Parsajora and Turamdih in East Singhbhum district, pyroxenite bodies with 34% to 38% MgO, 34% to 36% SiO_2, 2% to 3% Al_2O_3 and Na_2O + K_2O 0.10% to 0.15% have been identified. Resources has been estimated of the order of 3.1 million tonnes. In Kharsawan area 6.3 million tonnes of pyroxenite has been estimated.

3.2.17 PRECIOUS AND SEMI PRECIOUS STONE :

DMG, Andhra Pradesh estimated 45540 tonnes, 40950 tonnes and 11446 tonnes of amethyst from Warangal, Mehboobnagar and Kurnool districts respectively. In Khamman district, corundum bearing areas were identified.

DMG Karnataka: Carried out investigation for ruby in Kademane village, Chikmagalur district.

DMG, Rajasthan carried out search in Ajmer, Udaipur, Rajsamand and Bhilwara districts for precious/semi-precious minerals.

3.2.18 TUNGSTEN:

DMM, West Bengal: Investigation for tungsten in Ranibandh, Chhendapathar area of Bankura district was continued.

3.2.19 SILLIMANITE/KYANITE:

DGM, U.P.: Investigation for sillimanite continued and a total of 2.10 million tonnes of sillimanite reserves were estimated in Chhipia area, Sonbhadra district.

DMG, Karnataka: Survey was carried out in Hosnagar taluk, Shimoga district.

3.2.20 QUARTZ/QUARTZITE/SILICA SAND/ABRASIVE STONE :

1. Kalaktang (block) (Ph-II)	MECL conducted 484 m of drilling. A total of 5.27 million tonnes of refractory grade quartzite with 95.32% SiO_2 were estimated. Beneficiation test on bulk samples by IBM, indicated that the ore is amenable to test and is refractory in grade, due to high alumina content .
2. Jiajuri	MECL excavated 4300 cu.m. in shallow pits & trench based on geological mapping in Jiajuri block, Nagaon, Assam. A total of 18.43 million tonnes with 89.84% SiO_2 & 16.08 million tonnes with 84.57% SiO_2 glass sand reserves in probable & possible categories were estimated, respectively. Beneficiation studies on bulk sample by IBM, indicated that glass sand can be upgraded to grade II glass sand as per ISI norms.

DMR, Meghalaya: Five quartz veins of 20m to 50m long and 10m to 20m wide having 97.50% SiO_2 were recorded around Thadlaskein in Jaintia Hills district.

DMG, Rajasthan:

- Refractory grade quartzite bands were found near village Thari, Sawaimadhopur district.
- Quartz and felspar bearing pegmatites were located near villages Rozron Ka Badiya, Hiraton Ka Badiya, Thanita, Kali Ghati, Adawala, Kalaliya and near village Gurlia, Rajsamand district.
- Sandstone deposits located near villages Khavanli and Kharakpur, Dhaulpur district.

- Sandstone was found near villages Gordhanpura, Ghatti, Baran district.
- Sandstone reported near villages Bisnodha and Kakpur, Dholpur district and near Keru, Khetasar and Kaolai, Jodhpur district.
- Yellow colour sandstone was reported near villages Semli Gokul and Tunkri, Jhalawar district.
- Massive sandstone was found near villages Kasti and Sevki, Jhalawar district.

DMG, Andhra Pradesh: A possible reserve of 1.87 million tonnes of quartz and 0.96 million tonnes of felspar have been estimated in Andhra Pradesh.

DMM, West Bengal: Two quartz deposits with $SiO_2 > 99\%$ were located in Berada and Gobindopur areas, Purulia district. Reserve of 3.37 million tonnes has been estimated in the area.

DMG, Karnataka: Preliminary assessment indicated a reserve of 1.73 million tonnes of quartzite and 4.24 million tonnes of quartz in Sandur taluk. Around Baudihalli, Tumkur district 0.5 million tonnes quartz has been estimated. 0.2 million tonnes of quartz has been estimated near Arkeri village, Davanagere district.

CGM, Gujarat: A tentative reserve of 2.27 million tonnes of quartz has been estimated in Malpur taluk, Sabarkantha and Jenjha area , Panchmahal district.

DGM, Kerala: In Thrikarippur- Alap area, Kannur district, 3.72 million tonnes of silica sand has been estimated.

3.2.21 CALCITE:

DGM, Madhya Pradesh: Reserves of 52575 tonnes of calcite has been estimated in Dasalgeon, Khampur in Khargone district and in Khardwa and Burhampur district a reserve of 25100 tonnes of calcite has been inferred and 11 calcite veins were located.

DMG, Rajasthan: Calcite vein of 250m x 50m was located in Pania and Singha Ki Pawlia village in Sirohi district.

CGM, Gujarat: A total of 2100 tonnes of inferred reserve of calcite has been estimated in Banaskantha district.

3.2.22 COAL/LIGNITE/COAL BED METHANE :

GSI continued its quest for solid fossil fuel through its accredited task of regional exploration in the States of West Bengal, Jharkhand, Orissa, Madhya Pradesh/Chhattisgarh, Maharashtra, Andhra Pradesh for coal and Gujarat, Tamil Nadu and Rajasthan for lignite. The priorities/thrust areas were identified in conformity with X Plan document and in keeping with the recommendations of the Sub-Committee on coal and lignite. The programmes were drawn following the well defined strategies namely, (i) locating power grade coal at shallow depth, (ii) proving of superior quality and coking coal, (iii) identifying new areas either in virgin sector or as an extension of explored blocks, (iv) establishing additional resources of lignite from power hungry southern and western states, (v) concept oriented search for concealed coal and lignite resources with multi disciplinary in put and (v) assessment of CBM potentiality in selected coal fields. The significant findings and achievement are:

- Establishment of in situ - net geological resource (F.Y. 2002-03 to 2005-06) of 12177.33 million tonnes of coal from 18 coalfields which include
  - Coking - 322.66 million tonnes
  - Non-coking - 11854.67 million tonne (Superior Grade -1938.82 mt; Power Grade- 8555.97mt; Ungraded - 1359.88 mt)
  - Major share of the Superior grade non coking coal comes from Sohagpur, Singrauli and Mand-Raigarh coalfields; while Power grade is from Talcher, Rajmahal and Birbhum coalfields.
- Augmentation of resource (F.Y. 2002-03 to 2005-06) of lignite by 941.12 million tonnes which include 807.16 million tonnes from Tamil Nadu, 46.52 million tonnes from Rajasthan and 87.44 million tonnes from Gujarat.
- In an area of 9 sq km in parts of Kapasdanga-Bharkata sector, Birbhum Coalfield, West Bengal a total resource of 5.56 billion cu. m of CBM has been estimated on the basis of direct gas value data and other parameters in one borehole (BKB-1).
- Developed its own infrastructural facilities and initiated gas desorption studies in some of the boreholes of the said coalfield.
- Potential coal and lignite bearing areas identified with the aid of basin modeling, supplemented by scout drilling.
- Initiated CBM studies in certain coalfields. Simultaneously Coal Wing has also carried out compilation of the existing database for prognostication of CBM content in some of the potential coalfields.

MECL carried out priority regional exploration in 37 blocks in 12 coal fields covering an area of 1358 sq. km. with 257250 m. of drilling including the projection for 2006-07.

A total of 10651.46 million tonnes of reserves have been established covering blocks in Mand–Raigarh, Sonhat, Singrauli, Korba, Sohagpur, Katol basin, Bander, Wardha Valley, Godavari Valley, Makum, Daranggiri and Ranjit Valley Coal fields.

MECL carried out detailed exploratory drilling on behalf of CMPDIL, WCL, WBMDC, and IISCO and completed 45939 m. of drilling in 13 blocks of 7 coal fields (Singrauli, Mand-Raigarh, Raniganj, W. Bokaro, N. Karanpura, Hasdeo-Arnad and Auranga) estimating reserves of 2028 million tonnes.

MECL carried out promotional exploration of lignite in Tamil Nadu, Rajasthan and Karnataka covering an area of 3948 sq. km.with 293513 m. of drilling in X^{th} plan including the projection for 2006-07. A total of 4667.11 million tonnes reserves have been established. In addition, to assist NLC and RSMML in their expansion programme MECL has carried out detailed exploration in Mine II, Mine III, Mine'B', Devangudi, Kasnau and Sonari blocks.

DGM, Assam: Probable reserve of 0.15 million tonnes has been estimated in Amlakhi area, Karbi-Anglong district. In Langloi hills, sporadic occurrences of coal and lignite were located. In Klurdung area 1.5 m thick coal seam was located.

DGM, Orissa: Two major coal seams of 22.40m to 31.56m thick were intersected in Dulunga block, Ib River coal field, Sundergarh district.A 29.30m to 33.85m thick coal seam intersected in Lilari area, Ib river coalfield, Jharsuguda district.

DGM, Madhya Pradesh: An inferred reserve of 12.40 million tonnes of coal varying in grade from C to D category has been estimated in Rajnagar area, Shahdol district.

DMG, Rajasthan: i) 2.84 million tonnes reserve of lignite in Hadla area, Bikaner district making a progressive total of 40.19 m tonnes. ii) 16.53 million tonnes lignite proved in Ambasar area , Bikaner district. iii) 3.01 million tonnes of lignite in Chakvijaysingpura, Bikaner district; of which 1.672 million tonnes in mineable category. iv) 0.31 million tonnes of lignite in Lalasar area, Bikaner district. v) 2.96 million tonnes of lignite in Showa area, Nokha tehsil, Bikaner district of which 0.86 million tonnes in mineable category. vi) 1.32 million tonnes of lignite in Jhajhu and Dhane Ka Gaon , Bikaner district.

CGM Gujarat: Exploration by drilling in Tadkeshwar area estimated lignite reserve of the order of 7.60 million tonnes. From Umansar lignite field around 6.72 million tonne reserve has been estimated. In Ghogha area, Bhavnagar district a total inferred reserve of lignite of the order of 7.79 million tonnes has been estimated. In Jhadadia taluk, Bharuch district, a reserve of 65.76 million tonnes of lignite has been proved. 24.94 million tonnes of lignite has been estimated in south of Tapi river, Surat district.

For iron ore, MECL carried out drilling in Sindhudurg/Asniya on behalf of M/s. SMC and on behalf of NINL in Koira Area. On behalf of SWML in Thimmappangudi block. For gold ore, MECL carried out drilling in Bellara area on behalf of M/s. H.G.M.L.

Digital Conversion of Geological Reports	MECL carried out Digital conversion of 19 Nos. of geological reports of A & B category deposits and 3D ore body modelling of 8 Nos. of geol. Report of A category (7 bauxite & 1 gold) deposits were done.

3.3.0 REGIONAL SURVEYS FOR MINERAL PROGNOSTICATION

3.3.1 Systematic Geological Mapping

Systematic geological mapping on 1:50,000 scale is the core activity of GSI, providing National Geoscientific Information and knowledge base for undertaking all other earthscience related programmes including search and assessment of mineral resources.

During the Xth plan period (2002-2007) upto September 2006, an area of 800 sq. km was covered against a total target of 900 sq. km. Systematic geological mapping was mainly confined to the inaccessible areas of the states of North Eastern Region and Northern Region. Due to local unfavourable condition, many of the interior areas of the North Eastern region could not be approached. Out of the total mappable areas of 3.146 million sq. km. of the country, 3.098 million sq. km. stand covered by systematic mapping, bringing the total coverage to 98.252%.

The left out areas for systematic mapping are unapproachable areas of northeastern Himalayas within the states of Arunachal Pradesh, Nagaland, Manipur and a portion of Meghalaya bordering Bangladesh, the northern Himalaya in the states of Jammu & Kashmir and Uttaranchal, the Jarawa inhabited islands of Andaman and Nicobar and Abujhmar plateau of Chhattisgarh.

3.3.2 Airborne Geophysical Survey

The AMSE Wing of GSI is engaged in airborne geophysical surveys for data acquisition employing magnetic and gamma ray spectrometric techniques. The surveys are followed by data processing, preparation of aerogeophysical maps, interpretation and ground evaluation to aid prospecting and exploration for minerals and ground water. The survey acts as supporting tool for requirement of geological understanding including identification of favourable locales for mineralization, crustal structure etc.

During the Xth plan period (2002-2007) upto September, 2006, with the TOASS of GSI, a total of 102062.lkm was covered by multi-sensor surveys against a target of 115207 lkm in the first four years, involving magnetic and spectrometric surveys conducted in the following areas:-

* Mehboobnagar Block in Andhra Pradesh,
* Nalgonda Block in Andhra Pradesh,
* Bangalore – Penukonda Block in Andhra Pradesh and Karnataka,
* Mulubagal – Tamballapalle Block in Andhra Pradesh and Karnataka

- Wardha Valley and Kamptee Coalfield area, Maharashtra.

Aerogeophysical Data Processing

The Geophysical Mapping Centres (GMC) processed the aerogeophysical data for generation of total intensity magnetic maps and elemental distribution maps for U, Th, K and their total counts. Various derivative maps, ratio maps for radioactive elements, topography maps etc. were also prepared. Software for modelling the basement from profile data was developed and finalised. Processing of multisensor data pertaining to Mehboobnagar block, Nalgonda block, Mulubagal – Tamballapalle areas and Chhattishgarh area has been completed and maps were generated. Processing of multisensor data pertaining to Bangalore – Penukonda area is under progress.

Aeromagnetic Imaging

The AMSE Wing in collaboration with NGRI, has integrated aeromagnetic data, collected by different agencies in different periods and at different flying heights and has generated a digital aeromagnetic image map of India. This map represents aeromagnetic anomaly features for the land area of Peninsular India covering a total area of 12,72,000 sq. km. between 8^0 and 25^0N and longitudes 74^0 and 89^0E at a chosen height of 7000 feet above mean sea level on 1:2 million scale.

Ground evaluation of airborne geophysical survey data

The interpretation of the aerogeophysical data, supplemented by ground follow-up was a concurrent exercise that followed the airborne geophysical surveys. It aimed at collecting ground truth for the corresponding aerogeophysical anomalies by geological and geochemical studies. Subsequent to ground evaluation of aerogeophysical anomaly data, investigations were taken up involving detailed mapping, geochemical sampling, pitting and trenching followed by drilling wherever necessary. Investigations of AMSE Wing mainly covered basemetals, precious metals and diamond in the following areas.

- In Eastern part of Bastar Craton in Chhattisgarh and Orissa.
- Ibrahimpur-Mantralayan area, Eastern Dharwar Craton, Karnataka and Andhra Pradesh.
- Sausal–Buru Goilkera sector in Singhbhum (West) district, Jharkhand.
- Gaudikatte and Uppanayakanahalli Blocks, Karnataka.
- Dugocha (South) and Dugocha (East) blocks in Rajasthan.
- Umarraniyan block, Salumber- Dhariawad area, Rajasthan.
- Bara Talav, Ghagri and Manpur (South) blocks, Udaipur district, Rajasthan.

3.3.3 Specialised Thematic Studies

The necessity to keep pace with the growing concepts and knowledge base in geological sciences has inspired incorporation of specialised thematic studies in GSI. Specialised thematic studies have been undertaken to generate a new set of high resolution data to resolve problems related to structure, tectonics, stratigraphy, crustal evolution, basin analysis and ore deposit modelling. The geological data base established during the systematic geological mapping (STM) requires incorporation of additional parameter, enhancement of quality and quantity of existing data and also refinement of the data element.

The efficacy of STM has been effective in interpreting intriguing geological problems as well as towards locating potential mineralised zones. During Xth plan period about 67 nos. STM projects were taken up by GSI which covered 38511 sq. km. area till September, 2006. A few spin off gold and basemetal investigation programmes were envisaged on the basis of favourable findings in course of thematic mapping.They are:

- Gold investigation in Mananthavadi-Talapuzha area, Wayanad district, Kerala.
- Basemetal investigation in Panchokhar Khara and Mina Ka Nangal areas, Sikar district, Rajasthan.
- Basemetal investigation in Dokan-Patan-Bageshwar areas in the extension of Baniwali-Ki-Dhani block in Rajasthan.
- Preliminary prospecting for basemetal mineralization in Bhuyari block, Chhindwara district, Madhya Pradesh.

A number of projects helped in resolving some of the critical problems on stratigraphy, structure, ore localisation and other aspects including crustal evolution and metallogeny.

3.3.4 Ground Geophysical Surveys

During Xth Plan period, gravity-magnetic coverage with one sample per 2.5 sq km has been initiated by GSI on 1:50000 scale. Regional gravity-magnetic mapping has brought to light valuable information on subsurface geology. During X Plan (upto September 2006) a total of 25 items were taken up by GSI covering 58320 sq km of geophysical mapping. The mapping could bring out a NE-SW trending gravity anomaly zone indicating the extension of schist belt in Raichur district, Karnataka. In Ramnad Sub-basin Tamil Nadu, gravity low anomalies were observed indicating small sub-basins interesting for lignite. In Maharashtra, a gravity low representing a sedimentary basin parallel to the trend of Pranhita-Godavari trough has been recorded in Chandrapur, Wardha and Yavatmal districts. The existing gravity map of India has been revised in collaboration with other departments like SOI, NGRI, ONGC etc. which will be released shortly.

3.3.5 Geochemical Survey

With near depletion of target area for mineral prospecting delineated on the basis of ancient workings, gossans, outcrops of oxidised ore bodies etc. it has become imperative to look for hidden/concealed deposits through integration of data combinations (geology/geochemistry/geophysics). Realising the need for precise geochemical map of the country, GSI during the X Plan has initiated the ambitious programme of National Geochemical Mapping in almost all the states of country on a systematic grid pattern for creating multielemental data base, delineation of the geochemical relief of elements characterising the geological formations, locating geochemical anomalies for varied applications in the field of metallogenesis , mineral exploration, soil fertility, human and animal health, having a great bearing of socio-economic planning and development. During Xth plan (upto September,2006) a total of 62 items of geochemical mapping items were taken up in different parts of the country covering 85593 sq km. Initially there was a problem of chemical analysis and gradually the laboratories of GSI are now equipped with state-of-the–art technology and the analytical results are gradually being available. Based on geochemical mapping result one gold investigation item has been taken up in Ajmer district, Rajasthan.

3.3.6 Marine Survey

Salient achievements by GSI are:-

- Seabed survey in EEZ including territorial waters.
- Revealed occurrence of silica sand around Kochi in the western part of the territorial waters. Silica content of off shore sands are quite encouraging at places.
- Incidence of lime mud occurrences at the continental rise off Vishakhapatnam in the east coast and off Ratnagiri in West Coast has been reported.
- Geochemical scan for hydrocarbon in off shore basin of Krishna-Godavari,Cauvery and off west coast as sponsored item of ONGC.
- The study of near shore sediments to assess heavy mineral contents off Orissa and Andhra Pradesh has revealed heavy minerals from seabed between Malud and Brahmapur, between Gopalpur and Sonapurapeta and between Baurva-Nuvvalareva.
- Survey for assessment of silica sand in the near shore areas of Andaman coast in parts of North and Middle Andaman has indicated silica content of off shore sands are encouraging at places.

3.4.0 Research and Development

3.4.1 Laboratory back up to supplement the field activities of the projects and research and development are important activity domain of the organisation aimed at meaningful completion of the projects, solving the problems through research and keeping paces with the advancement in the various fields of earthsciences. Some of the R & D programmes undertaken by GSI during Xth plan relevant to mineral exploration include:

Determination of rock, petrographic composition and cleat properties of coal samples from different coalfields in order to estimate CBM generation capacity, storage capacity and permeability.

Petrological characterisation of coal samples in order to classify coal.

Fluid inclusion studies of different gold prospects.

Application of remote sensing data in geological interpretation with emphasis on mineral targeting and preparation of thematic maps.

Geochronology and isotope geology from crucial sectors of Indian Sub-continent (Nellore Schist belt and Kandra Igneous suite of Andhra Pradesh, granitoids of granite-greenstone terrain of Karnataka, Sausar belt, Maharashtra, Bundelkhand massif of U.P. and M.P., Dharmapuri shear zone and Elagiri syenite complex, T.N, granite pluton from Gangpur mobile belt of Orissa and Sushina area, West Bengal).

3.5.0 Training

During Xth plan the training courses are designed in a sequential manner to develop specialized skills. The thrust areas as spelt out in Xth plan has been taken into consideration for identification of training programmes. Special efforts have been made to upgrade the skills of those personnel whose particular trade have become obsolete and new technologies have been developed in those field for example - Refresher course in modern surveying techniques, digitization and data entry for draftsman and surveyors, refresher course on AAS, Fire Assay and modern instrumental methods for chemists, Workshop on enhancing managerial skills and personnel competence courses on motivation for Group – C – personnel, courses on Geoinformatics for Disaster Management, Refresher courses on vehicle maintenance and safety (for drivers), courses on Internet GIS-Advance GIS etc.

A few major achievement during the Xth plan include – collaboration of training programme between GSI-NRSA-ITC on the use of New Earth observation techniques for Landslide Hazard and Risk Assessment. This programme is expected to augment trained manpower requirement of GSI, the nodal agency for landslide studies. A number of innovative training on active fault mapping, physical volcanological features in Deccan Traps, seismotectonics, seismic design and engineering geophysics, mobile mapping, leadership and change management for JAG level officer, spatial analysis and 3D modelling etc. were also taken up.

During the Xth plan from 2002 to March 2006, 134 courses were conducted imparting training to a total of 2547 personnel including GSI and outside organizations. By the end of 2007, a total of 190 courses are likely (Xth plan) to be completed and a total of 3000 personnel will be trained.

3.6.0 Digital Infrastructure established in GS1 during the Xth Plan Period

3.6.1 GSI is the main repository of Earth Science data in the country since its inception in 1851. Optimum utilisation of these multi-theme data, available in the maps, reports and publications, has been a problem. There was thus a strong need for organising and storing the data so that retrieval becomes more efficient and responsive to the specific requirements of the geoscientific communities, mineral industries and planners. Opening up of Mineral Sector, emphasis on mineral exploration, opportunities for investment in Mineral Industry by MNCs and private sectors have all added to the urgency of customised information packages. Moreover, basic geological data are useful in National Activities like planning for mineral exploration and exploitation, civil engineering projects, natural hazard management, seismotectonic studies and environmental appraisal besides various research projects relevant to earth sciences.

GSI has been proactive in recognizing the strategic role of IT in today's environment and has decided to implement during the Xth Plan an information infrastructure (christened GSI Net & Portal) based on an open, state of the art technology platform. The said information infrastructure will comprise the following components:

- GSI Intranet including LAN at different Regional / Wing / Operational Offices and WAN connecting all these offices.

- **Enterprise Integrated Portal (EIP):** A centralized, web-base providing a single point of access to all the applications in the GSI Enterprise Application suite. Disaster recovery site will take care of site level disaster, to cater to all eventualities and to ensure continuity of operations. The GSI Enterprise Application suite contains the following:

    - **The GSI Information Portal**: The face of GSI over the World Wide Web.
    - **Employee Intranet:** The gateway to all back-office transactional and scientific applications integrated with the Document Management and Workflow engine accessible primarily within GSI Intranet.
    - **Transactional and other applications:** Information systems facilitating management of Stores, Manpower, Payroll, Finance, Field Season Projects, Library services, Laboratory services, Vehicle resources etc.
    - **Scientific applications:** A centralized Spatial Data Warehouse (SDW), which will act as a single spatial data repository for all users spread across the organization thus ensuring consistency and interoperability of data. It will allow GSI to "Publish" or serve GIS application over the World Wide Web to larger communities.

- **Employee Collaborative services:** A fully integrated platform for enterprise-wide communication and collaboration, including Email, voicemail, web conferencing and group calendar. All collaborative content will be centralized and consolidated in a single datastore thus facilitating knowledge management.

- **IP telephony and Video conferencing:** IP telephony will be implemented all over GSI, whereas, Video conferencing application will be deployed over the CHQ, RHQ and Wing headquarters.

So far Local area networks have been implemented at Central Headquarter and the Regional/Wing Headquarters as part of the GSI Intranet. Implementation of LAN at operational offices and the Wide Area Network connecting all these LANs will be completed in 2005-06. The SRS phase for the GSI Enterprise Integrated Portal has been completed and is being followed by the Design and Development phase. The Portal will go live after successful System Testing and User Acceptance Testing within 2006.

Commensurate with the GSI Information Infrastructure development and NSDI movement, a holistic approach has been adopted in developing and consolidating digital data and metadata holdings. Accordingly, strong emphasis has been put to generate, update and fine tune databases and metadatabases for different thematic domains and products. Correspondingly, institutional strengthening in the fields of GIS, Remote sensing, RDBMS and allied technologies is also in progress through an ITC collaborative venture with Training Institute – Project: INDIGEO.

The achievements in the field of information technology during X Plan (2002-2007) can be summarized as follows:

- GSI Net and Portal Project: LAN at Regions and Wings completed except NER, LAN at operations; RFP for WAN, IP telephony and video-conferencing is under scrutinization; Work on Central Data Center at Kolkata and Disaster Recovery center at Hyderabad is in progress. Portal is on design-development stage; expected to go live in mid 2006.

- Fine tuning and integration of the existing Geoscientific database, comprising the domains of Geological Map (1:50,000), Drilling, Mining & Geochemical exploration, Coal, and new domains like Quaternary Geology extension module, Geophysics, Remote Sensing, Natural Hazard, Environmental geology and Rock sample Analysis (developed during X plan) into the Spatial Data warehouse. Glaciology and Geothermal domains are being directly incorporated in the centralized Spatial Data Warehouse.

- Soft copy conversion and creation of Bibliographic metadatabase to store up-to-date information of 33000 unpublished reports of GSI and published earth science literature.

- Creation of an earthquake database having records of over 20,000 events from 1897 to 2002, within the area bounded by 68^o to 98^o longitude and 0^o to 37^o N latitude. This database resulted in the generation of several thematic maps useful to the developers and planners for mitigation of earthquake related hazards.

- Twenty-six Geoinformatics projects were under implementation in 19 distributed centres for creation of a comprehensive database of both graphic and attribute information with 1:50000 scale topographic base.

- Project Digital Archive aiming at building a digital inventory of compiled 1:50,000 geological maps.

3.7.0 Modernisation and Technology Upgradation

3.7.1 In the wake of radical reforms in economic and mineral policies of the country, it was envisaged that GSI would be appropriately equipped in order to provide up-to-date high quality database for optimum development of natural resources on both land and offshore, management of natural hazards like earthquakes, landslides and Tsunamis and protection of the country from environment degradation. Thus, in order to achieve this a quantum jump in the modernisation and technology up gradation in all the spheres of activities was made. These efforts initiated during the VIII Plan period were continued through the IX and X Plan periods, but due to severe limitation of human resources the targetted objectives could not be completely achieved.

As regard the Modernisation Programme of GSI, during the first four years of the X Five Year Plan, GSI has utilised Rs. 115.25 crore (FY.2002-03 – Rs.11.33 cr; FY2003-04-Rs.31.40 cr; FY 2004-05 Rs. 29.52 cr; FY 2005-06-Rs.43.00 cr) under Modernisation & Replacement Scheme, and Rs.68.99 crore (FY.2002-03 –Rs.9.88 cr; FY 2003-04-Rs.14.48 cr; FY 2004-05 Rs.24.10 cr; FY 2005-06- Rs.20.53 cr.) for the Information Dissemination Scheme. The total fund utilisation for both the schemes taken together works out to be Rs.184.24 crore.

A list of major equipment / instruments, drilling rigs and accessories procured during the X Plan period is encapsulated below:

Geological	Geophysical	Chemical Equipment	Marine	Drill Rig & Accessories
1. Advance Research Polarising Microscope 2. Stereo Zoom Research Microscope 3. Trinocular Polarising Microscope 4. Magnetic barrier Lab Separator 5. Scintillation Counter Spectrometer 6. Induced Polarising Probe 7. Gas Source Mass Spectrometer 8. XRF Spectrometer 9. TL Dating 10. UVVS Spectrometer	1. GPR 2. EM Ground Conductimeter 3. DGPS 4. GPS 5. RG Micro Logger 6. Terraloc MK-6 7. TG/DTA/DSC 8. XRD	1. ICP MS 2. ICP AES 3. Graphite Furnace Hydrate Generator 4. Graphite Furnace Auto Sampler 5. UV VIS Spectrometer (Double Beam) 6. XRF 7. AAS 8. DC Arc 9. CHNS Analyser 10. Ion Analyser 11. Standard Reference Materials(SRM) 12. Protace Software 13. Microwave Digester 14. Microwave Digestion Pressure Vessel 15. Fusion Bead Machine 16. Portable Multiparameter Water Analytical Kit 17. Single Beam Operate Spectrometer	1. Cesium Magnetometer 2. Marine Magnetometer 3. Marine Graphic Recorder 4. Gas Chromatograph with head space sampler 5. HPLC 6. DTA 7. Mercury Analyser 8. Current Meter 9. Particle Size Analyser	1. 1000m Drill Rig 2. Triplex Pump 3. Duplex Pump 4. NQ Wire Line Drill Rigs 5. BW Right Hand Drill Rod 6. Liquid Polymer

3.7.2 MECL has procured instrument/equipments during the X Plan period inspite of suffering from acute financial constraints. The details are enlisted below :-

Equipments/Instruments procured by MECL during X Plan (2002 to 2007)

Sl. No.	Items	Quantity
1	Drill RD-30 (Medium Capacity)	3 Drills
2	Mud Pump TSA-75	3 Nos.
3	Gravimeter CG-5	1 No.
4	Total Station	1 No.
5.	GPS	2 Nos.
6.	Auto Level	1 No.
7.	CaO Analyser	1 No.

3.7.3 High Cost Items

Blue Water Research Vessel

The replacement vessel of **R.V.** Samudra Manthan has been proposed with improved ship manoeuvrability and dynamic positioning system, equipped with state-of-the-art equipments viz. multichannel seismic system for working up to 6000 m water depth and penetration of sea bed up to a depth of 6 - 7 km, multi-beam bathymetry with a large swath angle of 150", gravimeter, magnetometer, piston-core and vibrocore with depth penetrability of 30 m and 10m respectively, dredging capability, heat-flow measurement systems etc.

Regarding the Blue Water Research Vessel, "In principal" approval has been received from Planning Commission for acquisition of a new research vessel for seabed survey, exploration of non – living resources for GSI as a replacement vessel of R. V. Samudra Manthan. GSI submitted the Detailed Project Report (DPR) to MOM on 31.08.2005 incorporating the necessary details and this has been followed by the submission of the Expenditure Finance Committee (EFC) Memorandum on 14.09.2005 to MOM. The Planning Commission after examining the EFC Memo, asked GSI to revise the cost estimate and also advised to incorporate the comments of the Financial Advisor. The GSI submitted the revised EFC Memo to MOM on 27.02.2006. The EFC meeting has been held on 10.10.06

3.7.4 Geotechnical Vessel:

Feasibility Report for another research vessel, proposed for shallow water geotechnical investigations has been placed before Planning Commission. The proposed upgradation in capability for geotechnical study is envisaged as creation of additional database by means of specific surveys with coastal launches and through drilling in shallow waters from about 6 m to 30 m with the acquisition of new tailor-made Geo-technical vessel fitted with equipment for on-site measurement of parameters of offshore sediment column.The Planning Commission has accorded "In Principle Approval" for the acquisition of Geotechnical Vessel and the necessary DPR & EFC documents have been submitted. Further procurement action is under process.

3.7.5 Helicopter & Heliborne Survey System

Regarding **Helicopter & Heliborne Survey System,** administrative approval and financial sanction from MOM conveyed procurement of a heliborne geophysical survey system with four sensors at a cost of Rs.49.47 crore. An amount of Rs.18.50 crore has already been paid to M/S HAL, as an advance payment for helicopter "Dhruv". Administrative approval and financial sanction of Rs. 4.9569 crores for cost of procurement of essential spares and accessories for Dhruv (Skid version) Helicopter has been obtained from MOM. For financial sanction of Rs. 17.20 crores for the aero geophysical survey instruments, as per the report of Financial Bid Evaluation Committee, has been sent to MOM.

3.8.0 GAPS IN EXPLORATION ACTIVITIES AND CONSTRAINTS

3.8.1 In spite of substantial augmentation in the National Mineral Inventory both in terms of number of minerals explored and produced and in quantitative reserves the country still lacks resources in respect of many minerals and continues to be net importer of minerals and metals. With the increasing demand and growth of industrial economy the dependence on other countries will increase. Moreover the time lag between discovery and eventual extraction of minerals is very long mainly due to lack of extraction technology and fund constraints. The outdated technology, small size of mines/leases, ' high costs of production etc. are also contributing factors. There is an urgent need to bring in revolutionary changes for improving productivity through good planning, cost effective strategies, better beneficiation methods and recovery of by-products etc. through consolidated joint efforts by Govt., mine owners, technologists etc.

3.8.2 The deposits occurring at the surface or near the surface have mostly been explored. There remains a pressing need for locating buried/concealed deposits in known mineralized belts and in identifying new geological environments for ore localization mainly in respect of deficient and unknown commodities through conceptual studies. Emphasis for deeper exploration is also necessary along with the wider application of remotely sensed data, satellite imageries, airborne image sensor, geophysical surveys etc.

3.8.3 **GSI** and other agencies involved in exploration have brought to light several low-grade, low tonnage prospects which are exploitable as per global standards. However, the non-development of such prospects has created an adverse impact on further prospecting initiatives. Detailed exploration priorities should be viewed in the long term perspective guided by national and global scenario.

3.8.4 An analysis of the projected planned programme targets and their achievements reveal that short falls are mainly due to non-availability of sufficient funds in time for operational activities and for replacements of capital equipment like drills, pumps, analytical instruments etc. Feed back received from Central and State Govt. Agencies clearly demonstrate that several projects could not be taken or targets in many had to be reduced due to non-availability of desired/envisaged funds. Moreover, even if partial funds were available on yearly basis, the system/procedure of acquisition of several major capital equipment (Imported laboratory instruments, drill machines and accessories etc.) as prevalent in Govt. organization (say for instance in GSI) did not allow approved/envisaged procurement in the same year. Recurring delay poses a severe constraint in timely modernization/upgradation programme of the organizations.

3.8.5 Lack of adequate scientific and technical professionals have caused serious impact in the performances of several organizations particularly in GSI. No additional manpower of S&T professional was approved during the X plan. Rather there is no addition from VIIth plan onward. Moreover, 20% to 50% of sanctioned post in various scientific and technical streams of GSI remained unfilled.

3.8.6 Another field where Indian scientists are constrained is lack of exposure to the advanced metrodology/technology/tools in the field of mineral exploration for which the remedy lies in providing opportunities for training abroad and international collaborations.

3.8.7 There is more or less uniform set of exploration activities being followed in respect of metallic minerals but the same is lacking in respect of non-metallic, industrial and minor minerals where participation by private mine owners and State Govt. agencies are involved and their programmes are mainly based on short term strategies. Systematic studies are necessary for augmenting resources with sufficient degree of confidence.

3.8.8 Another major operational problem faced by cxploration agencies of both Central and State Govt. is the restrictions imposed by several State Forest Departments under the Forest conservation Act, 1980 in spite of clarifications circulated by MOEF in 1998 to all concerned for allowing surveys and investigations by agencies like GSI etc. as long as it does not involve any clearing of forests or cutting of trees. Action need to be taken at appropriate level for ensuring adherence to the above guidelines of MOEF. Moreover, it is necessary to take comprehensive view to facilitate the choice or order of land use keeping in view the needs of mineral development as well as needs of protecting the forests, environment and ecology as minerals are non-renewable natural assets. The policy decisions and suitable legislations are necessary for proper coordination to ensure a sustainable development of mineral resources in harmony with environment instead of a total ban on mineral exploitation operations in reserved forest areas.

3.8.9 In general, there are several types of constraints like those related to trained personnel, equipment, funds and policy and these are in varying proportions in different organizations involved in exploration activities. A prerequisite to induction of sophisticated and new technology, whether in the field of drilling, analytical chemistry, data processing or even in geochemical and geophysical surveys (both airborne and ground) is adequately trained manpower. Suitable training avenues are to be explored both within and outside the country alongwith strengthening backup and maintenance facilities for upkeeping these sophisticated equipments.

3.8.10 A realistic review of National Mineral Inventory and its reframing as per United Nations Framework Classification (UNFC) is a definite need for pragmatic evaluation of the resource/reserves available in the country, so that development and investment decisions could be taken on sound economic grounds. Steps have already been initiated in this direction but it should be carried out with full appreciation of quality of original data, confidence level and gaps in the information. Any hurried and arbitrary approach with the task would distort the database rather than desired improvement. Additional inputs necessary for ascertaining the status of a prospect/deposit in the geological, feasibility and economic axes of UNFC should be clearly identified in each case and appropriate action plan should be drawn for implementation. This obviously would be a task to be attended by National Agencies to facilitate and attract private investment in mineral sector. The whole purpose will be defeated if the exercise is taken up as a desk job in isolation.

3.8.11 An imperative need exists for continuous refinement and updating of geoscientific database in the light of changing concepts and innovations in the field of Earth Science. With the reforms and liberalization policies, private sectors including Multinational entrepreneurs (MNC's) demand high quality and uptodate geoscientific data base in different spheres as a starting point before considering investment decisions.

3.8.12 The lack of timely exchange of data among different agencies due to present tight compartmentalizations/limitations/rules/procedures need change in our perceptions. Free exchange of ideas among personnel involved in exploration activities of different organizations may help in a long way. The combined concerted efforts on Research & Development is the need of present day.

3.8.13 With the privatization in the mineral exploration sector, it is necessary to have reservation of areas for national agencies in order to complete the geological studies upto a meaningful stage. As State Governments are the owners of land, a uniform legislation is necessary to safeguard the interests of national agencies.

TABLE – III-1

ADDITIONAL MINERAL RESOURCE ESTABLISHED BY GSI DURING THE FIRST FOUR YEAR

(Reserve in million tonne unless stated otherwise)

Sl. No.	Ore/Mineral	Augmentation of mineral Resources during the first four years of X plan.
1.	Coal	12177.33
2.	Lignite	941.12
3.	Copper ore	8.20
4.	Lead-Zinc ore	0.80
5.	Iron ore	37.42
6.	Manganese ore	14.38
7.	Bauxite	5.70
8.	Limestone	1883.53
9.	Gold Ore	42.49
10.	Cesium bearing Pegmatite	0.03
11.	Clay	5.83
12.	CBM	556 billion cu.m.

TABLE - III-2A

XPLORATION CARRIED OUT BY MECL DURING X-TH PLAN (2002 - 2007), MOM PROJECTS

S. NO.	Block	Mineral	District	Period	Exploration Inputs	Reserves (mt)	Grade (%,g/t)
1	Dhadkidih (OCP) Eastern Sector	COPPER	Singhbhum(E) Jharkhand	12/04-3/06	D-2937m	7.10 m.t.	1.01% Cu 0.94% (Cu)
2	Nandup (East)	COPPER	Singhbhum(E) Jharkhand	3/05-3/06	D-2400m	2.47 m.t.	1.04% (Cu)
3	Bayanbil	COPPER	Singhbhum	3/05 -	D-2890m	8.79 m.t.	1.00% (Cu)
4	Ramchandrapahar	COPPER	Singhbhum	12/05 -	D-3000m	GR In Progress	
5	Shitalpani	COPPER	Balaghat,MP	7/01 - 3/03	D-1545, T-500 Cu.m Geophy(1m x 2.17% Cu; MSP-2) (4.60m x 0.65% Cu MSP-4)	No reserves Preselection Studies	
6	Malanjkhand (West)	COPPER	Balaghat,MP	11/02 - 5/03	D-1586m	No significant mineralisation found	
7	Thanewasna	COPPER	Chandrapur Maharashtra	1/04 - 12/04	D-2002m	3.40 m.t.	0.80% (Cu)
8	Uppar Pachekhani	COPPER	Sikkim East	6/01 - 10/02	D-1096m	0.04 m.t.	1.25% (Cu)
9	Singhana Extn (Block-II)	COPPER	Jhunjhunu Rajasthan	2/01 - 10/02	D-3038m	2.83 m.t.	0.82% (Cu) + 0.3-0.5 g/t(Au)
10	Devtalai (Ph-I)	COPPER	Bhilwara	3/03-11/03	D-1700m	1.27 m.t. 422 kg gold	1.36(Cu), 0.37 g/t(Au)
11	Bhagal (Ph-I & II)	COPPER	Chittargarh	1/03 - 10/05	D-4237m	9.23 m.t.	0.74% (Cu)
12	Kalabar	ZINC	Ajmer Rajasthan	11/04 - 9/05	D-902m	1.37 m.t. V.C.150m (400 mRL & 250mRL) 500m strike	4.24% Zn 0.37% Cu
13	Bajta Central	LEAD-ZINC	Ajmer Rajasthan	12/05	D-1070m	GR In Progress	
14	Latio-Ka-Khera	LEAD-ZINC	Ajmer Rajasthan	12/05	D-3235m	- Do -	
15	Kolari-Bhaonri	ZINC	Nagpur, M.S.	02/06	D-2248m	- Do -	
S. NO.	Block	Mineral	District	Period	Exploration Inputs	Reserves (mt)	Grade (%,g/t)

16	Serangdag (West)	BAUXITE	Gumla Jharkhand	1/04 - 12/05	D-8800m P-147m Tr-1000Cu.m.	15.44 m.t.	45.91% Al_2O_3 4.75% SiO_2
17	Jamirapat (MEF)	BAUXITE	Surguja Chattisgarh	2/02 - 9/04	D-3214m V.S. 310-ConV	} 9.68 m.t.	48.66% Al_2O_3 4.11% SiO_2
18	Lanjigarh (on behalf of M/s Sterlite Industries, India Pvt. Ltd.)	BAUXITE	Kalahandi & Rayagada	01/03 - 02/04	D-4602 m Deep pitting-70m	76.05 m.t.	47.11% Al_2O_3 2.07% SiO_2
19	Gobbalihalli-Balehalli-Pennasamudra Area	CHROMITE	Hassan Karnataka	10/03 - 1/05	D-2100 m Geophysical survey	0.10 m.t.	41.0% Cr_2O_3
20	Beku Area	RARE METAL Cs,Li,Rb	Purulia W.B.	11/01-11/03	P-141m Tr-862 Cu.m.	0.178 m.t.	0.443% (Cs), 0.262% (Li), 0.101(Rb)
21	Ratanpur Area	TUNGSTEN	Bankura W.B.	9/03 - 11/04	Geo.Map-10 Sq.km. Tr-1000 Cu.m	No reserves Pre-selection Studies	
22	Girar Area	GOLD	Lalitpur Uttar Pradesh	9/03-7/04	Geo.Map-10 Sq.km. Tr-1000 Cu.m Geo.Chem.Surv.-10 Sq./km.	No reserves Preselection Studies	
23	Dona East (Phase-II)	GOLD	Kurnool Andhra Pradesh	9/01 - 3/03	D-6904m. P-64m	3.356 m.t.	3.66 g/t(Au)
24	Chinmulgund (Ph-II)	GOLD	Haveri Karnataka	11/01 - 4/03	D-4036m	No significant mineralisation intersected below +350 mRL	
25	Dona Temple	GOLD	Kurnool Andhra Pradesh	10/04	D-2260m	GR In Progress	
26	Kalaktang (Phase-II)	FERRO SILICON QUARTZITE	West Kameng Arunachal Pradesh	9/03 - 9/04	D-484m	5.27 m.t.	95.32% SiO_2
27	Jiajuri	GLASS-SAND	Nagaon Assam	10/04-11/05	4300 Cu.m.	18.43 16.08	84.84% SiO_2 84.97%
28	Saipum	Decorative stone	Kolasib Mizoram	2/06 -	Geo Map-2.50 Exv -502	In progress	
29	Digital conversion of Geol. Reports and 3D Ore body Modelling	--	--	11/04 - 3/06	19 A & B Cat GR Digital & 7 Cat. GR for 3 D.M.	Completed –	

TABLE – III-2B

ADDITIONAL MINERAL RESOURCES ESTABLISHED DURING THE XTH PLAN PERIOD AND TOTAL RESERVES ESTABLISHED BY MECL SINCE 1972

Sl. No.	Mineral	Augmentation of Mineral Reserves during the Xth Plan from 1.4.2002 (m.t.)	Total Reserves as on 1.4.2006 (Million tonnes) Since inception
	A. ENERGY MINERALS		
1	Coal (Cocking & Non Coking)	10651.46	82290.31
2	Lignite	4667.11	32867.60
3	Coalbed Methane (B. Cu.m.)	--	471.40
	Sub-Total : A	**15318.57**	**115157.91**
	B. NON-FERROUS MINERALS		
4	Copper ore	35.13	559.68
5	Lead-Zinc Ores	1.37	141.21
6	Polymetallic ores		
	Copper + Lead + Zinc	--	11.50
	Copper + Lead	--	1.01
7	Bauxite	101.17	1277.34
	Sub-Total : B	**137.67**	**1990.74**
	C. FERROUS MINERALS		
8	Iron ore	--	2445.40
9	Nickel	--	64.60
10	Manganese	--	7.21
11	Chromite	0.10	0.10
	Sub-Total : C	**0.10**	**2517.31**
	D. PRECIOUS MINERALS/METALS		
	1. Gold	3.35	24.89
	2. Diamondiferrous conglomerate	--	2.93
	Sub-Total : D	**3.35**	**27.82**
	E. INDUSTRIAL MINERALS		
	1. Limestone (All grades)	--	2457.46
	2. Dolomite	--	53.70
	3. Phosphorite	--	32.29
	4. Magnesite	--	11.98
	5. Sillimanite / Fluorite	--	0.78
	6. Graphite	--	1.32
	7. Rock Salt	--	94.10
	8. Fuller's Earth/Fire clay	--	1884.84
	9. Stowing Sand	--	127.14
	10. Ferrosillicon Grade Quartzite	5.27	5.27
	11. Glass sand	34.51	34.51
	Sub-Total : E	**39.78**	**4703.39**
	F. STRATEGIC MINERALS		
	1. Tin ore	--	5.11
	2. Tungsten	--	4.00
	3. Molybdenum	--	1.50
	4. Raremetal	--	0.18
	Sub-Total : F	--	10.79
	GRAND TOTAL :	**15499.47**	**124407.96**

TABLE – III-3

RESOURCES OF MAJOR MINERALS ESTIMATED BY GEOLOGICAL SURVEY OF INDIA

(Reserves in million tonnes unless otherwise stated)

Sl. No.	Ore/Mineral	Resource Position in 1955	Resource Position in 1980	Resource Position in 1985	Resource Position in 1990	Resource Position in 1995	Resource Position in 2000	Resource Position in 2005
1.	Coal	25000	111000	125827	186044	200029	210448	253301.66*
2.	Lignite	--	2885	4290	5687	5857	29390	37154*
3.	Copper Ore	3.40	455	464.77	509.54	511.54	512.24	518.04
4.	Lead-Zinc Ore	4.87	241	360	466	498	531.25	532.05
5.	Iron Ore	5000	11470	13066	13651	13651	13651	13783.42
6.	Manganese Ore	--	95	135	150	151	155.772	170.15
7.	Bauxite	254	2489	2599	2631	2631	2631	2636.70
8.	Limestone	--	72229	73199	74443	74443	81712	84035.55
9.	Dolomite	--	3738	3948	3958	4086	4086	4086
10.	Gold Ore	--	3.94	16.1	22.018	27.018	54.38	99.233
11.	Chromite	3.4	17	132	135	146	146	146
12	PGE	Nil	Nil	Nil	Nil	Nil	14.2	14.2
13.	Caesium bearing Pegmatite	Nil	Nil	Nil	Nil	Nil	0.079	0.109
14.	Molybdenum	Nil	Nil	Nil	Nil	2.54	5.62	5.62
15.	China clay	Nil	Nil	Nil	Nil	Nil	2400	2405.83

TABLE – III-4

ADDITIONAL MINERAL RESOURCES ESTABLISHED BY STATE GOVT. AGENCIES DURING THE Xth PLAN PERIOD

(Reserve in million tonnes unless stated otherwise)

Sl. No.	Mineral Commodity	DGM of	Reserves estimated
1.	Chromite	Karnataka	0.10
		Manipur	33028 tonnes
2.	Sillimanite	Uttar Pradesh	2.10
3.	Amethyst	Andhra Pradesh	97936 tonnes
4.	Bauxite	Madhya Pradesh	225
		Maharashtra	0.57
		Chhattisgarh	1.11
		Kerala	5.20
5.	Limestone	Andhra Pradesh	1035
		Chhattisgarh	182.14
		Uttar Pradesh	40
		Gujarat	33.43
		Rajasthan	1109.02
		Madhya Pradesh	10
		Manipur	5.76
6.	Dolomite	Gujarat	37.10
		Rajasthan	3.29
		Madhya Pradesh	256.10
7.	Clay	Rajasthan	3.60
		Uttar Pradesh	2.50
		Madhya Pradesh	10000 tonnes
		West Bengal	4.20
		Kerala	25.51
8.	Quartz/Quartzite	Andhra Pradesh	1.87
		West Bengal	3.37
		Karnataka	6.67
		Gujarat	2.27
		Kerala	3.72
9.	Feldspar	Andhra Pradesh	0.96

CHAPTER –IV

REVIEW OF POST LIBERALISATION SCENARIO AND STRATEGY FOR MINERAL EXPLORATION INCLUDING POLICY INITIATIVES.

(Item – 4 & 6 of Terms of reference)

4.1.0 PREAMBLE

4.1.1 It has been the endeavor of the Ministry of Mines, Government of India to encourage greater investment in exploration and exploitation of minerals. Presently the Indian Mineral Sector is fully opened to both domestic and foreign private sector initiatives and investments. After the formulation of the National Mineral Policy in 1993, the Government had taken a series of new policy initiatives for the growth in the mineral sector, with a view to accelerating investment in the mining sector. Further, the National Mineral Policy stressed that the Central Government, in consultation with the State Governments, shall continue to formulate legal measures for the regulation of mines and the development of mineral resources to ensure basic uniformity in mineral administration so that the development of mineral resources keep pace, and is in consonance with the national policy goals. A major initiative has been in simplifying procedures to introduce transparency and avoid delay in granting different types of leases.

4.2.0 AMENDMENTS IN ACTS.

4.2.1 As a follow up of the objective of the National Mineral Policy, the Mines and Minerals (Development & Regulation) Act, 1957 has been amended twice in 1994 and 1999. The Mineral Concession Rules 1960 (MCR) and the Mineral Conservation & Development Rules 1988 (MCDR), framed under the MMDR Act, 1957 have also been modified.

4.2.2 The salient features of the important amendments are:

a) A new concept of reconnaissance operations distinct from actual prospecting operations has been introduced with a period of R.P. for three years in the Act. R.P. holder enjoys preferential right for grant of prospecting licenses. This should facilitate investment through deployment of state-of-the-art exploration technologies and accelerate exploration.

b) The amended act recognizes the evidence of existence of mineral contents in an area otherwise, than by means of prospecting as a criterion of grant of mining lease. This should lead, in some case, to saving expenses for prospecting activities and also shorten the gestation period of development of a mineral deposit.

c) A new type of permit namely ‘Reconnaissance Permit’ has been introduced signifying large area for aerial prospecting.

d) State Governments have been delegated powers to grant mineral concessions even for areas which are not compact or contiguous. This provision may provide for faster development of the mineral resources in isolated areas.

e) The State Governments have been empowered to renew prospecting licenses / mining leases in respect of specified minerals listed in Part C of the first schedule. This provision should help curtailing delay in the processing of applications for renewal of PLs/MLs.

f) Limestone has been deleted from Part 'C' of the First Schedule to the Act. This will enable the State Government to grant the mineral concessions in respect of limestone, finding vital applications and thus facilitating in the domestic core sector industries like cement, iron & steel etc.

4.2.3 Following liberalization of the mineral sector, restrictions on foreign direct investment have also been removed to a great extent. As per recent decision, foreign equity holding is now allowed upto 100% on the automatic route for all non-fuel and non-atomic minerals including diamonds & precious stones.

4.2.4. All these measures are contemplated to increase foreign capital investment and introduction of state-of-the-art technology into the mineral sector in the country. Reviewing the progress of foreign direct investment in the mineral sector and problems faced by investor it was felt that National Mineral Policy needs review. Recognizing this need and to further improve the investment climate for mining in the country, the Planning Commission has constituted a High Level Committee under the Chairmanship of Shri Anwarul Hoda, Member, Planning Commission, to review the National Mineral Policy and recommend possible amendments to the MMDR Act. The terms of reference of the Hoda Committee include review of existing procedures for grant of mineral concessions in order to streamline and simplify procedures, prioritize critical infrastructure needs of the Indian mining sector, facilitate investment to meet these needs, identify ways of augmenting State revenues and allow issues relating to value addition and forest and environment clearance.

4.2.5 The details of state-wise, mineral-wise RP, PL & ML distributed, granted and executed from 2000-2001 to 2005-2006 are given below:

1. Mineral-wise Reconnaissance Permits distributed from 2001-2002 to 2005-06 are given in Annexure IV-1.

2. State-wise Reconnaissance Permits distributed from 2001-02 to 2005-06 are given in Annexure IV-2.

3. Mineral-wise prospecting license granted from 2001-02 to 2005-06 are given in Annexure IV-3.

4. State-wise prospecting license granted from 2001-02 to 2005-06 are given in Annexure IV-4.

5. Mineral-wise Prospecting license executed during 2001-02 to 2004-05 are given in Annexure IV-5.

6. State-wise Prospecting license executed during 2000-01 to 2004-05 are given in Annexure IV-6.

7. Mineral-wise Mining Lease granted during 2001-02 to 2005-06 are given in Annexure IV-7.

8. State-wise Mining Lease granted during 2001-02 to 2005-06 are given in Annexure IV-8.

9. Mineral-wise Mining Lease executed during 2001-02 to 2005-06 are given in Annexure IV-9.

10. State-wise Mining Lease executed during 2001-02 to 2005-06 are given in Annexure IV-10.

4.3.0 **CHANGES IN RULES REQUIRED:**

4.3.1 In spite of the changes in Policy and Acts introduced, some bottle necks still exist, hampering the tempo of mineral exploration in the country.

4.3.2 Majority of the RP applications are located in the identified mineral bearing belts restricting exploration activities in established potential areas. Activities should extend in Greenfield areas, where favorable geological set up has been identified, though immediate potential of these areas have not been established. This will help identification of additional targets.

4.3.3 Though as per government guidelines, granting of RP to any agency does not prohibit any other state exploration agency to work in that area, wrong interpretation of rules by state government is hampering the ongoing activities on ground by the state agencies.

4.3.4 Change in policy for grant of area to the extent of 5,000 sq.km. in single block effectively reduces the intensity of exploration activity in the country and need to be reviewed on account of the following:

i) No Licensee can carry out the operations as stipulated in the rules/lease deeds within one year over such a large area before 50% of the area becomes due for surrender.

ii) No Licensee can concentrate on the quality and quantity of the work envisaged for prospecting in such a short time covering the whole area.

iii) This is leading to very preliminary coverage of the target areas without necessary intensive exploration inputs and surrendering of stipulated areas, sending out wrong signals in terms of actual potential of the terrain.

4.3.5 As already mentioned in the foregoing paras, the grant of Reconnaissance Permits over a single block of 5000 sq.km to one licensee does not appear tenable and this policy needs to be reconsidered. In this context, as per the technical requirement of all types of services, it is felt that the maximum area of 500 sq.km. may be stipulated in the rules for Reconnaissance Permits with all other conditions remaining the same. This is the size of the area normally granted to preliminary investigations all over the world including that of aerial surveys. In this case restrictions of total number of blocks each of a maximum 500 sq.km. with an upper limit of 10,000 sq.km area in a state, should be followed. Further, before RP is granted, the agencies interested in taking up such block must ensure a minimum level of expenditure in terms of actual work in each block. Further, the uniformity in procedure for grant of RP throughout the country must be followed.

4.3.6 National programme of Airborne Geophysical Surveys covering all the potential belts need to be intensified for deeper probing with low altitude surveys. Existing facilities are to be upgraded in different organizations like GSI, NGRI, NRSA, etc. The permissible height of flying in most cases has so far been 120 meters but it is desirable to conduct such surveys from a lower height of about 60-80 meters for increased sub-surface penetration and obtaining data for greater depth below the surface.

In view of the limited success so far on 'RP' by MNC's and other organizations it is felt that, the on going efforts for mineral search to locate the deposits of significant size and value need be continued by the Government Agencies such as Geological Survey of India and Mineral Exploration Corporation Limited as well as by the State Governments. Reduction in the activities of national agencies will not be in the interest of overall mineral development of the country.

4.4.0 SCALE & AREA OF PRIVATE INVESTMENT:

4.4.1 During 2001-02 to 2005-06 a total of 1172 PLs were granted over an area of 133743 hectares in twelve states viz. Rajasthan, Madhya Pradesh, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Maharashtra, Uttaranchal, Bihar, Chhattisgarh, Gujarat & Jharkhand.

4.4.2 Some of these licences are meant for high value and value based minerals, in which the MNCs have shown interest so far. The high value diamond and gold licences have been bagged mostly by MNCs and big domestic companies. These MNCs have the latest state-of-art technology and are backed by sound financial resources. MNCs have also started getting success in the endeavors. National interest is in the development of the mining industry as a whole, which includes several other commodities. The state agencies should be allowed to continue exploration for these minerals in addition to commodities in which the MNCs are interested.

4.4.3 As may be seen there are only a few MNCs viz. BHP-HZL Joint venture, ACC-Rio Tinto, Phelps Dodge, B. Vijaykumar, Chhattisgarh Exploration Private Limited, Ingliwood Minerals Pvt. Ltd., Geo-Mysore Services India Pvt Ltd, have actually carried out certain amount of work.

4.4.4 The other low value minerals remain by and large neglected. The low value minerals require a special attention so as to achieve a holistic development in the mineral sector in the country.

4.4.5 A substantial part of the leased out area has been surrendered in the recent past by the small and inactive players and many of these parties are in the processes of closing down the operations.

4.4.6 As per available government records out of 199 RPs granted up to 2005, 71 are currently operative. Leases for 76 have been surrendered. For the remaining 52 there is no record whether any exploration activity has been initiated.

4.5.0 **IDENTIFYING MINERALS WITH SCARCE RESOURCE BASE:**

4.5.1 India enjoys a very comfortable position in the resources of iron ore, bauxite, titanium minerals, limestone, dolomite, manganese ore, chromite, mica, gypsum, graphite and a host of other minerals but in minerals such as diamond, copper ore and concentrates, lead-zinc ore and concentrates, pyrite, apatite, rock phosphate asbestos, fluorite and kyanite the known resources are in deficit and the shortfall from demand is met by imports.

4.5.2 There are other minerals such as gold ore, silver ore, gallium, magnesium, platinum group, antimony, molybdenum ore, nickel ore, tin ore, tungsten ore, vanadium, cobalt, diamond, potash, native sulphur and borax which have a very scarce known resource base. Importing these mineral to meet the domestic demand, drains out foreign exchange reserve of the country. Exploration for these minerals needs to be augmented during the XIth plan period, with the purpose of building up future resource base.

4.6.0 **Strategy for the exploration of minerals with scarce resource base:**

4.6.1 The minerals with scarce resource base need special attention for their exploration as they consume a lot of foreign exchange for their imports. A strategy has to be evolved for a multidisciplinary systematic exploration of these minerals. Data generated in course of geological mapping activities has helped identifying favorable geological set ups. Best possible targets from this need to be selected through scanning by geochemical and ground geophysical surveys. Bigger area surrounding these targets should be investigated through airborne geophysical survey for locating favorable physical signatures from rocks. Utilizing remote sensing data, detailed trace mineral studies and carrying out detailed in depth laboratory studies to locate and identify the path finders which may lead to the discovery of new deposits of these minerals.

4.7.0 **Thrust on high value minerals such as gold, diamond, etc.**

4.7.1 Although India had a glorious past of gold production, currently it has dwindled, creating a huge gap between the demand and supply. The geological environment for hosting gold mineralization exists in many part of the country, but resources established so far for gold ore is meagre. In most of the cases resources have been established up to a shallow depth and the grade is found to be marginal. During the XI^{th} plan, efforts have to be undertaken/strengthened to locate new targets for follow-up regional assessment and finally through detailed exploration, resources have to be converted to reserves ready for exploitation.

4.7.2 The geological environment for hosting gold mineralization is about 1,12,000 sq km of which potential gold bearing areas are restricted to about 40,000 sq. km. Part of the potential areas have been covered by aerogeophysical and geochemical exploration. An area of 13,600 sq. km. has been covered in the greenstone belts of Karnataka by geochemical survey under GSI-BRGM collaborative programmes. Geochemical anomalies were selected for further prospecting. Approximately around 30% of the potential gold bearing areas have been covered by preliminary P-I & P-II stages of prospecting. It is interesting to note that although some of the P-II stage investigations were upgraded to E-I stage investigations but so far resources could not be established from those prospects. Till now gold deposits have been discovered only in the areas where there are old workings or in their extensions.

4.7.3 There are sporadic reports of the presence of gold in the river alluvium in the states of Karnataka, UP, Orissa, Uttranchal, West Bengal and Kerala, etc. These areas may be demarcated and a systematic exploration and exploitation of these alluvial deposits may be carried out in an organized manner under a Government policy which is otherwise presently being done in an unorganized and illegal manner by panning by the locals as can often be seen in these river alluvium areas.

4.7.4 There has been much interest shown by big MNCs and even the domestic private investors for diamond exploration in India. In the changed liberalized scenario 105 RPs were granted upto August 2005 covering an area of 1,62,640 sq.km in six states for diamond and other precious stones as shown in Table IV-1 & IV-2. The MNCs, equipped with the state-of-the-art technology and backed by sound financial resources, have already commenced their reconnoitary and prospecting activities in right earnest. A few kimberlite and lamproite pipes have been discovered by them and are reported to contain micro-diamonds.

4.7.5 Approximately 3,00,000 sq km area in India has been identified with geological set-up favorable for hosting diamond and other precious stones. More than half of the area has been under RP with MNCs and have been covered by state agencies. It still leaves large area where serious search for diamond is warranted. For these areas synthesis of remote sensing, geological and geophysical data is required to priorities exploration targets. Detailed sampling programs for searching heavy indicator minerals and multi-sensor heliborne surveys are to be planned.

4.7.6 Modern tools for collection and processing of samples in operational areas, vehicle mounted processing plants, light drilling machines are needed as back up.

4.7.7 Suitable laboratories for effective processing of recovery of heavy indicator minerals, EPMA/SEM-EDX back up are essential requisites.

Table-IV-1 Company-wise Reconnaissance Permits
(As on August, 2005, Source : IBM)

Name of the Company	No. of RPs granted	Total area granted (sq.km)
De Beers	30	49,248
Rio Tinto	23	39,112
BHP	18	28,727
AMIL	09	10,953
GMSR	11	5,442
NMDC	02	4,310
Phelps Dodge	04	6,940
B.V. Chhattisgarh Exploration Pvt Ltd.	02	7,000
Diamond Prospecting Ltd.	03	5,408
Jindal Steel Power	01	2,500
Emperor Granite	02	3,000
Total	**105**	**1,62,640**

Table IV-2 State-wise Reconnaissance Permits
(As on August, 2005, Source: IBM)

State	No. of RPs granted	Total area under RPs (sq.km)
Andhra Pradesh	34	45,513
Orissa	12	18,227
Madhya Pradesh	11	21,825
Karnataka	22	33,048
Chhattisgarh	21	39,128
Uttar Pradesh	05	4,899
Total	**105**	**1,62,640**

4.8.0 **Emphasis on PGE / PGM exploration:**

4.8.1 Platinum group of elements / metals (PGE / PGM) include Pt, Pd, Rh, Ru, Os, Ir are the rarest of the precious metals in the earth's crust. These metals are recovered from few primary deposits and as by-product in Ni-Cu production. The states of Karnataka, Tamil Nadu, Kerala, A.P and Jharkhand are having important locales for PGE / PGM mineralization besides Orissa which is the most promising state as far as PGE / PGM is concerned.

4.8.2 Although geological potential of the Peninsular India and Himalayan region for locating PGE deposit has been recognized, the identification of specific targets has remained unsatisfactory. The major problem has been precise chemical analysis at low levels of concentration. Now, with sophisticated instrumental facilities being available at several laboratories, it is proper time to plan some programs for PGE search in the XIth Plan.

4.8.3 In a few areas, PGE search has been taken up and the approach had been to prepare geological map of critical outcrops and limited bed rock sampling. Many diagnostic features in terms of lithological association, mineralogy and analytical data are indicative of PGE mineralization. During the XIth Plan, prioritization and phasing of work will be organised. A broad scheme of resource identification and development of PGE has been proposed. It may be cited that the base of the voluminous flood basalt of Tertiary age constitute suitable targets in which organized efforts are being planned.

4.8.4 In Orissa, chromite and titaniferous – vanadiferous magnetite are hosted by ultrabasic and basic members respectively of the stratiform intrusions which are exposed in several partially developed stratigraphic sections. These constitute the prime targets of PGE. Sukinda ultramafic chromite belt, Baula-Nausahi chromite belt, Betei-Pindbasa-Nilgiri sector show analogous set ups of early magmatic ultramafic sequence which gave anomalous values for PGE. During the XIth Plan the investigation for PGE will be taken up to the southwestern portion of the mafic-ultramafic girdle falling in the district of Keonjhar, Orissa.

4.9.0 Modernization and Upgradation of Technology :

4.9.1 In the wake of radical reforms in economic and mineral policies of the country, it was envisaged that GSI, MECL, IBM and State Government departments, etc. would appropriately equip themselves to provide up-to-date high quality data base required for optimum utilisation of mineral resources. The efforts in this line were initiated during the end of VIII Plan period and were continued during the Xth Plan period by most of the organizations. For different reasons the projected targets of modernization could not be achieved completely. The same needs to be pursued during the XIth Plan period with due focus on priority segments.

4.9.2 The immediate necessity is to search for concealed deposits, to look for so far undiscovered minerals of high value and strategic importance, to enhance the developmental potential of identified resources and also to locate off-shore mineral occurrences. Such all out efforts would call for technology upgradation for field data acquisition (ground, airborne and marine), state-of-the-art laboratory back up, exposure to desired tools for data synthesis & interpretation and development of manpower with desired capability.

4.9.3 Feed backs received from some of the organizations in respect of their modernization and technology upgradation programme envisaged for the XIth Plan period are outlined below:-

4.10.0 Geological Survey of India

4.10.1 Modernisation efforts were initiated by GSI during the VIII Plan and continued during IX Plan periods. Due to severe resource constraints and lengthy administrative procedures and also non – availability of sophisticated scientific equipment off the shelf, the envisaged objectives could not be achieved. An Expert Panel on Modernisation of GSI, constituted by the Dept. of Mines on the advice of the Parliamentary Standing Committee on Industries, submitted its recommendations to the Dept. of Mines, Ministry of Mines and identified several areas requiring major technological upgradation, covering field surveys, ground geophysical surveys, marine surveys and laboratory studies. GSI formulated an action plan for the procurement of prioritised state-of-the-art equipment covering different domains as a main thrust area in the Xth Plan proposal, based on suggestions of the Working Group of Sub-group I, for procurement of modern equipment/ research vessel/ aircraft, etc. A total outlay of Rs. 1000 crore was provided by the Government as budgetary support to the GSI to meet its operational as well as for modernisation purposes during the X Plan period which included Rs 800 crores as domestic budget support and Rs. 200 crores as ATB (aid through budget) .The ATB was withdrawn at a later stage.

4.10.2 During the first four years of the Xth Plan, significant progress has been made under the modernization programme and a sum of Rs. 127.94 crore has been utilized towards procurement of laboratory instruments, drilling accessories and IT equipment. Procurement process for some more equipment is on and some of these may materialize during the Xth Plan period and some may be carried forward for procurement during the XIth Plan.

4.10.3 Apart from the various field survey and laboratory instruments, several high-cost items were also planned to be inducted as a part of the modernization programme of GSI. A replacement Blue Water Research Vessel for the old RV Samudra Manthan for carrying out seabed survey and exploration had been proposed during the Xth Plan. A Detailed Project Report (DPR) has been submitted to the MOM followed by an Expenditure Finance Committee (EFC) memorandum to the Planning Commission. The EFC meeting under the Chairmanship of Secretary (Finance) is over and further action in this regard is being taken up. The Planning Commission has also accorded “In Principle Approval” for the procurement of a Geotechnical Vessel with shallow water drilling facility to cover the territorial water region and carry out geotechnical surveys for off-shore structures like ports, harbours, etc. The DPR and EFC documents have already been submitted to the Planning Commission through Ministry of Mines and EFC meeting is scheduled to be held anytime. GSI is also in the process of procurement of heliborne survey system for which part advance payment for the helicopter has been made and sanction for the sensors are awaited from MOM. This is expected to mature during the first year of the XIth plan.

4.10.4 GSI took up the ambitious GSI Net and Portal Project during the Xth Plan period apart from other engagements. The Net and Portal Project envisages a nationwide Intranet supported with an Enterprise Integrated Portal (EIP). This infrastructure promises to give seamless power of sharing information within the legitimate user-groups where knowledge can be created, captured, stored, retrieved, used, improved and restored. The activities, which have been initiated during Xth Plan in the field of automation of business processes at GSI, will have to be continued during XIth Plan. A summarized action plan is given below:

1. Maintenance and upgradation of GSI Information Infrastructure.
2. Augmentation of Enterprise GIS Infrastructure.
3. Abolition of digital divides between scientists and other staffs of the organization through e-learning and Employee collaborative services.
4. E-governance and e-commerce through e-shopping.
5. Manpower development to maintain such an infrastructure.
6. Equipment / machinery to be procured for the implementation of the GSI Information Infrastructure.

4.10.5 During the finalisation of the XI Plan proposals of GSI, encompassing all its activity components and as documented in the preceding chapters, a list of equipment/ instruments has been incorporated. Some minor modifications may be necessary to fine-tune the relative emphasis on top priority areas.

4.10.6 The modified list of equipment in different domain is furnished in the following tables.

TABLE-IV-3

FIELD GEOPHYSICAL EQUIPMENTS WITH INTERPRETATION SOFTWARE

Sl No	Name of Equipment	Quantity	Cost Rs in crores
1.	24 Channel signal enhancement seismograph with software	1	0.60
2.	Ground penetrating Radar	4	2.40
3.	Differential GPS system	8	0.80
4.	Digital Seismic recorders	5	0.50
5.	Broadband Seismic Unit	2	0.40
6.	Accelerometer	2	0.10
7.	Work Station		0.05
8.	Software for DGPS (Bernese)	3	0.48
9.	Geophysical Software		1.50
10.	Total Station	5	0.75
11.	Digital Level	30	0.6
12.	Gravimeter	15	5.25
13.	Magneto Telluric Instruments	1	1.5
14.	Deep Penetrating IP Resistivity Unit	2	1.50
15.	IP Resistivity Complete system	10	6.00
16.	Portable Multiparameter logger (Truck Mounted)	4	2.40
17.	Transient EM sounding	1	0.80
18.	Magnetometer (TF)	30	0.6
19.	2D Resistivity Imaging Unit	7	2.45
20.	2D Seismic Imaging Unit	3	1.50
21.	Hand held GPS	30	0.13
22.	Ground Radiometer	2	0.26
	Total		**30.57**

TABLE –IV-4

GEOPHYSICAL LAB INSTRUMENTS

Sl No	Name of Equipment	Quantity	Cost Rs in crores
1.	Storage Oscilloscope	11	1.5
2.	Digital Multimeter	29	0.03
3.	Digital LCR meter	14	0.15
4.	Frequency counter	14	0.075
5.	Logic analyser	9	0.029
6.	Portable Scope Meter with built in multimeter	5	0.1
7.	Function generator	13	0.065
8.	Power supply	19	0.095
9.	Soldering and desoldering station with pressure and temperature controlled	15	0.15
10.	Signal generator	10	0.05
11.	Precision Digital Multimeter	6	0.06
	TOTAL		**2.304**

TABLE – IV-5

CHEMICAL LABORATORY EQUIPMENTS OF GSI
(Additional requirement of Equipment/Instrument)

Sl No	Name of Equipment	Quantity	Cost Rs in crores
1.	ICP-MS (Inductively coupled plasma mass spectrometer)	2	2.50
2.	ICP-AES (Inductively coupled plasma atomic emission spectrometry)	2	1.40
3.	XRF (X ray fluorescence spectrometer)	2	2.00
4.	Ion Analyser	20	0.30
5.	Ion Chromatograph	2	0.70
6.	Fire assay	4	0.08
7.	Crushing/ grinding Machine	10	1.50
8.	AAS With complete attachments	6	1.50
9.	Automatic sample dispensers compatible with existing XRF	6	1.00
10.	Direct Solid Mercury Analyser	5	0.75
11.	Multiparameter water analysis kits	20	0.30
12.	Total Organic Carbon Analyser (TOC) (solid, liquid samples)	1	0.30
13.	Water Samplers (5 Litres)	20	0.15
14.	Water Samplers (2 Litres)	10	0.05
15.	Water purification System	3	0.30
16.	Portable Gas Chromatograph	1	0.10
	TOTAL		**12.93**

TABLE –IV-6

PETROLOGICAL , PALAEONTOLOGICAL & GEM TESTING LAB EQUIPMENTS
(Additional requirement of Equipment / instrument)

Sl No	Name of Equipment	Quantity	Cost Rs in crores
1.	Advanced Research petrological Microscopes with automatic photographic attachment, digital camera and image analysis system	4	1.00
2.	EPMA	3	12.95
3.	Isodynamic separators/Magnetic Barrier Separator	10	0.80
4.	Research type petrological microscopes with facilities for thin section photography	20	2.00
5.	Jaw crushers	10	0.07
6.	Heating & Quenching stage upto 1400 C	1	0.05
7.	WDS Spectrometer with 4 ordinary crystals with dating software for EPMA	1	0.80
8.	Differential Thermal Analyzer (D.T.A)	1	0.45
9.	Portable X-ray Radiograph	4	0.09
10.	Quartz/Ceramic distillation plant	5	0.01
11.	Digital Pipette	10	0.03
12.	Piston cylinder apparatus for experimental petrological studies	1	0.23
13.	Technological upgradation of PANalytical XRF	1	0.75
14.	Raman Spectrometer	2	1.50
15.	Pulverizers	8	0.65
16.	Setting up Oxygen isotope line for silicates	1	0.05
17.	Fine sample cutting equipment with low speed motor and diamond coated wafer blades & low quality sample grinding apparatus	1	0.02
18.	Laser particle size analyzer	2	0.50
19.	Particle size analyzer	1	0.02
20.	Analysetter Vibratory sieve shaker with complete set of sieves	4	0.08
21.	Pyrolitic Gas Chromatograph attached with mass spectrometer	1	1.50
22.	Clean room facility		0.50
23.	Inverted stereomicroscope with photographic attachment	1	0.35
24.	New set up of Limnological Lab		0.50
25.	New set up of Quaternary geology laboratory.		1.00
26.	Differential GPS	4	0.60
27.	Rock cutting/polishing machines	2	0.12
28.	Stereo-zoom binocular polarizing microscope with photographic attachments	4	0.45
29.	Automatic thin section preparation unit	10	1.60
30.	Scanning Electron Microscope with EDX	3	3.00
31.	Research type petrological microscopes	1	0.03
32.	Gem refractometer	1	0.12
33.	Laser Ablation Microprobe ICP MS with attachment for thin section study	1	4.00
	Total		**35.82**

TABLE –IV-7

MINERAL PHYSICS LABORATORY EQUIPMENTS
(Additional requirement of Equipment / instrument)

Total Items to be procured including spill over from Xth plan			
Sl No	**Name of Equipment**	**Quantity**	**Cost Rs in crores**
1.	Fully automated X-ray Powder Diffractometer (APA) with ICCD and related software	2	1.20
2.	Differential Thermal Analyzer (TG-DSC/DTA-DTA/T)	3	1.50
			2.70

TABLE –IV-8

GEOCHRONOLOGY AND ISOTOPE GEOLOGY LABORATORIES OF GSI

Total Items to be procured including spill over from Xth plan			
Sl No	**Name of Equipment**	**Qty**	**Cost Rs in crores**
1.	Carbon Analyser (Caulometer)	1	0.25
2.	Imported Benzene synthesizer complete system	1	0.45
3.	Multi-barrel Tungsten Carbide Terra Mill	1	0.08
4.	Large capacity Wilfley Table	1	0.05
5.	Microprocessor controlled precision oven and pressure controlled dissolution vessels	2	0.06
6.	Gas source Mass spectrometer for Ar-Ar dating	1	4.50
7.	Microwave Digestion System	1	0.07
8.	Preheat unit for TIMS with external controls	1	0.01
9.	Fume hoods for Clean chemistry laboratory + laminar bench	1	0.06
10.	Diffusion Resistant Gas regulator	3	0.01
11.	Fused Disc Preparation unit for XRF Lab.	1	0.16
12.	Various ancillary components (equipments for TIMS, Clean chemistry Lab, XRF Lab, Radiocarbon Lab etc.)		0.20
13.	Zephyr Water Chiller for XRF Lab.	1	0.12
14.	Instrumental set up for ^{3}H studies (to be taken up in collaboration with BARC)	1	0.25
15.	Water Multiparameter compact set	1	0.03
16.	Lithium Metal Rod	1	0.02
17.	Induced polarization probe	1	0.05
18.	Lithium Reactor Vessel	1	0.06
19.	Air compressor	1	0.02
20.	Bellows flange welding assay	1	0.02
21.	Teflon Distillation Assay	1	0.02
22.	HT unit	1	0.08
23.	Water purification System	1	0.02
24.	Brandenburg Ion Energy Module	1	0.02
25.	High precision DC supply	1	0.01
26.	Turbomolecular Pumps with control units	2	0.30
27.	Secondary Ion Mass Spectrometer (SIMS) Sensitive High Resolution Ion Micro Probe (SHRIMP)	1	20.00
	Total		**26.92**

TABLE –IV-9

AIRCRAFT, HELIBORNE SURVEY EQUIPMENTS/SYSTEMS FOR AIRBORNE SURVEY

Items Proposed during XI Plan				Balance in respect of Xth plan projection		Total Items to be procured including spill over from Xth plan	
Sl No	**Name of Equipment**	**Quantity**	**Cost Rs in crores**	**Quantity**	**Cost Rs in crores**	**Quantity**	**Cost Rs in crores**
1	New Aircraft with Time Domain EM system			1*	55.00	1*	55.00
2	Heliborne survey system with aircraft			1*	53.52#	1*	35.02(-)
					108.52		**90.02**

revised cost
(-) Balance after part payment to HAL for "Dhruv" Helicopter

TABLE –IV-10

MARINE VESSEL, EQUIPMENTS FOR MARINE SURVEYS IN GSI
(Additional requirement of Equipment / instrument)

Total Items to be procured including spill over from Xth plan			
Sl No	**Name of Equipment**	**Quantity**	**Cost Rs in crores**
1	Magnetometers for R.V Samudra Manthan and two coastal launches	1	0.50
2	Shallow seismic systems for two coastal launches	2	2.00
3	Mobile Mapping System: Laptop with portable GPS (10m resolution)	16	0.20
4	Electronic Total Station	4	0.24
5	Auto level	4	0.40
6	Portable side scan sonar	8	0.40
7	Portable Echo sounder	8	0.40
8	Phleger Corer	8	0.08
9	Tide gauge	4	0.40
10	Wave gauge	4	0.40
11	Turbidity Meter	4	0.01
12	Core logging sensor for high resolution volume susceptibility measurement on whole cores	5	0.50
13	Magnetic susceptibility system	5	0.50
15	Base station recording Total field Magnetometer	1	0.20
16	Precision GPS	2	0.02
17	Multimedia Projector with digital document camera	1	0.03
18	Multimedia Projector with digital document camera	1	0.03
19	Torvane Shear Apparatus	7	0.025
20	Vane Shear apparatus (motorised)	1	0.01
21	In-situ Vane Shear Apparatus	1	0.03
23	T-bar and Ball Penetrometer	1	0.01
24	Cone Penetrometer	1	0.015
25	Liquid Limit Device with counts	1	0.005
26	Universal Cone Penetrometer (automatic)	1	0.01
27	Direct Shear Apparatus with electronic conversion kit: transducer, data logger and read out unit	1	0.09
28	Soil Trimmer	1	0.02
29	Unconfined Compressor Tester	1	0.01
30	Computerised Direct Shear Apparatus	1	0.05
31	Computerised Consolidation Apparatus	1	0.05
	Total		**6.635**

TABLE – IV-11

DRILLING MACHINES AND ACCESSORIES IN GSI
(Additional requirement of Equipment / instrument)

Sl No	Name of Equipment	Quantity	Cost Rs in crores
1	Deep drills (Hydraulic drill) of 1200 m /1500m capacity	2 (1500 m)	3.00
2	Drills (600 m capacity mechanical drive)	15	1.20
3	Drills (300 m capacity mechanical drive)	10	1.00
5	Mud pumps (duplex double acting)	50	4.00
6	Mud pumps (Triplex single acting) capable of handling mud up to 1.10 density	6	1.25
7	Drilling accessories (drill rods, casing, core barrels, diamond bits and spares)		15.00
8	Mini drill 60 m capacity mounted with small pump on LCV	10	0.8
9	Deep Drills (1000m capacity, mechanical drive)	15	3.0
			29.25

TABLE – IV-12

REQUIREMENT OF TRANSPORT DIVISION, GSI
(Replacement of old vehicles, necessary spare parts)

Sl No	Name of Equipment	Quantity	Cost Rs in crores
1	Jeeps Bolero/Qualis Ambassador cars Mahindra/Scorpio Toyota/Innova	83 2 20 5 5	4.54
2	Tata 407	5	0.20
3	Field camper	2	0.60
	TOTAL		**5.34**

TABLE –IV-13

FIELD (TOPOGRAPHIC) SURVEY INSTRUMENTS IN GSI
(Replacement and new addition of modern field equipments)

Sl No	Name of Equipment	Quantity	Cost Rs in crores
1	GPS with Palmtop computer	56	0.78
2	Cellular Phones	208	0.1
3	Digital Camera	250	0.38
4	Differential GPS	46	1.03
5	Real time differential GPS Accuracy static	5	0.13
6	Automatic total (survey) station digital level	3	0.24
7	Electronic total (survey) station	25	1.12
8	Miscellaneous field survey equipment		0.2
9	Automatic Digital Theodolite	11	0.83
10	Digital Auto levels	1	0.03
11	Portable GPS (Handheld) 10 m resolution	302	0.60
12	Brunton Compass (water and shock proof)	100	0.10
13	Geological Hammer (Schmidt/Estwing)	125	0.125
			5.665

TABLE –IV-14

INFORMATION TECHNOLOGY

Sl No	Name of Equipment	Quantity	Cost Rs in crores
1	Computers	2500	8.75
2	Work stations	50	0.70
3	Peripherals (plotters and scanners) for geoinformatics projects	30	1.80
4	Cost of deskjet printers 100 per year	500	0.15
5	Cost of replacement of Laser printers 20 per year	100	0.16
6	Software Rs. 1 crore per year		5.00
7	Servers for GSI portal		3.00
8	Bandwidth charges for GSI Net Rs, 50 lakhs per year		2.50
9	Maintenance of Hardware and software		2.00
10	Maintenance of Net and portal Rs. 2 crore per year capacity expansion of GSI Net through addition of 2000 nodes		10.00
11	i) Cost of active components		0.75
12	(ii) Cost of passive Components (including service)		0.40
13	Laptop computers		2.80
14	Cost of media and cartridges Rs. 445 lakhs per year		2.25
	TOTAL		40.26

TABLE –IV-15A

ABSTRACT COST ESTIMATE OF EQUIPMENT/INSTRUMENTS

Sl. No	Equipment/Instruments	*Cost in crores* Total cost of Equipment during XI Plan
1	Ground Geophysical Survey Instruments/ Equipment	30.57
2	Geophysical Lab. Equipment	2.30
3	Geochemical Lab. Equipment	12.93
4	Petrological/Palaeontological/ Gem Testing/ Geotechnical Lab. Equipment	35.82
5	Mineral Physics Lab. Equipment	2.70
6	Geochronological/ Isotope Geology Lab. Instruments	26.92
7	Marine Survey Equipment	6.64
8	Drill Machines and Accessories	29.25
9	Field Surveys Equipment	7.51
10	Engineering and Transport Division	5.67
11	IT Infrastructure peripherals a) GSI-Net; b) NSDI; c) Computers, software, hardware and; d) Archival of GSI unpublished reports	40.26
	Total	200.57

TABLE –IV-15B

HIGH COST EQUIPMENT

		Total Cost	Payment made during X Plan	Balance to be paid during XI Plan
	Airborne Survey Systems			
	a) New Aircraft with Time Domain EM System	55.00	nil	55.00
	b) Heliborne Survey System			
	i) Helicopter	31.24	18.50	12.74
	ii) Geophysical Sensors	17.50	nil	17.50
	iii) Spares	4.78	nil	4.78
	Marine Vessels			
	a) Research Vessel	450.00	8.00*	442.00
	b) Geotechnical Vessel	50.00		50.00
	c) Coastal Launch	40.00		40.00
		648.52	**26.50**	**622.02**
	* expected to materialise during Xth Plan			

TABLE –IV-15C

LIST OF EQUIPMENTS

GEOPHYSICAL EQUIPMENT INTERPRETATION SOFTWARE	24 Channel signal enhancement seismograph with software
	Ground penetrating Radar
	Differential GPS system
	Digital Seismic recorders
	Broadband Seismic Unit
	Software for DGPS (Bernese)
	Geophysical Software
	Total Station
	Digital Level
	Gravimeter
	Magneto Telluric Instruments
	Deep Penetrating IP Resistivity Unit
	IP Resistivity Complete system
	Portable Multiparameter logger (Truck Mounted)
	Transient EM sounding
	Magnetometer (TF)
	2D Resistivity Imaging Unit
	2D Seismic Imaging Unit
GEOPHYSICAL LAB INSTRUMENTS	Storage Oscilloscope
	Portable Scope Meter with built in multimeter
CHEMICAL LAB EQUIPMENT	ICP-MS (Inductively coupled plasma mass spectrometer)
	ICP-AES (Inductively coupled plasma atomic emission spectrometry)
	XRF (X ray fluorescence spectrometer)
	Ion Chromatograph
	Crushing/ grinding Machine
	AAS With complete attachments
	Automatic sample dispensers compatible with existing XRF
	Direct Solid Mercury Analyser

PETROLOGICAL LAB EQUIPMENT INCLUDING PALAEOLOGICAL AND GEM TESTING	Advanced Research petrological Microscopes with automatic photographic attachment, digital camera and image analysis system
	EPMA
	Isodynamic separators/Magnetic Barrier Separator
	Research type petrological microscopes with facilities for thin section photography
	WDS Spectrometer with 4 ordinary crystals with dating software for EPMA
	Technological upgradation of PANalytical XRF
	Raman Spectrometer
	Pulverizers
	Laser particle size analyzer
	Pyrolitic Gas Chromatograph attached with mass spectrometer
	Clean room facility
	New set up of Limnological Lab
	New set up of Quaternary geology laboratory.
	Differential GPS
	Automatic thin section preparation unit
	Scanning Electron Microscope with EDX
	Laser Ablation Microprobe ICP MS with attachment for thin section study
MINERAL PHYSICS LABORATORIES	Fully automated X-ray Powder Diffractometer (APA) with ICCD and related software
	Differential Thermal Analyzer (TG-DSC/DTA-DTA/T)
GEOCHRONOLOGY AND ISOTOPE GEOLOGY EQUIPMENT	Gas source Mass spectrometer for Ar-Ar dating
	Secondary Ion Mass Spectrometer (SIMS) Sensitive High Resolution Ion Micro Probe (SHRIMP)
HELIBORNE SURVEY EQUIPMENTS/SYSTEMS FOR AIRBORNE SURVEY	New Aircraft with Time Domain EM system
	Heliborne survey system with aircraft
MARINE SURVEYS EQUIPMENT	Magnetometers for R.V Samudra Manthan and two coastal launches
	Shallow seismic systems for two coastal launches
	Core logging sensor for high resolution volume susceptibility measurement on whole cores
	Magnetic susceptibility system

DRILLING EQUIPMENT	Deep drills (Hydraulic drill) of 1200 m /1500m capacity
	Drills (600 m capacity mechanical drive)
	Drills (300 m capacity mechanical drive)
	Mud pumps (duplex double acting)
	Mud pumps (Triplex single acting) capable of handling mud up to 1.10 density
	Drilling accessories (drill rods, casing, core barrels, diamond bits and spares)
	Mini drill 60 m capacity mounted with small pump on LCV
	Deep Drills (1000m capacity, mechanical drive)
TRANSPORT DIVISION	Jeeps Bolero/Qualis Ambassador cars Mahindra/Scorpio Toyota/Innova
	Tata 407
	Field camper
FIELD (TOPOGRAPHIC) SURVEY INSTRUMENTS	GPS with Palmtop computer
	Cellular Phones
	Differential GPS
	Electronic total (survey) station
	Automatic Digital Theodolite
	Portable GPS (Handheld) 10 m resolution
INFORMATION TECHNOLOGY	Computers
	Work stations
	Peripherals (plotters and scanners) for geoinformatics projects
	Software Rs. 1 crore per year
	Servers for GSI portal
	Bandwidth charges for GSI Net Rs, 50 lakhs per year
	Maintenance of Hardware and software
	Maintenance of Net and portal Rs. 2 crore per year capacity expansion of GSI Net through addition of 2000 nodes
	i) Cost of active components
	(ii) Cost of passive Components (including service)
	Laptop computers
	Cost of media and cartridges Rs. 445 lakhs per year

4.11.0 Mineral Exploration Corporation Ltd.

4.11.1 The MECL envisaged upgradation of drilling technology, geophysical instrumentation and laboratory facilities, besides acquiring latest survey instruments and global positioning systems, costing about Rs.6584.37 lakhs during the XIth Plan period. The details for the machineries and equipments/instruments with cost break up are furnished below:-

(A) Drilling :

The equipments required for up gradation of drilling technology are as under :

1. Under balanced drill machine with equipment and accessories for CBM production wells (upto 1500 m depth).
2. Diamond core drills (High, medium and low capacity).
3. Hydrostatic drills (700 – 1000 m and upto 2000 m depth).
4. Reverse circulation drills (R.C. drills) 150 m depth for Iron ore drilling.
5. Rotary drills with accessories for exploration of lignite etc.
6. Assembly for geohydrological and geotechnical studies.

(B) Mining :

For modernization and upgradation of equipments a provision for Rs. 1732.67 lakhs is proposed.

(C) Geophysics :

1. State-of-the-art Digital Geophysical Logging Systems to replace old system.
2. High Resolution Seismic Survey equipment with accessories for coal and lignite and other mineral explorations.
3. Electro-Magnetic Unit.

(D) Laboratories :

1. Automatic Coal Analyser with microprocessor for coal / lignite analysis and CHN Coal analyzer.
2. Inductively coupled plasma spectrometer (ICP). Fully computerized Atomic Absorption Spectrophotometer along with Graphite furnace, various fuel burners, Hydride vapour generating system.
3. Facilities for Environmental analysis for water, soil, air etc.

4. X-Ray Diffractometer (XRD) with software (Desk Top Model) for rapid quantitative mineral determination.
5. XRF Spectrometer for rapid elemental and mineralogical determinations.
6. Gamma – Spectrometer for faster elemental analysis.
7. Computerised, Thermo gravimetric Analyser with T.G. DTG, DTA, DSC parameter.
8. High resolution petrological microscope with accessories.
9. Image analyzing and photo camera attachment alongwith computer and softwares for faster mineral determinations.
10. High resolution Digital Camera.
11. Laptop Computer and LCD Projector.

(E) Survey :

1. More widespread use of Total stations for accurate and fast survey.

2 Differential Global Positioning System (DGPS) starting with Mini GPS and Autolevel for precise accuracy -2 Nos.

Summarised cost of upgradation for the XIth Plan is furnished in Table-IV-3.

Table –IV-3

SUMMARISED COST OF UPGRADATION FOR THE XITH PLAN (MECL)

Sl. No.	Equipment	Quantity	Cost (Approx) In Rs lakhs
A	**DRILLING**		
1.	Drilling Machine with equipment for CBM Production Wells & Accessories	1	1700
2	Reverse Circulation drills (R.C. Drill) with all accessories	1	150
3	Hydrostatic drills (700 – 1000 metres) with accessories	3	600
4	Hydrostatic drills (beyond 1000 m depth) with accessories	2	400
5	Rotary drills with accessories	4	350
6	Diamond Core Drills with accessories with various capacity a) Upto 300 m depth b) 300 – 500 m depth c) 500 – 700 m depth	 4 4 20	 30 50 600
7	Packers Assembly	1	20
	Sub Total (A)		**3900**

Table-IV-3 Contd.

SUMMARISED COST OF UPGRADATION FOR THE XITH PLAN (MECL)

Sl. No.	Equipment	Quantity	Cost (Approx) In Rs lakhs
B	**MINING**		
1.	Motive Power		
	(i) Compressors (600 Chm)	2	30.75
	(ii) Compressors (350 Chm)	4	43.00
	(iii) Generators (250 KVA)	4	61.50
2	Blast hole Drilling		
	(i) Rock drills with Air legs	50	16.50
	(ii) Airleg for rock drills	50	4.13
	(iii) Stopper with leg	5	1.65
	(iv) Drill Steel grinder (Electrical)	2	0.66
3.	Blasting		
	(i) Exploder	12	0.66
	(ii) Ohm Meter	12	0.20
4.	Loading & Transporting		
	(i) Emco 824	2	39.60
	(ii) LPDT	2	462.00
	(iii) LHD	2	258.00
	(iv) Mining Tubes	10	3.45
	(v) Locomotives	2	14.10
	(vi) Charger	2	1.88
5.	Drainage		
	(i) Electric Pump with Starter	2	2.86
	(ii) Pneumatic Pumps	6	3.63
6	Electricals		
	Pumps, Hoist starters, cables of 50 sq.mm, 35 sq.mm, 25 sq.mm, 10 sq.mm, Welding Transformer (air & oil)		8.0
7	Stone Mining		
	(i) Crusher with vibrating screen, feeder, hoper, conveyor belts etc	1	50.00
		1	18.90
	(ii) Front End Loader	8	103.20
	(iii) Tippers		
8.	Shaft Sinking		
	(i) Winder with Accessories	1	500.00
	(ii) Head Gear with Dump chute	1	50.00
	(iii) Grab loader	1	25.00
	(iv) Buckets	6	3.00
	(v) Drill machines (U/G) with accessories and bits	2	30.00
	Sub Total (B)		**1732.67**

Table – IV-3 Contd.

SUMMARISED COST OF UPGRADATION FOR THE XITH PLAN (MECL)

Sl. No.	**Equipment**	*Quantity*	**Cost (Approx) In Rs lakhs**
C	**GEOPHYSICS**		
1 2 3	EMG equipment mainly for sulphide / Metallic exploration Digital Geophysical logging system HRSS equipment Digital Microgravimeter	3 3 1	60.00 240.00 120.00
	Sub Total (C)		**420.00**
D.	**LABORATORIES**		
	1. Inductively coupled plasma spectrometer (ICP) and Spare parts in coal analyzer and ICP 2. Hot plates 3. Automatic Calorimeter 4. CHN Coal Analyser 5. Micro balance 6. Analytical balance 7. Laboratory renovation for ISO Certification 8. Image analyzing system alongwith computer and necessary software 9. Polarising microscope with accessories 10. Petrological microscope with accessories 11. Latest computer system with software and accessories 12. High resolution digital camera 13. Fully computerized X-ray, Defractrometer with software (Desktop and Lab) model with air conditioner 14. XRF Spectrometer 15. Fully computerized and automatic absorption spectro-photo meter along with graphic furnace, fuel 16. Computerised thermogravimeteric analyzer with TG, DTG, T, DTA, DSC parameters	1 6 1 1 1 2 Lumpsum 1 1 1 2 1 1 1 1 1	58.90 0.90 25.0 20.0 8.0 1.50 30.0 5.0 5.0 5.0 2.0 2.0 130.20 100.00 25.00 20.00
	Sub Total (D)		**438.30**
E	REMOTE SENSING & ENVIRONMENT		
	1. Ground Truth Radiometer **2. Radar analysis package** **3. GPS (Hand field acuracy) Digital camera, laser printer black & white & Colour** **4. Portable analysis** **5. Latest Kit for Soil , water , air analysis Kit**	1 1 1 1 1	2.00 1.00 1.70 6.00 26.70
	Sub Total (E)		**37.40**

Table – IV-3 Contd.

SUMMARISED COST OF UPGRADATION FOR THE XITH PLAN (MECL)

Sl. No.	Equipment	*Quantity*	Cost (Approx) In Rs lakhs
F	**SURVEY**		
1	Total Stations	1	19.50
2	Global Positioning System	1	30.00
3	Auto level	4	3.00
4	Computer with Printer	1	1.00
	Sub Total (F)		**53.50**
G	**EXPLORATION DIVISION**		
1	Lap Top Computer	1	1.00
2	LCD Projector	1	1.50
	Sub Total (G)		**2.50**
	GRAND TOTAL (A TO G)		**6584.37**

4.12.0 Indian Bureau of Mines

4.12.1 Beneficiation of Low grade ores.

4.12.2 Several priority fields/thrust area have been identified by IBM towards modernization.

a. Augmentation of ore dressing / Agglomeration facilities in IBM.

b. R & D enhanced gravity and magnetic separation studies for the recovery of values from waste, plant tailings and ore slimes for conservation of resources as well as for addressing environmental problem/aspects in respect of (i) Iron ore (ii) Manganese ore (iii) Chromite ore (iv) Base Metal.

c. Characterization and beneficiation of low grade phosphate deposits for utilization in fertilizer industry.

d. Beneficiation tests in Glauconite for agricultural application etc.

e. Characterization of diamondiferous kimberlite of Chhattisgarh and Madhya Pradesh region for beneficiation study for recovery of diamonds. Automatic dry up unit and X-ray diamond sorter to be added.

f. Characterization and concentration of Platinum group of elements and the extraction of PGE from the Baula-Naushai ultramafic rocks of Orissa (jointly proposed by IBM and RRL, Bhubaneswar).

g. Develop suitable beneficiation process so as to obtain suitable refractory grade bauxite from the deposits of Gujarat and Madhya Pradesh.

4.12.3 Application of Bio-leaching and Bio-beneficiation techniques both for sulphide and non-sulphidic ores currently commanding attention. The bio-leaching is now widely applied to copper, uranium and refractory gold ores.

4.12.4 Possible joint collaboration projects of IBM with RRL, Bhubaneswar & Bhopal, ISM, Dhanbad, IISC, Bangalore in the following areas have been identified.

* Removal of alumina from iron ores.
* Removal of silica from magnesite ores.
* Removal of phosphorous from manganese ores.
* Removal of iron from clay and silica sand.

4.12.5 Indo-Australian collaboration projects in "Mineral Processing Technology" is also proposed in the following fields.

Pre-concentration of sulphide minerals and ores:

1. Optical sorting technique
2. Radiometric technique
3. Gravity methods/techniques

4.13.0 Hindustan Zinc Limited

4.13.1 Hindustan Zinc Limited (HZL) which was earlier totally under the control of Government of India is presently functioning in a joint venture with M/s Sterlite Opportunities and Ventures Ltd. (SOVL) after its disinvestment and handing over of management in favour of M/s SOVL by the Government of India.

HZL-SOVL has played a pivotal role in induction and influx of state-of-the-art techniques for base metal exploration in India. It has carried out airborne magnetic and electromagnetic survey (GEOTEM deep) campaign over 20,535 km^2 at 400m line spacing at a flying height of 120m in Rajasthan area in collaboration with BHPM, Australia. This system has been used for the first time in India and comprises a high speed, digital time-domain electromagnetic towed-bird receiver, a transmitter mounted on a CASA212-200 turbo-prop STOL aircraft utilizing 25 HZ base frequency, about 4 ms pulse width, a Tx loop magnetic dipole moment of 6.65 x 105 Am^2, a high sensitivity (0.01 nano tesla) tail mounted Cesium Vapor magnetometer and an optional 256 channel Gamma Ray Spectrometer. The system integrated with the highly sensitive GPS receivers for flight path recovery and altimeters for digital terrain modelling. It had a high signal to noise ratio and could penetrate effectively below conductivity over burden.

4.13.2 HZL also deployed state-of-the-art fast drilling machines at its advanced exploration sites. The machines are top driven, all hydraulic and capable of delivering 60-100m of progress per day as against the conventional 3-12m drill machines.

4.13.3 Technology advances have also been made in data acquisition, integration and interpretation, map generation and reporting.

4.14.0 BHP-Billiton, India

4.14.1 BHP-Billiton has been operating in India for over 25 years has two offices one at New Delhi and the other at Bhubaneswar. It has spent around US $ 2 million (Rs. 9.00 crores) in the past five years on exploration in India. It has been granted Reconnaissance permits in some states in India. It continues to explore opportunities to apply the leading edge technology in mineral exploration and mining in India. It is expected to maximize the development of scarce resources in the unexplored areas.

4.14.2 BHP-Billiton has got a vast experience of the application of advanced technologies in different countries of the world in the field of mineral exploration. The applications of remote sensing having access to Quick Bird, Landsat Thematic Mapper™, Advanced Space Borne Thermal Emissions and Reflection (ASTER), Ikonos, Infrared Imageries and image processing technology data from latest satellite, airborne and ground geophysical surveys with exclusive rights to FALCON™ and GEOFERRET™ technology, cost effective and time saving drilling techniques, Selective Extraction and Soil Gas geochemical techniques and advanced sampling analytical and beneficiation techniques are the highlights of their capabilities.

4.15.0 Jawaharlal Nehru Aluminium Research Development and Design Centre (JNRDDC)

4.15.1 JNRDDC has developed its capacities for the analyses and beneficiation of the bauxite deposits. It is also carrying out R&D projects for bauxite mines. It envisages the coming up greenfield alumia refineries in Orissa in Kalahandi district for M/s Vedanta Aluminium Ltd., in Raigada district for Utkal Alumina, M/s Raykal Aluminium, L&T-Dubal and M/s Aditya Aluminum and in Sabbavaram, Vishakhapatnam (AP) for M/s JSW Aluminium, Mumbai and is gearing up to meet the challenges. Further, it is also planning to develop technologies to handle huge east coast gibbsitic bauxite deposits for which future alumina refineries are expected to be set up in Orissa.

4.16.0 The State Government Directorates of Mining and Geology have also proposed to strengthen and modernize the exploration capabilities. Setting up of laboratories with latest equipments for the analysis of the exploration samples and also to develop the IT capabilities.

4.17.0 Review and assessment of the technological gaps of the country and comparison with International levels.

4.17.1 Exploration by the State agencies in India had been using conventional tools for detection of surface indications of mineralization, extending to shallow depths. For sub-surface probing of identified targets shallow drilling by conventional drilling equipments are still continued. In contrast mineral exploration in developed countries has attained a state of supremacy by using advance geophysical techniques, aero geophysical surveys using multi-sensor equipments and sophisticated analytical equipments. The advantage of these techniques are generating data up to greater depth of sub-surface bodies and lower limits of detection for very low level but significant geochemical signatures. Further computer aided analysis of multi-parametric data is used regularly for screening worthwhile targets. The targets thus identified are then probed directly using wire line top drive hydrostatic drills thus reducing the total effective time for detecting exploitable targets and introducing improved economic viability of the project.

4.17.2 Constant efforts world over are on for improvement in the exploration technology for detection of viable target and complete understanding of the deposits for exploration by adopting suitable mining technology for the purpose of making hitherto unviable prospect economically viable. In order to accomplish the above tasks variety of techniques are used to locate and assess the deposits right from aerial surveys, ground geological, geophysical, geochemical surveys and finally drilling with increasingly closer spacing.

4.17.3 The effort of the State agencies at present are to remove the above stated technological gaps by introducing upgraded exploration techniques and equipments. The Table IV-5 gives a statement of expenditure in different exploration methodologies by state agencies and MNC's . It is apparent from the table that the expenditure incurred by state agencies are significantly lower. It is anticipated that even after taking into consideration the required additional fund the cost of exploration by state agencies will remain lower.

4.18.0 Enhancing/speeding-up off-shore mineral exploration

4.18.1 In keeping pace with the worldwide trend, the Geological Survey of India has expanded it's geological activities on to sea bed survey and offshore mineral exploration during the last four decades. As per the provisions made in the Third United Nations Conference on Law of the Sea (III UNCLOS), the Exclusive Economic Zone (EEZ) of India including Territorial Waters (TW) is about 2.02 million sq.km**.** Survey and Assessment of non-renewable resources in this submarine domain continue to be one of the major responsibilities of the GSI.

4.18.2 More than 99% of the seabed within the EEZ (excluding TW) has been covered by reconnaissance mapping by GSI till 2004-05, whereas about 77% of the offshore area within Territorial Waters has already been covered by Geological mapping.

4.18.3 Under Article 76 of the UNCLOS the outer limit of the continental shelf could be extended upto 350 nautical miles from the shore depending on several parameters including thickness of the sediments in the area. In the Indian scenario, the area of the extended continental shelf may be about 1.07 million sq.km, thereby making the total offshore area around 3.09 million sq.km, which need to be mapped and assessed within a specific time target for the purpose of staking claim.

4.18.4 To achieve this objective, the process of acquiring a replacement vessel and coastal vessel has been initiated.

4.18.5 Simultaneously augmentation in the capability of analytical study of marine sediments and biota has been planned.

4.18.6 Resource evaluation for placer minerals including micro diamonds, construction-grade silica sands etc. on the continental shelf, search for sulphide mineralization, ferromanganese and cobalt rich encrustation, phosphate rich sediments, lime mud deposits is also planned as priority areas.

Annexure IV-1

Mineral wise/ State wise. Reconnaissance permits/ prospecting Licenses /Mining Leases approved by the Ministry of Mines and Granted /Executed by the various State Government for mineral exploration in the country.

Mineral wise Distribution of Reconnaissance Permit 2001-02 to 2005-06

Unit:_ Area in Sq .km

Sl. No.	Mineral	2001-02		2002-03		2003- 04		2004-05		2005-06	
		No.	Area	No.	Area	No.	Area	No.	Area	No.	Area
1	Copper, lead, zinc, gold, silver, bismuth, Cadmium, nickel & associated minerals	13	16804	7	11634	4	4164	-	-	-	-
2	Diamond	1	481	1	2010	-	-	-	-	-	-
3	Diamond and associated minerals	13	19118	10	15417	6	6196				
4	Dolomite and associated minerals	-	-	1	1975	-	-		-	-	
5	Gold	1	702	1	1980P	-	-		-	1	834
6	Gold and associated minerals	6	2733	10	17268	-	-		-	~	-
7	Diamond, Precious stones and associated minerals	-	-	-	-	12	19668				
8	Ilmenite, garnet	-	-	-	-	1	1428	-	-	-	-
9	Copper, lead, zinc, gold & associated minerals	-	-	-	-	-	-	4	5450	-	-
10	Diamond, gold and associated minerals	-	-	-	-	-	-	1	578	-	-
	Total	34	39838	31	50284	23	31456	1	6028	1	834

(Source : IBM)

Annexure – IV- 2

State wise Distribution of Reconnaissance Permits (Source : IBM)
2001-02 to 2005-06

Unit: Area in Sq.km.

S No.	State	2001-02		2002-03		2003-04		2004-05		2005-06	
		No.	Area	No.	Area	No.	Area	No.	Area	No.	Area
1	Andhra Pradesh	9	7289	4	8725	6	8593	-	-	-	-
2	Chhattisgarh	-	-	8	10626	7	11693	-	-	-	-
3	Jharkhand	-	-	1	1870	-	-	-	-	-	-
4	Karnataka	11	14932	8	11626	1	2130	1	578	-	-
5	Kerala		-	-	-	-	-	-	-	1	834
6	Madhya Pradesh	-	-	8	16623	5	6240	-	-	-	-
7	Rajasthan	14	17617	2	814	-	-	4	5450	-	-
8	Orissa	-	-	-	-	3	2423	-	-	-	-
9	West Bengal	-	-	-	-	1	377	-	-	-	-
	Total	**34**	**39838**	**31**	**50284**	**23**	**31456**	**5**	**6028**	**1**	**834**

Annexure – IV-3

Mineral wise Prospecting License Granted
2001-02 to 2005-06 (Source : IBM)

Unit: Area in Hect.

Sl. No.	Mineral	2000-01		2001-02		2002-03		2003-04		2004-05		2005-06	
		No. of PL	Area	No. of PL	Area	No. of PL	Area	No. of PL	Area	No. of PL	Area	No, of PL	Area
1	Amethyst Quartz	-	-	-	-	-	-	1	++	2	4	1	2
2	Barytes	9	1243	5	31	4	58	8	312	2	9	-	-
3	Bauxite	-	-	-	-	1	151	-	-	2	304	-	-
4	Bismath	1	423	-	-	-	-	-	-	-	-	-	-
5	Calcite	14	1978	8	1009	17	2242	9	1466	-	-	-	-
6	Chalk	04	50	-	-	1	2	-	-	-	-	-	-
7	China Clay	-	-	1	58	1	150	1	16	2	841	2	49
8	Clay	-	-	1__	396	-	-	-	-	1	++	-	-
9	Corundum	-	-	-	-	-	-	1	6	-	-	-	-
10	Dolomite	18	367	10	71	8	21	6	124	1	11	1	11
11	Dunite	-	-	1	50	-	-	-	-	-	-	-	-
12	Diamond	4	1114	- -	-	-	-	-	-	-	-	-	-
13	Felspar	5	141	1	58	1	2	-	-	-	-	-	-
14	Fire Clay	4	12	8	30	2	8	1	8	-	-	1	2
15	Fluorite	-	-	1	192	-	-	1	265	-	-	-	-
16	Garnet(abrasive)	1	121	-	-	7	530	-	-	1	63	-	-
17	Graphite	-	-	1	6	-	-	-	-	-	-	-	-
18	Gypsum	4	1696	4	1560	5	1582	-	-	-	-	-	-

Annexure IV-3 Contd.

19	Iron Ore	-	-	1	18	-	-	4	695	3	96	1	57
20	Jasper	-	-	-	-	3	479	-	-	1	60	1	132
21	Laterite	3	12	4	118	5	73	2	7	2	29	-	-
22	Lime shell	-	-	-	-	1	65	-	-	-	-	-	-
23	Lime stone *	43	10787	17	1979	15	2225	10	1780	5	356	5	914
24	Magnesite	-	-	-	-	1	45	-	-	-	-	-	-
25	Magnetite	1	60	-	-	-	-	-	-	-	-	-	-
26	Mangenese ore	1	10	1	123	2	199	3	37	3	89	2	59
27	Mica	2	7	1	263	-	-	-	-	-	-	2	230
28	Moon stone	-	-	-	-	-	-	1	++	-	-	1	2
29	Moulding sand	1	14	1	14	-	-	1	11	-	-	-	-
30	Ochre	2	15	-	-	-	-	-	-	-	-	-	-
31	Pyrophyllite	3	187	2	154	-	-	I	138	-	-	1	52
32	Quartz	6	887	4	101	6	581	6	25	3	6	1	5
33	Quartzite	-	-	1	2	-	-	-	-	-	-	-	-
34	Red Ochre	-	-	2	4	8	1092	1	1	-	-	2	19
35	Rock Phosphate	2	600	-	-	-	-	-	-	-	-	-	-
36	Semi-precious stone	-	-	-	-	-	-	2	24	-	-	4	8
37	Soap stone	16	1247	16	1667	5	458	3	95	7	74	1	7 .
38	Shale	1	1	1	2	1	-	-	-	-	-	-	-
39	Silica Sand	-	-	-	-	14	1532	7	108	3	29	2	259
40	Tin ore	5	92	-	-	1	24	-	-	-	-	-	-
41	Vermiculite	-	-	-	-	-	-	-	-	-	-	1	1
42	White Clay	2	5	2	16	2	27	-	-	-	-	-	-
43	Yellow clay	-	-	-	-	1	1	++	-	-	-	-	-
44	Yellow Ochre	1	4	-	-	-	-	1	++		++		
45	Group Minerals	128	18918	223	25454	275	36468	16	521	19	849	13	1070
	Total	**281**	**39991**	**317**	**33376**	**387**	**48016**	**86**	**5639**	**58**	**2820**	**42**	**2879**
	Figures rounded off												
	++ Negligible												

Annexure IV - 4

State-wise Prospecting License Granted

2001-02 to 2005-06 (Source : IBM)

Unit: Area in Hects.

Sl. No.	State	2000-01		2001-02		2002-03		2003-04		2004-05		2005-06	
		No. of PL	Area	No. o	Area	No. of PL	Area	No. of PL	Area	No. of PL	Area	No. of PL	Area
1	Andhra Pradesh	56	10449	30	5088	12	1106	19	1790	12	393	4	102
2	Bihar	4	78	-	-	-	-	-	-	-	-	-	- -
3	Chhattisgarh	-	-	13	158	15	103	9	571	6	102	5	75
4	Gujarat	18	1394	5	414	6	1317	-	-	3	484	2	478
5	Jharkhand	-	-	-	-	2	22	-	-	1	11	1	2
6	Karnataka	1	1592	-	-	-	-	-	-	1	40	-	-
7	Kerala	-	-	1	-	3	67	2	19	-	-	-	-
8	Madhya Pradesh	57	570	59	580	36	642	20~	499	10	250	13	221
9	Maharshtra	-	-	-	-	-	-	14	654	3	348	-	-
10	Rajasthan	156	26863	209	27136	312	44700	17	2104	5	1122	12	1987
11	TamilNadu	1	55	-	-	-	-	1	1	-	-	4	7
12	Uttaranchal	-	-	-	-	-	-	4	8	7	74	1	7
	Total	**293**	**41001**	**317**	**33376**	**386**	**48017**	**86**	**5646**	**48**	**2824**	**42**	**2879**

Annexure IV- 5

Mineral-wise Prospecting License Executed during 2001-02 to 2004-05 (Source : IBM)

Sr. No.	Mineral	2000-01		2001-02		2002-03		2003-04		2004-05	
		No. of PL	Area in Hects	No. of PL	Area in Hects	No. of PL	Area in Hects	No. of PL	Area in Hects	No. of PL	Area in Hects
1	Amethyst Quartz	"	~	~ .	~	-	-	1	1	~	~
2	Barytes	3	254	9	547	3	53	1	4	-	-
3	Bauxite	-	-	1	1323	1	-	1	151	-	-
4	Calcite	9	1048	7	1156	11	1526	7	828	-	-
5	Corundum	-	-	-	-	-	-	1	6	-	-
6	China Clay	5	54	4	62	2	428	-	-	1	150
7	Chromite	-	-	1	92	-	-	-	-	-	-
8	Dolomite	2	5	6	46	4	13	4	32	1	10
9	Diamond	-	-	-	-	-	-	2	225	- .	-
10	Dunite	-	-	1	50	-	-	-	-	-	-
11	Felspar	2	3	03	69	-	-	1	2	-	-
12	Fire Clay	-	-	01	17	1	4	-	-	-	-
13	Fluorite	-	-	-	-	-	-	1	265	•	-
14	Garnet(abrasive)	1	191	-	-	1	113	-	-	-	-

Annexure IV- 5 Contd.

15	Graphite	3	147	7	342	3	62	•	-	-	-
16	Gypsum	3	1049	~	~	2	725	~	~	-	-
17	Gold & Associate	••	••	~	••	1	4310	1	793	-	-
18	lolite (Semi-precious stone)	~	--	-	~	--	--	1	4	-	-
19	Iron Ore	1	7	3	430	2	86	2	526	-	-
20	Jasper	-	-	-	-	3	685	1	20	-	-
21	Laterite	-	-	-	-	-	-	1	5	-	-
22	Lime stone	12	3824	9	5060	9	1087	12	1938	1	3
23	Lime shell	-	-	-	-	-	-	1	65	-	-
24	Magnesite	1	32	-	-	-	-	-	-	-	-
25	Mangenese ore	1	31	1	12	2	197	2	22	1	39
26	Moulding sand	-	-	-	-	-	-	1	11	-	-
27	Mica	-	-	1	14	-	-	-	-	-	-
28	Nickeliferous L.St.	-	-	1	367	-	-	-	-	-	-
29	Ochre	-	-	-	-	3	212	3	13	-	-
30	Pyrophyllite	4	415	5	240	1	59	1	138	-	-

Annexure IV - 5 Contd.

31	Pyroxenite	-	-	-	_	3	74	-	-	_	_
32	Quartz	3	396	6	167	4	189	6	33	-	-
33	Quartzite	-	-	1	9	3	9	-	-	-	-
34	Shale	-	-	-	-	1	2	-	-	-	-
35	Semi-precioustone	21	44	-	-	-	-	-	-	-	-
36	Silica Sand	-	-	-	-	2	72	1	50	-	-
37	Soapstone	49	2488	10	928	10	1123	5	329	4 •	206
38	White Clay	-	-	-	-	-	-	1	7	-	-
39	White Quartz	-	-	2	16	-	-	-	-	-	-
40	Tin ore	-	-	-	-	-	-	1	24	-	-
41	Group of minerals	50	4532	57	8049	183	24356	74	7758	25	3691
	Total	**170**	**14520**	**136**	**18996**	**255**	**35385**	**133**	**13250**	**33**	**4099**

Annexure IV - 6

State-wise Prospecting License Executed during 2000-01 to 2004-05 (Source : IBM)

Sl. No.	State	2000-01		2001-02		2002-03		2003-04		2004-05	
		No. of PL	Area in Hects.	No. of PL	Area in Hects	No. of PL	Area in Hects.	No. of PL	Area in Hects.	No. of PL	Area in Hects.
1	Andhra Pradesh	53	4082	26	5980	12	1285	10	1628	-	-
2	Chhattisgarh	-	-	.	-	14	237	6	574	-	-
3	Haryana	-	-	1	413	-	-	11	806	15	2313
4	Himachal Pradesh	-	-	-	-	-	-	1	21	-	-
5	Karnataka	-	-	2	786	-	-	-	-	1	38
6	Kerala	.	-	1	0.19	1	-	1	65	-	-
7	Madhya Pradesh	-	-	-	-	1	2	11	195	-	-
8	Maharshtra	5	55	15	1018	8	537	26	842	8	156
9	Meghalaya	-	-	-	-	-	-	1	473	-	-
10	Orissa	12	328	39	2617	13	427	2	78	-	-
11	Rajasthan	71	9707	45	8937	201	32864	60	7769	-	- •
12	Uttar Pradesh	34	909	-	-	1	24 .	-	-	-	-
13	Uttaranchal	-	-	3	7	3	5	4	799	3	796
14	West Bengal	-	-	-	-	1	4	-	-	-	-
15	Gujarat	5	75	4	941	-	-	-	-	-	-
	Total	**180**	**15156**	**136**	**20699**	**255**	**35385**	**133**	**13055**	**27**	**3303**

Annexure IV - 7

Mineral wise Mining Lease Granted 2000-01 to 2005-06 (Source : IBM)

Unit: Area in Hects

Sl. No.	Mineral	2000-01		2001-02		2002-03		2003-04		2004-05		2005-06	
		No. of ML	Area in Hect.	No. of ML	Area in Hect	No. of ML	Area in Hect	No. of ML	Area in Hect	No. of ML	Area in Hect	No. of ML	Area in Hect.
1	Barytes	21	87	20	335	9	165	7	174	7	46	2	23
2	Bauxite	16	1129	1	34	10	1526	3	248	4	284	6	1502
3	Calcite	1	1	3	139	11	20	4	12 -	1	5	3	14
4	Chalk	9	21	6	9	5	12	-	-	7	10	2	11
5	China Clay	4	21	4	17	6	15	8	24	6	107	15	48
6	Chromite Ore	1	55	-	-	-	-	-	-	-	-	-	-
1	Dolomite	34	418	30	346	19	149	18	81	9	175	6	41
8	Felspar	5	195	8	266	4	61	3	41	1	5	1	5
9	Fire Clay	4	4	4	17	3	8	6	19	6	11	7	34
10	Garnet	2	10	8	111	1	5	1	3	-	-	5	12
11	Iron Ore	2	94	3	132	7	117	2	24	1	38	13	487
12	Kyanite	1	4	-	-	-	-	1	7	-	-	-	-
13	Laterite	8	53	10	56	12	189	15	133	10	106	6	70

Annexure IV - 7 Contd.

14	Mangenese ore	3	11	4	62	3	98	2	30	3	58	33	65
15	Pyrophyllite	4	47	3	70	1	31	1	9	1	13	-	-
16	Quartz	50	648	62	873	32	451	28	538	21	301	15	123
17	Shale	2	4	3	6	4	20	1	1	1	5		
18	Silica Sand	14	45	20	234	14	100	14	187	28	322	19	124
19	Silicious earth	2	10	1	5	1	5	-	-	-	-	-	-
20	Slate	1	31	-	-	-	-	1	6	-	-	-	-
21	Soapstone/steatite	3	11	6	28	-	-	-	-	1	2	1	2
22	River sand	-	-	-	-	1	65	1	42	-	-		
23	White clay	8	49	3	24	2	3	-	-	5	34	2	18
24	Steatite	-	-	-	-	1	1	-	-	-	-	-	-
25	Agate/Stowing sand	1	41	-	-	2	48	-	-	1 .	156	1	78
26	Clay	1	10	-	-	-	-	-	-	2	12	1	17
27	Soapstone	-	-	3	28	-	-	2	4	9	45	3	17
28	Moulding sand	1	14	-	-	-	-	-	-	1	5	-	-
29	Lime shell	-	-	-	-	2	40	-	-	4	17	2	15
30	Ochre(red)	3	22	-	-	3	12	3	19	3	46	-	-
31	Pyroxenite	5	30	-	-	3	12	1	3	-	-	2	38
32	Quartzite	1	40	2	72	1	9	4	62	2	61	4	29
33	Gypsum	-	-	2	560	2	751	-	-	01	01	-	-

Annexure IV - 7 Contd.

34	Ochre(yellow)	-	-	4	31	2	30	4	30	-	-	-	-
35	Pozolanic clay	-	-	1	49	-	-	-	-	-	-	-	-
36	Yellow clay	-	-	1	5	-	-	-	-	-	-	-	-
37	Amethyst	-	-	1	1	4	18	-	-	1	4	-	-
38	Ball Clay	-	-	1	5	-	-	-	-	-	-	-	-
39	Mica	-	-	1	1	-	-	-	-	-	-	1	10
40	White Shale	-	-	1	3	3	21	-	-	1	3	-	-
41	Limestone	43	1140	68	3742	55	1256	57	7250	21	388	21	2463
42	Graphite	-	-	2	10	1	67	-	-	3	39	-	-
43	Rock Phosphate	-	-	-	-	-	-	1	2	-	-	-	-
44	Lime Kankar	-	-	-	-	-	-	5	40	-	-	-	-
45	Semi precious stone	-	-	-	-	-	-	7	26	1	10	2	6
46	Tin Ore	1	8	-	-	-	-	1	36	-	-	-	-
47	Mineral sand	-	-	-	-	-	-	-	-	1	5	-	-
48	Corundum	-	-	-	-	-	-	-	-	-	-	1	2
49	Vermiculite	-	-	-	-	-	-	-	-	-	-	1	3
50	Ochre	-	-	-	-	-	-	-	-	-	-	4	18
51	Group of Minerals	74	784	158	1508	156	1467	97	1756	83	1139	79	838
	Total	**325**	**5037**	**444**	**8779**	**380**	**6772**	**298**	**10798**	**246**	**3445**	**258**	**6113**

Annexure IV - 8

State wise Mining Lease Granted 2000-01 to 2005-06 (Source: IBM)
(Unit: Area in Hects)

Sl. No.	State	2000-01		2001-02		2002-03		2003-04		2004-05		2005-06	
		No. of ML	Area in Hect.	No. of ML	Area in He	No. of ML	Area in Hect.	No. of ML	Area in Hect.	No. of ML	Area in Hect.	No. of ML	Area In Hect.
1	Andhra Pradesh	175	2711	241	5174	130	2724	122	3755	94	1955	73	2870
2	Bihar	11	58	2	24	1	4	-	-	-	-	-	-
3	Gujarat	21	52	27	323	29	200	11	29	21	66	20	1924
4	Karnataka	8	102	3	17	3	65	-	-	-	-	5	126
5	Kerala	10	22	11	8	5	6	9	17	14	54	14	28
6	Madhya Pradesh	46	460	41	1519	63	401	65	2580	23	273	15	250
7	Maharshtra	19	1268	1	34	23	1843	6	340	8	644	14	604
8	Rajasthan	24	321	61	1385	63	1060	37	185	33	164	104	521
9	Tamilnadu	10	28	45	98	36	75	26	71	39	101	42	145
10	Chhattisgarh	1	14	8	74	23	377	12	115	4	19	3	198
11	Jharkhand	-	-	2	19	2	6	5	29	3	130	5	311
12	Himachal Pradesh	-	-	-	-	-	-	1	3720	-	-	-	-
13	Uttaranchal	-	-	-	-	-	-	1	2	8	39	-	-
14	Meghalaya	-	-	2	104	1	5	-	-	-	-	-	-
	Total	**325**	**5036**	**444**	**8779**	**379**	**6766**	**295**	**10843**	**247**	**3445**	**295**	**6977**

Annexure IV - 9

Mineral wise Mining Lease Executed 2000-01 to 2005-06 (Source : IBM)

Unit: Area in Hects

Sl. No.	Mineral	2000-01		2001-02		2002-03		2003-04		2004-05		2005-06	
		No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area
1	Bauxite	4	643	1	34	-	~	4	685	4	327	1	1
2	Barytes	12	69	26	377	3	71	13	296	7	44	6	123
3	Calcite	1	1	1	5	1	5	-	-	1	118	-	-
4	Chalk	10	71	8	18	10	20	4	24	8	22	3	32
5	China Clay	6	418	4	40	10	779	7	37	6	24	7	25
6	Clay	1	14	2	57	1	4	2	6	2	8	1	4
7	Dolomite	7	164	13	255	3	396	5	60	1	31	5	29
8	Felspar	3	32	6	294	1	10	2	35	-	-	-	-
9	Fire Clay	6	22	1	5	-	-	2	6	5	41	-	-
10	Graphite	1	27	2	28	-	-	-	-	-	-	-	-
11	Gypsum	2	353	1	5	1	162	-	-	1	1	-	-
12	Iron Ore	2	29	3	1095	8	344	I	5	3	167	1	322
13	Laterite	2	22	1	4	2	129	5	10	5	139	5	51
14	Limestone	13	89	16	790	18	2058	15	442	5	2148	4	336

Annexure IV - 9 Contd.

15	Mangenese ore	4	743	2	45	2	121	2	12	4	77	3	49
16	Magnesite	-	-	1	40	-	-	-	-	-	-	-	-
17	Pyrophyllite	1	35	2	14	2	66	-	-	-	-	-	-
18	Quartz	10	65	15	187	12	182	8	55	7	33	4	23
19	Sand	2	31	-	-	-	-	4	71	-	-	-	-
20	Shale	2	4	-	-	8	40	-	-	1	4	1	1
21	Soapstone	16	498	7	163	9	349	3	27	2	7	4	29
22	White clay	4	46	4	266	4	81	-	-	5	27	4	20
23	Silica Sand	6	196	IS	268	2	130	9	65	12	121	9	31
24	Quartzite	-	40	[2	107	-	-	-	-	1	[46	-	-
25	Chromite	-	-	3	218	-	-	-	-	-	-	-	-
26	Dunite	-	-	1	4	-	-	-	-	-	-	-	-
27	Garnet	-	-	3	15	2	100	1	5	1	95	1	12
28	Lime shell	-	-	1	6	-	-	-	-	-	-	-	-
29	Ochre	-	-	3	14	-	-	-	-	-	-	-	-
30	Phosphorite	-	-	1	1370	-	-	-	-	-	-	-	-
31	Ball clay	-	-	1	4	-	-	-	-	-	-	-	-
32	Ruby(Gemstone)	-	-	1	3	-	-	1	28	-	-	-	-
33	Sand stone	-	-	2	10	-	-	-	-	-	-	-	-
34	Semi precious stone	-	-	1	10	-	-	-	-	-	-	-	-

Annexure IV - 9 Contd.

35	White shale	-	-	1	3	-	-	-	-	-	-	-	-
36	Mica	-	-	-	-	I	1	-	-	-	-	-	-
37	Rock Phosphate	-	-	-	-	1	105	-	-	-	-	-	-
38	Ochre(red)	-	-	-	-	1	106	2	10	2	41	4	20
39	Iolite(semi precious stone)	-	-	2	12	2	5	-	-	-	-	1	1
40	Lateritic Iron Ore	-	-	-	-	-	-	1	144	-	- •	-	-
41	Lime Kankar	-	-	-	-	-	-	3	19	-	-		-
42	Moulding Sand	-	-	-	-	-	-	-	-	1	5	-	-
43	White Shale	-	-	-	-	-	-	1	9	-	-	-	-
44	Stowing sand	-	-	-	-	-	-	-	-	1	71	-	-
45	Yellow ochre	-	-	-	-	-	-	-	-	-	-	1	36
46	Wollastonite	-	-	-	-	-	-	1	5	-	-	-	-
47	Mineral sand	-	-	-	-	-	-	-	-	1	721	-	-
48	Group of Minerals	44	3322	80	1804	72	2786	57	2081	55	971	84	1638
	Total	**160**	**6934**	**233**	**7570**	**176**	**8049**	**153**	**4137**	**141**	**5289**	**147**	**2783**

Annexure IV-10

State wise Mining Lease Executed during 2000-01 to 2005-06 (Source: IBM)

Sl. No.	State	2000-01		2001-02		2002-03		2003-04		2004-05		2005-06	
		No. of ML	Area in l	No. of ML	Area in Hects	No. of ML	Area in Hects	No. of ML	Area in Hects	No. of ML	Area in Hects	No. of ML	Area in Hects.
1	Andhra Pradesh	64	651	76	1703	35	3257	57	695	52	3807	35	1147
2	Gujarat	20	130	21	1586	31	543	22	93	26	259	17	433
3	Haryana	2	238	5	245	8	1083	-	-	1	118	-	-
4	Kerala	5	8	11	13	2	31	5	8	8	10	15	52
5	Karnataka	2	48	11	576	13	584	3	120	8	416	-	-
6	Madhya Pradesh	2	7	-	-	7	361	1	52	-	-	1	1
7	Maharshtra	7	1688	14	385	2	57 ,	14	1239	8	376	7	663
8	Meghalaya	-	-	-	-	1	4	-	-	-	-	-	-
9	Orissa	5	1011	20	1697	10	564	10	432	-	-	2	13
10	Rajasthan	39	3080	61	2638	60	1557	37	1468	33	278	66	339
11	Tamilnadu	1	3	9	8	3	5	2	25	-	-	-	-
12	Uttarpradesh	10	31	2	15	-	-	-	-	1	11	-	-
13	Uttaranchal	-	-	-	-	4	3	2	3	2	8	2	10
14	West Bengal	1	5	3	18	-	-	-	-	2	6	-	-
15	Sikkim	1	34	-	-	-	-	-	-	-	-	-	-
16	Chhattisgarh	-	-	-	-	-	-	-	-	-	-	1	322
	Total	**159**	**6934**	**233**	**8884**	**176**	**8049**	**153**	**4135**	**141**	**5289**	**146**	**2980**

TABLE IV – 17

COMPARATIVE COSTS OF SURVEYS AND EXPLORATION IN INDIA AND ABROAD

Sl.No.	Input Activities for Survey and Exploration	*COUNTRIES*		World average	GSI's Cost	Remarks
		Canada	**Europe**			
1.	Airborne Geophysical Survey using multi sensor equipments	US$54.1 per line km. for combined EM & magnetic. N.B.: Current cost in these countries are expected to be much higher	US$26 per line km. for combined EM and magnetic. N.B.: Current cost in these countries are expected to be much higher	US$36 per line km. for combined EM and magnetic	US$32 per line km. for combined EM, Magnetic and radio-metric.	The GSI's rates is not only for survey but also includes data processing and interpretation. Therefore, cost of airborne surveys in India is much less in comparison to global cost
2.	A. Geological Mapping (R.F. 1:50,000) B. Thematic Mapping. (R.F.1:25,000)	- -	- -	-	US$ 2000 for 50 sq km by deploying one geologist + supporting contg. for one month US$ 4000 for 50 sq km by deploying one geologist + supporting contg.	The cost for large scale geological mapping or geochemical surveys are also based on similar norms. In all cases, it is evident that total cost of field data collection in India is less than even the salary of one geologist in advanced countries.

TABLE IV – 17 Contd.

Sl.No.	Input Activities for Survey and Exploration	*COUNTRIES* Canada	Europe	World average	GSI's Cost	Remarks
3.	Ground Geophysical Surveys. a. I.P. b. Combined (IP, SP, Mag, EM) c. Magnetic d. Gravity & magnetic	-	-	US$ 1000 per line km 405 per line km. 52 per line km. 132 per line km.	US$ 500 per line km. 650 per line km. 160 per line km. 7914/200 sq km.	
4.	Drilling	US$75/metre for diamond drilling US$43/metre for noncore drilling.	-	US$90-100 /metre	US$60/metre down to 300m (GSI+MECL)	The costing under world average is certainly higher than Indian rate inspite of much higher efficiency, much larger working hours and significantly higher productivity.

(Source : 'The leading Edge',1993,pp1094 – 1117 & http://www.nrcan.gc.ca/MMS/efab/invest/exploration/archives97/table 1.g.f)

TABLE – III-2B

ADDITIONAL MINERAL RESOURCES ESTABLISHED DURING THE X^TH PLAN PERIOD AND TOTAL RESERVES ESTABLISHED BY MECL SINCE 1972

Sl. No.	Mineral	Augmentation of Mineral Reserves during the Xth Plan from 1.4.2002 (m.t.)	Total Reserves as on 1.4.2006 (Million tonnes) Since inception
	A. ENERGY MINERALS		
1	Coal (Cocking & Non Coking)	10651.46	82290.31
2	Lignite	4667.11	32867.60
3	Coalbed Methane (B. Cu.m.)	--	471.40
	Sub-Total : A	**15318.57**	**115157.91**
	B. NON-FERROUS MINERALS		
4	Copper ore	35.13	559.68
5	Lead-Zinc Ores	1.37	141.21
6	Polymetallic ores		
	Copper + Lead + Zinc	--	11.50
	Copper + Lead	--	1.01
7	Bauxite	101.17	1277.34
	Sub-Total : B	**137.67**	**1990.74**
	C. FERROUS MINERALS		
8	Iron ore	--	2445.40
9	Nickel	--	64.60
10	Manganese	--	7.21
11	Chromite	0.10	0.10
	Sub-Total : C	**0.10**	**2517.31**
	D. PRECIOUS MINERALS/METALS		
	1. Gold	3.35	24.89
	2. Diamondiferrous conglomerate	--	2.93
	Sub-Total : D	**3.35**	**27.82**
	E. INDUSTRIAL MINERALS		
	1. Limestone (All grades)	--	2457.46
	2. Dolomite	--	53.70
	3. Phosphorite	--	32.29
	4. Magnesite	--	11.98
	5. Sillimanite / Fluorite	--	0.78
	6. Graphite	--	1.32
	7. Rock Salt	--	94.10
	8. Fuller's Earth/Fire clay	--	1884.84
	9. Stowing Sand	--	127.14
	10. Ferrosillicon Grade Quartzite	5.27	5.27
	11. Glass sand	34.51	34.51
	Sub-Total : E	**39.78**	**4703.39**
	F. STRATEGIC MINERALS		
	1. Tin ore	--	5.11
	2. Tungsten	--	4.00
	3. Molybdenum	--	1.50
	4. Raremetal	--	0.18
	Sub-Total : F	--	10.79
	GRAND TOTAL :	**15499.47**	**124407.96**

CHAPTER – V

EXPLORATION PROGRAMME FOR THE XIth PLAN

5.1.0 INTRODUCTION

5.1.1 The VISION Statement- 2020 of Ministry of Mines stipulates the following:

"To promote and facilitate rapid and sustainable development of national mineral sector, continuing with efforts for enhancing mineral inventory by intensive search for new mineral findings and regulating mines and minerals giving stress for conservation and utilisation of waste and low grade resources by technology development".

Matching with the vision statement, action has been initiated during the Xth Plan Period for enhancement of mineral resources through detailed mapping and extensive exploration for additional resources in known areas and new findings in potential regions at depth, inaccessible areas and in ocean bed by application of advanced techniques. It can, therefore, be concluded that in the vision statement and the action plan, Mineral Exploration has rightly been considered as thrust area by the Government of India for the Xth plan and continues to be so during the XIth Plan.

5.1.2 India, having 2.4% of the world's land area have 16% of the world population. With the second largest population in the world, the per capita consumption of most minerals and associated products, like power, steel, fertilizers, copper, lead-zinc, aluminium etc. is one of the lowest in the world. In vast majority of cases, it is lower than the world average which implies lower consumption as compared, even to some small and developed/developing countries.

5.1.3 Since minerals are the backbone of most of industries, the mining sector must be ahead of overall industrial growth. However, the fact is that the overall growth in industrial sector in India is much more compared to mining sector. Considering the fact that it takes 10-15 years of gestation time to convert a mineral discovery into a producing mine, more intensified exploration activities is the call of the day. Sustained efforts from exploration agencies are expected to create a bunch of shel projects, needing detailed investigation for maturing into a payable property and allow the mining industry to flourish.

5.1.4 Since India is fast emerging as an industrial power, the demand for most of minerals in future may be much more than anticipated at this juncture. In such an eventuality supply position for a number of minerals would be precarious and would demand substantial increase in the mining front.

5.1.5 Mineral exploration is a high risk investment, with low success rates. It may be noted that India's index of exploration success compares with that of USA, Canada, Australia and some European countries, in spite of the expenditure on exploration being much less. It is apparent that skills in exploration had been the factor responsible for what ever development the mining industry has achieved, which has finally percolated down and is reflected as the industrial growth of the country. The effort to utilize the same skills should, therefore continue during the XIth Plan period together with introduction of high end technologies and higher investments.

5.1.6 The situation in India is different compared to countries with flourishing mining industry. The diversity of geology is much less compared to countries likes Canada, Australia, Russia, China and Brazil and preservation of geologically potential material is in a less grander scale. Moreover, the country has a long history of exploration and exploitation of mineral resources, making easily accessible near surface targets difficult to find any more. Location of concealed deposit is the main hope. This is a serious challenge.

5.1.7 At the time of Independence, India's mineral industry had not much to show to the world except a few minerals like mica, manganese, iron, kyanite, etc. The known reserves of important minerals at that time were very limited. In spite of the basic difficulties stated earlier and through expertise available with **GSI, MECL, State Governments**, and other Central and State agencies particularly after 1970, the position has undergone a sea change. The exploration efforts upto the end of the Xth plan has augmented mineral resources substantially and in production India is 2nd ranked in chromite & barite, 3rd ranked in coal & lignite, 4th ranked in Iron ore and kyanite, 6th ranked in bauxite and 8th ranked in manganese and mica (sheets) and 9th in magnesite. This development has made India's position among the top one dozen countries in the field of mineral resources and production.

5.1.8 The critical analysis of mineral resource position as given in Chapter-II, indicates that self sufficiency in respect of mineral commodities is restricted one. While India can draw satisfaction about availability of minerals like non-coking coal, iron-ore, metallurgical grade bauxite, limestone & dolomite (excluding low silica grade), etc., deficiency continues in large number of minerals. In Table V-1 salient features of estimated apparent consumption, domestic production, resource situation and Life Index of some selected minerals is given. These minerals form the core of our agriculture, chemical, construction, defence and industrial sectors. Practically in all cases Life Index gives a bleak picture and raises an alarm. Similar is the case of base metals except aluminium in which the position is satisfactory and coking coal, as could be seen from Table-V-2.

5.1.9 The export and import of minerals, mineral based products and metal & alloys for the year 2003-04 are given in tables V-3 to V-8, respectively. India exported 29 varieties of mineral commodities and earned Rs.49,910.6 crores of revenue. However, import of 29 mineral commodities valued at Rs.1,30,060 crores, resulted in a net deficit of Rs.80,149 crores. Similarly, the net deficit in trading (export/import) of mineral based products and metals and alloys is Rs.4,000 crores and Rs.29,599 crores respectively. Hence, it can be seen that the total deficit in mineral trading during 2003-04 alone stands at nearly Rs.1,13,748 crores, mostly in terms of foreign exchange. Efforts are required to narrow down not only the trade deficit but give boost to explore for minerals which can attract .high value and foreign exchange.

5.1.10 In addition to mounting intensive search for such minerals in which the country is deficient, exploration efforts have to be continued towards augmentation of the existing resources in respect of those minerals having key-role in sustaining industrial growth and potential for new investment opportunities from private sector. Accordingly, exploration ventures have to be revived in the field of ferrous minerals, non-ferrous minerals, few industrial minerals as well as coal and lignite.. It needs to be emphasised that commodities having high potential for exports like iron ore, manganese ore etc. should receive priority. Before identifying certain mineral commodities under different groups and assigning an intense priority, it is necessary to appreciate that the trend of mineral search in any country is guided basically by the following factors:

1. Mineral resource inventory and status of assessment.
2. Mineral resource potential as can be conceptualised from type and favourable geology of the country.
3 Internal short-term and long-term demand for different mineral commodities.
4 Existing exploration scenario for different mineral commodities.
3. Import substitution and stock piling of strategic minerals
4. Technological innovation, changing specification of raw-materials thereby helping utilisation of marginal sub grade/locally available mineral raw materials.
7 Trend of using alternate and cheaper minerals in metallurgy.
8 Evolution in material science/engineering, bringing about changes in mineral use pattern and new demands.
9. Need for development of backward and remote areas through industrialisation with the help of mineral raw materials.

5.1.11 Taking into consideration the overall national perspective in conjunction with the factors outlined above (including the short-term and long-term demand projections) and mineral resources inventory, the mineral endowments can be classified in the four groups which require careful attention. Out of the four groups, the minerals grouped under Deficit and Scarce category require intensive exploration efforts during the XI^{th} plan period and beyond. The details of different group of minerals are given in Table V-9.

5.1.12 The exploration programmes are to be planned in keeping with the short-term as well as long term requirements. With the near exhaustion of target areas delineated on the basis of ancient workings, outcrops of oxidised ore bodies etc., there is a need to locate "concealed/hidden" ore bodies through modern and sophisticated exploration methods/techniques and on the basis of conceptual studies and by identifying favourable geological mileau, mainly in respect of unknown and non-reported minerals. (It is equally essential to have linkages with the X^{th} Plan exploration programmes in order to reach logical conclusions in respect of the ongoing projects).

5.1.13 Regional surveys and preliminary resource appraisal of the located prospects are important function and forms the base of mineral exploration activities. Inputs from remote sensing and aero-geophysical data form an integral part of these activities. During the XI^{th} Plan and beyond, efforts should be made, on a war footing, to undertake resource appraisal of the minerals which includes energy minerals, deficit group of minerals, minerals which are poor or nonexistent and minerals which have export potential. The resource appraisal of these minerals would add to the existing level of inventories in the known mineralised belts and also for the minerals which are yet to be located, such as platinum group of minerals, rare earths, etc. A special thrust is also required to be given to the mineral exploration and development activities in North-Eastern region and other far off places in the Himalayas, coastal regions, desert areas and areas covered by vast expanse of Deccan Traps, thick alluvium etc. At the stage of resource identification, through regional efforts, emphasis should be more on extensive coverage of large areas rather than intensification of activity in small blocks which should be done at the stage of detailed exploration,

5.1.14 The detailed mineral exploration objectives are different from those of the resource appraisal of the minerals and cover the following aspects:

i) Detailed exploration is necessary to establish different categories of reserves in appropriate proportions, stipulated for the type of mineral deposit so as to lead to bankable feasibility study and mine construction, if need be. This calls for not only increasing the confidence levels of reserve estimates and checks and counter checks on grade and tonnage but also for providing adequate data on shape, size, configuration, structure, mineralogy, amenability, beneficiability, ground water condition, geotechnical stability and such other parameters needed to take investment decisions in all sectors.

ii) Ensuring established reserves for the operating mining blocks by systematic delineation of ore body, both in the strike and depth extensions.

iii) In the known mineralised belts, particularly the parallel mineralised zones, intervening portions and strike and depth extensions are to be explored.

iv) Detailed exploration programmes to cover a greater range of minerals, based on the mineral-wise priorities indicated.

v) Evaluation of byproduct metals/minerals as a part of the objective for detailed exploration.

vi) Intensification of exploration as required to obviate the regional imbalance in resource position of the economic minerals.

vii) National indexing of mineral endowments with detailed note on characterisation studies for national and international long term perspective planning.

viii) Intensifying exploration so as to create a shelf of deposits to choose from keeping environmental impacts in view. This would also help in selection of optimal one developing the same at least cost option.

5.2.0 Concept oriented activities for the XIth Plan period:

5.2.1 Survey & mapping:

A. SPECIALISED THEMATIC STUDIES

Geological Survey of India initiated **Specialised Thematic Studies during the VIII Plan** encompassing **theme-oriented mapping on 1:25,000** scale. Several geologically significant key sectors covering cumulative area of **2,63,000 sq. km** (which is only **6-7%** of the total area of the country) was initially identified as **Priority – I** for updating the database generated during systematic geological mapping by applying higher resolution and the emerging concepts. About **38,611 sq.km.** of area has been covered during the X Plan up to September 2006 and the total coverage till date is **1,22,125 sq. km**. i.e. around **46%** of **Priority–I**.

It may be elaborated that Specialised Thematic Studies have been undertaken with a view to resolving problems related to stratigraphy, structure and tectonics, ore localisation and conceptual modelling on various aspects including crustal evolution and metallogeny. The geological database established during the systematic geological mapping on 1: 50,000 scale requires incorporation of additional parameters, **enhancement in quality and density of existing parameters** and also systematise the data element/data subsets in accordance with the present status of knowledge. This involves integration of airborne geophysical data, regional gravity data (aero-gravity or ground gravity), geological and geochemical data backed by high precision laboratory data.

In view of the fact that a large number of mineral occurrences with surface manifestation have either been located or proved, it has been essential to probe the deeper levels of the crust. This would require identification of every minor litho-facies through mapping, from which a three dimensional model can be postulated to identify favorable locales for concealed economic resources. As a matter of fact **akin to other developed countries**, the whole country should be mapped in larger scale and then synthesize the observations, digitise and integrate with overlays of geochemical and geophysical data for meaningful synthesis and identification of newer target areas.

B. AIRBORNE SURVEY

Airborne geophysical survey acts as an important tool for the geological understanding of the earth's crustal structures, including the surface and subsurface framework and identification of favourable physical properties indicative of minerals and hydrocarbons/ground water sources, through integration of aero-geophysical data with available geological map and other data followed up with rigorous ground checking and interpretation. Future perspective of airborne geophysical survey would encompass concerted efforts towards identifying new target areas for gold, diamond, platinum group of metals, basemetals, tin-tungsten and molybdenum exploration. This will be pursued by aerogeophysical survey with fixed wing aircraft and high resolution heliborne survey.

In view of the role played by regional lineament and shear zones in facilitating the transport of deep crustal and mantle derived magmatic bodies that effectively scavenge the aforesaid economically important minerals, it would be of immense help to identify such linear and circular magmatic bodies that are closely associated with the regional shear zones. In order to achieve this during XIth Plan, ground checking of anomalous zones (in preference to single/point/circular anomaly checking more prevalent during the surveys carried out so far), preparation of integrated regional scale maps and detailed mineral exploration programme would be taken in respect of following surveys (i) left out EM anomalies of OHR, BRGM/CGG in (lie remote areas, and re-evaluation/re-checking of anomalous zones in view of favourable geological set up and the experience gained so far, (ii) magnetic and radiometric anomalies generated by OHR/BRGM/ surveys and (iii) multisensor data generated by TOASS. For the first time low altitude multisensor aerogeophysical data will be generated from heliborne survey which will be followed by ground evaluation. Greater emphasis would be laid on interpretation of aerogeophysical data and remotely sensed data with input of image processing, digital analysis and geographic information system, refining of existing geological maps and delineation of potential zones of basemetal /precious metal mineralisation with information derived from aerogeophysics, remote sensing and field evaluation.

C. MARINE SURVEY

- Completion of systematic mapping of sea bed (in 1:50,000 scale) within the territorial water by the year 2015.
- Geotechnical mapping (1:50,000 scale) of territorial water in the tune of 80,000 sq. km., by the end of XII Plan to facilitate development / management of port, harbour, pipe line installation, mineral resource exploitation.
- Sea bed mineral resource evaluation by high resolution survey.
- Geochemical scans in potential areas of gas hydrate occurrences.
- Appraisal of sites for Ocean Thermal Energy Conversion (OTEC) emerging area for Non Conventional Energy Resources.
- Closer spaced mapping of additional area of about 1.5 million sq. km. under Legal continental shelf

D. GEOCHEMICAL MAPPING

Geochemical mapping serves as an aid to mineral exploration, soil fertility assessment, human and animal health, establishing valid environmental baseline database and understanding the geochemistry of the environment.

The country, which has a total land area of 3.28 million sq. km. is practically yet to be mapped geochemically. **Hardly, 0.3 % of the land area** has been systematically geochemically mapped till the beginning of X Plan and that too with a mineral exploration bias. Local, detailed mapping has been carried out in some areas for mineral prospecting in identified mineralised belt, and for specific environmental purpose.

With near exhaustion of target area for mineral prospecting delineated on the basis of ancient workings, outcrops of oxidised ore bodies etc., it has become imperative to look for hidden/concealed deposits. **This has to be done through modernization/sophistication in exploration methods / techniques,** based on conceptual studies for identifying favourable geological milieu. It would require use and integration of data from diverse domains of geology, geochemistry and geophysics. **For such purpose a precise geochemical map of the country is the basic pre-requisite.**

The dividend harvested by **China** through **Regional Geochemical Exploration** should be an eye opener in this context. The programme for Geochemical Exploration was launched in China in the year 1981. In the span of 14 years from 1981 to 1995, their endeavor led to **discovery of 140 gold and silver prospects, 140 nonferrous metal and 9 other mineral** deposits in areas, which were considered to be **absolutely barren** and thus came as a **total surprise**. The database generated through geochemical exploration, has also found widespread application in the **field of agriculture and environmental issues.** The highly informative geochemical data played a vital role in geoscience research and prognostication of ore deposits.

Though geochemical mapping of the Geological Survey of India was an ambitions programme since the VIII Plan, yet it could not be properly launched, due to non-availability of professional manpower, component and sophisticated analytical instruments capable of analysing various elements below the Clarke's value. **During the end of VIII plan period and initial part of IX Plan period geochemical exploration** was conducted in parts of Karnataka Craton covering 13,600 sq. km. area within greenstone belts, with a positive bias for gold in **collaboration with BRGM, France.** As an end product the geochemical map were prepared for the area using GIS. Subsequently during the **IX Plan period platform geochemical exploration** was carried out in scattered areas within the states of **Karnataka, South U.P, Rajasthan, Gujarat, Andhra Pradesh, Maharastra and Madhya Pradesh primarily as a tool to search for minerals.** As such, during IX Plan also not much headway could be made in this field due to lack of adequate manpower and instrumental facilities for precision analysis.

E. Exploration

Surface manifestations of mineral deposits, such as gossans, old workings and ore-shows, are increasingly becoming things of the past. Most of the mineral deposits marked by such obvious signatures of mineralisation and discovered by follow-up exploration are presently being exploited. All our existing minerals are getting depleted very fast. Due to closure of Kolar Gold Mine, gold production in the country has dwindled. Currently around 3 tonnes of gold is being produced annually by the Hutti gold mines Company Limited from their mines at Hutti, Uti and Hira-Budini in Karnataka. A small deposit in Jharkhand has started production. Bulk of gold is from imported copper concentrate as by product. As far as basemetals are concerned, lead and zinc resources may last for a while but copper deposits possibly may not survive for long. The declining success rate in mineral exploration endeavours today is a global phenomenon. Compared to all the developed and most of the developing countries, India happens to be the worst sufferer from population explosion. In order to narrow down the gap between production and ever increasing demands for various minerals, we need to have an approach of realistic optimism and take up as a challenge the stupendous task of invigorating and re-orienting our exploration strategies to make them capable for locating deposits lacking any kinds of conventional surface manifestation.

Reorientation of our mineral exploration programmes basically requires reorganisation of our efforts, getting ourselves conceptually and instrumentally better equipped, developing high level of confidence in indigenous expertise and going all out in our quest for mineral deposits with the motto "optimism is the key to mineral discoveries".

The present-day geothermal systems provide us with natural laboratories to study the mechanism of dissolution and alteration of primary minerals and precipitation of secondary minerals, enrichment and depletion trends of chemical species during the course of a hydrothermal alteration event and trends of variation in stable isotopes in the system may be regarded as large scale, uncontrolled, open ended natural experiments amenable to direct physical and chemical measurements on both the solid and liquid phases of the reaction. It is now widely established that active geothermal systems are the-present day equivalents of those ancient systems that had been responsible for Au and Au-Ag bearing base metal mineralisation. The analogy between the present-day geothermal systems and mineralisation processes operating at shallower level has helped in understanding hydrothermal and their potential for mineralisation, which are as follows:

- Hydrothermal systems, in most of the cases, are genetically related to magmatic events. They either intervene two successive magmatic events or follow the latest event.
- Whether a hydrothermal system would have conditions conducive for mineral formation depends on extent, intensity and duration of the event and composition of the fluid.
- Effectiveness of mineralisation process also depends on composition of rocks in contact with the fluid and cumulative water to rock ratio.
- Hydrothermal systems that existed along convergent plate margins have large mineralisation potential.
- Such systems also known from continental margins, calderas, rifts and in regions of thick continental crust.
- In addition to conventional geophysical and geochemical methods, main exploration tools for locating concealed mineral deposits of hydrothermal origin.

Application of time-tested geophysical techniques in locating concealed deposits is considered as the one of most effective exploration tools. Airborne surveys including airborne magnetic, electromagnetic and gamma-ray surveys have proved quite useful in identifying first order target areas world wide and may be used as direct tool in exploration. Airborne data from multispectral reflectance/thermal systems and imaging spectrometer also provide information on concealed mineral deposits.

Application of geochemistry to mineral exploration, adopting conventional as well as advanced geochemical techniques, in soil surveys, stream-sediment surveys, vapour surveys and bedrock surveys has proved useful to pick up the results of the partial disintegration of an ore body and trace this back to its source. The geochemical exploration of hydromorphic dispersion haloes of hidden ore bodies, sometimes, leads to positive targets and ultimately to concealed deposits. Globally soil surveys and stream-sediment geochemical surveys have proved spectacular success in discovering gold deposits e.g. gold mineralisation at Asthani, Ghana; Xiongershan, Central China; Dahuabei, Inner Mongolia; Hunjiang, Jilin Province etc while the vapour surveys (i.e. autogeochemical surveys and soil gas surveys) and the bed-rock geochemical surveys have made significant achievement in targeting gold, all basemetal sulphide deposits and radioactive minerals. In the granitic terrain, the use of Rb/Sr ratio is considered a reliable diagnostic tool in the regional assessment of the sulphide ore potential.

The hydrothermal alteration studies are capable of playing a very significant role in our quest for concealed mineral deposits. The hydrothermal alteration process bring about changes in primary mineralogy as a result of gradual conversion of mineral phases thermodynamically unstable under the given set of hydrothermal conditions (temperature, fluid composition, rock composition, water to rock ratio and pressure) to a stable assemblage through an overall irreversible reaction. Water-rock interaction in hydrothermal systems manifests a number of processes replacement of primary minerals by hydrothermal minerals. Deposition of hydrothermal minerals in pore spaces, fractures and complete dissolution leading to eventual leaching of some primary minerals. Hydrothermal minerals also give clues to the qualitative fluid composition, hydrostatic pressure in the system, distribution of permeable zones and possibility of boiling attending the deposition of hydrothermal and associated ore minerals.

The basic challenge in carrying out exploration for concealed deposits lies in judicious selection of area based on identification of specific geological parameters in developing a proto-type conceptual genetic model, e.g., the theory of Plate Tectonics in understanding of basic endogenic and exogenic processes responsible for mineralisation and their modelling through application of

- experimental and theoretical geochemistry.
- fluid inclusion geothermometry and geobarometry.

- stable isotope systematics.
- hydrothermal alteration studies.
- new geochronological methods.
- radiogenic tracers.
- computer-based simulations and remote sensing.

The examples of Chinese experience between 1978 and 1985 may be indicated here to elucidate that 0.2 ppb detection limit for gold can do miracles. No one could imagine that 4 ppb Au contour encompassed many hidden gold deposits, which are now China's major producers.

Here in India, both in the Peninsular and Himalayan terrain there are several important shows of metallisation which deserve re-exploration in the light of emerging conceptual models and modern exploration techniques. The vast terrain of Southern greenstone belt, Bastar Craton and surrounding ensemble, Central Indian Tectonic zone, Bundelkhand Craton, parts of Western Himalaya would merit immediate attention for re-evaluation

The Deccan Plateau, for its size, has rather scarce mineral shows but conceptual considerations and continuity of hydrothermal activity to present day in the form of hot springs along the west coast, do not permit us to rule out the area occupied by Deccan basalts as possible host to hydrothermal mineralisation. Systematic geochemical surveys, particularly in lateritic capping, may provide some significant clues.

Application to Norilsk-Tanlakh model and identification of borehole continuity of greenstones below Deccan, giving rise to leakage anomalies along major fracture system has to be seriously considered.

Geochemical surveys carried out in other countries have clearly demonstrated that there is no point in taking up this exercise unless the detection limits of all analytical determinations are brought down to ppb levels. Before taking up systematic regional geochemical surveys and expecting for break-through, it is of utmost importance that laboratory facilities should be upgraded drastically. Geological Survey of India has upgraded its regional laboratories through modernization for low detection analytical determinations on ever increasing number of samples generated during geochemical surveys and also to acquire the facility for $\partial^{18}O$ determinations on silicate rocks and mineral samples.

In regard to diamond search in the country, there has been significant success during the recent past in locating several new Kimberlite - Lamproite (K.L) fields of which the Raipur cluster (Payalikhand - Bahradih-Kodomali) and Wajrakarur cluster have been proved to be diamondiferous. During X^{th} plan new diamondiferous kimberlite pipes have been located in Andhra Pradesh. However, many of the newly discovered KL clusters are non-diamondiferous and appear to represent the root zones. To look for preserved crater zones, more concerted efforts will have to be directed towards such areas which have a cover of late Proterozoic or younger sediments such as Cuddapah basin, Chhattisgarh - Khariar -Indravati basins and so on. The investigations in Indravati basin area have already yielded positive results. It would be also prudent to launch KL search programmes in parts of Western Dharwar Craton, Eastern Indian Craton (Singhbhum-Orissa) and Bundelkhand Craton and other similar segments of Peninsula. The alkaline ultramafic intrusives in Deccan province and lamproite dykes in Gondwana belts would also need a closer look for locating younger diamond bearing KL bodies, which are world over known to be more productive. It may be also necessary to build up terrain-wise models for most prognostic indicator mineral catalogue for Indian set-up, based on local database introduction.

MINERAL-WISE ACTION PLAN FOR GSI DURING XIth PLAN PERIOD

In course of survey over a prolonged period of time, Geological Survey of India has identified a number of domains with favorable geological signatures suggesting the possibility of occurrence of different types of mineral deposits in them. Commodity-wise identification and demarcation of these domains have now been made and the products are the different mineral belt maps. Mineral discoveries, which have been or are currently being exploited, occur within these belts. Still substantial area within the potential geological domain is left, which needs systematic exploration for a proper assessment of their potential for different mineral commodities. A major part of the exploration activities during the XIth Plan period will be concentrated in these known mineral belts. Further, efforts would be made at identifying new areas with favorable signatures on the basis of improved geological understanding. This will be aided by heliborne multi-sensor airborne surveys for which GSI is in the process of procurement of equipments.

A. Basemetals:

In India basemetal occurrences are mainly hosted by supra-crustal rocks and granitoids of late-Archaean and early Proterozoic ages. These are confined to Rajasthan, Jharkhand, Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh, Karnataka, West Bengal, Sikkim and Orissa. Exploration programs of GSI for basemetals during the XI Plan are likely to be pursued in the known belts located in some of these states. The state-wise details are as follows:

Rajasthan:	Bhilwara, Aravalli and Delhi Super Group of rocks in Jhunjhunu, Sikar. Udaipur, Jaipur, Chittorgarh, Bhilwara, Dungarpur and Bundi districts.
Maharashtra:	Sakoli Fold Belt.
Jharkhand:	Chottanagpur Gneissic Complex and Singhbhum Fold belt.
Sikkim:	Daling Group of rocks
West Bengal:	Singhbhum Fold Belt.
Madhya Pradesh:	Betul Belt.

B. Gold:

Gold mineralisation in India has been established to occur in diverse geological environment. These are similar to known gold hosting geological environments all over the world. The potential geological environments for primary and secondary gold prospects recognized so far as follows:

a) Archaean granite-greenstone belts hosting lode type deposits. Such setting is common in the states of Karnataka and Andhra Pradesh and some minor ones in Tamil Nadu and Orissa.

b) Early Proterozoic volcano-sedimentary sequences of the supracrustal/fold belts hosting lode gold and volcanogenic massive sulphide type deposits. It includes occurrences in Sonakhan, Sakoli, Mahakoshal, Kotri and Raigarh belts of Central India; continuation of Mahakoshal belt in Northern India; Aravalli belt of Western India and Singhbhum belt of Eastern India.

c) The high grade granulitic rocks of Kerala and Tamil Nadu.

d) Secondary gold in laterite and in placers. These include reported occurrences in laterite caps over supra-crustal rocks of southern, central and eastern India and also occurrences of placer gold in fluviatile sand in the Peninsular and sub-Himalayan areas.

The Archaean granite-greenstone assemblage in the Dharwar Craton of southern India has so far been the most promising gold producer generating almost 99% primary gold of the country. During the XIth plan exploration efforts would continue in the un-explored territories of this geological assemblage and also in the areas which have indicated mineralization during regional exploration. Geological information collected and analyzed for some other belts also appear to hold promise. Such favorable geological domains are Mahakoshal belt, Sonakhan belt, Gorumahishani- Badampahar belt, Aravalli fold belt and Singhbhum fold belt.

The belts showing the areas of gold exploration are the following.

Dharwar Craton: In the States of Karnataka, Andhra Pradesh and Tamil Nadu	Hungund-Kushtagi-Hagari schist belt, Chitradurga schist belt, Shimoga-Dharwar-North Kanara schist belt, Gadag schist belt, Hutti-Maski schist belt, Sandur schist belt, Kolar schist belt, Ghanapur schist belt, Nellore schist belt, Veligallu schist belt, Peddavuru schist belt

Singhbhum Fold belt in the states of West Bengal, Jharkhand.

Granulite terrain in Tamil Nadu and Kerala.

Aravalli Fold Belt of Rajasthan.

Mahakoshal belt in Madhya Pradesh and Uttar Pradesh.

Kotri volcanic belt and Sonakhan belt in Chhattisgarh.

Gorumahisani-Badampahar belt in Orissa.

Himalayan region in Arunachal Pradesh and Uttaranchal.

C. Diamond:

In India diamonds are found in kimberlite-lamproites of Chattishgarh, Madhya Pradesh and Andhra Pradesh and as placers in Proterozoic conglomerates within Kurnool and Vindhyan rocks and also in recent and sub-recent gravel horizons along the river basins. Apart from the only diamond mine in Panna, the geological domain potential for search of diamond are:-

Granite-greenstone terrain of Andhra Pradesh.

Cuddapah basin of Andhra Pradesh.

Granite-greenstone terrain of Karnataka in Gulbarga-Raichur-Bellary-Bijapur,Tumkur and Chitradurga districts.

Bastar, Raigarh and Raipur districts in Bastar Craton.

Upper reaches of Ong and Jira rivers in parts of Bargarh and Sonepur districts,Orissa.

Terrain exposing Vindhyan Supergroup, Bundelkhand Granite, Bijawars and Gwalior Group of rocks, Madhya Pradesh.

Amgaon Gneiss**,** Bhandara district, Maharashtra.

In potential geological domain search for kimberlite/lamproite, the source rock for diamond would continue. Besides, primary rock search for diamond will be taken up from secondary sources in favourable geological milieu in Andhra Pradesh. Apart from diamond, India has diverse source of semi-precious stones and precious stones from different geological set up. The most potential gem tract of India which deserves attention are:-

Gem tract of southern granulite terrain of Kerala and Tamil Nadu.

Gem tract of Eastern Ghat granulite belt of Andhra Pradesh and Orissa.

Granulite terrain in Chhattisgarh.

Gem tract of Rajasthan and Karnataka.

D. Platinum Group of Elements (PGE)

Platinum Group of Elements/Metals (PGE/PGM) (Pt, Pd, Rh, Ru, Os, Ir) are the rarest of precious metals in the earth’s crust. These metals are recovered from a few primary deposits and as byproduct in Ni-Cu production. In recent years, PGE are gaining worldwide importance in view of their increasing application in modern technology. GSI accordingly laid due emphasis on search and assessment of PGE/PGM in the country. The primary deposits are likely to be located in orthomagmatic deposits. Only some occurrences are known in epigenetic hydrothermal type of environment.

The following geological domains are favourable for PGE mineralization and the target areas for exploration are:-

Plutonic and hypabyssal layered intrusives of Archaean as well as Early Proterozoic ages in Singhbhum, Dharwar and Bastar Craton.

Layered, differentiated mafic-ultramafic complexes with chromite and titaniferous vanadiferous magnetite in greenstone belts and komatiite in greenstone belt.

Mafic-ultramafic layered sequences within Proterozoic Mobile belt skirting cratonic block.

Hydrothermally altered high Mg-volcanic rocks in Proterozoic fold belt.
Ophiolite belts of Cenozoic age in the Extra Peninsular India and Andaman-Nicobar islands.

The belts with differentiated layered complexes which would deserve special attention are:-

North Kanara schist belt, Karnataka.

Nuggihalli schist belt, Karnataka.

Kushalnagar area, Coorg district, Karnataka and Usgaon area, Goa.

Sandur schist belt, Karnataka.

Sittampundi Layered Complex, Tamil Nadu.

Mettupalem-Velliankadu area, Tamil Nadu.

Ultramafic rocks in Attapadi and Nilambur valley, Kerala.

Chimalpad-Chimakurthi-Kondapalli in Andhra Pradesh

West Singhbhum district in Jharkhand

In Orissa, chromite and titaniferous – vanadiferous magnetite are hosted by ultrabasic and basic members respectively of the stratiform intrusions which are exposed in several partially developed stratigraphic sections. These constitute the prime targets of PGE. Sukinda ultramafic chromite belt, Baula-Nausahi chromite belt, Betei-Pindbasa-Nilgiri sector show analogous set-ups of early magmatic ultramafic sequence which gave anomalous values for PGE. During the XIth Plan the investigation for PGE will be taken up to the southwestern portion of the mafic ultramafic girdle falling in the district of Keonjhar, Orissa.

E. Bauxite:

Bauxite resources are dominantly located in the Peninsular area. The deposits are associated with both high level and low level laterite. Majority of the Indian deposits are associated with high level laterite occurring in Eastern Ghat, Western Ghat, plateaus in Jharkhand and Madhya Pradesh and among the large areas occupied by 'low-level' laterite deposits, bauxite has been recorded in Katni area (Madhya Pradesh); Saurashtra and Kutch (Gujarat); Thane and Kolaba (Maharashtra) and also in parts of Kerala and Tamil Nadu.

Vast expanse of laterite profile in central and coastal (both east and west) Peninsular India holds promise for addition to the bauxite resources. Moreover, resources already established require upgradation of confidence level through further drilling. Study of laterite in a new domain where it occurs as Deccan trap cover in Rajasthan will be pursued.

F. Iron Ore:

India is bestowed with large resources of Iron Ore. Iron ore occurs in different geological associations. However, in India, like in most other countries belonging to the Gondwana Super-continent, major economic deposits of Iron ore are found associated with volcano-sedimentary banded iron formation (BIF) of Precambrian age. The major iron ore deposits in India occur in Jharkhand, Chhattisgarh, Orissa, Karnataka, Goa, Maharashtra, Andhra Pradesh and Tamil Nadu.

In view of the assessment, India is having large quantity of exportable surplus iron ore, exploration for iron ore after early eighties was given lower priority compared to gold, basemetal, diamond and other minerals in which the country is deficient. With the increasing global demand for iron ore and its escalating price in the international market, the issue has undergone a quantum change in the last two years of the Xth Plan period. The trend is anticipated to continue and as a result there is a considered feeling of assigning importance to iron ore exploration in the XIth Plan tenure. As per reasonable estimate approximately 5000 sq km is occupied by potential iron ore targets distributed in different states. Out of these large part has been covered by regional exploration some of which are under exploitation, while major parts of the areas are under lease hold. GSI envisages to identify lease free areas beyond forest cover and continue exploration in these sectors to augment the iron ore reserves of the country.

In the XIth Plan the following areas for iron ore exploration is proposed to be taken up.

Karnataka and Andhra Pradesh**:** Sandur schist belt ,Gadag and Hungund schist belt

Madhya Pradesh**:**	In Bijawar, Mahakoshal, Bundelkhand and Gawalior Groups of rocks located in Jabalpur. Sidhi, Katni, Gwaliar and Shivpuri district.
Maharashtra**:**	Chandrapur and Gadchiroli district.
Orissa:	Kendujhar district, northwestern part of Daiteri-Tomka belt
	Mayurbhanj district, Badampahar-Sulaipat area.
Tamil Nadu:	Vellore, Tiruvannamalai district.
Chhattisgarh:	Continuity of Dalli-Rajhara iron ore belt.
Jharkhand:	Bonai-Keonjhar belt.

G. Manganese ore

Manganese ore is an important material required in iron and steel industry. A good number of manganese ore provinces are located in Peninsular India which include deposits of Madhya Pradesh and Maharashtra, Orissa, Karnataka, Andhra Pradesh and Goa. Two states namely Karnataka and Orissa dominate the reserve of manganese ore.

Although India has substantial amount of metallurgical grade manganese ore but chemical grade and battery grade ores are rare. Search for such ores in the extension areas of known mining districts and geologically potential belts would continue during the XIth Plan period.

Exploration activities would be focused in the following areas.

Orissa: Bonai-Keonjhar belt and also in Rayagada, Kalahandi, Bolangir and Sundergarh districts.

Karnataka: North Kanara district.

H. Chromite

The major chromite resources are from Sukinda followed by Baula-Nausahi area of Orissa. Small resources have been established in Karnataka, Maharashtra and Jharkhand. In the past, thrust was given in Orissa. Now the time has come to explore for chromite ore in the extension areas of the known bodies which are at present under mining activity in Orissa, Karnataka, Maharashtra and Jharkhand by ground survey, which includes geological mapping, geophysical and geochemical survey and drilling during XIth Plan period

I. Rare Metals (RM) and Rare Earth Elements (REE)

Rare metal mineralization occurs in diverse geological set ups. The primary mineralization can be classified as (a) felsic volcanic hosted, (b) granite hosted, (c) pegmatite hosted and (d) alkaline ultramfic carbonatite complex hosted. In India, Rare Earth Elements are produced principally from by-products of beach sand mining. The geological provinces favourable for RM/REE mineralization, which deserve attention, are as follows:

(a) Mica belt of Jharkhand, (b) Bhilwara mica belt, Rajasthan, (c) Tin belt of Orissa and Chhattisgarh, (d) Chhotonagpur Gneissic Complex in Jharkhand and West Bengal, (e) Nellore mica belt, Andhra Pradesh and (f) Jalore and Sewaria granitoid terrain in Rajasthan, (g) carbonatite and molybdenum bearing areas in Tamil Nadu and (h) Sung valley, Meghalaya.

During the XIth plan, search for RM and REE has been proposed to be taken up in West Bengal, Rajasthan, Tamil Nadu and Meghalaya.

J. Strategic Minerals (Tin, Tungsten, Molybdenum, Nickel)

The geological domain deserve attention are:

a) Tin:

i) Bundelkhand granitoid complex, (ii) Bastar-Koraput region of Chhattisgarh and Orissa and (iii) Tertiary granitoids in the Himalyas.

b) Tungsten:

i) Extension areas of Degana in Rajasthan, (ii) Skarn zone and granitoids enveloping the rocks of Delhi Super Group of Rajasthan and (iii) In hydrothermally altered zone associated with gold mineralization in Uttar Pradesh.

c) Molybdenum:

i) Extension areas of Harur-Uttangarai belt, (ii) Hydrothermal setting in Bundelkhand granitoid complex.

d) Nickel:

In India, so far, no substantial magmatic Ni-Cu sulphide resource has been identified despite local abundance of potential host rocks. Nickeliferous laterites with low nickel 0.5 to 1.0% over the ultramafic complex of Sukinda has been estimated but appropriate mining and extraction technology is yet to be developed to use the ore. The situation calls for improvement in extraction technology and search for nickel in the layered complexes and komatiites of Southern and Eastern India. These zones are target areas for search of PGE also.

K. Fertiliser minerals:

i) Phosphorite (Rock Phosphate)

Phosphate deposits are confined to Proterozic sedimentary rocks located in Udaipur district of Rajasthan; Jhabua, Sagar and Chattarpur districts of Madhya Pradesh and Maldeota belt of Uttaranchal and Lalitpur districts of Uttar Pradesh. Potential apatite deposits are located in Purulia district of West Bengal and Singhbhum district of Jharkhand. The areas for future targeting for rock phosphate are:

The intervening region between southern extension of Jhamarkotra in Rajasthan and Jhabua in Madhya Pradesh.

Extension and surroundings of Jhamarkotra in Rajasthan.

Vindhayan basin in Madhya Pradesh and Uttar Pradesh.

ii) Potash:

Deep seated bedded potash mineralization has been located in Nagaur district of Western Rajasthan. The amenability of these deposits to conventional mining/solution mining is not established. Occurrences of potash and potash rich brines are in J&K and Gujarat. Saltpetre type of potash is found on the soil surface in Punjab, U.P., A.P. and Tamil Nadu. Glauconite occurring in Gujarat, Rajasthan and Madhya Pradesh have poor grade of potash. The areas warranting relook for potash are:-

Extension areas of Nagaur-Ganganagar evaporite basin, Rajasthan.
Glauconitic sandstone of Vindhyan Super Group in Uttar Pradesh.

L. Limestone:

India has huge resources of limestone distributed over different parts of the country. India is comfortably placed in the world in annual capacity and production of cement. Although cement grade limestone occur in all the limestone bearing areas, SMS, BF and chemical grade limestones occur in selective areas. Due to increase in steel production of the country, the demand for SMS and BF grade limestone is increasing. During the XIth plan emphasis to be given for locating SMS and BF grade limestone along with cement grade limestone from the states of Meghalaya, Rajasthan, Madhya Pradesh, Gujarat, Orissa and Assam.

M. Graphite:

The resources of graphite in India, particularly of high grade are limited. Graphite is reported from manganese belt of Madhya Pradesh, Maharashtra, granulite terrain in Eastern Ghat, Kerala and Tamil Nadu and many other places. It is necessary that these regions are taken up for search of graphite. During the XI^{th} plan graphite investigation will be taken up in Tamil Nadu.

N. Sillimanite:

There are large resources of sillimanite in beach sands from where granular sillimanite is recovered. The reserve position is adequate to meet the requirements. There is shortage of lumpy sillimanite for which exploration efforts need to be intensified. Search for sillimanite will be taken up in Maharashtra to establish the continuity beyond the mining area.

O. Other industrial Minerals:

India has a large potentiality of various industrial minerals spread across the length and breadth of the country in various geological formation belonging to different ages. Clay, barytes, high Mg rocks, fertilizer minerals, dimension stone, glass sand, fluorite and gypsum are some of the commodities which deserve attention.

P. Coal and lignite:

To meet the spiraling demand of energy sector, emphasis will be given on the following aspects for regional exploration of coal and lignite.

- Locating power grade coal at shallow depth in northern and central parts of Pench Coalfield, central part of Singrauli Coalfield, western part of Hasdo-Arand Coalfield, central part of Mand – Raigarh Coalfield and western part of Wardha Valley Coalfield.
- For coking coal, sectors outside the traditional areas of Damodar Valley Coalfields would be prioritized.
- Search for superior noncoking coal in Raniganj, Birbhum and Sohagpur coalfields.
- Identifying additional resources in deeper part of the basins as well as delineating concealed coal and lignite prospects through application of concept oriented search with multidisciplinary inputs in eastern part of Birbhum-Rajmahal Master Basin, eastern part of Raniganj, central part of North Karanpura, western part of Ib and Talcher, central part of main basin of Singrauli, central part of Mand-Raigarh, eastern part of Pench-Kanhan coalfields and central part of northern Godavari basin.
- Establishing additional resources of lignite in eastern part of Neyveli, northeastern part of Mannargudi, virgin tract of Ramnad sub basin in Tamilnadu, western and northwestern part of Palana and unexplored areas of Nagaur basins of Rajasthan and Little Rann of Kachchh in Gujarat.

- Intensification and extension of CBM studies in Birbhum - Rajmahal Master Basin, Talcher Coalfield, Singrauli Main Basin, Mannargudi Lignite field and Ramnad Sub basin.
- To identify deep seated coal reserves, not amendable to conventional mining in the near future, for underground coal Gasification in Raniganj, Birbhum, Jharia, East Bokaro South Karanpura and Talcher coalfields. Northwestern part of Godavari valley coalfields would be taken up for search studies for the first time.

5.3.0 Exploration Programme for the XI Plan period.

5.3.1 The main agencies involved in the regional and the detailed mineral exploration for minerals other than oil and natural gas and atomic minerals are GSI, MECL, State Departments of Mines and Geology, CMPDIL (for coal in CIL command areas), SCCL (for coal in Godavari Valley coalfield), NMDC (for ferrous minerals) etc. In addition, during the Xth plan period, private entrepreneurs both national and MNC's like ACC Rio Tinto, BHP Minerals, CRA, De Beers, Geomysore Services etc.have taken up regional search through ground surveys and/or aerial survey followed with ground work. Some of the prospects, mainly for diamond have been converted to PL from RP. The programme of these organizations for the XIth Plan period is not certain. Out of the above, it is only GSI, MECL and State Directorates within the state jurisdiction which take up exploration for a variety of minerals. In case of the Public Sector units, the exploration programmes are mostly oriented at the development of existing resources and delineation of the ore bodies within their lease-holds with the main object of helping the mining activity or to augment the resources to be blocked for active mining. Hence, the exploration programme of the major agencies, i.e. **GSI, MECL** and **State Directorates of Mining & Geology** are only discussed hereinafter**.** For **coal and lignite the programmes of CMPDIL, NLC and SCCL,** which undertake detailed exploration for coal in their respective leasehold areas, are discussed separately in the report of Sub-Group-II on coal and lignite for formulation of the XIth Plan.

5.3.2 Geological Survey of India

The GSI undertakes a wide variety of activities including exploration and resource appraisal for minerals, details of which have already been discussed in the previous paragraphs. For the mineral sector, the GSI's activities would be spread over 190 investigations covering a wide variety of the minerals. The details of the physical targets in respect of various components of mineral exploration activity in different commodities are given in Table-V-10. According to the programme, GSI would undertake nearly 4,29,200 m of drilling, 13,530 sq. km of large scale geological mapping, besides detailed mapping, geochemical surveys, geophysical surveys, pitting & trenching sampling, etc. during the XIth plan period under Regional Surveys and mineral exploration activities. The action plan to achieve the activities listed in Table-V-10 is discussed under para 5.2.2.

5.3.3. ACTION PLAN OF SURVEYS & MAPPING BY GSI

A. Specialised Thematic Studies

Around 54% of the areas are still remaining to be covered in the following selected geologically significant belts/themes (under Priority-I):

- ⇒ Granite–granulite, high grade metasedimentary terrain.
- ⇒ Granite-greenstone terrain.
- ⇒ Supracrustal, cover sequences and mobile belts.
- ⇒ Biostratigraphy and lithostratigraphic problems.
- ⇒ Cenozoic –Mesozoic mobile belts (Himalayan and Indo Burman ranges).
- ⇒ Quaternary including neotectonic studies.
- ⇒ Volcanic suite of rocks.
- ⇒ Prospecting on regional scale and terrain evaluation.

During the XI Plan, about 35,000 sq.km. area is likely to be covered under Specialised Thematic Studies in the following sectors under the belts/themes mentioned at foregoing para:

Central Region - 6,000 sq.km

- Area between Sausar and Sakoli Groups.
- Deccan Trap Mapping for sub-surface geology in marginal areas.
- Crystallines of Chandrapur and Gadchiroli districts.
- Proterozoics of Sindhudurg.
- Betul Belt.
- RM & REE study of pegmatites.
- Bundelkhand Gneissic Complex.
- Mahakoshal Group between Sidhi and Singrauli.
- Gneisses in Surguja district.
- Archaean / proterozoics of Rajnandgaon district.

Northern Region – 3,000 sq.km.

- ❖ Delineation of the extension of Mahakoshal Group of rocks south of Dudhi-Renusagar-Kasar fault Sonbhadra district, Uttar Pradesh.
- ❖ Delineation of eastern extension of Agori Formation to the north of Kon, Sonbhadra district, Uttar Pradesh.

- ❖ Delineation of the stratigraphical status of Jungel sediments, Sonbhadra district, Uttar Pradesh.
- ❖ Discontinuities across the lithostratigraphic sections of Central Crystallines to resolve problems of correlation of lithostratigraphy in parts of Chamoli and Almora district, Uttaranchal.
- ❖ Bijni and Amri Nappe to establish stratigraphic status and extension in the lesser Himalaya.
- ❖ To establish lithostratigraphy and tectonic status of Bhilangana formation vis-à-vis Central Crystallines.
- ❖ Volcano-Sedimentary sequence of Bhimtal Formation around Padampur-Dalkandiya area (Part of toposheet No. 53O/15 & 16) with a view to find out controls of base metal mineralisation.
- ❖ To resolve the discrepancies geological maps of Uttaranchal Himalayas.
- ❖ Tertiary belt of Himachal Pradesh and Punjab.

Northeastern Region – 1500 sq.km.

- Mapping in parts of Jaintia Hills to study Basement-Shillong Group Relationship, Jaintia Hills District, Meghalaya.
- Petrogenesis of Claystones of Khasi Hills and Garo Hills districts, Meghalaya.
- Mafic ultramafic complex of Dienglieng-Mawkynrew area East Khasi Hills and Jaintia Hills districts, Meghalaya.
- Siwalik and Lesser Himalaya of Assam and Arunachal Pradesh.

Eastern Region – 5,000 sq.km.

- Singhbhum Mobile Belt and Dalma Volcanic Belt, Jharkhand.
- Lesser Himalayan Belt, East and West Districts, Sikkim.
- Ultramafic rocks in East Singhbhum/West Singhbhum districts.
- Stratigraphic status of the arenaceous horizon along the eastern and southern fringes of the Noamundi-Koira and Nuakot volcanics in Keonjhar district.
- Tectono-stratigraphic relation between the Tomka-Daitari.
- Mahagiri and the Malaygiri Greenstone Belts in Jajpur and Dhenkanal districts.
- Mahanadi tectonic zone between Sonepur and Cuttack, Sonepur, Sambalpur, Baudh, Angul, Nayagarh and Cuttack districts.

Western Region – 4500 sq.km

- Mesozoic-Tertiary succession in Jaisalmer Basin with special emphasis on lithostratigraphy and structure.

- Delhi Supergroup of rocks in parts of Toposheet 45H/2, district Sirohi, Rajasthan.

- Tectono-stratigraphic investigation of Neoproterozoic Sirohi group of rocks in southern sector of Delhi Fold belt, NW India Kalinjara and Sallopat in Banswara district, Rajasthan.

- Khandu and Ghatol in Banswara district, Rajasthan to differentiate various types of volcanics of AFB in relation to gold mineralisation (Bhukia type) and economic significance of graphite deposit of the area.

- Geological and geochemical investigation of granitoid bodies of Aravalli Fold belt, NW India with emphasis on their economic significance.

- Structure and tectonics of major dislocation zones of Rajasthan.

- Geological Evolution of the Greater and Little Rann of Kutch in Gujarat.

Southern Region – 15,000 sq.km.

- Jonnagiri and Gadwal schist belts Kurnool district, Andhra Pradesh.
- Granites in and around Nellore schist belt, Nellore and Prakasam districts, Andhra Pradesh.
- Granite/granulite terrain along the Godavari Valley in Karimnagar and Warangal districts, Andhra Pradesh.
- Major crustal-scale shear zones/faults/thrusts traversing the Archaean-Proterozoic areas in Andhra Pradesh.
- Sileru-Machkund shear zone in parts of Khammam district, Andhra Pradesh.
- Southern (Chelima - Giddalur) and northern (Atmakur - Dornala) corridors of Iswarakuppam dome with special emphasis on stratigraphy, structure, tectonism and mineralisation.
- Honnali Gneissic dome, Karnataka.
- Western part of Hanur covering areas around Kaudalli, Ajjapuram, Bandahalli, M.M. Hills including Kollegal and Yelandur, B.R. Hills upto Chemrajnagar south of Tunga and Koppa, Shimoga districts, Karnataka.
- Khanapur – Kittur area, Belgaum district, Karnataka.

- Kabbal – Kushalnagar area, Coorg district, Karnataka (Greenstone – granulites transition Zone).
- Sandur Schist Belt, Bellary district, Karnataka.
- In parts of Hassan, Chikmagalur, Mysore, Mandya, Chamarajnagar and South Coorg districts, Karnataka.
- Greenstone belts with the enclosing basement rocks in parts of Shimoga, Chikmagalur, Hassan and South Kanara districts, Karnataka.
- Inland Quaternary Formations of Krishna river basin, Northern Karnataka.
- QPC in Bababudan Schist Belt in type sections of Kalsapura and Tattikere, Karnataka.
- Amphibolite facies to granulite facies transition zone in Krishnagiri-Kaveripattinam-Karimangalam Sector in Northern Tamil Nadu.
- Granulite terrain of Vellore – Polur sector lying south of Palar in northern Tamil Nadu.
- Tectonomagmatic and metamorphic evolution of Varshnad hill sector in Southern Granulite Terrain.
- Tectonomagmatic and metamorphic history of granulite – gneiss terrain of Kodaikkanal and Erode areas of Central Tamil Nadu.
- Structural studies in parts of Thiruchirapalli and Pudukottai districts (Degree Sheet 58) east of Kadavur basin in Central Tamil Nadu.
- Structural studies in major shear zones / lineament zones in the granulite terrain of Tamil Nadu by transect mapping.
- Wayanad Supracrustals and associated rocks in the vicinity of the western termination of the Moyar Shear Zone in Sulthan Bathery area, Wayanad district, Kerala.
- Bavali Tectonic Zone (BTZ) in Srikantapuram – Talipparamba – Payyannur area, Kannur and Kasargod districts, North Kerala.
- Tectonostratigraphy and structure of Nilambur area with emphasis on gold mineralisation.
- Study of structure, stratigraphy palaeo-magnetism and geochemistry of the Achankovil tectonic zone with special reference to its evolution and bearing on mineralisation of economic value.
- Elucidation of tectonostratigaphy of graphite bearing lithounits in relation to migmatisation events in South Central Kerala.
- Supracrustals and associated rocks and the tectonic configuration of Bhavani Shear Zone, Mannarkad-Malappuram Sector, Palakkad and Malappuram districts, Kerala.

B. Multisensor Airborne Surveys

i) Multisensor Aerogeophysical Surveys by TOASS: Keeping in view the prioritized scientific needs, availability of infrastructure facilities and pending mandatory MOD and DGCA clearances it is proposed to cover areas as shown in the table below by magnetic and spectrometric aerogeophysical surveys employing TOASS during the XIth Plan period :

Proposed area coverage by Multisensor Twin Otter airborne Geophysical Surveys during XIth Plan (2007-2011)

Sl No	Proposed items	Quantum of coverage	Objective
1	Alwar area, Rajasthan.	14,000 sq km 28,000 line km.	To aid mineral investigation and refinement of geological maps.
2	Marwar area, Rajasthan.	16,000 sq km 32,000 line km	To aid mineral investigation and refinement of geological maps.
3	Vairagarh area, Chandrapur and Gadchiroli District, Maharastra.	9,000 sq km 18,000 line km	Identification of target areas for multi metal surveys including gold and also for KCR investigation.
4	Kurnool-Adoni Block, A.P.	5,000 sq km 10,000 line km	To aid in search of KCR bodies
5	Abujhamar-Sonakhan Belt of Bastar District.	8,000 sq km 16,000 line km	To aid in regional geological mapping and to identify areas for mineral targeting
6	Below Deccan Trap, Maharastra and M.P.	24,000 sq km 48,000 line km	To identify areas for mineral targeting.
7	Baiharkutru(extension of Malanjkhand) area	20,000 sq.km. 40,000 line km	To aid in regional geological mapping and to identify areas for mineral targeting
Total		96000 sq.km **(1,92,000 line km)**	

Note : Out of the above mentioned area152000 line km.will be covered during XIth Plan

ii) Multisensor Aerogeophysical Surveys by Heliborne Geophysical System. Geological Survey of Inida is likely to procure multisensor heliborne survey system to locate concealed deposits. The system will be operative during XI Plan period. Low altitude detailed surveys with close spaced line interval helps in delineation of kimberlite pipes under favourable geological milieu. Similarly, such type of surveys are also useful in tracing the extensions of known mikneralised prospects.Initial years of heliborne geophysical surveys are planned in the following six selected blocks as shown in the table below:

Proposed area coverage by Multisensor Heliborne Geophysical Surveys during XI[th] Plan (2007-2011).

Sl. No.	Area	Quantum*	Proposed area
1	Goa-Karwar-Yellapur Block	6000 km^2	Parts of potential and mineralized belts of Western Dharwar Craton in Goa and Karnataka
2	Raichur Block	17500 km^2	Parts of potential and mineralized belts of Eastern Dharwar Craton in Karnataka and Andhra Pradesh.
3	Satyamangalam Block	5000 km^2	Parts of potential and mineralized belts of Southern Granulite Terrain in Tamilnadu and Karnataka.
4	Jhansi Block	>20000 km^2	Parts of potential and mineralized belts of Bundelkhand Craton in UP and MP
5	Alwar Block	10000 km^2	Parts of potential and mineralized belts of Aravalli Region in Rajasthan
6	Bangalore Block	5500 km^2	Parts of potential and mineralized belts of Eastern Dharwar Craton in Karnataka and Andhra Pradesh.
Total		**142000 km^2**	

* Target coverage to be selected from this quantum

In the remaining period of XI[th] Plan, it is proposed to cover selected parts in the following areas.

1. Bhadrachalam area, A.P.
2. Salem-Udagamandalam and Dindigul area (south of Coimbatore), Tamil Nadu.
3. Foothills of Arunachal Pradesh
4. Detailed survey over Panna-Mahoba area - KCR
5. Detailed survey over Narayanpet-Mahboobnagar area - KCR
6. Detailed survey over Nalgonda, A.P. – Uranium/KCR

Need for Aerogeophysical Surveys for which infrastructure has to be developed:

(i) Considering the present status, there is need to cover the gap areas particularly in Western Shield area for combined gravity-magnetic surveys. This area with the Mesozoic-Tertiary sedimentaries and Indus Alluvium is likely to be the potential area for hydrocarbons, tertiary coal, lignite, salt and some metalliferous minerals at depth.

(ii) Other interesting area is quaternary alluvial plains covering Ganga, Brahmaputra, Sindhu, Sabarmati, Godavari, Krishna and Cauvery plains mainly for hydrocarbons. Though some areas have been covered for the Oil Industry in the earlier years, the peri-cratonic sedimentary belts of the peninsula with extensions offshore needs attention for gravity surveys. Moreover geoscientific information beneath the alluvium is also needed for future exploration strategy.

(iii) The offshore areas are the potential zones for future natural resources mainly for hydrocarbons, placer minerals and polymetallic nodules/deposits. Moreover the sub-marine resources of the EEZ are national property and assessment of such potential is obligatory for the government. Though shipborne surveys are ideal and more dependable, it is very slow and costly proposition apart from the large time required. So, it is worthwhile to consider aerogeophysical surveys (gravity and magnetic).

(iv) Low altitude aerogeophysical surveys using fixed wing aircraft are not possible in hilly terrains. The heliborne aerogeophysical surveys are to be considered in Himalayas, Western and Easternghats, Northeastern states, Vindhyan-Satpura range etc.

C. Marine Survey

- Multibeam bathymetry, magnetic survey and sampling in the Mid Oceanic Ridge in Indian Ocean and in the Andaman Sea.
- Study in connection with offshore energy sources viz. OTEC.
- Investigation of Lime mud occurrences in the selected sectors in the Arabian Sea and the Bay of Bengal.
- Survey will be carried out for geological, geophysical and geochemical mapping of seabed within the remaining area of EEZ and 0.2 million sq km out of the additional area of around 1 million sq.km. likely to be gained beyond EEZ.
- Resource evaluation within the EEZ and beyond. Search for sulphides mineralization, ferromanganese and cobalt rich encrustation, phosphate rich sediments, lime mud deposits will be taken up.
- Identification of potential areas for gas-hydrate accumulation.
- Search for polymetallic nodules in selected sectors of Indian Ocean.

- Remaining unmapped area off Maharashtra and Gujarat in West coast and off Tamil Nadu in the East Coast will be surveyed by coastal vessels.
- Carry out survey for offshore resources, mainly placer minerals and creating database of shelf and deep sea deposits and energy resources.
- Study of geotechnical and mass physical properties of seabed sediments along with close spaced bathymetry, shallow seismic and side scan sonar survey using coastal vessels are proposed in the near shore areas off Orissa, Andhra Pradesh, Kerala, Karnataka, Goa and Maharashtra.
- Remaining unmapped area, spread over in the offshore areas of Andaman & Nicobar and Lakshadweep Islands in the deep sea and in parts of Ganga and Mahanadi deltas and also some places in Maharashtra and Gujarat coast is proposed.
- Regional assessment of construction grade silica sand in Andaman & Nicobar Islands.
- Identifying sites for harnessing tidal energy in Sundarban in West Bengal and in Gujarat.
- Creation of additional database for means of specific surveys with coastal launches and through drilling shallow water from about 6m to 30m with the acquisition of new tailor-made Geotechnical vessel.
- Study of geo-environmental parameters in relation to various anthropogenic activities viz. port activity, mining of heavy minerals, bank erosion, channel aggradations, shoreline changes along the active delta and coastal plains in the sedimentary basins will be carried out.
- Study under Projects with high societal values like evidence of last glacial maxima, land–ocean interaction, environmental catastrophes in Holocene.
- Scientific collaborations with national and international earth science organisations on the relevant themes on marine domain will continue to receive attention.
- R&D work on design and development of current meter and technology development for in-situ measurement of thermal gradient of sea floor sediments at 1.0 to 1.5m below sea floor will be taken up.
- R&D investigation will be carried out to study tectonic set up of the ocean basin for building up ocean basin models and ocean environment etc. to build up magnetic stratigraphy of deep-sea sediments to study impact of changes in ocean-circulation on the climate and deep-sea sediments; sea-surface temperature (SST) of Indian Ocean during Neogene with special reference to monsoon-related changes.

- Studies on collation/correlation of evidences of LGM in Indian Ocean.
- Participation in international endeavour for study of issues of global concern viz. climatic changes, sea level fluctuation and coastal hazards would continue during the XIth Plan.
- Intra-organizational collaboration with various departments of GSI viz. AMSE, Glaciology & Antarctica Division etc. will also be given a new thought and dimension.
- With the induction of new replacement vessel, hands-on-training for the officers be introduced to get familiarize with data acquisition and interpretation and of collation of the same with the existing database. Foreign training and collaboration on data processing and interpretation are being planned and to be implemented immediately.

D. Geochemical Mapping

Thus during the X Plan, National Geochemical mapping programme was initiated in the country, which requires sampling and analysis of stream sediment, soil, stream water, humus etc. Stream sediment is the prime media for sampling. Stream sediments are being collected from a cell size of 1 km by 1 km and composited on 2 km by 2 km cell for analytical purposes. Samples from the other media are being collected on a 5 minute by 5 minute cell size of the base map. Sampling is carried out using 1: 50,000 toposheet as the base map. 68 elements are proposed to be analysed up to the 'Clarke' level.

The initial two years (F.S. 2001-03) for the Project was assigned for pilot surveys in different parts of the country, with the aim of standardising sampling procedure, sample processing, analytical techniques, data processing, retrieval and quality control scheme. Once the pilot surveys were over and feasibility of all the aspects tested, systematic geochemical mapping programmes was mounted from the third year of X Plan.

The National Geochemical Mapping (NGCM) Project has completed five years since its inception in F. Y. 2002-2003 (F.S. 2001-2002).

About 98,947.30 square kilometre area (up to September 2006) has been covered in different parts of the country. With the availability of ICPMS, XRF and other precision instruments as part of modernisation and upgradation of laboratory facilities, the number of NGCM samples analysed has significantly improved.

During the XI Plan, about 1,80,000 sq km area is likely to be covered under Geochemical Mapping in the following sectors:

Central Region – 40,000 sq.km	
Maharashtra **M.P.** **Chhattisgarh**	55 toposheet to cover the major parts of mineral belts in Central Region.

Northern Region – 35,000 sq.km	
U.P. Uttaranchal **HP** **Punjab** **Haryana** **J&K**	50 toposheets to cover the parts of Peninsula and extra Peninsula in Northern Region.

North-Eastern Region – 17,500 sq.km	
Assam **Meghalaya** **Mizoram** **Tripura** **Arunachal Pradesh**	25 toposheets to cover the parts of Peninsula, extra Peninsula and Indo-Burma Arc in Northeastern Region.

Eastern Region – 30,000 sq.km	
West Bengal **Sikkim** **Bihar** **Jharkhand** **Orissa**	42 toposheets to cover the major parts of mineral belts and extra Peninsula in Eastern Region.

Western Region – 20,000 sq.km	
Rajasthan **Gujarat**	28 toposheets to cover the major parts of mineral belts in Western Region.

Southern Region – 37,500 sq.km	
Andhra Pradesh **Karnataka** **Goa** **Tamil Nadu** **Kerala**	52 toposheets to cover Peninsular Gneissic Complex, Proterozoic Cuddapah basin, granite-gneiss – greenstone terrain, magmatitic terrain with high grade supracrustals, Miopliocene, Quaternary sediments and laterite in Southern Region

E. GEOPHYSICAL MAPPING

Systematic ground gravity-magnetic mapping for the preparation of G-M maps of the country in 1: 50,000 scale is the mission of GSI. This involves acquiring G-M data at an average frequency of one station per every 2.5 sq.km. over the entire Indian shield, the Indo-Gangetic plain, the Eastern and Western Ghat areas including the coastal plains and other covered areas. However, this excludes the inaccessible terrains both in the extra peninsular regions and even over the shield. Such areas are expected to be covered by Heliborne Surveys by GSI.

Such coverage will pave the way for grass root level planning in prognostication of potential areas for the exploration of metallic/non-metallic mineral deposits in addition to the demarcation of potential hazard areas from environmental point of view. Even 3D basin configuration and important geohydrological parameters can be mapped through such endeavours.

So far only gravity coverage has been initiated by GSI and almost every regional office is taking part in such surveys. In a toposheet (1:50,000) scale, 300 G-M station are needed to be observed as per the present scheme. But due to inaccessibility and other societal/topographic hazards even a frequency of (150-200) station is considered suitable for this purpose.

Systematic gravity and magnetic (VF) mapping covering 89 toposheets (1: 50,000) with 59,334.30 sq. km. area has been completed upto end September, 2006 during **X Plan period** under the project Geophysical Mapping with a station density of 1 station per 2.5 sq km for the preparation of G-M maps at 1 - 2 mGal contour interval.

During the XI Plan, about 2,40,000 sq km area is likely to be covered under Geophysical Mapping in the following sectors:

		Target (sq km)
1)	Deccan Trap covered areas	41,000
2)	Aravalli and Delhi Fold belt and adjoining areas	25,000
3)	Bikaner,Barmer,Jaisalmer areas	22,000
4)	Greenstone Belts of Dharwar Craton, Cuddapah basin and adjoining areas	25,000
5)	Godavari valley coal fields, Mannargudi lignite fields	21,000
6)	Parts of Singhbhum and Eastern Ghat mobile belts and adjoining areas	21,000
7)	Gondwana basins of Talcher and Rajmahal coal fields	23,000
8)	Gondwana basin of Sigrauli coal fields	14,000
9)	Indogangtic Plains of UP,Haryana and Parts of Punjab	32,000
10)	Parts of Northeastern Region	16,000

5.3.4 Mineral Exploration Corporation Limited.

MECL had built up an annual capacity of 4,25,000 m of drilling, 10,000 m of exploratory mining, one lakh m. of borehole geophysical logging and other matching geological and analytical facilities during the VIIth plan period. The phase of economic liberalization, initiated with the start of decade of 1990's had a direct impact on MECL's activities as well, the traditional clients like Coal India (CMPDIL), SCCL, NLC, etc. due to their budget cuts, have started shrinking the allotment of work to MECL. On the promotional activity side also, the work availability has reduced.

During the end of IXth Plan period / start of Xth Plan period, MECL has diversified its activity like CBM (slimhole) drilling, coal sampling analysis (as referee) and has emerged out as one of the leading organization in these fields inspite of tough competition from private sectors. For CBM drilling, organizations like ONGC, CMPDIL, etc. are awarding their work to MECL. During the end of Xth Plan period, allotment of promotional work of Ministry of Mines has also shown an increase trend. During Xth Plan Period, MECL has benefited due to economic liberalization and change in National Mineral Policy. Various private entrepreneurs have started awarding work in the field of mineral exploration particularly in energy minerals like Coal and Lignite.

Reduction of work from traditional clients, aging of machinery reduction of manpower (mostly technical) have had its impact on MECL's capacities. The capacity utilization during Xth Plan period annually has been 2 lakh m. of drilling and 5000 m. of mining and other matching services. The number of drill machines in operation have been gradually reduced due to improvements registered in productivity levels. The operational fleet has also reduced during Xth Plan period. Government of India, has increased the working capital of MECL during the end of Xth Plan period from 100.00 crores to 125.00 crores with restructuring of the company. With the above considerations, the annual capacities of company are 2 lakhs metres of drilling, 5000 m. of equivalent exploratory mining, about 1 – 1.5 lakhs metres of borehole geophysical logging, analytical facilities etc. to match with the challenges ahead during the XIth Plan period.

The work programme for MECL has been identified keeping in view the past experiences of sharing of work in Coal & Lignite sector and opportunities available in the market vis-à-vis promotional activity to be funded by Govt. of India. It is also expected that for promotional activities, Geological Survey of India, as an accomplishment of their programme in mineral sector, would throw open several prospects for detailed exploration and accordingly provisions are made in MECL's activity for the XIth Plan period. For the purpose, recently (end of Xth Plan) Govt. of India, Ministry of Mines has constituted a Co-ordination Committee of GSI and MECL to ensure continuous and timely flow of regional exploration reports to MECL and to draw short term / long term road map for detailed exploration.

In the Table V-11, mineral wise / region wise / belt wise tentative programmes have been indicated. In Table V-12, a summary of different activities proposed to be taken up in different mineral sector is summarized. As indicated earlier, out of 10,66,325 m. of drilling planned for entire plan period, about 5,86,000 m. of drilling is kept for Coal and Lignite sector alone, 1,00,000 m. of drilling and 10,000 m. of mining has been kept for CBM and miscellaneous work from client organization both in public & private sector. The balance meterage of around 3,80,000 m. drilling and 7,500 m of mining is projected for specific mineral commodities (non-coal lignite sector) to be funded under promotional activity. The above provisions would also be utilized for the development of mineral sector in the North Eastern Region including state of Sikkim. The total provision kept for promotional drilling is about 35% of the total drilling programme envisaged for MECL for XIth Plan period.

5.3.5 The Central Public Sector Organisations working in non-coal/lignite mineral sectors are SAIL, NMDC, KIOCL, MOIL, NALCO, BALCO, HCL, HZL, etc. These organizations are by and large taking up developmental exploration to upgrade the resources, mostly for the immediate production requirements. Some of these organizations have indicated their programmes which they would like to take – up during the XIth Pan period but these are essentially to prove the immediate extensions of the working mines except NMDC which intends taking up regional prospecting for diamonds in the States of A.P., M.P. and Chhattisgarh. Hence, no provision is kept for exploration purpose during the proposed Plan period in the present document in consonance with the objectives of present exercise.

5.3.6 The State Directorates of Geology & Mining are undertaking exploration mainly for the minor minerals. But in some cases, the exploration for coal, lignite, gold, base-metals, fertilizer minerals, dimensional stones, etc. is also taken up depending upon the priorities identified by the State Governments. Although, most of the State Directorates are taking up exploration activities, the notable ones are A.P., Jharkhand, Gujarat, Karnataka, Maharashtra, Madhya Pradesh, Chhattisgarh, Orissa, Rajasthan and Tamil Nadu which contribute to nearly 90% of the total exploration activities being undertaken in the State Sector. Similarly, the mining companies in the State Public Sectors are also taking up exploration activity limited to providing the extensions of mining areas. Details of work programme proposed by the State Directorates of Geology and Mining, as received, are incorporated in Table V-13(i to vii).

Tabale V-1 Salient features of estimated Apparent Consumption, Domestic Production, Resource situation & Life Index during XIth Plan period of some selected minerals.

(Thousand Tonnes)

	Minerals	Estimated Apparent consumption in terminal year of		Estimated apparent production for Terminal year of		Total estimated balance of resources As on 1.04.2012	Life Index beyond 2012
		Xth plan 2006-07	XIth plan 2011-2012	Xth plan 2006-07	XIth plan 2011-2012		
A	**Refractory Minerals** 1. Bauxite	12934	19900	14214	21875	3176799 (2091585)	96
	2. Chromite	2978	4583	4302	6619	192569 (106932)	16
	3. Graphite	113	174	113	174	157788 (10087)	58
	4. Ball clay	2045	3147	1610	2477	52493 (13335)	5
	5. Wollastonite	170	262	194	298	18429 (14255)	48
B	**Flux & Construction Minerals**						
	1. Gypsum	3437	5289	3994	6145	1194934 (767507)	125
	2. Asbestos	227	349	6	9	21724 (11228)	Very large
C	**Fertilizer & Chemical Minerals**						
	1. Rock Phosphate	4475	6695	1340	2061	383547 (139631)	68
	2. Sulphur (By product)	1320	2031	128	197	-	-
	3. Fluorspar	126	194	12.86	20	12591 (10765)	538

(Source IBM)

Table V-2

Life Indices for selected Base Metals & Coking Coal

Mineral	**Total Resources as on 1.4.2005 (Million tonnes)***		**Anticipated demand at the end of the XIth Plan (Million tonnes)**	**Life Index beyond 1.4.2012**
	Reserves	**Resources**		
Lead-Zinc ore	125.7	396.9	-	34
Lead Metal	2.6	4.6	0.16	-
Zinc metal	11.1	13.1	0.19	-
Copper Ore	369.5	1024.9	-	142
Metal	4.4	7.0	0.7	-
Aluminium (Bauxite)	914.7	2391.3	20	102
Coking Coal	32091	-	50.31	Large

* Provisional

(Source IBM)

Table V-3

EXPORT OF MINERAL (2003-04)
(Source : IBM Mineral Year Book,2003)

Sl. No.	Item	Quantity	Value (Crore Rupees)	% of Total Export (2003-04)
1	Diamond *	--	38145	76.93
2	Iron Ore	51.5 Mill. Tonnes	5174	10.43
3	Granite	2098165 Tonnes	2506	5.05
4	Alumina	0.81 Mill. Tonnes	795	1.60
5	Prec/Stone*	--	714	1.44
6	Building & monumental stone	1.41	362	0.73
7	Coal & Other Fuel	1.61 Mill. Tonnes	292	0.59
8	Marble	233663 Tonnes	227	0.46
9	Emerald*	--	216	0.44
10	Bauxite	0.1 Mill. Tonnes	171	0.34
11	Chromite	0.75 Mill. Tonnes	149	0.30
12	Slate	131357 Tonnes	146	0.29
13	Mica	123271 T(?)	136	0.27
14	Titanium ores & concentrates	205329 T	116	0.23
15	Zinc Ore Conc.	62041	75	0.15
16	Garnet	213863 +Gem Type	64	0.13
17	Baryte	0.41 Mill. Tonnes	58	0.12
18	Manganese Ore	0.24 Mill. Tonnes	50	0.10
19	Felspar (natural)	245197 +Gem variety	47	0.09
20	Silica Sand	35436 T	26	0.05
21	Abrasive (natural)	51723T	19	0.04
22	Steatite	29340	18	0.04
23	Fullers Earth	66078T	13	0.03
24	Bentonite	0.08 Mill. Tonnes	14	0.03
25	Salt	165183T	17	0.03
26	Gypsum & Plaster	62963T	8	0.02
27	Wollastonite	7673T	7	0.01
28	Graphite	2818T	3	--
29	Magnesite	7441T	4	--

(Source : IBM Mineral Year Book,2003)

* Exports after processing the imported diamond in the country.

- Minerals account for 17% of total merchandise exported during 2003-04, of value Rs.49,910.6 Crore.
- Increasing trend – 7% more than the previous year.

Table V-4

IMPORT OF MINERALS DURING (2003-04)

Sl. No.	Item	Quantity	Value (Crore Rupees)	% of Total Import
1.	Petroleum (crude)	93 Mill. Tonnes	86512	66.08
2	Diamond*	--	32251	24.64
3	Coal	21.68 Mill.Tonnes	5008	3.83
4	Coke	1.89 Mill. Tonnes	1474	1.13
5	Copper Ore (conc.)	488063 T. 0.49 Mill. Tonnes	1341	1.02
6	Rock Phosphate	2.31 Mill. Tonnes	602	0.46
7	Sulphur	1 Mill. Tonnes	395	0.30
8	Iron Ore	1588000 T	359	0.27
9.	Prec. Stone*	--	306	0.23
10	Asbestos	182761 T	257	0.20
11	Zinc Ore(conc.)	103007 T	144	0.11
12	Limestone	1.2 Mill. Tonnes	133	0.10
13	Magnesite	90544 T	116	0.09
14	Natural Gas	82818 T	116	0.09
15	Borax	55911 T	68	0.05
16	Fluorspar	100062 T	68	0.05
17	Bauxite (Refractory grade)	37432 T	21	0.02
18	Kaoline	28259 T	24	0.02
19	Ball Clay	17742 T	14	0.01
20	Mica	2551 T	11	-
21	Graphite	5587 T	9	-
22	Lead Ore	8266 T	8	-
23	Manganese Ore	6258 T	8	-
24	Sand-metal free	60055 T	8	-
25	Gypsum	18502 T	6	-
26	Tungsten Ore	190 T	3	-
27	Vanadium Ore & others Ore(conc.)	300 T	1	-
28	Tin Ore	0 T	0	-
29	Dolomite	885 T	1	-

(Source : IBM Mineral Year Book,2003)

* Imported for processing & then exported

- Import of minerals of value Rs.130060 Crores is 36% of total merchandise with increasing trend of 10.9% over 2002-03.
- Deficit in mineral trading

Import - Rs.130060 Crores

Export (-) - Rs.49911 Crores

Net deficit - <u>Rs.80149 Crores</u>

Table V-5

EXPORT OF MINERAL BASED PRODUCTS (2003-04)

Sl. No.	Item	Quantity	Value (Crore Rupees)
1.	Petroleum produces	14620000T	16781.00
2	Cement	6944537T	845.96
3	Fire Bricks	55653T	107.03
4	Soda Ash	183864T	96.51
5	Refractory Materials	25929T	58.46
6	Titanium dioxide	6540T	43.16
7	Caustic Soda	28473T	27.26
8	Graphite Products	5588T	20.26
9.	Phosphoric, Phosphorous & Phosphatic Fertilizers	15824+286+1190	19.69
10	Potash Fertilizers	8388T	10.37
11	Aluminium fluoride	2694T	8.57
12	Silicon Carbide Products	2567T	8.54
13	Asbestos Cement & Products	3511T	5.81
14	Bleaching Powder	16300T	3.34
15	Boric Acid	304T	1.00
16	Calcium Carbide	27T	0.05
	Total		**18037.01 Crores**

(Source : IBM Mineral Year Book,2003)

Export excluding Petroleum Products: 18037.01-16781 = Rs.1256.01 Crores

Table V-6

IMPORT OF MINERAL BASED PRODUCTS (2003-04)

Sl. No.	Item	Quantity	Value (Crore Rupees)
1.	Petroleum & its produces	7.90 Mill. Tonnes	9677
2	Phosphoric Acid/Element	3.09 Mill. Tonnes + 18367T	3096.05
3	Potash Fertilizers	2.31 Mill Tonnes	1336.46
4	Fire Bricks	527613T	173.69
5	Calcium Carbide	45720T	90.91
6	Soda Ash	0.13 Mill Tonnes	75.02
7	Titanium dioxide	7277T	59.15
8	Other refractories	68021T	56.71
9.	Caustic Soda	73069T	51.13
10	Graphite (articifical)	2714T	43.07
11	Absestos Cement, Spl. Cement, Boric Acid, HF, etc.	6890	16.73
12	Crucible, bricks	--	--
	Total		**14675.92**

(Source : IBM Mineral Year Book,2003)

Total Import excluding Petroleum etc : Rs.14675.92 (-) Rs.9677 = Rs.4998.92 Crores
Export of Mineral products excluding petroleum & its Products (-) Rs.1256.01 Crores

Rs.3742.91

Net deficit due to metallic & non-metallic mineral sector= **Rs.4000 Crores.**

Table V-7

IMPORT OF METAL & ALLOYS (2003-04)

Sl. No.	Major Import	Quantity	Value (Crore Rupees)	% of Share
1.	Gold	767T	29946	64.02
2	Iron & Steel Items	4.86 Mill Tonnes	8978	19.19
3	Silver	2368T	1635	3.50
4	Copper and Alloys & Scrap	229694T	1605	3.43
5	Aluminium Alloys & Scrap	211735T	1579	3.38
6	Nickel & Alloys	24592T	1046	2.24
7	Zinc Alloys & Scrap	178851	629	1.34
8	Lead and Alloys & Scrap	169284T	446	0.95
9.	Ferro Alloys (Ferro-boron, ferro chrome, cobalt, manganese, moluybdenum, nickel, niobium, phosphorous, sicicon, Tatanium, Tungsten, Vanadium, Zirconium, Silico-chrome, Silico-manganese, etc.)	65038T	336	0.72
10	Silicon	22172T	105	0.22
11	Tin and Alloys	4462T	96	0.21
12	Platinum	3352Kg.	87	0.19
13	Cobalt & Scrap	500T	62.5	0.13
14	Tungsten Alloys & Scrap	838070Kg.	56.9	0.12
15	Magnesium & Scrap	4609T	48	0.10
16	Pig Iron (Spiegelisesen)	15086T	43	0.09
17	Antimony & Alloy	2214T	23.4	0.05
18	Molybdenum & Scrap	153T	22.5	0.05
19	Other Minor imports (Tantalum & Telurium)	85T	9.5	0.02
20	Chromium & Scrap	177T	5.9	0.01
21	Manganese Alloys NES	810T	5.4	0.01
22	Selenium	268T	6.2	0.01
23	Boron	4T	0.4	-
24	Cadmium & Scrap	288T	1.4	-
25	Mercury	197	4.1	-
	Total		**46778**	

(Source : IBM Mineral Year Book,2003)

Table V-8

EXPORT OF METAL & ALLOYS (2003-04)

Sl. No.	Item	Quantity	Value (Crore Rupees)	% of Share
1.	Iron & Steel	5.16 Mill. Tonnes	12458	73.28
2	Copper & Alloys including Brass & Bronze	213460T	2076	12.21
3	Aluminium & Scrap	177302T	1444	8.49
4	Pig & cast iron including Spiegelesen	460474T	466	2.74
5	Ferro Alloys	149108T	389	2.29
6	Zinc & Alloys & Scrap	31226T	107	0.63
7	Tin & Alloys & Scraps	12891T	42	0.25
8	Tungsten Alloys & scraps	48087Kg.	19	0.11
9.	Other metal Alloy & Scrap	--	--	--
	Total		17001	

(Source : IBM Mineral Year Book,2003)

1. This accounts for 5.8% of total export
2. Export of metal & alloys has been Rs.17,114.2 Crores in 2003-04 and Rs.13,578.4 Crores in 2002-03 registering an increase of 26% as compared to previous year.
3. Deficit in international trade of metal & alloys.

Import - Rs.46713 Crores
Export - Rs.17114 Crores

Rs.29599 Crores

Table-V-9.

CATEGORISATION OF MINERALS

Sl. No.	Group of Minerals	Categories of minerals with respect to availability			
		Abundant	Adequate	Deficit	Scarce
1.	Fuel Minerals	Non Coking Coal Lignite		Coking Coal Petroleum (Crude)	--
2.	Metallic Minerals	Iron Ore Bauxite TitaniumMinerals	Chromite (metallurgical grade) Manganese Ore	Chromite(refractory) High grade Manganese (Battery and Chemical) Bauxite (Chemical and refractory), Lead & Zinc Copper	Nickel, Tungsten, Cobalt, Molybdenum, Vanadium, Antimony, Gold, Platinum Group, Silver, Tin, Cesium, Rubidium Lithium
3.	Non-Metallic minerals	Limestone Dolomite Baryte Bentonite Felspor Fireclay Fullers Earth Clay-Kaoline Magnesite Sillimanite (granular) Quartz, quartzite & Silica sand Garnet Calcite	Steatite, Ball Clay Mica Gypsum Graphite Wollastonite Ochre Vermiculite Pyrophyllite Rock Salt	Apatite rock phosphate Asbestos Fluorite Kyanite Dolomite Low Limestone Silica Mangnesite Gypsum Selected Graphite grades Mica only Ballclay Sillimanite (Lumpy)	**Borax** Native Sulphur Potash
4.	Precious Stone	--	--	--	Diamond, Emerald, Sapphire, Ruby
5.	Other\ Mineral/ rocks	Granite (Dimension Stone) Marble, SLATE, Decorative Stones	--	--	--

Table –V-10

PHYSICAL TARGET IN RESPECT OF MINERAL EXPLORATION PROGRAMMEOF GSI DURING XI PLAN

(Figures in parentheses denote number of item)

Sl. No	Mineral	State	Items	Quantum
1	Gold	Andhra Pradesh, Karnataka, Tamil Nadu, Rajasthan, Uttar Pradesh, Jharkhand, Madhya Pradesh, Kerala, Bihar, West Bengal, , Arunachal Pradesh, Uttaranchal, Chhattisgarh, Orissa	1. Large Scale Mapping (LSM) (1:10,000-1:25,000) 2. Detailed Mapping (DM) (1:1000-1:2000) 3. Drilling (D) 4. Geochemical and other Sampling (GCS) 5. Geophysical Survey (GPS) 6. Pitting and Trenching (PT)	3000 Sq. km 25Sq.km 25,000 m 40,000 nos 200 lkm 12000 Cu.m
2	Base Metals	Rajasthan, Jharkhand, Maharashtra , West Bengal, Sikkim ,Madhya Pradesh, Uttar Pradesh	1.LSM 2.DM 3.Drilling 4.GCS 5.GPS 6.PT	1500 Sq.km 35 Sq.km 50,000m 21,800 nos 200 lkm 2000 Cu.m
3	Diamond	Andhra Pradesh, Karnataka, Maharashtra, Orissa, Madhya Pradesh, Chhattisgarh	1.Reconnaissance/Geological mapping(1:50,000) 2.PT 3.GCS 4. Drilling 5. GPS	18,600Sq.km 1500 Cu.m 18600 nos 3000m 100 lkm
4	PGE and Nickel	Andhra Pradesh, Karnataka, Tamil Nadu, Orissa, Jharkhand, Goa, Kerala, Arunachal Pradesh, Manipur, Nagaland	1.LSM 2.DM 3.Drilling 4.GCS 5.GPS	2500 Sq.km 30 Sq.km 13000m 14,200nos 100 lkm
5	RM & REE	West Bengal, Rajasthan, Tamil Nadu, Meghalaya, Uttar Pradesh, Gujarat,Chhattisgarh, Orissa., Andhra Pradesh	1.LSM 2.DM 3.Drilling 4.GCS	3000 Sq.km 10 Sq.km 4000m 3400 nos

6	Strategic Mineral(W,Mo,Sn)	Uttar Pradesh, Andhra Pradesh, Uttaranchal	1.LSM 2.DM 3.GCS 4.PT	200 Sq.km 2 Sq.km 1800 nos 400 Cu.m
7	Iron ore	Orissa, Jharkhand, Chhattisgarh, Andhra Pradesh, Karnataka,Mahrashtra Madhya Pradesh, Tamil Nadu.	1.LSM 2.DM 3.Drilling 4.GCS 5.PT	1500Sq.km 10 Sq.km 5000 m 5400 nos 2700 Cu.m
8	Manganese ore and Chromite	Orissa, Karnataka, Maharashtra	1.LSM 2.DM 3.Drilling 4.GCS 5.PT	200Sq.km 10 Sq.km 11,000 m 3000 nos 1000 Cu.m
9.	Lime stone and Dolomite	Meghalaya, Gujarat, M.P., Rajasthan, Orissa, Assam	1.LSM 2.DM 3.Drilling 4.GCS	300 Sq.km 20 Sq.km 10,000 m 10,000 nos
10	Dimension stone	Karnataka,Tamil Nadu, Gujarat.	1.REC.MAPPING 2.DM	1000 Sq.km 5 sq.km.
11	Bauxite	Rajasthan, Andhra Pradesh, Maharashtra Orissa	1.LSM 2.DM 3.Drilling 4.GCS	100 Sq.km 5Sq.km 5000m 5000 nos
12	Other Minerals (glass sand, clay, barite, fluoride, graphite,sillima-nite, placer minerals, serpent-inite as flux)	Tamil Nadu, Andhra Pradesh, Gujarat, Meghalaya, Maharashtra, Bihar,Rajasthan, Assam,Orissa, Chhattisgarh	1.LSM 2.DM 3.Drilling 4.GCS 5.PT	500 Sq.km 10 Sq.km 3200m 3200 nos 2000 Cu.m
13	Fertiliser mineral	Rajasthan, Madhya Pradesh, Uttar Pradesh	1.LSM 2. DM 3.Drilling 4. GCS 5.PT	200 sq.km 10sq.km. 2800m 2000nos. 500cu.m.

A. Total target in respect of various components of Mineral Exploration Activities

(Except Coal and Lignite, ground evaluation items of AMSE) in GSI

Mapping

1. Large scale mapping (LSM)Scale 1: 10000 - 25000 : 13000 Sq.km
2. Reconnissance/Geological mapping (REC/GM) Scale 1: 50000 : 19,600 Sq.km
3. Detailed Mapping (DM) Scale 1: 100 - < 10000 : 172 Sq.km

Exploration

1.	Drilling	:	132000 m.
2.	Pitting & trenching	:	22100 Cu.m.
3.	Geophysical Surveys	:	600 l km.
4.	Geochemical sample	:	128400 nos.

B. Target of LSM and drilling for Coal & lignite

1. LSM – 530 sq km
2. Drilling - 2,97,000 m

TABLE – V-11

MINERAL WISE ACTION PLAN FOR MECL, DURING THE XITH PLAN

SL. NO.	MINERAL	STATE	FIELD / BELT	EXPLORATION INPUTS
A.	**COAL**	Andhra Pradesh Madhya Pradesh Chhattisgarh Maharashtra Assam	Godavary Valley C.F. Sohagpur C.F., Singrauli C.F. Sonhat C.F., Mand-Raigarh C.F., Hasdo-Arad C.F. Katol Basin Bhander C.F. Wardha Valley C.F. Makum C.F.	Remote Sensing : 12 Scenes Geological Mapping : 1664 Sq.Km Geophysical logging : 262462m Promotional Drilling : 291625m Sampling: 29250 Nos. Environmental studies : 31 Nos.
B.	**LIGNITE**	Tamil Nadu Rajasthan Gujrat	Neyveli Basin, Mannargudi Basin, Ramnathpuram-Basin Barmer Sector Nagaur Sector Bikaner Sector Cambay-Sanchor Basin	Remote Sensing : 6Scenes Geological Mapping : 2741 Sq.Km Geophysical Survey i. Gravity Survey : 1500 sq.km. ii. Resistivity Survey : 200 Nos. Promotional Drilling :295000m Geophysical Logging : 295000m Sampling : 29500 Nos. Environmental studies : 12 Nos.
C.	**BASE METAL** **1. Copper**	Jharkhand Rajasthan Madhya Pradesh	Singhbhum South Khetri Copper-belt Pindwara-watera Basantgarh Rajpura-Dariba Dhani-Bhusri Baniwala Ki-Dhani Sanganer-Siwatha Pratapgarh-Raigarh Betul Belt (Dhelwara)	Environmental studies : 4 Scenes Geological Mapping : 25 Sq.Km. Promotional Drilling : 36000m Geophysical Survey : 10 Sq.km. Sampling & Analysis :18000 Nos. Exploratory mine : 500

Table –V-11 Contd…..

SL. NO.	MINERAL	STATE	FIELD / BELT	EXPLORATION INPUTS
C.	**BASE METAL** **2. Lead-Zinc**	Rajasthan Madhya Pradesh Maharashtra Sikkim	Pur Baneru belt Sawar-Bajata Pindwara-watera Deri-Ambaji Rajpura-Dariba Betul Chindwara belt Sakoli fold belt Small occurrence	Geophysical Survey : 10 Sq.km. Geological Mapping : 31 Sq.Km. Promotional Drilling : 52000m Sampling & Analysis : 23500Nos. Exploratory mining-500m
D.	**GOLD**	Andhra Pradesh Karnataka Tamil Nadu Rajasthan Jharkhand Kerala	Ghanpur Schist belt Vellore Schist belt Veligallu Schist belt Gani Kalva Area Peddavaru Schist belt Hutti-Muski Schist belt Gadak Schist belt Chitradurga Schist belt Hungund-Kushtangi Hagari - Schist belt Shimoga Schist belt Nuggi-halli Schist belt Extention of Kolar-Schits belt Darampuri distt., Tamil Nadu Arawali Fold belt (Bhukia Prospect) Singhbhum Fold belt (Parsi block) Southern Granite-Terrain	Geological Mapping 23 Sq.Km. Promotional Drilling 112700m Sampling & Analysis-89000Nos. Exploratory mining-2000m Environmental Studies-6 Scenes

Table –V-11 Contd…..

SL. NO.	MINERAL	STATE	FIELD / BELT	EXPLORATION INPUTS
E.	**FERTILISER MINERALS**	Rajasthan Madhya Pradesh West Bengal Andhra Pradesh	Area between Jamar kotra-jhabua Nagaur-Gangasagar Banswara distt. Jhabua belt Sugar Chhattarpur belt Purulia distt. Cuddapah basin	Geological Mapping : 22 Sq.Km. Promotional Drilling : 50,000m Sampling & Analysis : 42,500Nos. Exploratory mining : 1000m Environmental Studies : 3 Scenes
F.	**STRATEGIC MINERALS)** (Tin, Tungsten, Molybdenum)	Maharashtra Rajasthan West Bengal Tamil Nadu	Sakoli fold belt Motia-pipalia Area Syenite-Carbonatite province (Sirohi, Pali distt.) Sewaria Granite (Motia-pipalia Area) Bankura Tungsten belt (Ratanpur Area) Harur Uttangiri belt	Environmental Studies : 2 Scenes Geological Mapping : 13 Sq.Km. Promotional Drilling : 24,000m Sampling : 20,500Nos. Exploratory mining : 500m
G.	**HIGH TECH MINERAL** (Cesium, Lithium & Rubidium)	West Bengal Rajasthan Chhattisgarh Orissa	South Purulisa Shear Zone Sewaria Granite Area Mica bearing pegmatite belts Bastar tin Area (Pegmatites) Bolanoisai belt	Environmental Studies:3 Scenes Geological Mapping : 8 Sq.Km. Promotional Drilling : 24,000m Sampling & Analysis : 21,000Nos. Exploratory mining : 500m

Table –V-11 Contd…..

SL. NO.	MINERAL	STATE	FIELD / BELT	EXPLORATION INPUTS
H.	**FERROUS GROUP** (Iron, Chromite & Manganese)	Orissa	Badampahar belt Tomka-Daitari Sector, Sukinda Malangtoli group Boilangir, Kendurjhar distt.	Geological Mapping : 73 Sq.Km. Promotional Drilling : 76,000m Sampling : 60,000Nos. Exploratory mining : 2000m Environmental Studies:4 Scenes
		Jharkhand	Singhbhum belt	
		Chhattisgarh	Bailadila, Rowghat	
		Maharashtra	Surajgarh Bhandara distt. Sausar belt	
		Tamil Nadu	Tiramalai Nainamalai Southern granulite	
		Karnataka	Nuggihalli Schist belt	
I.	**BAUXITE**	Orissa	**East Coast Bauxite (unexplored plateau** (Kadalia block)	Environmental Studies : 3 Scenes Geological Mapping : 25 Sq.Km. Drilling : 25000m Sampling & Analysis : 23000Nos. Exploratory mining : 500m
		Andhra Pradesh	East Coast Bauxite belt (unexplored plateau)	
		Jharkhand	Lohardaga, Gumla distt.	
		Chhattisgarh	Jamirapat, Pandripat Raigarh High land, Mainpat	
		Maharashtra	Konkan belt	

TABLE – V-12

MINERAL WISE ACTION PLAN FOR MECL, DURING THE XITH PLAN

Sl. No.	Mineral	Remote Sensing (Scene)	Envir. Studies (Scene)	Geophy. Survey (Sq.Km.)	Geophy. Logging (m)	Survey+ Geol. Mapping (Sq.Km.)	Drilling (m)	Explora-tory Mining (m)	Sampling & Analysis (Nos. of samples)
1.	Coal	12	31	–	2,62,462	1,664	2,91,625	–	29,250
2.	Lignite	6	12	1500	2,95,000	2,741	2,95,000	–	29,500
3.									
i.	Base metals	–	4	10	–	25	36000	500	18000
ii.	Copper	–	5	10	–	31	52000	500	23500
	Lead-Zinc								
4.	Gold	–	6	–	–	23	1,12,700	2000	89000
5.	Fertiliser Minerals	–	3	–	–	22	50,000	1000	42500
6.	Strategic Minerals	–	2	–	–	13	24,000	500	20,500
7.	High Tech Minerals	–	3	–	–	8	24,000	500	21,000
8.	Ferrous Group of Minerals	2	4	–	–	73	76,000	2000	60,000
9.	Bauxite	–	3	–	–	25	25,000	500	23,000
10.	CBM	–	–	–	–	–	50,000	–	–
11.	Miscellaneous (other Minerals, Ground water, geotechnical, large diam.drilling, mine construction etc.)	3	2	15	–	30	50,000	10,000	2000
	Total :	**23**	**75**	**1535**	**557462**	**4655**	**1066325**	**17500**	**358250**

Table-V-13 (i)

ACTION PLAN OF DMG, KERALA FOR THE XITH PLAN

Sl.No.	Mineral	Deposit/District	Exploration Inputs
1.	Gold	Nilambur area	Not indicated
2.	Iron Ore	Kojhikode, Malappuram, Kottayam, Idukki	
3.	Bauxite	Kasaragod, Kannur, Kollam	
4.	China Clay	Thiruvananthapuram, Kannur, Kasaragod	
5.	Sand	Pamba, Periyar, Bharathapujha basin	

Table-V-13 (ii)

ACTION PLAN OF DMG, WEST BENGAL FOR THE XITH PLAN

Sl.No.	Mineral	Deposit/District	Exploration Inputs
1.	Kyanite	Purulia	Not indicated
2.	Magnetite & associated minerals	-	
3.	Tungsten & associated minerals	-	
4.	Other minerals (Quartz/quartzite, glass sand, pyrophyllite, kaolin, road metal	-	

Table-V-13 (iii)

ACTION PLAN OF DMG, KARNTAKA FOR THE XITH PLAN

Sl.No.	Mineral	Deposit/District	Exploration Inputs
1.	Iron ore	-	Not indicated
2.	Manganese ore	-	
3.	Bauxite	-	
4.	Chromite	-	
5.	Limestone (Cement grade)	-	
6.	Refractory minerals	-	
7.	Ceramic minerals	-	

Table-V-13 (iv)

ACTION PLAN OF DMG, MAHARASHTRA FOR THE XITH PLAN

Sl.No.	Mineral	Deposit/District	Exploration Inputs
1.	Iron ore	-	Not indicated
2.	Pyrophyllite	-	
3.	Sillimanite	-	
4.	Limestone	-	

Table-V-13 (v)
ACTION PLAN OF DMG, ORISSA FOR THE XITH PLAN

Sl.No.	Mineral	Deposit/District	Exploration Inputs
1.	Iron ore	Keonjhar, Sundargarh, Malkangiri and Mayurbhanj	Not indicated
2.	Chromite & PGE	Sukinda, Baula-Nausahi and in the extension areas	
3.	Manganese ore	EGMB of the state	
4.	Bauxite	Raygada, Koraput, Kalahandi and Sundargarh	
5.	Beach Placers	Remaining coastal tracts	
6.	Graphite	EGMB of the state	
7.	Gemstones	EGMB-Purana contact zone	
8.	Diamond	EGMB-Purna contact zone	
9.	Other minerals (quartz, quartzite, soapstone, pyrophylite)	-	

Table-V-13 (vi)

ACTION PLAN OF DMG, RAJASTHAN FOR THE XITH PLAN

Sl.No.	Mineral	Deposit/District	Exploration Inputs
1.	Lignite	Gap areas in Tertiary basin	• Regional Mineral Survey-30000sq.km • Regional geological mapping-2500sq.km. • Detailed mapping-260sq.km • Drilling-56000m
2.	Lead-Zinc	South of Agucha to Rajpura-Dariba, Rajpura-Dariba to south of Bhinder, Jahazpur belt, Pur-Banera-Dariba-Bhinder-Sawar belt. Agucha extension, Zawar belt.	
3.	Copper and Gold	Follow-up exploration in anomalous areas identified by other companies (multinational/domestic)	
4.	Precious and Semi-Precious stones	-	
5.	Dimensional and Decorative stones (Granite, Marble,Sandstone, Shale, Slate, Flaggy limestone)	-	
6.	Limestone (SMS, Chemical, Cement grade)	-	
7.	Industrial Minerals (Glass and Ceramic, Quartz, Feldspar, Silica sand, Ball clay, China clay, White clay, Fire clay, Bentonite clay and Fulle's earth, Wollastonite)	-	
8.	Fertilizer and Chemical (Rock Phosphate, Gypsum,)	Banswara, Udaipur and Jaisalmer districts and western Rajasthan	
9	Steatite, Pyrophyllite	Bhilwara,Aravalli and Delhi Supergroup	

Table-V-13 (vii)

ACTION PLAN OF DMG, MADHYA PRADESH OR THE XITH PLAN

Sl. No.	Mineral	Deposit/District	Exploration Inputs
1.	Coal	--	Geological Survey – 45,000 Sq.Km. Drilling 25,000.00 m Sample analysis 22,500
2.	Limestone & Dolomite	--	
3.	Precious stones, Noble Metals (Gold), Base metals.	--	
4.	Mineral Inventory preparation	Bhind, Ratlam, Indore, Bhopal, Sagar, Panna, Balaghat.	

CHAPTER-VI

(Item-9 of Terms of reference)

ASSESSMENT AND STRATEGY FOR SPEEDY EXPLOITATION OF PROVEN MINERAL DEPOSITS

6.1.0 **PREAMBLE**

6.1.1 The exploration and exploitation efforts taken by State agencies besides private organizations during Xth plan have contributed substantial augmentation in the National Mineral Inventory both in terms of number of minerals explored and produced and in quantitative reserves. Still our country lacks in respect of many minerals and continues to be net importer of minerals resulting in substantial trade deficit. As such efforts are required to narrow down not only the trade deficit but give boost to exports for minerals which can earn foreign exchange.

6.1.2 Keeping above in view during the XIth plan period it is necessary to assess and identify the strategies as to how quickly the proven economically viable mineral deposits under deficit and scarce category can be explored and exploit.

6.1.3 Investment decision on exploitation can be taken up after feasibility study and evaluation of economic viability. In most of the cases, regional exploration carried out by GSI has not covered study on feasibility. In such a situation it is not possible to comment on economic exploitation. In areas where MECL and state agencies have carried out detailed exploration and feasibility studies, those prospects could be considered for exploitation. However, in the present case potential prospects established by GSI have also been considered.

6.1.4 The following paragraphs deal with identification of potential prospects pertaining to gold, lead-zinc, copper, diamond, bauxite, iron ore, manganese and chromite which could be considered for exploitation after feasibility studies in near future for domestic and foreign direct investment. In addition to above, feasibility of economic exploitation of small and isolated deposits through cluster mining have also been assessed.

6.2.0 Identifying proven and economically viable deposits, Strategy for their speedy exploitation and supplementation of reserves by additional exploration.

6.2.1 Gold

6.2.2 Historically India has been a leading producer of gold in the world with Kolar, Hutti, Ramagiri and Gadag belts of the Dharwar craton as the major contributors. Outside the Dharwar craton, Kunderkocha and Lawa mines of Singhbhum craton and Wayanad Gold Field of Tamil Nadu and Kerala have contributed to the gold production in a small way. In the present time the production of gold is around 3-4 tonnes/annum and that is produced in two forms namely the primary gold and the secondary one as a by-product from base metal mining. Hutti Gold Mines Company Limited (HGML) is the primary gold producer from its three mines located in Karnataka.

6.2.3 Exploration efforts have brought to light some gold deposits such as Chigargunta-Mallapakonda, Jagpura-Bhukia, Dona, G.R.Halli, Parasi and Maruda etc. These deposits along with some small, low grade deposits have to be mined and the metal has to be extracted with the development of beneficiation technology which will suit better extraction from low grade ores. On these lines the Government of India had signed a Protocol with South Africa for a mutual co-operation on characterization and processing of gold, diamond and platinum group of metal ores and to evolve suitable beneficiation processes. Bacterial leaching of low grade gold ores and extraction of gold from gold ores of Bhukia-Jagpura deposits were the targets for this protocol.

6.2.4 It is an emergent need to introduce suitable systems and layouts, which would be amenable to mechanized, productivity oriented mining, to reduce mining costs which is central issue for gold deposit development. The mechanization should always be optimal and the capacity in the mine and mill must match. There is also need for serious efforts in designing and developing indigenous equipments which would suit different conditions and purposes.

6.2.5 Strong mine planning inputs are needed as also continuous and persistent R&D efforts in adopting latest advances and updating the mining methodology. Interaction with the academic institutions and other mining organizations equipped with improved mine planning software could be very useful in this context.

6.2.6 In India, there are a number of isolated small gold deposits which call for improved methods of narrow vein mining for their economic exploitation. Introduction of small scale mining culture in gold industry is a need of the day. Various options like cluster mining, having common facilities, portable caravan type gold treatment plants may find relevance once this culture is inducted.

6.2.7 Adoption of modern gold extraction techniques is an immediate need. No amount of progress in other related fields of activity can be fruitful unless the recovery techniques are improved.

6.2.8 The gold extraction process all over the world have come a long way from age old obsolete methods. India is keeping pace with the development. Advancements in this field have rewritten the economic viability of the sub marginal grade deposits. The emphasis now is to adopt appropriate gold recovery techniques to suit different ores. Methods have been developed to deal with both free milling and refractory gold. CIP, CIL, heap leaching, pressure leaching, coal-gold agglomeration are some of the currently employed processes/techniques which lead to very high percentage of recovery. The world over, low and high grade ores are treated by different processes.

6.2.9 The economic viability of the placer and lateritic gold is largely dependent on the efficient concentration and recovery technology. Proper evaluation and extraction of by-product metals like silver, platinoids, tungsten etc. may also be attempted to enhance the economic viability of gold industry. Technology import and training of personnel may be necessary to achieve the objectives. Interaction with suitable academic and research organizations may also be useful.

6.3.0 Diamond

6.3.1 India is presently known as a major exporter of cut and polished diamonds in the world. It imports rough and uncut diamonds and exports it after value addition. This industry is the second largest foreign exchange earner next only to software products and services in the country. Since 1950, GSI has been engaged in the exploration of diamond for a long period. Geologically diamonds are confined mainly to Dharwar, Aravalli/Bundelkhand, Singhbhum and Bastar cratons. The known areas of diamond source rocks are broadly grouped into three diamond provinces namely, the South Indian Diamond Province, the Central Indian Diamond Province and the East Indian Diamond Province.

6.3.2 With the liberalization and the introduction of National Mineral Policy the MNCs have shown much interest in diamond. The data base generated by the GSI and other government agencies formed the source for attracting foreign investments in diamond in the country. These MNCs are expected to bring in the state-of-the-art technology in diamond exploration and its subsequent mining. The kimberlites, lamproites and the conglomerates will be the targets for diamond exploration in India. M/s De Beers, Rio-Tinto, BHP, AMIL, GMSR, NMDC, Phelps Dodge, B.V. Chattisgarh Exploration Pvt. Ltd., Diamond Prospecting Ltd., Jindal Steel Power, Empror Granite are the companies which have been granted 105 Reconnaissance Permits upto August,2005 for a total area of 1,62,640 sq km spread over in the states of Andhra Pradesh, Orissa, Madhya Pradesh, Karnataka, Chhattisgarh and Uttar Pradesh. The RP holders have already started the reconnoitory and prospecting activities and at some places they have received good results.

6.3.3 The role of the state agencies will continue in the free hold areas in generating diamond exploration data base which will form the basis for the future foreign investments in the country.

6.4.0 Copper Ore

6.4.1 India is not a significant contributor either in copper mining or in smelting. According to the National Mineral Inventory, as on 1.4.2005 (provisional) the total resources are placed at 1394 million tonnes with a metal content of 11.41 million tonnes. At present demand of copper ore for primary copper production is met through two sources viz., copper ore mined from indigenous mines and imported concentrate produced from copper ores mined elsewhere in the world. The indigenous mining activity is limited to HCL while private sector i.e. M/s Birla Copper and M/s Sterlite Industries produce copper metal from imported concentrate through their share based smelter plants. For speedy exploitation of copper ore new strategy has to be adopted.

6.4.2 Copper deposits in India are localized mainly in the Precambrian terrains of the Peninsular Shield and to small extent in the lesser Himalayas. The three prominent belts, where copper deposits are located include Singhbhum Copper Belt (SCB), Khetri Copper Belt and Malanjkhand Copper Belt. Under Singhbhum Copper Belt, the Turamdih cluster of deposits consisting of five prospects viz. Turamdih, Dhadkidih, Nandup, Bayanbil and Ramchandrapahar extending over a strike length of 5 km hold potential for cluster mining through open cast method after detailed exploration by MECL. The Chapri-Siddheswar deposits of central part of SCB deserve attention for exploitation as Chapri block with a combination of wide ore zone and high tonnage hold potential for open cast mining while Siddheswar having narrow zone with rich copper ore bodies can be thought for underground mining in near future. The Khetri Copper belt has significant copper deposits at Khetri, Kolihan, Chandmari, Banwas, Singhana etc. Two mines viz. Khetri and Kolihan mines of HCL are producing copper ore at present. Mining feasibilities of Singhana prospect has to be studied as an integrated one with development of Banwas prospect to precisely determine the economic production level, degree of mechanization etc. The Chandmari intervening block has a reserve of 12.10 m.t.x1.03% Cu. The ore reserves of the block may be won economically by extending development of Kolihan mine towards south. The Basantgarh Multimetal Prospect in the South Delhi fold belt can be put up to private investor for further detailing.

6.4.3 The following sector merits exploration for supplementation of reserve and to assess mineability.

6.4.4 The Khetri Mine Area and North Khetri Copper Belt require deeper level probing. The South Khetri Copper Belt is relatively less explored. From Satkui-Dhanota upto Raghunathgarh, the area is spotted with a number of old working. Bhagal-Akola, Sanganel-Siwaha, Alwar-Jaipur, Devtalai, Dhani Basri and Baniwali ki Dhani blocks require immediate attention for detailed exploration.

6.5.0 Lead and Zinc:

6.5.1 India has limited resources of lead & zinc. The total resources of lead and zinc ores as per UNFC as on 1.4.2005 (provisional) are placed at 522.57 million tonnes containing 7.2 million tonnes of lead metal and 24.25 million tonnes of zinc metal. Presently Hindustan Zinc Ltd. and M/s Sterlite Opportunities and Ventures Ltd. (SOVL) are the major producers of primary lead and zinc metals based on indigenous ores. It’s mining operations are spread over the states of Rajasthan, Orissa and Andhra Pradesh. Besides HZL-SOVL joint venture, M/s Binani Zinc limited (BZL) with their smelter located near Kochi and M/s Indian Lead Ltd. (ILL) with their smelters at Kalipark (W.B.) and Thane (Maharashtra) are the other producers in this sector.

6.5.2 The exploration efforts of GSI, MECL and DMG, Rajasthan in recent times have proved a number of small deposits such as Devpura, Ghughra, Kayar, Sawar, Bajta, Kalabar within Pur Banera, Sawar-Bajta, Ghughra-Kayar belts in Rajasthan. In the other states some of the proven deposits include Askote (Uttaranchal), Kolari-Bhanori (Maharashtra) and Dhukonda (Andhra Pradesh). M/s HZL have employed state-of-the-art fast drill machines and have carried out advanced geophysical surveys involving deep penetration IP and time domain (INFINITEM) for exploration in their lease hold areas.

6.5.3 These small deposits mentioned above may be taken up for mining in clusters alongwith the other high tonnage low grade/low grade high tonnage in their vicinity with the development of suitable beneficiation technology including graphite separation etc. and increasing the smelting capacities.

6.6.0 Iron Ore

6.6.1 India has a substantial resource of iron ore to meet the domestic demand. There is an increase in demand due to substantial increase in the export market. The country has planned for capacity expansion on a large scale from its existing mines and development of new mines. Apart from expansion plans of present iron ore mines in all the sectors, development of following identified hematite and magnetite deposits/mines are envisaged for further exploration wherever required and exploitation by interested parties from within or outside the country.

a. Hematite Deposits:

Jharkhand: Chiria, Gua

Orissa: Thakurani, Malangtoli, Mankarnacha, Badampahar, Gandhamardan, Garjantoli and Daitari.

Chhattisgarh: Bailadila deposit Nos. 1,4 and 13, Rowghat and Dalli-Rajhara.

Karnataka: Kumarswamy and Ramandurg

b. Magnetite Deposits:

Karnataka:
a) Kudramukh group of deposits: Kudramukh deposits of KIOCL, Nelibadu, Gangrikal.
b) Bababudan deposits.

Andhra Pradesh: Ongole group of deposits.

6.6.2 Besides, magnetite deposits in Tamil Nadu also deserve attention. The areas, although already explored and came out to be quite potential.

6.6.3 There are areas of iron ore which are not available for exploitation as these lie under forest cover, some falling within national Park region and also owing to sensitive environmental issues requiring necessary clearance from the Government. Problems of forest clearance and environmental issues have to be addressed properly to increase iron ore production.

6.6.4 In certain areas, several small, isolated but workable deposits occur in close proximity. Profitable exploitation of these individual deposits is not possible owing to their small sizes. This type of situation calls for cluster mining by a single or a joint Group.

6.6.5 Technically and financially sound parties may be invited for economic exploitation of the following isolated deposits through cluster mining with conditions of proper environmental management and systematic development of the resources.

i) Bellary-Hospet Sector, Karnataka: A good number of small deposits lie in close proximity.

ii) Chandrapur, Bhandara and Gadchiroli districts of Maharashtra Exploration work has revealed the presence of 14 isolated deposits yielding substantial reserves.

In the above two areas, feasibility study has already been carried out.

6.6.6 Recent advancements with the coming of giant steel companies such as Posco, Mittals' etc. to India in a big way and with the increasing of capacity of the existing steel companies is going to observe a sea change in the country. The role of government agencies will be enhanced manifolds with the changing iron-steel scenario in the country. Exploration for the development of more and more new deposits in the free hold areas is required to feed the increasing demand for iron ore for the fast developing iron-steel industry in the country.

6.7.0 Chromite

6.7.1 Considering the relatively small area in Orissa where almost all currently known reserves of high quality chrome ore are confined, all the lease holders need to be persuaded to implement accelerated and time bound investigation programme to prove the total reserves in their respective lease areas and possible extensions beyond.

6.7.2 To meet the growing need, thrust needs to be given for systematic exploration and proving operations for discovering additional resources of chrome ore particularly, in the possible extensions of the ultramafic belts in Orissa.

6.8.0 Manganese ore

6.8.1 Large deposits of manganese ore are restricted in Maharashtra-Madhya Pradesh belt with higher manganese content. In Orissa-Jharkhand sector the deposits are small, grade is low with low phosphorous content. In view of occurrence of large proportion of low-grade manganese ore in the Eastern

India, most effective measures to be undertaken for beneficiation to improve manganese grade for marketing.

6.9.0 Bauxite

6.9.1 The public sector company BALCO was the first company in which the Government of India has disinvested its stakes to M/s Sterlite after liberalization. Earlier extensive exploration by GSI and MECL in 1970s & 1980s in the east and west coast of the country proved huge bauxite reserves in the country. To exploit these reserves giant company NALCO was set up as a public sector company under the Ministry of Mines. The bauxite production in India in 2003-04 has been 10.96 million tonnes which increased by 11% from 9.87 million tonnes in the previous year. There were 204 reporting mines in 2003-04 comprising 191 mines in the private sector and only 13 in the public sector. M/s HINDALCO, INDAL, BALCO and MALCO are the major private sector operators besides NALCO, a public sector company.

6.9.2 Exploration by MECL in the Xth plan has proved bauxite reserves in Amtipani-Deepakujam, Jamirapat, Lanjigrah and Serangdag deposits.

6.9.3 The increasing participation of the private sector in bauxite mining shows a phenomenal rise by the mechanization of the mines and increasing the refining capacities. The exploration for new deposits in the free hold areas will continue by the government agencies so as to develop a data base for attracting future investments in bauxite mining.

6.9.4 Out of 1700 million tonnes bauxite available in Eastern Ghat Belt in Orissa and Andhra Pradesh only Panchpatmali deposit in Koraput district in Orissa has been developed into a mine. Many other deposits with good potential are yet to be exploited in Orissa and Andhra Pradesh.

The prospects which can be taken up for mining are:-

In Orissa: Gandhamardan, Baphimali, Sijimali-Kutrumali, Sasbahumali-Pasangmali, Pottangi, Kodingamali.

In Andhra Pradesh: Jarrela-Korukonda, Sapparla, Gudem.

6.9.5 In many states namely Jharkhand, Chhattisgarh, Maharashtra, Goa, Gujarat, Madhya Pradesh and Tamil Nadu. There is a gap between reserves and resources which suggest there are scopes to convert resources to reserves through detailed exploration.

CHAPTER-VII

(Item-5 of Terms of reference)

REVIEW OF THE ROLES OF STATE INSTITUTIONS

7.1.0 Introduction

7.1.1. The introduction of New Mineral Policy-1993 has brought about radical reforms in the economic and mineral policies of the country. The mineral sector including the exploration and exploitation of the minerals was totally under the government control but with this new policy thirteen minerals such as iron ore, manganese ore, chromite, sulphur, gold, diamond, copper, lead, zinc, molybdenum, tungsten, nickel and platinum group of minerals which were reserved exclusively for exploitation by the public sector companies of the government were thrown open for the private sector. The atomic minerals however, continued to be under the control of the government for strategic reasons.

7.1.2. Such crucial modifications enforced introduction of significant changes in the role, the Government used to play in the sector of mineral exploration and exploitation. Its earlier functions beginning from the finding and locating a mineral deposit and culminating in the exploitation and marketing of the mineral have been modified many folds. In its changed role it also acts as a promoter for attracting the private sector investments in the mineral sector, both from the domestic as well as from the foreign entrepreneurs. To accommodate these changes, the National Mineral Policy, 1993 was introduced and the MMDR Act 1957 has been amended once in 1994 and again in 1999. Similarly, Mineral Concession Rules, 1960 (MCR) and the Mineral Conservation and Development Rules, 1988 (MCDR) have also been modified. All these amendments and modifications were introduced to attract and accommodate more and more private sector investments in the mineral sector. Further, the rules have also been relaxed for the FDI up to 100% through automatic route in the mineral sector.

7.1.3. With so much of liberalization and so many concessions being offered through the amendments and modifications of the rules, the pace of private sector participation in the mineral and mining sector is gradually showing improvement.

7.1.4. In the wake of increase in the interest shown by the private sector entrepreneurs in recent times in the mineral sector, the government and its institutions such as Geological Survey of India (GSI), Indian Bureau of Mines (IBM), Mineral Exploration Corporation Ltd.(MECL) and the State Government Departments need to provide data on mineral resources available with them in a format understood globally. They have to also ensure that such a database is easily accessible and avoiding the cumbersome procedure of buying a hard copy report currently prevalent in these departments.

Information is the commodity, which the investors need to make investment decision in a particular property either for exploitation or for the purpose of generating more data. The departments have already started efforts in the Xth plan period to create such data base with well framed guidelines to up-date them regularly.

7.1.5. Discussions were held between these departments and the Ministry to review the role of the different public sector undertakings with the anticipated changes in the policies and the acts likely to be introduced for the purposes discussed above. Modifications in functions have already been suggested, to reduce negative interference between them and the private entrepreneurs and facilitate overall development of the mineral industry by using collective wisdom.

7.2.0 Geological Survey of India (GSI)

7.2.1 The Geological Survey of India, a premier organization of earth science studies, was set up in the year 1851. Over the years, GSI has expanded its role to undertake assessment and regional level exploration for several mineral resources as per priorities laid down in the five year plans and coal, besides providing inputs to engineering projects, geotechnical studies of geo-environment and natural hazards, glaciology, seismotectonics, marine exploration, airborne geophysical survey etc. It has been responsible for the augmentation of the national mineral resources inventory, done by IBM with exploration results provided by GSI, updation and refinement of the national geo-scientific infrastructure and the principal provider of geo-science information since one and a half century.

7.2.2 In the early nineties geological surveys all over the world felt the necessity of introducing changes in their functions to accommodate the growing awareness of people about the societal value of earth science data and also to accommodate the changing expectations of the society from earth science. The thrust areas of the Geological Survey of India were redefined and a new charter was created and notified. The thrust areas now identified are as follows :

- the creation and updation of national geo-scientific data-base through specialized thematic studies, geochemical and geophysical mapping.
- concept oriented search for concealed mineral deposits with stress on minerals in which the country is deficient, precious minerals, noble metals, strategic minerals and high-tech minerals.
- seismic micro-zonation of urban clusters, active fault mapping and observational seismology for delineation of potential risk zones for geohazard management.
- landslide studies and creation of a national inventory on landslides for the country.

- compilation and digitization of maps for archival and disseminations by creating the GSI portal and interconnectivity between different GSI offices to offer easy free flow of data.
- Up-gradation of field and laboratory equipments for introducing sophistication in earth science data generation techniques and to improve levels of discussions to discover hitherto undetected mineral targets.

7.2.3 GSI has been the custodian of geo-scientific data. Anticipating future demands and the expectation of investors they have started acting as facilitator by installing GSI portal and making way to load it maps and reports for easy dissemination of the geological information for the benefit of the customers specially the prospective investors in the mineral sector. The geological reports and maps are being digitized. GSI Net, LAN, GSI PORTAL, GSI website, Project Digital Archive are in various stages of development and have been helpful in getting on-line geo-scientific information from the GSI. District resource maps and quadrangle maps are also made available on nominal payment.

7.2.4 GSI is already acting in advisory capacity to the Ministry of Mines in evaluating RP, PL applications and submit recommendations. It has been further suggested that GSI be entrusted with the responsibility of monitoring of the activities of the RP holders and reviewing the data generated by them for making recommendations for the conversion of the R.P. to PL/ML and so on.

7.2.5 GSI acts as a nodal agency for the co-ordination of the Central Geological Programming Board. It interacts with the State Geological Departments to avoid overlapping /duplication of work and to give priority to the geological programmes of the state based on the availability of the resources and its distribution as per national priority. It then formulates its State-wise and activity-wise programme for the approval of the CGPB under the chairmanship of the Secretary (Mines).

7.2.6 GSI also gives suggestions and recommendations of the Five Year Plan document, Sub-Committee of CGPB and the State Geological Programming Boards.

7.3.0 Indian Bureau of Mines (IBM)

7.3.1 The Indian Bureau of Mines (IBM) is engaged in the promotion and conservation of minerals, protection of mines environment and scientific development of mineral resources of the country other than coal, petroleum and natural gas, atomic minerals and minor minerals.

7.3.2 IBM performs the regulatory functions of the enforcement of the Mineral Conservation and Development Rules, 1988, the relevant provisions of the mines and Minerals (Development and Regulation) Act, 1957, Mineral Concession Rules, 1960 and Environmental Protection Act and Rules.

7.3.3 IBM also undertakes scientific, techno-economic, research oriented studies in various aspect of mining, geological studies, ore beneficiation and environmental studies.

7.3.4 Technical consultation services are also provided by the IBM to the mining industry for the geological appraisal of mineral resources and the preparation of feasibility reports of mining projects including beneficiation studies.

7.3.5 The preparation of mineral maps and a countrywide inventory of mineral resources depicting the leasehold and freehold areas are also being prepared by the IBM. The National Mineral Inventory (NMI) is updated every fifth year. The mineral-wise reserves/resources data as per UNFC as on 1-4-2000 has been finalized and published in the Indian Minerals year Book 2004. The data as on 1-4-2005/1-4-2005 (provisional) is being updated by the IBM for the NMI. The finalized updated data as on 1-4-2000 of the National Mineral Inventory has been utilized in the present XIth Plan document.

7.3.6 IBM is the custodian of the data-bank of mines and minerals which it publishes in the form of statistical periodicals, technical publications, monographs on individual mineral commodities and bulletins of topical interest.

7.3.7 In the advisory capacity, the IBM advises Central and State Governments on all aspects of mineral industry, trade, legislations, export and import policies, mineral consumption and industrial utilization, recovery of by-products, demand and supply of minerals and the renewal of prospecting/mining leases, etc.

7.3.8 To enforce the environmental laws, IBM carries out inspections to ensure that mine operators are taking due care for the removal and utilization of the top soil, storage of overburden / waste rocks, reclamation and rehabilitation of land, precaution against ground vibrations, control of ground subsidence, abatement measures against air, water and noise pollution restoration of flora etc. Besides these, IBM also promotes and monitors community development activities in mining areas. It provides necessary guidance to mine management/operators for systematic and scientific development of mine including protection of environment.

7.3.9 In the field of Information and Technology, IBM has well established LAN facility, besides WAN system for internal departmental communication. IBM is linked through a sophisticated system based on client-server architecture established with the help of BRGM, France. The IBM website is linked with the website of the Ministry of Mines. These developments facilitate the mining industry to access the IBM on-line for suitable guidance as and when required.

7.4.0. Mineral Exploration Corporation Limited (MECL)

7.4.1 The Mineral Exploration Corporation Limited is the premier exploration agency in the country which carries out mineral exploration activities both under promotional programmes funded by the Government of India and the contractual programmes on behalf of other agencies including public sector, private sector and the State Governments on agreed terms and conditions.

7.4.2 In the present scenario to face the challenges of liberalization, disinvestment and privatization, MECL has geared itself by diversifying its activities besides its normal and conventional exploration. It has stepped into the fields of slim hole drilling for the Coal Bed Methane exploration, drilling for geotechnical studies, coal sampling and analysis as a referral agency, supply of ballast stone to Railways and imparting training and IT enabled services.

7.4.3 Efforts of MECL to carry out exploration in the areas covered by Deccan Traps have proved fruitful by the discovery of coal seams in Nagpur District of Maharashtra. This finding of MECL has opened new vistas in the field of mineral exploration.

7.4.4 MECL has to carry out the detailed exploration of the regionally explored deposits by the GSI as per its charter of functions. The targets / deposits explored by GSI in their Regional exploration mode are handed over to MECL for detailed exploration and a set procedure for exchange of such data is in place together with a committee which periodically review the development and future course of action.

7.4.5 Another hurdle in the exploration activities of MECL is to get forest and environmental clearance for its projects. MECL could not take up many sanctioned MOM projects for want of Forest clearance. This aspect needs to be re-looked by the concerned ministries in the interest of national development.

7.4.6 In view of MECL's efforts and contributions in the field of mineral exploration and with the recent developments in the Government / Public / Private Sector interface the role of MECL has become all the more important. Keeping in view the importance of MECL in the field of mineral exploration in the national perspective the Government has approved a revival package for MECL and may entrust MECL with more responsibilities of quasi-commercial nature in the times to come.

7.5.0 State Directorates of Geology & Mining

7.5.1 Almost all the States have Directorates of Geology and Mining of their own to look after the activities related to mineral exploration, mining and marketing of minerals. All the directorates have dual roles to play. One is the exploration of the mineral resources within the state and the other of mineral administration for controlling the exploitation and movement of the minerals in the state. The exploration efforts of the state DGMs are confined to surface and shallow depths only of the freehold and the leasehold areas of the State Mineral Development Corporations.

7.5.2 The New Mineral Policy 1993 and the subsequent amendments of 1994, 1999 have empowered the State Governments to grant mineral concessions even in areas which are not compact and contiguous, to permit amalgamation of two or more adjoining mining leases, to renew prospecting licences / mining leases in respect of specified mineral listed in Part C of the First Schedule and to approve mining plans in respect of 29 non-metallic / industrial minerals in case of open cast mines.

7.5.3 The roles of the State DGMs have increased many folds as a result of the delegation of these powers to the State Government. The State DGMs accordingly administer, monitor and advise the State Government in the implementation and enforcement of these rules and legislations.

7.5.4 The DGMs of West Bengal, Tamil Nadu, Rajasthan, Maharashtra have suggested for strengthening their directorates by central assistance for exploration activities. Further, it has been suggested that there is a need for developing the laboratories with latest equipments and adoption of information and technology services in exploration. Addition of technical manpower and provisions for suitable training to the existing manpower so as to cope up with the changing scenario.

7.6.0 Other Government Agencies/PSUs involved in mineral exploration

7.6.1 There are a number of other Government Agencies such as NGRI, NRSA, JNARDDC, NIRM., etc. which may although not directly involved in the exploration but their indirect contributions are very significant in mineral exploration NGRI is involved in the geophysical and air borne studies in an integrated manner throughout the country. NRSA is the custodian of the enormous data generated by our satellite and it disseminates the remote sensing data by interacting with the exploration agencies for their specific use. JNARDDC is the R&D organization engaged in the development of the processes for the extraction of alumina from bauxite. NIRM is engaged in the geotechnical and rock mechanics studies of the on-going mines and for the opening up of new mines. The contribution of IBM in the beneficiation studies of the exploration projects for the enrichment of low grade ores and for the better liberation of the metal from the ores is also very significant.

7.6.2 The organisations such as HZL, HCL, NALCO, BALCO., etc. are involved in the exploration of the area in their leasehold for the extensions of their mines. HZL has been partially disinvested with its 26% stakes in the equity capital and the transfer of management in favour of M/s Sterlite Opportunities and Ventures Limited (SOVL). Similarly, the Government of India has diverted its 51% equity with transfer of management of BALCO in favour of M/s Sterlite Industries (India) Limited. Consequently, the Company ceased to be a Public Sector Undertaking with effect from 02.03.2001.

7.6.3 HZL has taken up base metal exploration in a big way in Rajasthan. It has carried out air borne magnetic and electromagnetic survey (GEOTEM DEEP) over 20,535 Km2 at 400m line spacing and at a flying height of 120 m. It has also deployed state of art fast drilling machines at its exploration sites which have the capacity of delivering 60-100m. progress per day as against 3-12m. by conventional machines.

7.7.0. **Assessment of Power, roles, jurisdictions and limitations**

7.7.1. The charter of functions, powers, roles and jurisdictions of the Geological Survey of India and the Indian Bureau of Mines have been well defined and these two organizations function as the subordinate offices of the Ministry of Mines, Government of India.

7.7.2. The functioning of the Directorates of Geology and Mines under the State Governments in light of the changed scenario needs to be discussed. Presently, the State of DGMs are playing a dual role – one is the exploration of the mineral resources within the state and the other of mineral administration involving the control over the exploitation and movement of the minerals within the state. The state DGMs, therefore, need to be strengthened. The powers and roles of the state DGMs to be made clear so as to avoid the overlapping of the jurisdictions of the Central and State Governments.

7.7.3. The role of MECL has been to carry out detailed exploration of the regionally explored blocks of GSI under the Government funded promotional scheme. It carries out contractual exploration work for clients in Government, public and private sectors on mutually agreed terms and conditions. Thus, MECL serves as a link between the Government (including its PSUs) and the private sector in the exploration of mineral deposits. Therefore, there is a need for strengthening MECL by entrusting it with more quasi-commercial functions. The forest and environmental clearance policy may be reviewed and relaxed in favour of MECL in the interest of broader national interest.

7.8.0. **Modifications and suggestions**

7.8.1 The state DGMs have, in general, expressed their opinion for strengthening them with more powers and more Central assistance in the exploration activities as the mineral deposits are located in the territory of their state.

7.8.2 The state DGMs may further be strengthened with more net-working in the field of IT on mineral related aspects both within the state DGMs as well as with Central Government and its allied organization involved in mineral exploration activities.

7.8.3 The state DGMs may develop well equipped laboratory facilities either with the Central assistance or on their own so as to help in their endeavors in mineral exploration.

7.8.4 The overlapping of the powers and jurisdictions of the Central and State Governments may be clearly spelt out so as to avoid confusion.

7.8.5 M/s ACC have suggested for some incentives for the exploration in remote and difficult terrains, relaxation/waiving of customs duty for import of exploration equipments and accessories, easy dissemination of the data either free or with very reasonable cost. The details about the lease-hold and free-hold areas be made available on internet for the benefit of the prospective

RP/PL/ML applications. The restriction on the availability of topo-sheets, aerial photographs and satellite imageries may be reviewed and relaxed.

7.8.6 MECL suggested that the information about the grant of RP/PL/ML may also be made available to MECL so as to avoid overlapping of the area while preparing its proposals for promotional exploration.

7.8.7 In the efforts of GSI in finding / locating new mineral deposits, MECL and the state DGMs may also contribute so that more number of blocks are available in a short time for detailed exploration by MECL.

7.8.8 The policy of forest and environmental clearance for mineral exploration projects may be reviewed and modified so as to facilitate the mineral exploration in the interest of National Development.

7.8.9 Recruitment of the technical and qualified manpower and providing suitable and advanced training to the existing manpower so as to cope up with the changing scenario of the mineral sector in the country.

7.8.10 Frequent trainings, workshops, brain storming sessions and interactions of the manpower of the Government/Public/Private Sectors may be organized to keep the manpower engaged in the mineral sector abreast with the time to time changes and advancements going on in the country. Participation in the seminars and conferences in the country and abroad may also be encouraged so that the knowledge of global developments is also obtained which will be helpful in the national development.

CHAPTER-VIII

(Item-7 of Terms of reference)

INVESTMENT NEEDED FOR MINERAL EXPLORATON

8.1.0 World scenario in mineral exploration spending :

8.1.1 Mineral exploration is a high risk and high investment area of activity. Therefore, success ratio would depend much on the degree of investment, of course guided by the high sense of understanding of the favourable geological milieu of mineralization on the one hand and the natural mineral/metal endowment in different crustal segments of the globe on the other hand. Analysis of the exploration spending in the world during the last 15 years (1991 to 2005) reveals interesting features. During the first 5 years (1991 to 1995) out of the US $ 18,500 million spent on exploration, South America accounted for 35%, North America (USA & Canada) 20%, Africa 18%, Asia 13%, Australia 12% and the balance in the rest. In course of the next 5 years (1996 to 2000), there was a definite declining trend with total spending of US $ 14,890 million, of which South America continued to top the list of sharers with 29% spending (inspite of 6% decline), North America (USA & Canada) almost same as before with 21%, Australia improving to 18%, Africa declining to 15%, pacific & South East Asia 8.5% and rest of the world including Indian sub-continent 8.5%. During the period from 2001 to 2005, the declining trend continued in the initial 3 years and then the trend was reversed with total spending of US $ 14,370 million, of which North America (USA & Canada) top the list of sharers with **27%** spending registering an increase of 6% followed by South America with 24% (5% decline), Africa improving to 16% while Australia declining to 15%, Pacific and South East Asia 4.6% and rest of the world including Indian sub-continent improving to 13.5% (data soured : Metal Economic Group , Canada, compiled and communicated by FIMI, 2006). Based on the last five year trend it may reasonably be expected that both North & South America will continue to account for more than 50% of mineral exploration spending over next 5 years. The order of investment is expected to increase substantially in Africa and rest of the world including Indian sub-continent. Pacific & South East Asia may face marked decline in investment.

8.1.2 An analysis of the data furnished in the following table further reveals that annual world exploration spending showed upward trend from 1995 onwards for three years, following which it declined in the year 1998 and 1999 and thereafter it recovered marginally in 2000. The fall in exploration expenditure during 1998 and 1999 was due to slowing down in world economy and financial crisis in “Asian tigers”. After the year 2000, the annual exploration spending declined to an all time low in the year 2002 thereafter it started picking up sharply in the year 2004 & 2005.

TABLE-8-1

WORLD EXPLORATION EXPENDITURE

Year	Planned Amount (US $ Billion)	Amount Utilised (US $ Billion)	No. of Companies	%age increased / decreased over last year
1995	3.55	2.69	154	36.54 / 28.10
1996	Not available	3.52	223	(-) 0.85*
1997	5.01	4.03	279	42.33 / 14.49
1998	3.50	2.83	182	(-) 30.14 / (-) 29.78
1999	2.70	2.17	132	(-)22.86 / (-) 23.32
2000	2.60	2.34	Not available	(-) 3.70 / 7.83
2001	2.2	2.0	679	(-) 15.38 / (-) 14.52
2002	1.9	1.73	724	(-)13.64 / (-) 13.50
2003	2.4	2.19	917	26.32 / 26.58
2004	3.8	3.55	1138	58.33 / 62.10
2005	5.1	4.9	1431	34.21 / 38.02

(Source : Metals Economic Group, Canada)

- Calculated on total planned basis

8.1.3 The regional spending in mineral exploration for the last eight years (1998 to 2005) is detailed in Table-8-2.

8.1.4 The report of Metal Economic Group, Canada citied that the global spending for gold exploration. was US $ 2.61 billion (64.9% of total) in 1997 which declined to US $ 1.56 billion (55.1%) in 1998 and further slided down to US $ 1.08(50%) in 1999, in 2005 declining the trend continues and it was 47%. The spending in base metals was US $ 1.09(27.1%) in 1997, US $ 0.934 (33%) and US $ 0.801 (37%) in the year 1998 and 1999 respectively, indicating a proportionate rise in spite of decline in total spending. In the year 2005, the spending in base metal declined to 29%. Maximum expenditure was recorded for Copper amongst the base metal. The exploration spending for diamond in the range of US $ 0.23 to 0.27 billion during the period of three years and during 2005 it was 13% indicates sustained effort with gradual rise. Thus, it may be concluded that globally there has been a gradual shift of priority from gold exploration (from 80% spending in 1990 to 47% in 2005) towards base metals, diamond and platinum group of metals but basically the overwhelming thrust remained on these few commodities only.

8.1.5 A review of recent discoveries of gold deposits in various parts of the globe in the last few years shows that they are commensurate with exploration spending in the respective regions. In essence, risk venturing is paying due dividends and further scrutiny may authenticate this opinion.

8.2.0 Indian scenario in exploration spending

8.2.1 The level of funding for mineral exploration (including solid fuel sector) in India has been extremely meager in comparison with global scene. Since the first five year plan (1951-56), the total exploration spending in GSI has been to the tune of Rs.700 crores , out of which spending for non-coal sector was around Rs.500 crores. Taking GSI's expenditure on exploration over last 47 years as an indicator, it may safely be surmised that the total expenditure of the Government in this field (both Central and State sectors) could not have exceeded Rs.800 to 900 crores. The direct operational spending, however, would have been up to a maximums pf 30% of the above i.e. within Rs.300crores as the rest 70% was spent on infrastructure maintenance. During the IXth Plan, there was a significant boost in exploration spending, our share would stand at less than 1.0% of global spending (US $ 14,900 million), for same period.

8.2.2 The expenditure on exploration activities in the developed countries is largely met by the Private Sector, while in India this funding comes mainly from the Government. With the recent liberalization of economic policies, it was contemplated that a major share of exploration spending will be borne by the Private Sector but till this time no significant overtures in the new direction are visible. The possibilities of any change in the funding situation are still in the nascent stage and as such major responsibility of exploration funding is expected to be continued with the public sector as before for quite sometime to come. Moreover, in a country like India, it may not be feasible to shift away the entire responsibility of mineral sector from the hold of public sector at one stroke in view of the far-reaching societal impact and overall national interest towards resources build-up keeping an eye on sectoral balance.

8.2.3 The Government should regard the mineral exploration activity as a scientific endeavour having great societal impact rather than considering the expenditure as plan investment meant for quick returns. The field of development may be categorized as plan investment, but the grass-root exploration ventures should be viewed differently. At present, the science and technology component in the total funding scheme of the 'Industries and Minerals of Planning Commission is entirely directed towards R&D efforts in mining and metallurgy. It would be worthwhile to review the situation and bring the funding for mineral search and exploration largely under S&T and social causes. Any complacency in the anticipation of foreign investment/private funding may also lead to a let up in this vital field, which may ultimately result in technological/professional gaps.

8.2.4 In spite of deficient financial support enjoyed by the mineral sector as a whole and exploration in particular, the success ratio of exploration in India has been remarkable. India's performance in terms of exploration efforts in respect of ferrous minerals and bauxite is commendable. In respect of gold and some strategic minerals, India does lag behind, but the picture would have been much better, if technological up-gradation and break through were commensurate with the requirement in the field of exploitation of small and marginal grade deposits.

8.2.5 The private companies in domestic sector should also allocate exploration funds for the augmentation of resources similar to the global practice. This philosophy is totally missing in our country. For changing this attitude and securing adequate investment from private sector, it is essential to create an attractive mining and fiscal regime and an investor friendly environment. Recognizing this need and to further improve the investment climate for mining in the country the Planning Commission has constituted a High Level Committee to review the NMP and recommend possible amendments to the MMDR Act.

8.2.6 In view of above, it is felt that there is an emergent need for proper nurturing of the exploration sector in India by adequate Government funding during XIth Plan. If some areas are looked after by the private sector in future, the Government priorities may be shifted to others. The need for up-gradation of the nation's expertise and capabilities in the field of mineral exploration is long felt but yet to be achieved due to resources constraint. In appreciation of the limitation of fund availability through budget support serious efforts have to be made for mustering extra budgetary resources through appropriate external funding avenues to meet the up-gradation and modernization needs to the extent of at least 50% of the total need.

8.2.7 It may be noted that the Standing Parliamentary Committees for budget grant have been consistently recommending higher allocation of funds to GSI and MECL for furthering the basic mineral resource information in national interest. It is also stressed that the efforts may be made for modernization and up-gradation of the capability of these organizations at the earliest.

8.3.0 Scale of private investment expected during XIth plan

8.3.1 Domestic private investment for exploration has remained insignificant in the country before and after liberalization. Traditionally, the private mining companies in India seldom look ahead of immediate commercial interest and any spending other than on-going production is related to the development of the mine working in immediate extension of their existing property.

8.3.2 Some Indian private exploration companies like ACC, HZL, Geo-Mysore, etc. have taken or preparing to take RP over large areas independently or jointly with MNC's. A total number of 202 reconnaissance permit covering an area of over 2,78,773.503 Sq.Km. till 31/12/2005 were approved by Union Government. 73 FDI proposals have been approved covering global majors of more than 20 countries expected to bring more the US $ one billion of FDI into the mining sector.

8.3.3 For making any reasonable projection of expected private investment for exploration in the next five years of the XIth plan period several factors have to be considered. Traditionally, the domestic private sector is not really ready to go out to the high risk, high-investment areas outside their known fields of industrial and minor minerals, that too on limited scale only. Comparatively bigger corporate bodies in majority are oriented towards joint venture propositions in league with global enterprises and are largely dependant on their prospective foreign partners, both in terms of financing and technology . Ultimately it is the granting of RP or PL by State Governments, permission of DGCA to fly, defence clearance etc. determines the actual implementation of the projects and consequent investment flow. The review of global pattern of investment in exploration reveals that Asian Countries even otherwise have been less attractive for the MNC's. Moreover, the recent exploration activities of MNCs in Rajasthan and elsewhere reveals that their basic strategy was to locate only large deposits of high value metals within shallower depth. The scenario may further improve on grant of large area under PL for exploration.

8.3.4 In view of the scenario presented above and existing mineral policy, there appears a scope of substantial improvement in order of private investment (foreign & domestic) during the XIth Plan period. Keeping in view the upward trend in the Indian economy and interest being shown by private investors (both domestic & foreign) in the mineral sector and opening of 100% FDI on automatic route in the mining sector, the most optimistic projection of expected private investment in the XIth Plan period would be around US $ 1 billion. It is obvious that even if the investment flow matches above projection, it will be spent only for searching gold, diamond and base-metals betraying a severe lack of balanced approach to much cherished national goal of resource augmentation on a wider spectrum;. It is therefore evident that during the XIth Plan private investment alone cannot be expected to attend the national priorities.

8.3.5 It may be realized that even with the outstretched expectation of private sector contribution of US $ 1 billion for next five years the nation cannot fulfill the balance to reach the optimum level of spending of 4% of global spending on exploration. Hence, within the possible means the national exploration agencies will have to be supported for ensuring a balanced growth in this sector in the foreseeable future. This should also include adequate thrust on up-gradation of their capability through modernization of equipment and acquiring of state-of-the-art technology and expertise in all related field of mineral exploration at a pace to match the global advancements.

8.4.0 Financial out lays (agency-wise projection of promotional funding) for the XIth plan period.

8.4.1 The financial out-lays for Govt. agencies viz. GSI, MECL, State DGMs and others are presented below, which are in consonance with work plan and schemes of modernization presented in chapter IV and V.

8.4.2 Geological Survey of India:

8.4.3 The total expenditure (Plan & Non-Plan) for the XIth Plan period in respect of GSI is estimated at Rs.2,722 Crores (except construction). This includes Rs.200 crores as cost of capital equipment needed for upgradation & modernization (excluding the cost of, sea going research vessel, geotechnical vessel, part payment of heliborne survey system, additional fixed wing aircraft, etc.). The estimates for ship etc. as detailed above works out to be Rs.622 crores. For the sea-going research vessel EFC meeting is over and cabinet note is being prepared. For the geotechnical ship DPR & EFC have been submitted. The heliborne survey system is in an advanced stage of procurement.

8.4.4 Out of total outlay of Rs.2100 crores, (Rs.2722-622 crores) barring capital equipment, estimates for survey & mineral exploration comes to about 1,365 crores(65% of total expenditure). One sixth of this will be spent on coal & lignite exploration while remaining Rs,1,138 crores is projected against survey & exploration for non-fuel commodities. Adding the share of capital expenditure for these activities (Rs.750 crores), the total outlay for survey, mineral exploration & related activities (other than coal & lignite) works out as Rs.1,888 crores. All the expenditure to be borne by the general budget (both under Plan & Non-Plan).

8.4.5 The details of the financial outlay with year-wise phasing of survey & exploration expenditure over the XIth Plan period is presented in the following tables :

Break up of Expenditure proposed by GSI for the XIth Plan

1.	Total XI Plan outlay of GSI (Plan & Non-Plan) excluding expenditure on construction of building	Rs.2,722 Crores
2.	Expenditure on high cost capital equipment (including Airborne survey system & marine vessels)	Rs.622 Crores
3.	Total expenditure for GSI barring high cost equipment (1-2)	Rs.2,100 Crores
4.	GSI's component of Survey & Mineral Exploration expenditure [about 65% of total expenditure i.e. of (3)]	Rs.1,365 Crores
5.	GSI's component of Survey & Mineral Exploration on non-fuel minerals about 1/6 of (4) is considered for coal & lignite and balance for others	Rs.1,138 Crores
6.	Share of capital equipment towards Survey & Exploration of non-fuel minerals	Rs. 750 Crores
7.	Total likely expenditure on Survey & Mineral exploration related activities – other than coal & lignite	Rs.1,888 Crores
8.	Total likely expenditure on Survey & Mineral exploration barring high cost capital equipment (i.e. 622 Crores)	Rs.1,266 Crores

8.4.6 Annual phasing of Rs.2100 Crores barring the cost of high value equipment i.e. Rs.622 Crores (where annual phasing would depend upon the stage of maturity of procurement of the equipments) and construction (in Rupees Crores) :

GSI	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	Total
	357	386	418	451	488	2100

8.4.7. Mineral Exploration Corporation Ltd

8.4.8 MECL's annual capacity during the Xth Plan period was around 1.72 lakh m. drilling and 4000 m mining supplemented by other geological/geophysical components connected with exploration of minerals. With the modernisation and technological upgradation programme being taken up/implemented, the drilling productivity and the drilling capacity is expected to increase upto the level of 2.00 lakh metres annually. Excluding the share of coal exploration on behalf of Ministry of Coal and other contractual assignments for different minerals on behalf of other PSUs/Private Sector. MECL envisages annual achievement of 50000m drilling and 1500 m of exploratory mining together with matching activities in conformity with National priority during the XI th Plan period.

8.4.9 The above activity package with a wide mineral mix is proposed to be covered under promotional programme of MECL funded by the Government of India through Ministry of Mines. A provision of over Rs. 250 crores on the average price of inputs will be required for the purpose under the Promotional head for MECL during 2007-08 to 2011-12 financial years. In addition an amount of Rs. 66 crores towards replacement of machinery / equipment / instruments is also to be made available. The exploration expenditure for the contractual work to be undertaken during the XI th Plan is to be met by the client agencies.

8.4.10 State Government and others:

8.4.11 The Directorates of Mines and Geology also carry out exploration of minerals and their output vary depending on their resources and other considerations. It is estimated that about Rs. 400 crores will be the share of exploration expenditure for all types of minerals by State Governments and others involved in this activity.

8.4.12 Overall Expenditure for Mineral Exploration.

8.4.13 The overall expenditure estimated for the XIth Plan period for mineral exploration and related activity (other than Coal and Lignite) alone totals to around Rs. 2816 crores. The organization-wise break-up is as follows”-

Agency	**Estimates**
GSI (Promotional & Capital)	Rs. 2100 crores
MECL(Promotional & Capital)	Rs. 316 crores
States Govt and other agencies	Rs. 400 crores
Total	**Rs. 2816 crores**

8.4.14 The annual phasing pf expenditure of Rs. 2816 crores is given below:

Exploration Agency	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**Total**
GSI	357	386	418	451	488	2100
MECL 1. Promotional 2. Capital	 45 12	 45 12	 50 14	 55 14	 55 14	 250 66
Total	57	57	64	69	69	316
States Govt and other agencies	80	80	80	80	80	400
Total	**494**	**523**	**562**	**600**	**637**	**2819**

TABLE-8-2

REGIONAL EXPENDITURE

(US $ billion)

Sl. No	Location/Region	1998		1999		2000		2001		2002		2003		2004		2005	
		Amt.	**%**	**Amt.**	**%**	**Amt.**	**%**	**Amt.**	**%**	**Amt.**	**%**	**Amt.**	**%**	**Amt.**	**%**	**Amt.**	**%**
1	Latin America	0.814	28.7	0.630	29.1	0.662	28.3	0.576	28.8	0.448	26.0	0.518	23.6	0.773	21.8	1.127	23
2	Australia	0.495	17.5	0.410	18.7	0.405	17.3	0.349	17.5	0.304	18.3	0.339	15.5	0.522	14.7	0.637	13
3	Africa	0.494	17.5	0.320	14.9	0.293	12.6	0.277	13.8	0.257	14.8	0.374	17.1	0.572	16.1	0.833	17
4	Pacific and South East Asia	0.266	9.4	0.180	8.1	0.199	8.5	0.133	6.7	0.085	4.9	0.093	4.2	0.156	4.4	0.196	4
5	Canada	0.308	10.9	0.230	10.8	0.348	14.9	0.333	16.6	0.317	18.3	0.471	21.5	0.696	19.6	0.931	19
6	U.S.	0.243	8.6	0.217	10.0	0.234	10.0	0.158	7.9	0.125	7.2	0.153	7.0	0.284	8.0	0.392	8
7	Rest of world (including Europe, Middle-East, Russian, CIS Countries and countries of Indian Sub-continent)	0.210	7.4	0.183	8.4	0.197	8.4	0.175	8.7	0.197	11.4	0.244	11.1	0.547	15.4	0.784	16
	TOTAL	**2.83**	**100**	**2.17**	**100**	**2.338**	**100**	**2.001**	**100**	**1.733**	**100**	**2.192**	**100**	**3.550**	**100**	**4.900**	**100**

(Source : Metals Economic Group, Canada)

REPORT OF

THE WORKING GROUP ON

MINERAL EXPLORATION AND DEVELOPMENT

(other than Coal and Lignite)

FOR

THE ELEVENTH FIVE YEAR PLAN

MINERAL OUTPUT INDUSTRIES

VOL - III

GOVERNMENT OF INDIA

PLANNING COMMISSION

January, 2007

REPORT OF'

SUB- GROUP-II ON

MINERAL OUTPUT INDUSTRIES

of

The Working Group

on

Mineral Exploration and Development

(Other than Coal & Lignite)

FOR

THE 11TH FIVE YEAR PLAN

GOVERNMENT OF INDIA

PLANNING COMMISSION

CONTENTS

PREFACE

The Planning Commission constituted a Working Group on Mineral Exploration and Development (other than coal and lignite) in the context of formulation of the Eleventh Five Year Plan (2007-20012) under the Chairmanship of Secretary, Ministry of Mines, Government of India vide Office Order No.I&M-3[24]/2006 dated 6 March, 2006. The composition of the Working Group and its terms of reference are given at **Appendix-I.**

The Working Group in its first meeting held on 12 April, 2006 decided to constitute four Sub-Groups, of which Sub-Group-2 was set up on the Mineral Output Industries under my Chairmanship with Shri R.K. Sharma, Secretary General, FIMI as Member Convenor. The composition of the Sub-Group and the terms of reference are appended at **Appendix-II.**

The first meeting of the Sub-Group-2 was held on 9 August, 2006 at New Delhi when it was decided to constitute nine Core Groups with Co-Convenors to study and give recommendations on various mineral output industries. The composition of these Core Groups is placed at **Appendix-III.**

These Core Groups met a number of times and debated on the subject in detail keeping in view the terms of reference of the Working Group as applicable. Subsequently, in the second meeting of the Sub-Group-2 held on 28 August, 2006, draft reports prepared by the various Core Groups were considered in depth and the suggestions made by the members were noted. It was then decided that these suggestions may be incorporated and the modified drafts may be submitted to FIMI for further improvements, if any.

The reports of the Core Groups bring out the present status and projections for demand and supply of various industries and minerals connected therewith, as well as short-term and long-term strategy for mineral development.

The report has an Executive Summary, Recommendations and mineral-wise chapters and is the outcome of the combined coordinated efforts of all members of the Sub-Group-2 and in particular all the Co-Convenors. I would like to express my sincere thanks to all the members for their valuable suggestions, active support and contribution.

(**AJITA BAJPAI PANDE**)
JOINT SECRETARY (MINES)
and
CHAIRPERSON
SUB-GROUP-2 ON MINERAL
OUTPUT INDUSTRIES

EXECUTIVE SUMMARY

1 - COPPER

(copper, cobalt, molybdenum, selenium and tellurium)

1.0 While copper is found worldwide, 90% of reserves are located in four areas, the Great Basin of the western United States, Zambia, Central Canada, and the Andes of Peru and Chile. India is not self sufficient in resources of the copper ore. The domestic demand of copper is mostly met through imports. Copper deposits are located mainly in Precambrian formations of the peninsula shield in India. Copper mineralization occurs in number of States but major and commercial deposits are located in Madhya Pradesh, Rajasthan, Jharkhand, Karnataka, Orissa and Sikkim. Hindustan Copper Limited (HCL), a public sector undertaking is the only vertically integrated manufacturer of primary copper.

1.1 There are other three copper manufacturers who are primary copper refined manufacturers. M/s Birla Copper and Sterlite Industries import copper concentrate for their smelters whereas Jhagaria Copper Limited (erstwhile SWIL) has smelter cum refinery based mainly upon copper scrap and about 15% concentrate.

Production of refined copper from Indian manufacturers in 2005 is given below:

S No.	Manufacturer	Installed capacity (t)	Production in 2005(p) (t)
1	Birla Copper	330,000	199892
2	Hindustan Copper Limited	47500	31711
3	Jhagadia Industries	50400	38000
4	Sterlite Industries	250000	245191
5	Total	677900	514794

Source: Reuters

1.2 **Reserves Status over past five years**

1.2.1 There has not been significant change in inventory of copper reserves over past five years in India as no major copper deposit was located during this period. According to IBM India has an estimated copper resources of 1394.43 million tonnes containing 11.42 million tonnes metal as on 1.4.2005 as per the exploration carried out so far. Of these, 28.03 million tonnes are above 1.85% Cu, 621.98 million tonnes between 1 to 1.85% Cu, 604.49 million tonnes between 0.5 to 1% Cu and remaining 139.92 million tonnes are less than 0.5% Cu.

1.2.2 Total reserves in HCL leasehold areas is 413.73 tonnes of 1.32 % copper grade containing 5.46 million tonnes metal. Details of the reserves as on 01.04.2006 for each lease is given below:

Geological Reserves in million tonnes as on 1.4.2006

	Rajasthan		**Madhya Pradesh**
Reserves	Khetri	**Kolihan**	**Malanjkhand**

			Up to (-) 8 m
Proved	7.50	11.62	96.19
Probable	8.48	2.08	75.01
Possible	43.02	7.98	37.06
Total	59.00x1.37	21.65x1.33	208.27 x 1.32% Cu
Lease area	395.07 Hect.	163.23 Hect.	479.87 Hect.

1.3 Production from mines

1.3.1 Hindustan Copper limited is sole producer of copper from mines. Production from mines in last five years is meager and has remained less than 30,000 tonnes per year.

S.No.	Year	Metal in concentrate (t)
1	2005-06	22984
2	2004-05	28926
3	2003-04	28306
4	2002-03	30824
5	2001-02	34282

1.3.2 Not much exploration for copper has been done in recent past. There are ample indication of finding copper reserves in depth as well as unexplored area. It is proposed that in addition to GSI and MECL, PSU like Hindustan Copper Limited who are primarily a copper mining organization, should also undertake exploration either independently or as a joint venture with overseas organizations.

1.4 World Scenario

1.4.1 Copper prices trended upward throughout the year, and the COMEX spot price reached a record-high monthly average of $1.90 per pound in October, 2006. Despite a more than 3% estimated growth in world production of refined copper, production was insufficient to meet global demand, and the refined copper production deficit that had developed during the preceding 2 years continued.. Global mine production fell short of its anticipated growth owing to production shortfalls in the United States and South America, and mine capacity utilization fell to its lowest level in recent years. New capacity and increased capacity utilization was expected to reverse the global production deficit, and a modest production surplus was anticipated for 2006.

1.4.2 A recent assessment of U.S. copper resources indicated 550 million tonnes of copper in identified (260 million tonnes) and undiscovered resources (290 million tonnes), more than double the previous estimate. By extension, global land-based resources are expected to be much larger than the previously published estimate of 1.6 billion tons. Resources in deep-sea nodules were estimated to contain 700 million tonnes of copper.

1.5 Review of present status of copper Industry in India

1.5.1 The past few years saw the Indian copper industry taking remarkable strides towards the goal of self-reliance. Hitherto the indigenous production capacity of 47,500 tonnes of copper of HCL met 25 to 30% requirement of the country before economic liberalization, while the rest was imported. After liberalization in 1992, two domestic private producers viz. M/s Sterlite industries & M/s Hindalco industries based on imported concentrates entered the primary refined copper market with smelter production capacities of 1,00,000 tonnes per annum each in 1997. Currently, the annual production capacities of these private producers is 5,00,000 tonnes & 3,00,000 tonnes. Besides another private player viz M/s. SWIL Ltd. has started operating its 50,000 tonnes plant based on secondary route. The capacity for production of primary copper in India has risen from a mere 47,500 tonnes per year till 1997 to approximately 8,97,000 tonnes in FY 2006-07; with the result that India is now a net exporter of refined copper.

Production capacity of refined copper in India

Company	Capacity (tonnes per annum)
Hindalco industries	5,00,000
Sterlite industries	3,00,000
SWIL limited	50,000
HCL	47,500
Total	**8,97,500**

1.6 Growth & demand projection of copper in India

1.6.1 During the year, the demand for copper in global market has been growing steadily. Demand in Asian Countries, i.e. China & India driving the copper prices in the global market, this trend is expected to continue in the near future. Growth of copper usage in the country is projected to be about 6% this year, exceeding the world average of about 4% but still we are far behind from China where the average growth rate during the last decade is more than 10 %. In 2004-05, the total refined copper usage in the country was ~ 3,95,000 MT; in the coming years, this is expected to rise to about 4,40,000 MT in 2006-07.

1.6.2 Domestic demand is expected to grow at about 6% per annum while production is expected to increase by 15.1% per annum on account of new capacities being added by private players.

1.7 Sector-wise Consumption

1.7.1 Four industry sectors account for over 75% of the copper demand in the domestic market, viz. – electrical, wire and cables, auto components and refrigeration & air conditioning. Electrical industry is the most dominant segment; accounts for about 40% of copper demand; is expected to grow by ~ 6.6% p.a. In the wire and cable industry, housing wire demand is increasing steadily. Growth in auto component industry has been driven by rapid growth of domestic automobile industry (CAGR: 10% in FY00 – FY04) as well as strong export demand of auto components (CAGR: 25% in FY00-FY04). Copper demand in the auto components sector is expected to grow by ~9.4% p.a. Refrigeration & Air conditioning (RAC) segment: refrigerators is the most dominant copper consuming segment; Copper demand in the refrigeration and air conditioning segment is expected to grow by ~6.6% over next ten years

1.7.2 **Export/ Import :** India exports refined copper largely to neighboring countries in the Middle East & Asia, such as UAE, Oman, Korea, Singapore, and Sri Lanka. These markets present good oppurtinuities for India on account of strong demand growth. Hindalco and Sterlite are the key exporters of refined copper; HCL made a maiden entry into the export market in 2005.

1.8 **Future plans of Hindustan Copper Limited (HCL)**

1.8.1 In addition to the detailed exploration in potential areas by HCL, the development of Banwas Copper mine, Malanjhkhand underground mine and Chapri Sidheswar mine are envisaged during 11th plan period. Full production from Banwas mine containing 19 million tonnes reserves can be achieved through the existing facilities of Khetri mine. The Malanjhkhand underground copper mine is critical for development of 30% of country's copper reserves as well as for long term sustenance of HCL. The development of Chapri Sidheswar mine in Singhbhum copper belt would be desirable while considering the potentiality of 80 million tonnes reserves.

Associated Metals

1.9. Cobalt

1.9.1 The availability of refined cobalt worldwide increased during the first half of 2005 compared with that of the first half of 2004, as world refinery production was higher and shipments of cobalt from the National Defense Stockpile continued to contribute to supply. Cobalt prices trended downward during the first 10 months of 2005, reflecting adequate supply to meet demand.

1.9.2 In recent years, exports of cobalt-rich ores from Congo (Kinshasa) to refineries mainly in China have helped to balance cobalt supply and demand. Future export of these ores could be affected by declining cobalt prices, which could make their export less economical, and by efforts by the Government of Congo (Kinshasa) to require that cobalt ores be processed before being exported.

1.10 Molybdenum

1.10.1 Reported consumption increased 10% from that of 2004 and Mine capacity utilization in 2005 was about 77%. China continued its high level of steel production and consumption, thus providing strong demand for molybdenum. High copper prices and a deficit of refined copper allowed the Bagdad and Sierrita Mines in Arizona to return to full production capacity, thus increasing byproduct molybdenum production.

1.10.2 Identified resources amount to about 5.4 million tonnes of molybdenum in the United States and about 13 million tons in the rest of the world. Resources of molybdenum are adequate to supply world needs for the foreseeable future.

1.11 Selenium

1.11.1 Selenium production in India by HCL as byproduct has been 7719 kg in 2005-06. The supply of selenium is directly affected by the supply of the materials from which it is a byproduct—copper, and to a lesser extent, nickel and cobalt. Continued concern about the adequacy of the selenium supply caused the price of selenium to rise to $53 per pound by the end of the first quarter 2005, where it remained through the end of the third quarter.

1.11.2 China continued to use selenium as a fertilizer supplement, as an ingredient in glassmaking, and as a substitute for sulfur dioxide in the form of selenium dioxide in the manganese smelting process. Domestic use of selenium in glass remained unchanged, while use in copiers continued to decline. The use of selenium as a substitute for lead in free-machining brasses continued to increase as more stringent regulations on the use of lead were implemented. Selenium's higher cost, however, has limited its use in many of its applications. The use of selenium in fertilizers and supplements in the plant-animal-human food chain and as human vitamin supplements increased as its health benefits were documented. High-purity silicon has replaced selenium in high-voltage rectifiers. Silicon is also the major substitute for selenium in low- and medium-voltage rectifiers and solar photovoltaic cells.

1.12 Tellurium

1.12.1 Tellurium production in India by HCL as byproduct has been nil. Tellurium supply and demand has remained in fairly close balance for the past decade in the United States. In 2005, however, demand greatly outstripped supply. There was a significant increase in demand for high-purity tellurium for cadmium telluride solar cells. Tellurium consumption also increased in thermal elements for small ice packs and refrigerators. The large supply imbalance led to a large price jump starting in late 2004 and extending through 2005. Currently, tellurium alloyed with germanium and antimony used in digital video discs (DVDs) consumes only small amounts of tellurium. New developments in coupling materials, however, which consist of bismuth, germanium, and tellurium and enable DVDs to be rewritable at high and low recording speeds, could have an impact on future world demand.

1.12.2 More than 90% of tellurium is produced from anode slimes collected from electrolytic copper refining, and the remainder is derived from skimmings at lead refineries and from flue dusts and gases generated during the smelting of bismuth, copper, and lead ores. In copper production, tellurium is recovered only from the electrolytic refining of smelted copper. Growth in the global use of the leaching solvent extraction-electro winning processes for copper extraction has limited the growth of tellurium supply.

2 - ZINC AND LEAD

(lead and zinc, cadmium, silver, nickel, antimony, arsenic, bismuth, mercury, indium, tungsten and tin)

2.1 After aluminium and copper, zinc and lead are among the most widely used non-ferrous metals in the world. Corrosion protection of steel by zinc coating is the most important use of zinc in the world. Zinc forms an important alloy - brass - which possesses a combination of versatile properties. Die-casting, chemicals and zinc semis are the other major zinc uses in the world. In case of lead, batteries are the important end-use sector for lead and their share in lead consumption has been increasing significantly over the years.

2.2 Resources and Production :The world's zinc resources are estimated at 460 million tonnes of contained metal and lead resources at 140 million tonnes of contained metal. USA, China, Australia and Canada together constitute about 64% and 66% of zinc and lead resources respectively. India accounts for 5% of the world's total zinc-lead resources.

The major zinc-lead mines are in China, Australia, USA, Peru and Canada with. around 64.5% of the total zinc mine production and 77% of the total lead mine production. India is amongst the top ten mining countries and its share in zinc and lead mine production is nearly 4.5 and 2% respectively.

The leading zinc metal producing countries are China, Canada, Japan, Korea Rep and Australia. In case of lead, USA, China, Germany, UK, Italy, Japan and Korea Rep are the leading producing countries. India's share is nearly 3% for zinc and 1% for lead metal production.

2.3 Consumption

2.3.1 The global zinc metal consumption during 2005 was nearly 10.6 million tonnes. China, USA and Western European countries are the leading consumers. India's share in the world zinc metal consumption is about 4%.

2.3.2 The global lead metal consumption during 2005 was nearly 7.6 million tonnes. China, USA, Germany, Japan and Korea Rep are the leading consumers. India's share in the world lead metal consumption is 2%.

2.4 Exports/Imports/Prices

2.4.1 The main *zinc metal* importers are USA, China and Malaysia. The major lead metal importing countries are USA, Spain and Korea Rep. The main *zinc and lead concentrates* exporting countries are Australia, Peru and USA.

2.4.2 The zinc and lead price movement at LME during the last 10 years from 1996 to 2005 has been varying substantially. After declining to record low levels in 2002, the prices started showing improving trend in subsequent years. The prices reached to new highs in the recent past and are still ruling at relatively higher levels. Since the domestic prices of zinc and lead are linked to the international prices, similar price movements have been reflected in the Indian zinc - lead market.

2.5 Indian Scenario

2.5.1 The Indian zinc-lead industry comprises two primary producers - Hindustan Zinc Limited (HZL) and Binani Industries Limited (BIL), both in private sector. HZL was earlier a Government of India enterprise and post disinvestment in April 2002, it has become a private sector and presently a group company of Vedanta Resources plc. HZL is a vertically integrated producer from mining to smelting with its major operations in Rajasthan, while BIL has a custom smelter located in the south-west coast.

2.5.2 **Reserve - Resource:** The reserves are estimated to be around 126 million tonnes containing about 11 and 2.6 million tonnes of zinc and lead metals respectively. The remaining resources are estimated at 397 million tonnes with about 13 and 4.6

million tonnes of zinc and lead metals respectively. While the total all India resources are estimated at 522 million tonnes, about 89% of lead and 93% of zinc reserves are located in the state of Rajasthan.

Reserves in the operative mines of HZL, based on JORC (Joint Ore Reserve Committee) of HZL criteria, and their life span are presented below.

Mineable Reserves of HZL as on 1st April 2006

Mine/Deposit	JORC Reserves (million tonnes)	Avg. Production (million tonnes per annum)	Life in Years	Remark
Rampura Agucha	53.4	3.75	11	Open-pit
		expansion to 5Mtpa by 2008		
Rajpura Dariba	9.4	0.75	10	Underground
(inclusive of Sindesar Khurd)		expansion to 1.25Mtpa by 2010		
Zawar Group	5.8	1.02	6	Underground
		expansion to 1.35Mtpa by 2010		
Total	68.6			

Note: Resources in Possible/Inferred categories and other ore blocked in pillars are not considered for production planning.

In addition to these reserves, 109 million tonnes of resources have also been identified.

2.5.3 Looking at the present scale of operations and mine expansion under execution, the resource position will become critical to meet the concentrate requirement for the zinc metal production capacity which is projected at 9% CAGR during 11th Plan and beyond. Accordingly, a detailed exploration plan is required to be formulated for new economic green field discoveries.

2.5.4 **Production:** The present mine capacity of HZL stands at 5.85 million tonnes per annum (Mtpa). Further expansion of Rampura Agucha to 5 Mtpa mine is planned by 2008. HZL is also actively planning to open-up new deposit at Kayar by 2010, for which feasibility studies are in progress.

2.5.5 The total primary zinc metal production capacity in India at the end of terminal year of the 9th Plan (2001-02) was 199,000 tonnes per annum (tpa). (HZL – 169,000tpa, BIL – 30,000tpa). There has been progressive capacity build up by HZL during the early years of the 10th Plan through debottlenecking and modernization in its operating zinc smelters. This was followed by commissioning of a new 170,000 tpa hydromet zinc smelter at Chanderiya, Dist. Chittorgarh in Rajasthan which has been operationalised in 2005. This new smelter at Chanderiya is a world scale and state-of-art technology plant capable of producing zinc at much lower cost as compared to the old plants. With this capacity addition, HZL's zinc production capacity has surged from 169,000 tpa to 411,000 tpa and it is now the sixth largest producer of zinc in the world. In addition, the capacity of of BIL is 38,000 tonnes metal.

2.5.6 Looking to the rising demand of zinc in India and in the international market, HZL is coming up with another brownfield zinc smelter project of 170,000tpa capacity at Chanderiya, which is likely to be completed by 2008. Further debottlenecking and modernization will also be taken up by HZL in its existing capacities. This will raise HZL's capacity to around 6 lakh tpa and country's total primary zinc production to 6.4 lakh tpa.

2.5.7 Zinc metal production capacity in the secondary sector is estimated at 50,000tpa. Currently, about 25,000 to 30,000 tonnes of zinc per annum is being produced in the secondary sector. Present rising trend of zinc metal prices will be encouraging the recycling to enhance capacity as well as utilization besides investments in new facilities. Secondary zinc production is therefore, expected to increase to 40,000tpa during the 11^{th} Plan period.

2.6 **Lead**

2.6.1 HZL is the only primary lead producer in the country. It has a total lead production capacity of 85,000tpa at its two lead plants at Chanderiya, one of which has been operationalised in 2005 using eco-friendly Ausmelt technology with a capacity of 50,000tpa. The secondary lead production in the country, in both organized and small scale sectors is estimated at 50,000tpa. With the enactment of Battery Management & Handling Rules (BMHR), 2002, the domestic collection of used batteries has increased. This has helped in substantial increase in secondary lead production.

2.6.2 Looking at the growth in the Automotive and Information Technology and Communication Technology sectors, the demand for lead is poised to increase. This in turn will result in more recycling of batteries. This is expected to enhance the production of secondary lead to around 75,000tpa during the 11^{th} Plan period.

2.6.3 The present per capita consumption of zinc in India is about 0.4kg as against the world average of 1.3kg. Consumption of zinc during 2005-06 was nearly 430,000 tonnes. The zinc demand is riding the steel industry growth, mainly driven by galvanized sheets. Per capita consumption of lead in India is about 0.24kg. Consumption of lead during 2005-06 was nearly 239,000 tonnes. The lead demand is riding the automotive growth, mainly driven by storage batteries. The demand in the country during the 11^{th} Plan period is projected to grow at compounded annual rate of 8% for zinc and 10% for lead.

2.6.4 The lead industry is poised to rise @ 10% CAGR during the 11^{th} Plan. There is significant upsurge expected in applications of lead storage batteries in defence, power, auto and IT-CT and other end user industries. There continues to be supply deficit for lead metal, being met entirely through imports. This is basically due to inadequate lead resources limiting primary metal production capacity build-up. The demand-supply gap could only be reduced either by enhancing primary metal production once new resources are identified or upsurge in recycling of secondaries.

2.6.5 Zinc consumption in India has been growing substantially in recent years. Consumption of zinc during 2005-06 was 430,000 tonnes approximately. The sectoral consumption of zinc in India is as follows:

Galvanizing	70%
Dry cell	10%
Die Casting	5%

Alloys, brass etc	5%
Chemicals and others	10%

2.6.6 Despite its varied applications, the usage of lead has been subjected to several challenges from the environmental angle in recent years, because of its toxicity. In some applications, lead has been substituted by alternate materials, such as in the case of pigments, paints, solder alloys etc. in a phased manner. Lead use in cable sheathing has been substituted by plastics. However there are a number of applications for which no alternatives are available, at least for the next couple of decades such as lead batteries.

Applications wherein alternatives to Lead Metal are not available
In the next 10 years

Applications	Remarks
Lead Acid Batteries	All known alternatives are technically or financially worse than lead.
Sound and Vibration	Alternatives have not been identified

The end-use wise consumption of lead in India at present is given below:

Batteries	75%
Alloys, Chemicals	20%
Cable Sheathing	5%

2.7.7 **Investments** : There has been significant infusion of investment for capacity creation and increased operational efficiency by the Indian lead-zinc producing sector, mainly by HZL. An investment of Rs. 2,600 crore is estimated during the 10th Plan period. The investment has been mainly towards mineral exploration; development of mines; debottlenecking and modernization of mines, beneficiation plants and smelters; new capacity additions, captive power plants (zinc smelting process being power intensive) etc. The investment during the 11th Plan is projected at Rs. 2,400 crores, the major investment being on identification of new resources, development of new mines, capacity addition for zinc metal production with matching expansion in the mines along with captive power plant.

2.8 Associated Metals

2.8.1 Cadmium, silver, antimony, bismuth, mercury, indium and arsenic are generally associated as minor/trace elements with zinc-lead-copper deposits. Based on content in the ore, these are concentrated at ore beneficiation stage and finally some of these are recoverable during refining of main metals. These metals and their alloys find extensive application in a wide range of industries like - electronic, pharmaceutical, pesticides, space and defence, photographic materials, batteries, electroplating, cosmetics, paints, industrial and laboratory chemicals.

2.8.2 **Cadmium** : The bulk of cadmium is obtained from zinc concentrates. Estimated production of cadmium in the world was nearly 18,000 tonnes during 2005. China, Japan, Kazakhstan, Korea Rep., Mexico, Canada and Russia are leading cadmium producers and account for about 3/4th of world's total output.

2.8.3 **Silver** : During 2005, the estimated production of silver was nearly 20,300 tonnes. Peru, China, Mexico, Australia, Chile, Canada, Poland and USA are leading silver producers and account for about 80% of world's total output. In India, Hindustan Zinc Limited (HZL) is the major producer of Cadmium and silver metals which are recovered as by-products from the smelting of zinc-lead concentrates. Cadmium is also recovered in the plant of Binani Industries Ltd. (BIL) which is based on imported zinc concentrate. Small quantities of silver are also recovered in smelters of Hindustan Copper Limited (HCL). There is no commercial production for the other associated metals.

2.8.4 It is estimated that the zinc-lead reserves of HZL contain nearly 27,600 and 3,700 tonnes of cadmium and silver metals respectively. Estimated production of cadmium and silver in the terminal year of 10th plan will be of the order of 470 and 60 tonnes respectively. It is estimated that cadmium and silver production will rise to about 750 and 90tpa respectively from 2008-09 in the middle of 11th five year plan. This would be mainly on account of HZL's mining and smelting capacity expansion. In addition, the industry has taken up various measures to improve recovery efficiency through process flow-sheet modification, R&D projects for optimization of recovery of these metals both at beneficiation and smelting stages and recovery from wastes and residues. Antimony and arsenic contents are too low in the Indian ore for recovery.

2.8.5 **Nickel** : Bulk of the world nickel resources is confined to Australia, Cuba, Canada, Indonesia, New Caledonia, South Africa, Brazil and China. Russia, Australia and Canada are the major producers of refined nickel in the world. The estimated world nickel mine production during 2005 was 1.5 million tonnes. The estimated world refined nickel production during 2005 was 1.30 million tonnes. The estimated world nickel consumption during 2005 was 1.32 million tonnes, reflecting a deficit of 20,000 tonnes. During 2006 also, a similar worldwide deficit is forecast.

2.8.6 Main nickel occurrence in India is found in the Sukinda Valley in Orissa in the overburden of chromite. The nickel-ferrous limonites vary in composition from 0.5 to 0.9 Ni and is characterised by high iron content, low magnesia and occur as discontinue structures. Nickel also occurs in sulphide form along with copper mineralization in East Singhbhum district, Jharkhand. The total resources of nickel in India are estimated at 189 Mt of which 42.1 Mt contains +0.9% Ni. Orissa hosts about 92% of the total resources. So far, nickel is not produced from the primary source in the country and entire demand is met through imports. The sectoral uses of Nickel are given below:

Stainless Steel	65%
Alloys	12%
Plating	8%
Foundry	6%
Battery, others	9%

2.9 Tin

2.9.1 Tin resources in the world are estimated at around 11 million tonnes and about 82% of these are in China, Brazil, Malaysia, Peru and Indonesia. About 91% of world's tin mine production comes from Indonesia, China, Peru and Bolivia. The estimated refined tin production during 2005 was about 330,000t. China, Indonesia, Malaysia and Peru together produced about 78% of refined tin. India's share in refined tin production was nearly 1%. The refined tin consumption during 2005 was about 348,000t, of which nearly 33% was in China. The other leading consuming countries are USA, Japan, Germany and Korea Rep.

2.9.2 The total resources of tin in the country are placed at 87.34 million tonnes containing about 0.7 million tonnes of metal. Of this, about 12,700 tonnes containg 34.6 tonnes tin metal, located in Orissa, are classified as reserves. Most of the remaining resources are located in Haryana (61%), Chattisgarh (38%), and Orissa (1%). There is meagre production of primary tin metal in the country and almost entire consumption is met by imports. Demand for tin plate for packaging industry in the country is growing and the consumption is expected to grow at a moderate level of 5% per annum. The per capita consumption of tin plate in India is only 0.3kg compared with 10kg in USA, 8kg in Japan and 0,8kg in China. Lead-free solder are expected to find market for soldering of electronic and electrical devices in future. Motor vehicle industry is showing interest in tin-zinc coatings for fuel tanks to replace lead-based fuel tank coatings.

2.10 Tungsten

2.10.1 Tungsten has outstanding physical properties such as high specific gravity, hardness and the highest melting point and has therefore become indispensable in strategic and industrial uses, particularly in defence armaments. Tungsten is mainly used in:

1	Metal working, mining, & construction, machinery and equipment and cemented carbide	74%
2	Electric bulb filaments, electrodes, x-ray tube anode and other electronic uses	19%
3	Chemicals, organic dyes, pigments etc.,	4%
4	Others including alloys	3%

The most important tungsten bearing minerals are wolframite and scheelite. Total world tungsten reserves are 2.9 million tonnes of metal content. About 62% of the tungsten reserves are in China. Canada and Russia each contain nearly 9% of reserves.

2.10.2 The total resources of tungsten in the country are estimated at 87.3 million tonnes. Bulk of the resources are localised mainly in low-grade tungsten bearing granite at Degana in Rajasthan. It used to be the only operative mine for tungsten in India with a small production of about 10 tonnes of concentrate, but was closed in the early part of the 9th Plan on techno-economic consideration. Hence the entire quantity of tungsten is currently being imported.

2.10.3 The tungsten demand of 11,900 tonnes in 2006-07 and 17,500 tonnes by 2011-

12 can only be met by the imports as there is no indigenous production. However, due to its strategic importance, following measures are suggested.

- Vigorous exploration to identify new economic resources and evaluation of existing potential reserves
- Continue the efforts on effective utilisation of scrap
- R&D for flotation, solvent extraction, plasma smelting and refining of the metal

3 - ALUMINIUM

(aluminium, gallium, vanadium, magnesium, titanium and silicon)

3.0 Indian aluminium industry enjoys a number of competitive advantages over the producers in the world. Indian companies have captive resources of bauxite and the domestic demand for metal is expected to grow particularly in automobile industry and construction. For example, bauxite deposits in the states of Orissa and Andhra Pradesh are near to the coast and in these places thermal coal is available to generate power. With WTO regulations, aluminium sector in India has to rise to the occasion to improve its performance. Taking into account the expected increase in per capita consumption, growth in population, application of aluminium in new areas such as automobile, structural, packaging etc. and export potential, one foresees better prospects for aluminium in the coming years.

3.1 World bauxite resources are estimated to be 55 to 75 billion tonnes of which India's resources are 3 billion tonnes, whereas the estimated reserves of all grades and categories are 2.5 billion tonnes. India's position is 4th in the world after Guinea, Australia and Brazil. The production of bauxite in India has increased from 5.06 million tonnes in 1991-92 to 11.69 million tonnes in 2004-05. There are more than 200 mines operating in the country, most of them are small to medium size. 15 major deposits account for 75% of the country's production, which are captive mines of the major alumina players in the country like NALCO, BALCO, HINDALCO and MALCO. With the abundance of resources, Eastern Ghats region of Orissa and Andhra Pradesh would be the area of major bauxite mining activities in future.

3.2 Inspite of capacity additions in Brazil, India and Australia, it is expected that alumina demand will grow between 1 to 1.5 million tonnes per annum and the price is likely to remain around USD 550-600. In all probability, the alumina market is likely to remain steady with demand and supply gap of 3.5 million tonnes by 2007, which would increase around 2010. New refineries are likely to come up in Guinea, Brazil, China, India and Australia to meet this demand.

3.3 The total alumina production capacity which was 1.8 million tonnes in 1996-97 increased to 2.9 million tonnes in 2004-05. Increase in capacity have taken place through brownfield expansions of refineries of NALCO, HINDALCO and INDAL. As a result, the production of alumina registered a growth of 6%.

3.4 The surplus alumina, of about 8 lakh tonnes (2002-03) was exported to China,Russia, and Iran by various producers, after meeting their consumption in their respective smelters. NALCO is the major exporter of alumina. Some alumina produced by HINDALCO (INDAL) is used to produce special grades. The export of alumina from India is likely to increase further with proposed Brownfield expansions and Greenfield refineries under pipeline.

3.5 In spite of mergers, acquisitions and fluctuations in LME price, aluminium sector in global scenario has performed well. The major producing countries are USA, Russia,China and Canada followed by Australia, Brazil, Norway, South Africa, Venezuela, Germany, India and Bahrain. Inspite of high production of both the primary and secondary metal, USA is the major importer of metals, followed by Japan and China because of high consumption. It is expected that world aluminium production will increase steadily and by the end of 2007 it is expected to be around 32 million tonnes. The world production of Primary metal was 31.2 million tonnes in the year 2005

3.6 While NALCO, BALCO, HINDALCO and MALCO operate one each, HINDALCO (Ex-INDAL)has three smelters. Because of constraints of power, smelting capacity utilization of INDAL is very low. Details of the aluminium smelters with their capacities are given below.

Production of aluminium in 2005

Company	Location	Present capacity in tonnes
NALCO	Angul,Orissa	3,59,00
HINDALCO & INDAL [Aditya Birla Group]	Renukot,UP, Hirakud (Orissa)	4,27500
BALCO	***Korba, Chattisgarh***	***1,39,350***
MALCO	Mettur, Tamilnadu	36,600
	TOTAL	**9,62,450**

3.7 The production capacity of these smelters are likely to be enhanced to 1.075 million tonnes by the year 2006-07. The production of metal has registered a growth of about 5% during 10th Plan period (660,000 tonnes in 2001-02). The expected consumption during 10th Plan is likely to be around 700,000 tonnes compared to 500,000 tonnes in 9th Plan. This indicates that a sudden rise in growth rate and consumption. The per capita consumption which was close to 0.5 kg for a long period has now increased to 0.68 kg which is still much lower compared to other developing countries like Latin America, Asia and Africa.

3.8 In Asia, Japan, South Korea and China are net importers of primary metal and are exporting value added downstream products, semis and finished goods. China particularly is developing fast in both consumption and production of aluminium with a growth rate of 14%.The export from China is increasing. In the market economy with the growth plan of China, it will be a major competitor to domestic industries of India.

3.9 As regards the sectoral consumption pattern of aluminium is concerned, it is quite different in India. With the existing trend of growth and development this is likely to change soon. Sectoral consumption pattern analysis and forecast for the future are placed below.

(figures in %)

	W.World	**USA**	**World**	**India now**	**India in**	**CAGR**

			average		future	
Electrical	7	8	9	31	31	8.8
Transport	34	36	27	18	21	12.6
Consumer Durable	5	7	6	23	20	5.8
Building & Construction	19	14	19	8	10	13.8
Packaging	20	25	19	6	5	6.4
Industry & Machinery	9	10	10	10	10	7.7
Others	6		10	4	3	4.5

(Overall growth expected to be around 8%)

3.10 Regarding conductors, out of the total installed capacity, only 60% i.e. around 320,000 tonnes capacity is operational. Whereas existing operating capacity of extrusions is 180,000 tonnes, even though the actual capacity may be higher because of un-accounted units in un-organised sector. The rolled products capacity is 270,000 tonnes but the actual capacity including the un-organised sector may be around 400,000 tonnes. As per the information available, the domestic sectoral consumption are as follows:

Conductors	: 150,000 tonnes
Extrusions	: 150,000 tonnes
Rolled products including foil	: 250,000 tonnes
Castings	: 145,000 tonnes

3.11 About 80,000 tonnes of scrap is being imported and used for recycling besides 40,000 tonnes secondary metal production by recycling of domestic scrap.The only organized recycling unit in the country of Indal is under utilized. Obviously, the secondary producers and unorganized sector are carrying out recycling for which details are not available.

3.12 Taking into account the population growth and per capita consumption increasing to 0.8 kg, it is expected that the domestic consumption would be around 0.92 million tonnes around 2007 by the end of 10th Plan. The production of aluminium in 2005 is 0.96 million tonnes as given below

Company	**Aluminium Production (In million tonnes)**
HINDALCO & INDAL (Aditya Birla Group)	0.42
NALCO	0.36
BALCO	0.14
MALCO	0.04
	0.96

3.13 Proposed capacity expansion of aluminium smelter in 11th Plan and beyond are placed below:

('000 tonnes)

Company	Planned for 10th Plan (2006-07)	Likely to achieve (2011-121)
Nalco	345	460
Hindalco	356	356
Indal	100	100
Balco	250	400
Malco	025	025
Total	1076	1291

It is expected that per capita consumption would rise up to 0.8 kg. 1 kg and 1.1 kg by end of 10th Plan, 11th Plan and 12th Plan respectively.

3.14 During the 10th Plan period only the proposed brown field expansions of existing refineries have taken place to achieve the capacity of 27.20 thousand tones of alumina. Proposed green field export oriented alumina plants have not come up. As per the industry, in the 11th Plan there are proposals for expansions to meet the demand of respective smelters and surplus for export by Nalco and Indal.

3.15 The Country is today producing surplus alumina, which is being exported. This trend is likely to continue with the establishment of green field export oriented alumina refineries. As such with the surplus availability of alumina, the aluminium smelters in the country would not suffer. The projected capacities of alumina domestic consumption by smelters and surplus availability for export are placed below:

(Million tonnes)

	2001-02	**2006-07**	**2011-2012**
Capacity	2.72	4.24	5.64
Aluminium Production	2.4	4.00	4.50
Internal Consumption	1.3	1.90	2.50
Likely Export	1.1	2.10	2.00*

*-> (EOU plants to likely add 2 million tonnes)

3.16 Bauxite resources of metallurgical grade being in abundance in the country, development of bauxite mining in future would depend upon growth of aluminium sector i.e. the capacity of aluminium refining. With the brown field expansions already planned by the existing industries, the refining capacity at the end of 10th Plan would be 4.24 million tonnes. This should increase bauxite production to around 13 million tonnes by 2006-07.

3.17 **Gallium**: Gallium is of strategic importance. In India this can be easily produced. To meet the increasing domestic demand and to avail export opportunities, gallium production in the country should be given priority. Considering this collaboration with foreign technology suppliers and indigenous technology development for gallium, refining is essentially required. Aluminium industries should take initiative in this regard.

3.18 **Vanadium**: The future alumina plants being mostly based on East Coast bauxite having very low percentage of vanadium in the bauxite sources, will not be able to generate adequate quantity of vanadium sludge to meet the internal demand for ferro vanadium. This has to be met by import.

4 - CEMENT AND LIMESTONE

4.1 Limestone occupies the top position among non-fuel solid mineral deposit In the volume of annual extraction. The mining of about 225 million tonnes of limestone for cement industry is next only to coal (380 m.t). Indian cement industry has been serving the nation's construction industry since 1914 and now has achieved a remarkable status with total installed capacity of 159.80 million tonnes as on 01.01.2006 and Cement Production of 136.67 mt (excluding mini cement plants), which is second largest in the world only after China. Cement is perhaps the only industry where liberalization was put into concrete practice, even before the open market policy was adopted as a policy.

4.2 China is the largest producer of cement in the world followed by India. During the last one decade cement production in the world has gone up by 45%. The consumption level of Cement in the Asian countries is increasing rapidly. In view of the growth of economies in the Asian region the consumption is projected to rise further by 4-5% per annum for the next 10 years. Paradoxically, India's per capita cement consumption is one of the lowest among major cement producing countries. But it cannot obviously remain the same in the face of escalating growth of infrastructure development. The industry which is growing at the present CAGR of + 10% has to gain further momentum to meet the demands and aspirations of the growing population. Growth of cement industry will spur a proportionate demand on limestone availability. Limestone security is therefore vital for sustainable growth of the cement industry.

4.3 The industry has shown much improved performance and not only crossed the production target set by the Deptt. of IPP but also almost reached the target set by the Working Group for X Five Year Plan, failing short of only around 2 m.t. Export performance has, however, been better as over 6 m.t. of cement was exported during the year 2005-06 as against the target of 4.5 m.t. set by the Working Group for X Five Year Plan.

4.3.1 With the average capacity utilization increasing from 82% in 2001-02 to 90% in 2005-06 and around 95% in April-June 2006, the industry has been producing to meet the growing demand and will continue to do so with addition of capacities each year. Capacity utilization for large plants during the 1st two years was 81% but subsequently increased to 90% in the 4th year. In the first quarter of 2006-07, it averaged at 95% and this is inclusive of public sector plants. In fact, average capacity utilization of private sector plants in 1st quarter of 2006-07 was around 97% while that of the public sector was 46%.

4.3.2 A positive growth has been noticed in most of the states except Delhi which recorded a negative growth of 6.6%, Assam 2.9%, N.E. States 19.1% and the Union Territory of Goa, Daman, Diu 37.6%. The highest growth of 51% has been recorded by Union Territory of Andaman & Nicobar, followed by Chhattisgarh 47.3%, Chandigarh 40.2% and Andhra Pradesh 34.1%. Uttar Pradesh is the only state, which witnessed a growth of less than 1%. Indian cement industry has been exporting cement (9.19 m.t. in 2005-06), the final product and also clinker, which is an intermediate product, to countries across the globe for the last one and a half decades.

4.4 NCB has estimated the availability of total reserves as 97.43 billion tonnes as on 31 March 2006. In the year 1974, the total limestone reserves as estimated were of the order of 44,000 m.t, with only 3020 m.t (6.8%) of proved category. As on 31 March 2006, the country's estimated gross reserves of cement grade limestone stand at 97430 m.t. Out of this, 22476 m.t (23%) of **proved** category, 19031 m..t (20%) of **probable** category and 55923 m.t (57%) of **possible** category reserves. On the eve of ushering of the X Plan in March 2001, the gross reserves of cement grade limestone was 95939 m.t., but estimates showed that only 35585 m.t. of gross reserves were available for meeting the present and future demand of cement production. Lesser availability was primarily due to environmental and technological constraints. The gross limestone reserves of 97430.35 m.t. include 19031.02 m.t. of probable and 55923.70 m.t. of possible reserves, that are converted into proved equivalent category. The total proved equivalent reserves are estimated at 63760 m.t. However, 23% of proved equivalent reserves, i.e. 21,718 m.t falls under forest areas and 7.5% i.e. 5754 m.t are restricted under Coastal Regulation Zone (CRZ). Thus the net Proved Equivalent Reserves of 35,585 m.t are available during XI Plan.

4.4.1 The total limestone requirement in the XI Plan (2006-07, 2011-12) with the growth scenario of cement at 9%, 10% and 11% for the GDP growth of 7%, 8% and 9% and balance life of reserves is projected below:

Limestone Requirement during 11th Plan projected for various growth Scenarios (mn.t)	**Scenario - I (9%)**	**Scenario - II (10%)**	**Scenario - III (11%)**
	2322.87	2376.00	2432.10
Life of the residual limestone reserves excluding the reserves falling under forest & CRZ beyond terminal year of XI Plan (Years)	70	67	64

It is alarming to note from the estimates given above that the residual limestone reserves, after meeting the existing capacities and their logical expansion , will be able to support cement industry for 64 years (at 11% annual growth) and 70 years (at 9% annual growth). Limestone availability for sustainable development of the cement industry in meeting the fast-track demand growth of infrastructure development is thus not assured beyond 65 years. Mitigation of this crisis will need several radical steps; the important recommendations arising therein deserve consideration.

5 - DIAMOND AND PRECIOUS STONES

5.1 Diamonds are now produced from 22 countries, as compared to one country (India) in the ancient period. Kimberlites and associated secondary deposits of gravel and conglomerates are reported from all the continents, except Antarctica. The total Diamond production of 156 Million carats in 2004 came mostly from 14 countries, 10 in Africa, one in North America one in South America, one in Asia (Asian part of Russia) and Australia and rest from other countries. Africa still contributes around 60% of the total world production.

5.2 The Indian diamond production never crossed one lakh carat figure in the last ten years. The main production comes from Majhgawan, Panna district, Madhya Pradesh which is 98-99% of the Indian production. The value of Indian diamonds (rough) produced since 1995 till 2006 with average price of Rs.5300 per carat (source: IBM) has been reported, Rs.41.45 crores in 2004-05 and Rs.23.26 crores in 2005-06.Indian diamond industry relies on supply of rough diamonds directly from the producers.

*5.3 **Diamond cutting and polishing in India**-Share in Global Trade comes to*

- 50% share by value
- 80% in terms of caratage
- 90% in terms of diamond pieces sold

Diamond imports and exports in india : A steady growth of diamond imports and exports has been established between 1994-95 and 2003-04. The imports have risen from Rs.4,960 crores in 1994-95 to Rs.32,251 crores in 2003-04. The export figures have risen from Rs.12,357 crores in 1994-95 to Rs.38,145 crores in 2003-04.

5.4 Indian diamond industry handles 80% of the global polished diamond market, and earned us $ 8 billion in 2004 (compared to software's US $ 10 billion). So why do we hear so much about IT and so little about the diamond business? Well, try talking to someone in the diamond industry. Indian cut and polished diamond manufacturing industry is expecting a growth of 20% in 2005. The industry earns 90% of its revenue through the finished products. The $11 billion diamond industry has accounted for 85 percent of the total global business last year. The global business is worth almost $ 12.5 billion. The sector has witnessed a remarkable growth rate ranging from 15 to 20 percent in 40 years. Interestingly, global growth is in the range of 6 to 8 percent.

5.5 India has three diamond provinces i.e. Central Indian Diamond Province, East Indian Diamond Province and South Indian Diamond Province where the primary and diamond host rocks and the secondary occurrences are found.

5.5.1 The liberalization of our National Mineral Policy in 1993 has resulted in the entry of private entrepreneurs and Multinational Companies from overseas, for carrying out diamond exploration. A few renowned companies equipped with the state-of-the-art technology and backed by sound financial resources are working/worked in a total of 1,62,640 sq km area in various diamond provinces covering various companies and a few kimberlites / lamproites have been discovered.

5.5.2 Based on the exploration practices and activities which are multidisciplinary in nature (involving Airborne Geophysical Survey, Remote sensing, Stream Sediment sampling and other ground geological, geochemical & geophysical surveys) new kimberlites / Lamproites may be discovered. This may result in discovering a new mine and if so production may be expected only by 2015. The production from such economically viable kimberlites / Lamproites discovered may only meet a fraction of the industry's requirement. Therefore, for a long time to come, India has to depend on imports of rough stones.

6 - GOLD AND PRECIOUS METALS

(Platinum group of metals and silver)

6.1 **Gold** : Gold is a relatively scarce metal in the world and a scarce commodity in India. India is a minor producer of gold against a huge demand in the country. Domestic demand is mainly met with import and partly through recycled gold. India is the world's biggest market, importing bulk of its annual consumption of more than 800 tonnes, making gold market with one-fifth of the global demand.

6.2 As per UNFC, total resources (reserves and remaining resources) of gold ore (primary) in the country as on 1.4.2005 were estimated at 390.28 million tonnes. Out of these, 19.25 million tonnes are placed under reserves category and the rest 371.03 million tonnes under resources category. The total resources of gold (primary) in terms of metal stand at 491 tonnes. Out of these, 85 tonnes are under reserves category and remaining 406 tonnes under resources category. Besides, the total resources of gold ore of placer type in the country as on 1.4.2005 were estimated at 26.12 million tonnes, all in the resources category. The resources of gold in terms of metal (placer) are 6 tonnes.

6.3 As against the present status of the inventory it is seen that during last five years there was augmentation of gold ore reserves and resources in the country with increase in the metal content. Augmentation was mainly in the resource category. It is to be recorded that although in Bihar huge amount of resources have been augmented the grade is too poor. Resource augmentation figure vis-à-vis metal yield expected in West Bengal requires a relook.

6.4 Although in last few years there was significant ore resource augmentation but the country has not witnessed any radical change in gold production from primary gold ore. It is worth mentioning that mining of gold was primarily in the state of Karnataka and reserves augmentation was also only in the same state. However, significant augmentation of gold resources has been taken place by other states, where no investment has been made for mining. In order to enhance the gold production existing gold resources in other parts of the country have to be converted to reserves through detailed exploration and feasibility studies. This will help to open up new mines in the country. If new mines are opened the gold production will increase otherwise from the existing mines the annual production will remain between 3 and 3.5 tonnes during XIth plan period. The major producer will be the HGML from its three existing mines.

6.4.1 India's share in the total world consumption of gold was 855.2 tonnes and 1053 tonnes accounting for 26% and 27% of world consumption of gold during 2000 and 2001 respectively. Jewellery accounted for major consumption of gold, i.e. 85% followed by electronics 6%, metal and coins 2% and the remaining 7% by other sectors. The consumption of gold is far exceeding than the production owing to the continued consumption in ornament industry and increase in electronic industry.

6.4.2 The world reserve base of gold have been placed at 89000 tonnes of metal content. Out of the total reserve base of gold metal about 40% is located in South Africa. The other countries which are endowed with gold reserves are Australia and USA (6.8% each), China (4.6%), Canada and Russia (3.9% each) and Indonesia (3.1%). The world mine production of gold remained same during 2002 and 2003. The production was 2520 tonnes. The Republic of South Africa continued to be the world leader, contributing 13.92% of the world production followed by USA (10%), Australia (9.8%), China (8.5%), Russia (7.82%), Canada (6.92%) and Peru (6.47%) and Indonesia (4.02%).

6.5 The geological occurrences of gold have been reported from various parts of the country. Many of them have been explored and a number of deposits established. The deposits are generally of low grade and low tonnage which are not being exploited.

6.5.1 The mining sector calls for improved method of narrow vein mining for their economic exploitation. Introduction of small scale mining culture in gold industry is a need of the day. Adoption of modern gold extraction technology is an immediate need to treat low grade and complex ore type. For augmenting gold reserves in the country further detailed explorations have to be taken up for the deposits where preliminary assessment upto a shallow depth has been completed.

6.5.2 MNCs have to be inducted for this purpose with application of state-of-the art technology. The mining sector, which has been thrown open for private entrepreneurs and MNCs, has to provide with fast disposal and support from the Government so as to attract more and more investments.

6.5.3 During the eleventh plan period, in addition to the development of existing mines, the HGML will continue exploratory mine development and exploration by underground drilling in the Hutti South block over a strike length of 750m upto the southern limit of existing mining lease. A total of 9870m of mine develoment has been proposed in the Hutti mine including south block. Exploratory mine development will continue in Uti and Hira Buddini deposits. For furhter prospecting, HGML has applied for PL in Dharwar South Block, Chikanayakanahalli and Bellara blocks in Karnataka. In the XIth plan period HGML has projected maximum production at 3245 kg of gold during 2009-10.

6.6 Cluster mining of small gold deposits may also deserve consideration and should be encouraged. A case is that of Kunderkocha deposit in Potka block of East Singhbhoom District, Jharkhand which is being developed by M/s. Manmohan Mineral Industries Pvt. Ltd. (MMIPL) for a production target of 200 Kg. Gold per annum.

6.7 Replacement of gold extraction plant at Hutti Gold Mines Ltd. (HGML) by a new plant inclusive of Falcon Gravity Separator at a cost of around Rs. 70 crores need tobe done at the earliest in 11th plan.

6.8 To augment gold production in the country during XIth plan period Chigargunta and Bisanattam mines in KGF which were abandoned, deserve active consideration for reopening. A relook is required for the tailing dump lying in KGF area.

6.9 **Potential Prospects for Exploitation**

- **In KGF** - Chigargunta gold deposit, Tailing dump, Old Bisanattan mine
- **In Hutti belt** - Southern and northern extension within mining block, Wandalli block, Buddini block
- **In Jonnagiri Schist belt** - Dona East block
- **Ramagiri Schist belt** - Ompratima - Gantalappa Sector
- **Gadag Schist belt** - Hosur - Champion, Mysore Mine and Sangli Mine blocks
- **Nuggihalli schist belt** - Kempinkote
- **Dharwar Shimoga schist belt** - Chinmulgand, Rajasthan, Jagpura

6.10 **Small Deposits For Cluster Mining**

Archaean Greenstone Belt

- Wandalli-Chinchergi-Tuppadhur-Buddini blocks (Hutti Belt)
- Dona East, Dona Temple, Dona North, Dona South blocks (Jonnagiri Belt)
- Hosur champion East and West, Mysore mine and Sangli mine blocks (Gadag Belt)
- Ajjanahalli, G R Halli, C K Halli, Gonur-Kotemaradi blocks (Chitradurga Belt)

Proterozoic Fold Belt

- Bhukia West, Bhukia East, Timranmata East, Bhukia East Central and Jagpura blocks

6.11 **Areas identified for further search for gold**

- Dharwar craton in the states of Karnataka, A.P. and Tamilnaud (40,000 sq km + 1000 sq km in adjoining granitoids)
- Wynad, Nolambur and Attapady valley gold fields of Southern Granulite Terrain in the states of Tamilnadu and Kerala (450 sq km)
- Mahakoshal belt of Uttar Pradesh and Madhya Pradesh (8950 sq km)
- Kottri volcanic belt, Sonakhan belt, Bailadila Group and its equivalent rocks of Chhattisgarh (1600 sq km)
- Sakoli fold belt of Maharashtra (5500 sq km)
- Gorumahisani-Badampahar belt and Bonai - keonjhar belt of Orissa and Jharkhand (940 sq km)
- Singhbhum fold belt of Jharkhand and Orissa (21500 sq km)
- Aravalli fold belt of Rajasthan (30800 sq km)

6.12 A total of more than 1, 10,740 sq. km. area is potential for gold mineralisation.

6.13 Geomysore Services and associated companies have filed 81 PL applications for gold and platinum covering a total area of 2,057 sq km in 11 States and also 9 ML applications for gold over an area of 26.78 sq km. and investment of Rs. 37 crores by the GMSI is envisaged during the next 2-3 years. Also a modern gold-ore processing plant first in Jonnagiri Gold Fields, Karnool district, AP is proposed to be established by the Geomysore Services followed by another plant in Chhattisgarh.

6.14 However, lengthy and avoidable procedures in grant of prospecting licences need to be ensured by the Central/State Governments.

6.15 **Platinum Group of Elements(PGE) :** Platinum is naturally occurring precious metal that is scarce in India. Although there is no production of platinum there is demand of the metal in the country. The development of Indian platinum jewellery market is increasing steadily. The demand continues to grow with increasing consumer awareness. In India, incidence of platinum group of element (PGE) have been noted from the Pre-Cambrian mafic/ultramafic complexes in Baula - Nuasahi sector in Orissa, Sittampundi in Tamil Nadu, Hanumalapura in Karnataka and Usgaon area in South Goa. The resources of PGE ore in the country have been estimated only from Baula- Nuasahi area in Orissa. The largest reserve of PGE is located in Bushveld Complex in South Africa. The world reserve base of PGE is estimated at 80 million tonne concentrated mostly in South Africa (87.5%), followed by Russia (8.25%), USA(2.5%) and Canada (0.5%).

6.16 In India import of platinum registered an increase of more than 50% from 2,234kg in 2002-03 to 3,352kg in 2003-04. Import of other metals of PGE increased manifold from 62 kg in 2002-03 to 2655 kg in 2003-04 where as imports of platinum (powder, unwrought and others) decreased to 697 kg in 2003-04 from 1332 kg in 2002-03. The demand for platinum will continue to rise with tighter emission controls, robust growth of diesel engines and emerging Indian market for platinum jewellery. The demand of palladium is expected to rise in autocatalysts for petrol engines. Growth of rhodium will also be more in automotive industry.

6.17 At present facilities for ore beneficiation and extraction of PGE do not exist in the country. The metallurgical technique for extraction of platinum group elements from low grade ore is a closely guarded secret with a few enterprises in advanced countries. Technology has to be imported for extraction of PGE and this should be promoted. In addition, the PGE environment established in the country will have to be covered by regional exploration to identify prospects for detailed exploration. Foreign fund has to be inducted in the country for search of PGE through application of state-of-the art technology.

6.18 **Silver** : Silver is recovered as co-product as well as a by-product in the country. It occurs generally in association with lead, zinc, copper and gold ores and its extraction is as a by-product from electrolysis or chemical methods. Economically viable native silver deposits have not been reported in the country. Silver was recovered in the past as a co-product in gold refining at Kolar Gold field complex and Hutti Gold Mines in Karnataka and as a by product in smelting and refining of lead, zinc and copper concentrates. The present production of silver comes from Chanderiya lead –zinc smelter of HZL and gold refinery of HGML. As per UNFC system the total resources of silver ore in the country as on 1.4.2000 were estimated at about 198.17 million tonnes. Out of these, 91.98 million tones were placed under reserves category and 106.18 million tonnes under the resource category. The reserves were further divided into 54.29 million tonnes under proved and 37.69 million tonnes under probable category.
However, in terms of silver metal in the country as on 1.4.2000 were estimated at 6,082.29 tonnes. Out of which, 2843.41 tonnes belong to reserve category.

6.19 Production of silver in 2004-05 was 10,955 kg which has decreased by 31% from that in the previous year due to captive consumptions of high silverised lead metal for manufacturing anodes. Production of Jharkhand has come to a halt. The total reserve base of silver in the world is estimated at 570,000 tonnes of metal. Poland, China, USA, Mexico and Peru are the main countries in terms of resources.. World mine production of silver by principal countries indicates that the Peru topped the world to reach 2921 tonnes production in 2003. China stands as Asia's largest producer of silver to the tune of 2500 tonnes.

7 - DIMENSIONAL AND DECORATIVE STONES

7.0 Dimensional Stones form a major component of Indian construction sector, which accounts for 5% of the GDP and is the second highest employer after agriculture. India and China are expected to experience highest growth in the construction industry. India's anticipated growth rate in construction is 10% by 2007. With the higher anticipated spending in the private construction (housing) in coming years due to increased financing options, tax benefits and favourable interest rates, the stone sector is bound to have a leap forward.

7.1 Global Scenario

7.1.1 The global stone production is over 98 million tons. India is the largest producer of dimensional stones followed by China and Italy.

7.1.2 India, Italy and China together contribute to more than half the stone production in the world. The other major stone producers are Spain, Portugal, Brazil, Greece, France and Turkey. India accounts for about 28% of global stone production.

7.1.3 The major importers of stones in the world are Germany, Italy, China, Japan, Taiwan and USA. China and other EU countries like France, Spain, Belgium and Netherlands also contribute significantly to the world stone imports.

7.1.4 The major exporters of stones and stone products in the world are Italy, China, India and Spain closely followed by Brazil and South Africa. Other major exporters are Turkey, USA and Finland. Italy, China, India and Spain account for more than half of the world exports. There are however many countries which account for less than 1 % of the export share, but together account for over 24%.

7.1.5 The increasing market share of China, India and Brazil stand out, in view of their vast resources and a great number of varieties; as well as the low cost of production.

7.2 Indian Scenario

7.2.1 India is one of the largest producers of dimensional stones in the world. India is endowed with vast resources of granite, marble, sandstone, flaggy limestone (kotastone), slate and quartzite. Some of the colours and types of Indian granites are unique in the world and have no parallel and have regular flow of demand in the world market.

A. Indian Stone Industry accounts for

1. a sales turnover of over Rs. 15,000 crores
2. exports over Rs. 3,400 crores (2003-04) and provisional exports of Rs. 3,500 crores (2005-06)
3. employs over 1.5 million workforce

B. The rural economy of many developing states like *M.P., UP, Orissa, and the North Eastern states* is dependent on this industry

7.3 Production and Exports

7.3.1 The Indian stone production is estimated at 31059 thousand tonnes. Indian Stone exports was approximately Rs. 3,408 crores during 2003-04, with Granite alone accounting for Rs. 2653 crores.

Indian Stone Exports

(Million Rupees)

	1998-99	**1999-00**	**2000-01**	**2001-02**	**2002-03**	**2003-04**
Granite and Products thereof	10130	16712	19540	20463	24606	26538
Marble and Products thereof	1111	1580	2362	2085	2292	1993
Slate	867	1101	1436	934	1391	1460
Sandstones & other stone products thereof	911	1401	1530	2664	3502	4096
Total	**13019**	**20794**	**24868**	**26146**	**31791**	**34087**

Source: CAPEXIL

7.3.2 India has done well in exports of granites in the world market in last few years. However, severe competition is posed from countries like China, South Africa, Brazil, Zimbabwe, Spain

7.3.3 India is the **Second** largest exporter of granite after China. Next in line are **Brazil and South Africa.** With all the progress in granite processing industry (value added finished products), India is yet far behind i.e. at 5^{th} place in the world. Prior to 1987, the exports of Indian processed granite products was hardly 10% of the total granite exports, but in recent years, the share of value added finished products has touched **75-80%** of the total granite exports. Thus, the trend has reversed favaourably in favour of finished value added products.

7.3.4 India has abundant resources, technical know-how, large quarrying base and processing capacity and can safely ensure export growth @ 20% per annum during the 11^{th} Plan period.

7.4 Projections for domestic consumption and exports

7.4.1 Indian stone is widely accepted world over and also in the domestic market. The demand is growing rapidly with the boom in the construction sector.

7.4.2 The demand for granite and other decorative stones is increasing and is anticipated that the annual growth would be ***around 20%***, Indian granite, marble and other stones have established very well in world market where our share of world requirement is 12% of the total world market, which is Rs. 25,620 crores and 18% in terms of tonnage. India has abundant resources, sufficient technical know-how, large quarrying and processing capacity, and can safely ensure export growth at the rate of 20% per year in coming 15 years or more.

7.4.3 Domestic consumption of Granite stones is around Rs. 7,000 crores. It is anticipated that the dimension stone industry for the domestic sector will also grow simultaneously with the development of Export industry. Our country in the last few years is having a phenomenal growth in building activities and other infrastructural areas where the demand has picked up. The growth is continuing in domestic granite consumption and shall remain growing in the coming next 15 years.

7.5 Projections for Investment in Dimensional Stone Industry

7.5.1 Present investment in dimensional & decorative stone industry in India is estimated at Rs. 10,000 crores. It is expected that given the policy support, the total sales turnover of all the stones, which is today at around Rs. 15,000 crores will increase to over Rs. 44,788 crores by 2012, Rs. 1,11,444 crores by 2017 and Rs. 2,77,304 crores by 2022 considering an estimated growth rate of 20%. In order to meet the projections in next 15 years, it is estimated that further investment have to go up by about Rs. 2,00,000 crores (including foreign investment) by 2022.

8 - INDUSTRIAL/NON-METALLIC MINERALS

8.1 There are large number of minerals under the industrial/non-metallic group of minerals but all important minerals may be grouped into four categories as:

1. Rock Phosphate 2. Potash 3. Sulphur and Pyrites	**Fertiliser Minerals**
4. Asbestos 5. Dolomite 6. Fluorspar 7. Gypsum 8. Wollastonite	**Flux & Construction Minerals**
9. Quartz & other silica minerals 10. Fireclay 11. Chinaclay & Ballclay 12. Magnesite 13. Graphite 14. Pyrophyllite 15. Kyanite 16. Sillimanite 17. Vermiculite	**Ceramic & Refractory Minerals**
18. Barytes 19. Bentonite 20. Fuller's Earth 21. Mica 22. Talc, Soapstone and Steatite	**Export Potential Minerals**

These minerals are of low value and bulk materials but they are quite important for industrial base; most important being rock phosphate, dolomite, fluorspar, quartz & other silica minerals, chinaclay & ballclay, magnesite, graphite, barytes, bentonite and talc,soapstone, etc.

8.2 Fertilizer Minerals

8.2.1 **Rock phosphate** : The total resources of rock phosphate as per UNFC system in the country as on 1.4.2000 are placed at 289 million tonnes. Out of these resources, the exploitable resources are only 75 million tonnes. Remaining 214 million tonnes are resources which cannot be mined and utilised under present conditions. The apparent consumption of apatite and rock phosphate is estimated at 4475 thousand Tonnes by 2006-07 and at 6695 thousand tonnes by 2011-12 .Only about 35-40% requirement of raw material for phosphate fertiliser production is met through indigenous sources. The remaining requirement is met through import in the form of rock phosphate, phosphoric acid and direct fertilizers. In India, the finely-ground rock phosphate containing 16% P_2O_5 is used directly on the soil for soil amendment.

8.2.2 The reserves of chemical and fertilizer grades apatite and rock phosphate in India are very limited. Therefore, detailed exploration is necessary for conversion of remaining resources into reserves. Secondly, the search for apatite and rock phosphate may have to be intensified in Andhra Pradesh, Rajasthan, Madhya Pradesh, Jharkhand, Tamilnadu, Meghalaya, Gujarat, Uttar Pradesh, Uttaranchal, West Bengal etc. Till the domestic resources of these two minerals are improved, the country has no alternative but to depend on their imports.

8.2.3 In India, most of the existing phosphatic fertilizer and phosphoric acid plants have been designed for high-grade imported rock phosphate, mainly from Morocco and Jordan. The Indian deposits are of low grade. Therefore, the fertilizer and phosphoric acid plants that may be set up as replacement to the existing plants will have to be designed to accept indigenous ores as a feed. Beneficiation of domestic low-grade ores would-be a step in the right direction. Demand of phosphatic fertilizer will continue to rise due to growth in population and corresponding increase in food requirements. There is no substitute for phosphorus in agriculture.

8.2.4 **Potash** : About 93% of world potash production is used by the fertilizer industry to provide potassium which is essential plant nutrient. Potassium chloride (KCL) is the principal fertilizer product equivalent to 60-62% K_2O. Other salts for fertilizer use are potassium sulphate, potassium magnesium sulphate & potassium nitrate. Potassium chloride & potassium nitrate are used in manufacture of glass, ceramic, soap, synthetic rubber and chemical industries. Potassium nitrate is used in explosive manufacture.

8.2.5 Bedded marine evaporite deposits and surface & subsurface potash-rich brines are the principal sources of potash. The principal ore is sylvinite, a mixture of sylvite (KCL) and rock salt (NaCl). As per UNFC, the total resources of Potash as on 1.4.2000 are estimated at 21,815 million tonnes in the country. Rajasthan alone contributes 94% resources followed by Madhya Pradesh (5%) and Uttar Pradesh, a very negligible quantity. Any estimation of the reserves has not yet been made mainly because of lack of exploration in depth and high cost involved in this task. Presently there is no production of potash in the country.

8.2.6 **Sulphur and Pyrites**: The total consumption of elemental by-product sulphur in 2003-04 was 1,500 thousand tonnes. The main consumer of sulphur was fertilizer industry which accounted for about 77 percent. Chemical industry, the next important consuming industry, accounted for about 16% consumption for manufacturing carbon disulphide & dye-stuffs. Other industries like explosives, iron & steel, paint, paper, pesticides and sugar consumed about 7 percent. The apparent consumption and sulphur and pyrites is estimated at 1,320,000 tonnes by 2006-07 and at 2,031,000 tonnes by 2011-12 . The country will continue to rely on imports to meet its domestic demand.

8.3 Flux & Construction Minerals

8.3.1 **Asbestos:** The world production of asbestos was 2.4 million tonnes in 2004. The important producers were Russia, China, Kazakistan and Brazil. Canada and Zimbabwe are major producers of chrysotile variety. India's production was about 6 thousand tonnes. As per United Nation's Framework Classification (UNFC) system, total resources (reserves and remaining resources) of asbestos in the country as on 1.4.2000 are placed at 18.46 million tonnes. Of these, 3.67 million tonnes are reserves and 14.79 million tonnes are remaining resources. Out of total resources of 18.46 million tonnes, Rajasthan accounts for 54% and Karnataka 45%.

8.3.2 The internal consumption of asbestos was about 86,000-90,000 tonnes per annum, almost entirely in asbestos-cement and asbestos-based products manufacturing. The apparent demand of asbestos is estimated at 227,000 tonnes by 2006-07 and at 349,000 tonnes by 2011-12 .There has been a concern about the role of asbestos causing lung diseases. Research in this area has been hampered by the long period between asbestos exposure and symptoms, known as latency period which can exceed 30 years. Results obtained so far suggested that chrysotile, most widely used asbestos, was less dangerous than amphibole asbestos minerals.

8.3.3 The resources of chrysotile variety of asbestos are very much limited in India. So, there is an urgent need to go for detailed exploration of chrysotile which is required mainly in the manufacture of asbestos-cement products. To meet the domestic demand the country will continue to rely on imports.

8.3.4 **Dolomite:** Iron and steel including mini-steel plants and ferro-alloys are the main-stay of dolomite mining. Dolomite occurrences are widespread in almost all parts of the country. As per UNFC, total reserves and resources of all grades of dolomite are placed at 7084 million tonnes, out of which total reserves are 992 million tonnes and the balance; i.e. 6092 million tonnes are the resources. The apparent domestic demand is estimated at 4799 thousand tonnes by 2006-07 and at 7383 thousand tonnes by 2011-12.

8.3.5 The resources of the refractory grade dolomite in the country are meager and this type of material is in short supply but very much required for making tar-bonded dolomite bricks. Therefore, intensive search is needed in non-Himalayan regions for locating deposits of massive non-crystalline dolomite, containing less than 2.5% R_2O_3 for use in tar-dolomite bricks required for lining of LD steel furnaces. The total demand for various grades of dolomite including refractory grade by 2006-07 was estimated to 5.2 million tonnes at 6.5% growth rate and 6.1 million tonnes at 9.0% growth rate. This indicates demand-supply gap.

8.3.6 **Fluorspar**: Fluorspar is an indispensable material to aluminium metallurgy. It is an important fluxing agent and a source of fluorine chemicals which in turn find a variety of application. World production of fluorspar was 4.6 million tonnes in 2004. China ,Mexico and South Africa were the principal producers. India's . As per the UNFC, the total resources (reserves and remaining resources) of flluorite in the country as on 1.4.2000 were estimated at 12.77 million tonnes. Out of these, 2.23 million tonnes were placed under reserves category and 10.54 million tonnes under remaining resources category. The reserves were classified into 0.86 million tonnes under proved category and 1.37 million tonnes under probable category.

8.3.7 The average total consumption of fluorspar by all industries has been around 62,200 tonne per annum. The exports of fluorspar has increased to around 600 tonnes whereas imports have considerably increased to around 1 lakh tonnes during 10th Five-Year Plan period mainly from China. The apparent domestic demand of fluorspar is estimated at 126,000 tonnes by 2006-07 and at 194,000 tonnes by 2011-12.

8.3.8 The resources of fluorspar in India are limited and grades of the fluorspar produced do not meet the specifications of the chemical industry which is the bulk consumer of fluorspar. Ambadungar fluorspar mine of GMDC is the only domestic source of acid grade fluorspar, a slightly inferior quality with high phosphorus content. Hence, to meet the requirements domestic chemical industry the country will have to depend both qualitatively and quantitatively on imported fluorspar in the coming years, both for direct use and for blending with the domestic acid grade fluorspar.

8.3.9 **Gypsum** : World resources of gypsum are large. World production of gypsum was 111.6 million tonnes. The major producers were USA, Iran , Canada, Mexico, Thailand, Spain , India with a production of (3.5 million tonnes) ranked 11th position in world production. As per UNFC, the total resources of mineral gypsum in India as on 1.4.2000 were estimated at 1,243 million tonnes. Of these resources, 87 million tonnes have been placed under 'reserves' and 1,156 million tonnes under 'remaining resources'.

8.3.10 The production of gypsum is estimated at 4 million tonnes by 2006-07 and at 6.15 million tonnes by 2011-12. The exports and imports of gypsum have also shown a rising trend. The exports being at 65,000 tonnes and imports at 18,500 tonnes per annum during the 10th Plan period. The apparent domestic demand of gypsum is estimated at 3437 thousand tonnes by 2006-07 and at 5289 thousand tonnes by 2011-12.

8.8.11 In view of the environmental problem arising from huge accumulation of phospho-gypsum at different fertilizer plants, increasing utilisation of phospho-gypsum is necessary. Low-grade mineral gypsum being cheaper should be utilised more as a soil conditioner in the reclamation of alkaline soils. India occupies a comfortable position as regards the resources of gypsum. However, since gypsum is a low value high bulk mineral, there does not exist much prospects to increase exports of gypsum. roduction of gypsum wallboard which is negligible in India should be increased so that gypsum is used in value added form.

8.3.12 **Wollastonite** : World production of wollastonite was 733 thousand tonnes in 2004. China (395 thousand tonnes) and India (172 thousand tonnes) were the major producers. There are 3 reporting mines and the total production is at around 173,000 tonnes in 2004-05, this has registered an increase of 14% over the previous year. The production is estimated at 194,000 tonnes by 2006-07 and at 298,000 tonnes by 2011-12 . The consumption at around 6000 tonnes per annum is also registering the marginal increase. The apparent domestic demand of wollastonite is estimated at 170,000 tonnes by 2006-07 and at 262,000 tonnes by 2011-12.

8.3.12 Presently, the existing mines in the country are in a position to meet the domestic requirements of the industry as well as export demand. There is an increasing demand for wollastonite in the international markets, especially in ceramic and plastic industries and in construction activities. Since, wollastonite is mined and exported by only a few countries in the world, there is a scope for increasing the exports of this mineral from India in value-added form as coated powders, since Indian wollastonite is in tough competition from China and USA.

8.4 Ceramic & Refractory Minerals

8.4.1 **Quartz and other Silica Minerals**: Sand, and gravel resources of the world are large. However, because of their geographical distribution, environmental restrictions and quality requirements for some industries, extraction of these resources become sometimes un-economic. Quartz rich sand and sandstone, the main source of industrial silica sand occur throughout the world. As per the UNFC system of resource classification, the total resources of quartz and silica sand as on 1.4.2000 are estimated at 2,910 million tonnes, out of which 22%, i.e. 626 million tonnes are placed under reserves category while 78%; i.e. 2,284 million tonnes are placed under remaining resources category.

8.4.2 The production of quartz and other silica minerals is estimated at 2.57 million tonnes by 2006-07 and 3.96 million tonnes by 2011-12 . In India, quartz, quartzite and silica sand are used mainly in glass, foundry, ferro-alloys, refractory industries and also as building materials. According to its suitability for different purposes, it may be named as building sand, paving sand, moulding or foundry sand, refractory sand or furnace sand and glass sand, etc. However, the main use of silica minerals is in the manufacture of different types of glasses, natural silica sand being preferred material in the glass industry.

8.4.3 The domestic demand of quartz and silica minerals is estimated at 3.33 million tonnes by 2006-07 and at 5.12 million tonnes by 2011-12 . The demand for quartz, silica sand, moulding sand and quartzite is increasing over the years to cater to the requirement of ferro-silicon, silico-manganese, silico-chrome, silica refractories, glass and for moulding and casting purposes. The requirements of these products are linked up directly with iron and steel industry including alloy steel production. Further, setting up foundries and enhancing their capacities are also linked with metallurgical industry. The total resources of quartz and other silica minerals are 3084 million tonnes. There are very good prospects of increasing the exports of quartz and silica minerals to the neighbouring countries.

8.4.4 **Fireclay:** Fireclay is one of the most important minerals used in the refractory industry. Almost the entire production in the country is consumed in the manufacture of refractories and about 80% of these refractories are used by the iron and steel industry. India has huge reserves of this mineral and there does not seem to be any problem of supply to the refractory industry in the future. However, a serious dearth is being felt in the refractory industry with respect to availability of high grade clay analysing 37% and above Al_2O_3 and having Fe_2O_3 and fluxing impurities less than 2%.

8.4.5 The total consumption of fireclay in organised sector increased to 499,000 tonnes in 2003-04 from 435,800 tonnes in 2002-03. Cement industry has emerged as a major consumer of fireclay accounting for 54% consumption followed by refractory and ceramic industries. The apparent domestic demand of fireclay is estimated at 781,000 tonnes by 2006-07 and at 1.2 million tonnes by 2011-12. The exports of fireclay increased to 1,513 tonnes in 2003-04 from 795 tonnes in the previous year. The exports were mainly to UAE, Kenya, Nepal, Bangladesh, USA, Saudi Arabia, etc. The exports of fire bricks also showed an increasing trend. Use of fireclay in fireclay bricks as an export commodity should be encouraged.

8.4.6 **Kaolin(China Clay) and Ball Clay:** The world resources of all clays are extremely large.China clay resources in the country as per UNFC system as on 1.4.2000 have been placed at 2302 million tonnes, of which the reserves are only about 8% of the total resources at 181 million tonnes.The production of china clay and ball clay is estimated at 1.61 million tonnes by 2006-07 and at 2.5 million tonnes by 2011-12. The consumption of china clay in organised sector increased to 343,300 tonnes in 2003-04 and cement was the major raw china clay consuming industry accounting for 51% followed by ceramic (24%) and pesticides (7%), paint (7%), refractory (5%) and paper (4%).

8.4.7 The consumption of ball clay in the organised sector increased to 315,900 tonnes in 2003-04 from 285,300 tonnes in 2002-03. About 97% consumption was accounted for by ceramic industry and the remaining by the refractory and abrasives industries. In 2003-04, exports increased to 6279 tonnes from 662 tonnes in 2002-03, mainly due to increase in exports to Bangladesh whereas the imports of ball clay decreased from 39,511 tonnes in 2002-03 to 17,742 tonnes in 2003-04. The apparent demand of china clay and ball clay is estimated at 2045 thousand tonnes by 2006-07 and at 3147 thousand tonnes by 2011-12.

8.4.8 The resources of kaolin in India are abundant. With large resource base and limited domestic demand, there are prospects to increase exports of kaolin. The world markets are favourable for processed chinaclay in various industries like paper, plastic paints, rubbers, ceramics, etc. The paper industry continues to be the major market for processed chinaclay in the world. For this purpose the international market demand high quality standard market especially that of paper coating grades. Efforts are to be made in future to capture the potential markets like Egypt, Zimbabwe, Iran and neighbouring countries. New practices for processing have to be established and existing capacities are to be augmented in the country to meet the increased requirement of processed china clay in the future. Efforts are to be made in future to capture the potential markets like Egypt, Zimbabwe, Iran, Malaysia, Jordan and Pakistan, besides increasing the exports to the traditional neighbouring markets like Bangladesh, Sri Lanka and Nepal and other markets like Kenya, UAE, Saudi Arabia and Bahrain.

8.4.9 **Magnesite**: The consumption of magnesite in the organised sector increased to 226,000 tonnes in 2003-04 because of higher consumption reported by refractory industry. The apparent domestic demand of magnesite is estimated at 485,000 tonnes by 2006-07 and at 745,000 tonnes by 2011-12 The exports of magnesite increased to 7,441 tonnes in 2003-04 from 5,219 tonnes in the previous year. Out of the total imports, magnesite(calcined) were 2,794 tonnes only. The imports were mainly from People's Republic of China, Israel and Japan. India has large resources of magnesite. However, because of cheap imports the domestic resources are not being exploited optimally. There is a need to reduce imports of magnesite and encourage more use of domestic resources The imports also increased to 90,544 tonnes in 2003-04 from 71,665 tonnes in the prev ious year.

8.4.10 **Graphite**: Consumption of various grades of graphite in the organised sector ranged from 10,600 tonnes to 9,800 tonnes per annum during the last three years of 10th Plan. Out of total consumption, the refractory and crucible industries accounted for 35% each and foundry industry 10%. The consumption in refractory industry has decreased by 25%. The apparent domestic demand of graphite r.o.m. is estimated as 113,000 tonnes by 2006-07 and at 174,000 tonnes by 2011-12. The graphite reserves having +40% fixed carbon are rather limited in the country. Detailed exploration of graphite deposits in Orissa, Jharkhand, Jammu & Kashmir and Kerala should be carried out. Cost-effective beneficiation technologies for low-grade graphite ore need to be developed. Age-old application of graphite in clay-bonded graphite crucibles has to be substituted by silicon carbide-graphite crucibles to improve upon the use of inferior grade material with less quantity and at the same time ensuring longer life of crucible.

8.4.11 **Pyrophyllite**: The consumption of pyrophyllite in the organised sector was 2,500 tonnes and ceramic was the main consuming industry (76%) followed by refractory (24%). The apparent domestic demand of pyrophyllite is estimated at 210,000 tonnes by 2006-07 and at 323,000 tonnes by 2011-12. The use of pyrophyllite in ceramic industry seems to be static whereas that in the refractory applications is facing the problems like the most other refractory minerals due to change in technology and reduction of refractory consumption per tonne of metal.

8.4.12 **Kyanite:** The estimated world production in 2004 was 126,400 tonnes. The USA, China, India, Zimbabwe were the leading producers of kyanite. India's production of kyanite was 7,710 tonnes in 2004-05 and ranked third. I). The consumption of Kyanite in organised sector is estimated at 11,900 tonnes remains static. The apparent domestic demand is estimated as 11,000 tonnes by 2006-07 and 170,000 tonnes by 2011-12.

8.4.13 **Sillimanite:** The total resources of sillimanite as per UNFC system in the country as on 1.4.2000 are placed at 63 million tonnes. The consumption of sillimanite in organised sector is around 6,000 tonnes, mainly consumed by the refractory industry. The apparent domestic demand of sillimanite is estimated at 22,000 tonnes by 2006-07 and at 35,000 tonnes by 2011-12.

8.4.14 **Vermiculite**: The reported consumption of vermiculite in the organised sector was 300 tonnes. The refractory and asbestos product industries were the main consumers of vermiculite. The apparent domestic demand for vermiculite is estimated at 5,000 tonnes by 2006-07 and at 7,000 tonnes by 2011-12. Exports of vermiculite in 2003-04 decreased to 566 tonnes from 665 tonnes in the previous year whereas the imports increased to 138 tonnes from 7 tonnes. India's resources of vermiculite are limited and need to be conserved.

8.5 Export Potential Minerals

8.5.1 **Barytes :** India ranks second in the production of barytes in the world after China and is one of the important exporters in the world market. India has surplus resources of barytes and it can meet comfortably not only the needs of the domestic industry but also of the export market. Therefore, concerted efforts are necessary to boost up the export of barytes and its micronized products from the country. The world-wide demand for barytes may probably continue to grow till petroleum products endure to be the energy source of choice. Demand for oil and gas remained strong and the oil price remained high, encouraging exploration and development of wells that boost barytes consumption.

8.5.2 The world barytes market mainly depends on oil/gas drilling activity which is influenced by the price of oil, the state of world economy and political factors. Approximately 85% of the world's baryte is used in the petroleum industry as one of the key ingredients in drilling mud for oil and gas wells. Despite the growing use of non-hydrocarbon energy sources, the demand for petroleum is expected to continue to be high and as a result the demand for barytes will continue. Although China produces more barytes than India, but all over the world, market has a preference for Indian barytes because of its high quality. The unit realisation from powder barytes is nearly twice that of lumpy barytes. Therefore, exports of powdery barytes be encouraged for better unit realisation. For this purpose, more processing plants are required to be set up near the mining areas.

8.5.3 **Bentonite**: Total reserves and resources of bentonite in the country are about 527 million tonnes. Gujarat continued to be the leading producing State and accounted for 88% followed by Rajasthan. The total consumption of bentonite in 2003-04 decreased marginally to 146,300 tonnes from that in the previous year because of less demand in pulverizing and oil well drilling. The consumption in other industries remained almost static.

8.5.4 Bentonite is one of the exportable commodities in India. Bentonite is exported both in unprocessed (crude) and processed (including activated) forms. Exports of crude bentonite account for the bulk quantity. But exports of processed bentonite fetch higher value than the crude bentonite. There is a pressing need to develop various processing techniques to suit our available resources for making the product to suit the international standards. There is scope to establish bentonite processing granulation and paint grade grade processed bentonite units in the country to meet the indigenous demand as well as in the international market.

8.5.5 **Fuller's earth** : The consumption of Fuller's earth in the organised sector was at 10,100 tonnes in 2003-04. Fertilizer industry, the largest consumer, accounted for about 72% consumption. A sizeable quantity is also consumed in rural/urban areas for non-industrial uses like plastering mud walls, washing of hair, etc. Exports of Fuller's earth increased to 66,078 tonnes in 2003-04 from 52,079 tonnes in the previous year. Malaysia was the main buyer followed by Indonesia. Imports were 1,227 tonnes in 2003-04 mainly from Indonesia. India is one of the important exporter of fuller's earth in the world and needs to maintain its leading position.

8.5.6 **Mica:** Over hundred years, India has enjoyed the monopoly in the production and export of sheet mica in the world. But recently, production of mica has showed a continuous declining trend due to slow down in the demand of natural mica in the world market because of technological developments in use of mica and emergence of mica substitutes. However, there are sufficient resources in the country to meet the domestic requirement and export demand.

8.5.7 Some of the mica deposits in the country contain lithium mica and substantial concentration of rubidium and cesium. Process know-how needs to be developed for recovery of these values. There appears to be good demand for wet ground mica especially in the manufacture of pearlescent pigments which are increasingly used in the automotive industry. Therefore, establishment of wet ground mica plants based on imported know-how in the country needs to be encouraged.

8.5.8 **Talc, Soapstone and Steatite** : Talc/Soapstone is mainly used in pulverised form as a filler in various industries. The non-pulverised is used in refractory, sculpturing etc. The total consumption in the organidsed sector is around 270,000 tonnes per annum, of which 68% was in paper industry followed by pesticide (16%), paints (8%) and cosmetics (4%). The apparent domestic demand for talc-steatite is estimated at 831,000 tonnes by 2006-07 and 1.28 million tonnes by 2011-12 . The exports of steatite (total) is around 29,300 tonnes whereas imports were 485 tonnes in 2003-04.

8.5.9 The world market conditions for talc minerals are steadily growing. Therefore, concerted efforts are necessary to increase exports by adopting modern pulverising techniques for Indian talc. In view of India's large resource base, and well developed production facilities, there is considerable scope for boosting the exports of talc-steatite.

9 - HEAVY SAND MINERALS

(Ilmenite, Rutile, Leucoxene, Zircon etc.)

9.1 The term heavy minerals refer to minerals with a specific gravity greater than that of quartz, S.G. > 2.65 and include Ilmenite, Rutile and Leucoxene, Zircon, Monazite, Garnet and Sillimanite. India has over 7000 km coastal line and has huge reserves of minerals in the beach sand. Beach Sand consisting of heavy minerals is not fully exploited due to various historical reasons as well as dominant natural monopoly of government on atomic energy minerals. Presence of Indian Rare Earth and Uranium Corporation is obvious market signal that government is committed to exploit the concerned minerals reserves for atomic energy. However, DEA has shown its willingness to remove Ilmenite, Rutile, Leucoxene and Zircon from the list of Prescribed Substances notified by DAE.

9.2.1 India has large reserves of beach sand heavy minerals in the coastal stretches around the country specifically in South West coast of Kerala and Maharashtra. Beach Sand contains the important heavy minerals such as Titanium bearing minerals including Ilmenite, Rutile and Leucoxene, as well as Zircon, Monazite, Garnet and Sillimanite. Ilmenite is the largest constituent of the Indian beach sand deposits. The minerals other than garnet and sillimanite have been classified as "prescribed substance" under the Atomic Energy Act, 1962. India has about 7000 kms of coastline. Of this AMD could undertake exploration of about 2546 kms. AMD has also completed detailed survey of 1000 kms. However, actual mineral exploration taking place only in about 100 kms. Ilmenite is the major constituent of these heavy mineral deposits i.e. 30 to 35% Till now country is estimated to have 461.37 MT of Ilmenite.

9.2.2 Geological Survey of India (GSI) has conducted systematic surveys for seabed mapping and exploration of minerals in the territorial waters, continental shelf and within the Exclusive Economic Zone (EEZ) of India. It is reported that heavy mineral sands comprising ilmenite, rutile, zircon, sillimanite, monazite and garnet have been located off the coasts of Orissa, Andhra Pradesh, Maharashtra and Kerala. That means the probable reserves of heavy mineral sand may be higher than present estimates.

9.3 Ilmenite

9.3.1 Since its discovery, the mineral ilmenite has grown greatly in its importance. It is now the most important ore of titanium. Titanium was at one time a metal that had little use and basically no one knew what to do with it. Even as late as 1946 when the metal was finally shown to be capable of being produced commercially. Additionally, titanium dioxide **TiO_2,** is a white pigment that is used more and more in paints as lead paint is discontinued due to health considerations. In fact, the largest percentage (up to 95%) of world wide use for titanium is for the production of this white pigment.

9.4 Rutile and Titanium Oxide

9.4.1 Rutile is titanium dioxide which is naturally occurring in Australia, USA, India and South Africa. Synthetic rutile can be produced from naturally occurring ilmenite which is a complex oxide with iron. Rutile is used in the manufacture of titanium dioxide pigment. Rutile (TiO2, Titanium Oxide)**,** is an interesting, varied and important mineral. Rutile is a major ore of titanium, a metal used for high tech alloys because of its light weight, high strength and resistance to corrosion. Rutile is also unwittingly of major importance to the gemstone markets. It also forms its own interesting and beautiful mineral specimens.

9.5 Zircon

9.5.1 ZIRCON has formula: ZrSiO4, Zirconium Silicate and is associated with minerals like **albite, biotite, garnets, xenotime** and **monazite**. Zircon is used in ceramic and refractory industries besides acting as such as basic raw material for the production of Zr metal and alloys for its use as structural materials in nuclear power reactors. The mineral ‘monazite’ is radio active as it contains thorium and uranium and requires special measures for production and storage for exclusive use by the Dept. of Atomic Energy (DAE).

9.6 Monazite

9.6.1 Monazite is the only radioactive substance in the beach sands. However, percentage of Monazite in beach minerals varies between 0.1% to 2% with isolated patches up to 10%. Monozite is also a primary source of Thorium which might be used as nuclear fuel material in India's 3rd stage of Nuclear Power Generation Programme. Background radiation level in the areas where monazite is present are high, such as in the beach sand of Kerala. Radiological hazards increases after the separation process.

9.6.2 Monazite is a primary ore of several rare earth metals most notably thorium, cerium and lanthanum. All these metals have various industrial uses and are considered quite valuable. Thorium is a highly radioactive metal and could be used as a replacement for uranium in nuclear power generation. Monazite therefore is an extremely important ore mineral.

9.7 Garnet

9.7.1. Garnet is used as Abrasives and in Water filtration, Water jet cutting, Blasting media, Anti-skid agent for road surface for road & air-strips, in preparation of Artificial Granite tiles (Garnet tiles) and Decorative wall plaster.

Total world consumption of industrial garnet was estimated to be 450,000t in 1999, representing an increase of almost 44% since 1994/95, when total consumption was reported as being 170,000t. Demand for industrial garnet is expected to grow worldwide at the rate of 3-5% per year over the next five years. Abrasive blast cleaning and waterjet cutting are expected to be the markets that show the most growth.

9.7.2 Estimates of world industrial garnet production range from 110,000 to 155,000 tons. United States is a leading producer but in recent years have been Australia, China, and India to have started production of garnet. It is estimated that Australia produces at least 35,000 to 40,000 tones of industrial garnet.

9.8 Exploitation of Minerals Beach Sand

9.8.1 Indian Rare Earths Limited (IREL), a Govt. of India Undertaking under the administrative control of DAE, Govt. of India is operating three mines and mineral separation plants in the State of Orissa, Kerala & Tamil Nadu for the past five decades. Similarly, the only other agency authorized by DAE is Kerala Mines & Metals Ltd. (KMML), a State Govt. Undertaking for mining & mineral separation during the past several decades in Kerala State. Brief account of Tamil Nadu, Kerala and IREL is given below:

9.8.2 IREL has four Production Plants viz. Minerals Division at Chavara, Manavalakurichi, OSCOM and Rare Earths Division at Aluva. Major Activities of IRE Ltd are mining and separation of Heavy Minerals like, Ilmenite, Rutile, Zircon, Sillimanite, Garnet and Monazite from beach sand. It is also engaged in chemical processing of Monazite to yield Thorium compounds, Rare Earth Chlorides and Tri-Sodium Phosphate. These products find use in manufacture of white pigments, welding electrodes, foundries, ceramics, refractories, abrasives for polishing glass/ TV tubes and in sand blasting etc.

9.9 Policy Issues

9.91 With policy of selective liberalisation in the area of exploitation of beach sand minerals some companies have show interest and the proposals from the Private Sector were received including foreign Companies for setting up units such as Chem Plast India, Q.I.T., Westralian Sands, R.G.C., and WSIL Minerals India Ltd. The facts are that (a) Large reserves in the country – low production to reserve ratio, (b) Need to get latest technology for value addition of minerals within the country, (c) Need to attract resources - both domestic and foreign investment, and (d) No approved/notified policy or arrangements existing. DEA has made categorisation of activities for approval of private investment as follows: (i) Mining and mineral separation, (ii) Value addition per se to the products of (i) and (iii) Integrated activities [comprising both (i) and (ii)]. Participation of wholly Indian owned companies permitted in all the three categories of activities, with or without joint venture with Central or State Govt. concerned or any existing/new Central/State PSUs. Foreign Direct Investment (FDI) particularly with more advanced/latest technology vis-à-vis those prevailing within the country – both in pure value addition projects & integrated projects.

RECOMMENDATIONS

1 – COPPER

(copper, cobalt, molybdenum, selenium and tellurium)

1.0 Introduction of Robotic mining: It is proposed that automation combined with remote operation should be adopted not only in the new mines but also in existing mines. It not only increases workplace safety and efficiency, but it also reduces production costs.

1.1 High Volume and Multi-metal Extraction: It is proposed that exploration and development activities should be based on polymetalic occurrences. Whereas these investments are perhaps smaller in terms of contained Copper, they are nonetheless important in the context of overall World Copper supply.

1.2 Adoption of SX-EW Technology: Copper deposits in India are distributed in a scattered manner in widely separated areas & represented by unique blend of small scale and large-scale deposits. Considering the nature of deposits, we should go for SX-EW Technology. Initially, this process was meant to recover Copper from low-grade oxide ore which was not amenable to concentration by Conventional Forth floatation. But, now it has been conclusively established that even Sulphde ore can be successfully treated by accelerating leaching process through bacterial action at normal/elevated temperatures. The cost of production by SX-EW process works out to as low as 60% of that through Conventional Pyro-metallurgical route. This process also obviates environmental problems associated with Sulphur capture and dust emissions which is common in Smelters.

1.3 Strategic approach of PSUs: It is proposed that in addition to GSI and MECL, PSU like Hindustan Copper Limited who are primarily a copper mining organization, should also undertake exploration either independently or as a joint venture with overseas organizations.

1.4 R & D activities in mining: At present the R&D setup in the industry is largely working as an internal department with emphasis on problem solving and applied research. In order to updating of technology and developments of new technologies, strengthening of R&D department/organization with adequate budgetary support is necessary.

1.5 Re-opening of closed mines: In the present high copper prices scenario HCL may explore the possibilities of reopening of closed mines in joint Venture with overseas organisation

1.6 In addition to the detailed exploration in potential areas by HCL, the development of Banwas Copper mine, Malanjhkhand underground mine and Chapri Sidheswar mine are envisaged during 11th plan period. Full production from Banwas mine containing 19 million tonnes reserves can be achieved through the existing facilities of Khetri mine. The Malanjhkhand underground copper mine is critical for development of 30% of country's copper reserves as well as for long term sustenance of HCL. The development of Chapri Sidheswar mine in Singhbhum copper belt would be desirable while considering the potentiality of 80 million tonnes reserves.

2 - ZINC AND LEAD

(lead and zinc, cadmium, silver, nickel, antimony, arsenic, bismuth, mercury, indium, tungsten and tin)

2.0 The strong economic growth is set to continue in India during the 11th Plan and beyond with key growth drivers and major investment driven policies of Govt. of India. This would result in robust demand for metals/ emerging markets, particularly, in view of India's advantage as a natural resources destination. The zinc-lead industry will be no exception to this.

2.1 For significant growth of Indian zinc-lead industry, it would be necessary to carve out a way forward not only in attaining self sufficiency but also in establishing share in the global metals and mining map. In this regard, some of the key points requiring specific attention are recommended as under:

- Enabling & conducive environment to accelerate mineral exploration.
- Mining regulation framework revision to foster growth.
- Market Development and development of newer applications
- Infrastructure development
- Focus on Safe & eco-friendly Recycling
- Creating capacities with focus on global cost competitiveness and value addition
- Focused R&D efforts for recovery of minor/trace metals and development of cost effective newer applications
- Growth strategy for identification and development of resources of other metals like nickel, tin, tungsten etc.

2.3 It is recommended that to harness country's potential in metals industry, Central/ State Governments' support is solicited for the following:

1 Single window clearance for grant of permission from RP/PL/ML to mine operation/ closure. Process simplification on time bound grant of environment clearances through single empowered panel and single nodal agency for monitoring the compliance of environmental parameters/ issues as against a number of State & Central Departments. Clearances should be deemed to be granted after the expiry of the allotted time.
2 While opportunities exist, the metals industry is not able to grow to its full potential on account of inadequate exploration of the mineral resources and lack of enabling environment and specific infrastructure like power, water, roads etc.
3 To generate focus on mineral exploration, being fundamental for future development of metals industry. There is a need to evolve a framework of commitment to active exploration by mining companies.
4 To improve the Minerals Code – geo-scientific data availability, rationalization of tenements system/grant of larger areas under RP/PL/ML, licence security,

preferential rights to reserve areas.

5 Relaxation of environmental site clearance for PL – not involving any damage to flora and fauna.
6 To operationalize and simplify the application of provisions regarding compensation, land etc, for fast track large projects to deal with mining lease related issues in reserve forests/ bio forests.
7 To attract large investments in metals sector by introducing tax concessions on “Exploration” in line with R&D activities, allowing duty free imports of capital goods for setting up projects, incentivising “Mega projects”.
8 To rationalize royalty rates in line with international competitor countries.
9 Part of the royalty to be allocated towards infrastructure/ community development and also for funding fresh exploration.
10 Moratorium/ suitable structure for royalty deferment to support investment in mineral/ metal sector.

2.4 Some of these points have also been considered by the Hoda Committee and the same needs to be notified expeditiously.

3 - ALUMINIUM

(aluminium, gallium, vanadium, magnesium, titanium and silicon)

3.1 Except for Nalco all the remaining companies are not having adequate bauxite reserves in their mining leases to meet the requirement of existing capacity of their alumina refineries. These companies are forced to purchase bauxite from domestic market from small mine owners of the locality. Bauxite in small quantities are purchased from the mines of Jharkhand and Chattisgarh by Hindalco, Balco and Indal’s Muri plant, while Indal’s Belgaum plant purchases bauxite from mines of Maharashtra. Such purchases of bauxite from small mines have resulted in several constraints in operations particularly with respect to quality control, logistics and cost. No new mines of proposed export oriented units in Orissa and Andhra Pradesh have come up so far. Only few small mines have been developed in Chattisgarh for Balco and Hindalco. Grant of mining lease, environmental clearance, land acquisition, forest clearance, etc. have been the major constraints for development of new mines.

3.2 India exported about 0.9 million tonnes in 2003-2004 from 1.79 million tonnes in 2002-2003 of low grade bauxite to Middle East from Gujarat and imported about 37000 tonnes (2003-04) refractory grade bauxite from China. With the abundance of metallurgical grade resources, there is a scope for increasing bauxite mining of this grade. The refractory and chemical grade bauxite can be preserved for future use.

3.3 In case of India, with 7% of world resources, it produces only 4.3% of world alumina and its share in world trade is 3.5%. There is adequate scope for increasing production of alumina and its export. For over 12 years, Nalco has been exporting alumina and has earned reputation in international market for its quality.

3.4 Growth is expected to be higher in consumption of downstream products and semis, particularly for sheets, extrusions and castings. To meet this growth, primary producers and potential downstream producers together with new players are to consolidate, strengthen and expand their manufacturing process. R&D efforts for cost reduction, and better quality are to be put to remain competitive in both domestic as well as international market. With WTO regulations and likely competitive from Korea and China, the sector have to grow and develop.

3.5 The recycling process not only by-passes the use of valuable bauxite and consumption of costly inputs, it also required 90% less energy than primary smelting. Most of the recycling units today need to be increased to 30% of total metal consumption to meet the growing demand. This area is to be addressed for increasing production at low cost, energy saving, and ensuring availability for domestic consumption.

3.6 The shortfall in domestic production and availability of primary metal needs attention to initiate steps immediately.

- Green field smelters of about 400,000 tpy capacity to be planned now for the future.
- Secondary recycling should be promoted to contribute 30% of domestic metal requirements.
- Import of scrap to be increased with low duty which in turn can be exported as value added item. This will increase both import and export simultaneously giving benefit in international trade.
- Where power is cheap abroad,smelters can be established to produce metal at low cost.
- Tolling of low alumina and getting back metal after smelting abroad where power is cheaper, can also be planned.

3.7 For increasing the consumption and to develop aluminium sector in the country, the steps required are:

I. To make primary metal available for domestic consumption at a competitive cost for secondary producers, excise –duty for domestic aluminium and custom duty for imported aluminium could be reduced to make both at par and matching international price so that the option can be used when metal is not available for some reason.

II. Capacity development would be required for foils, extrusions and rolled products besides reorganizing castings.

III. To promote consumption in the country, the duty can be further reduced for extrusions used in building and structural areas to reduce consumption of wood from environmental considerations. Similarly,the tubes used for irrigation should get preference.

IV. Attention has to be given also for development of semi-fab production by improving quality and reducing cost.

3.8 Out of over 1.8 billion tonnes of metallurgical grade bauxite resources in the country, only 400 million tonnes confine to the operating leases. In view of this, the following would deserve consideration.

a) Small deposits with less than 50 million tonnes can be earmarked for brown field expansions of existing refineries.

b) Large deposits to be planned for future green field projects for which capacity of mine would be minimum 3.0 million tones per annum.

c) The problem now faced by Hindalco, Balco and Indal in getting lease and operating new captive mines in Chattisgarh, Jharkhand , Karnataka and Maharashtra need to be immediately resolved so that the brown field expansions of existing refineries during the 10th Plan do not delayed.

d) The Gandhamardan Bauxite deposit of Orissa having reserves of more than 200 million tonnes still remains virgin after Balco withdrew. It can be planned for development.

e) In Gujart and Chattisgharh, where chemical and refractory grade bauxite are mined, inferior grade which can be used as metallurgical grade is considered as waste and is not utilized properly. Gujarat also has sufficient resources of Metallurgical grade for future use, if required.

3.9 The constraints of red mud disposal would be the problem of future alumina plants. Utilization of this waste has to be taken care through R&D efforts. Caustic soda, from domestic sources may pose problems. Efforts should be made for setting up plants outside India where power is cheap, for importing back the product to India. Long term contracts with caustic soda plants abroad also need to be explored.

4 - CEMENT AND LIMESTONE

4.0 The mining of about 225 million tonnes of limestone for cement industry is next only to coal (3.80 mn.t). In view of the rapid growth of cement industry with an average CAGR of more than 8% and substantial increase in the capacity of single location plant from 0.4 MTPA to 2.25 MTPA, the availability of cement grade limestone to meet the requirement of projected cement capacity beyond XI Plan period has to be ensured through the appropriate measures. These are:

1 As only 23% of total limestone reserves are in proved category, there is, urgent need to convert 77% of probable and possible reserves into proved category by intensifying exploration activity through central and state level exploration agencies.

2 There has not been substantial increase in total reserves of limestone during X plan period. The need to identify potential limestone deposits for green-field projects, preferably away from the existing clusters are therefore paramount.

3 The availability of potential limestone deposits of hill states and northeastern states is restricted due to Forest Conservation Act. Efforts have to be made to release the deposits for exploitation on selective basis.

4 The exploitation of offshore / onshore deposits has been restricted by declaring coastal stretches as coastal regulation zone (CRZ). Review of the provisions of the CRZ is essential to enable eco-friendly use of enormous reserves of cement grade limestone blocked along Gujarat coast and to save operating plants from gradual demise.

5 Efforts have to be intensified to utilize 27% of marginal grade limestone. This will improve the life of mine and mine environment by drastically reducing the waste dumps presently lying in the existing quarries and occupying precious land.

6 In order to ensure rational utilization of reserves of various grades available in the mining lease area and to assess the shortfall, if any, for expansion of existing cement plants, periodic re-assessment of captive limestone reserves has to be made mandatory.

7 The Royalty rates of limestone need be rationalized following one standard norm. The royalty rates have increased from Rs. 4.5 in 1982 through Rs. 10 in 1987 to Rs. 45 in 2004. The rise in royalty rate is abnormally high in comparison to other minerals like iron ore mined in large volumes.

5 - DIAMOND AND PRECIOUS STONES

5.0 It is evident that presently diamond and precious stones cutting & polishing and jewellery industry of India relies mostly on import of rough diamonds, which after value addition (in the form of cutting and polishing and jewellery manufacture) are mostly exported. It is therefore essential to continuously review the diamond import and export policy so as to continuously make available the roughs to the industry and to facilitate the export of finished products.

5.1 All out efforts should be made to increase production of rough diamonds from India to partly meet the requirement of Indian diamond industry. At present the only mechanized mine producing diamonds in India is Majhgawan diamond mine of NMDC. Exploration activity in different states is required to be boosted. This will help in discovering new economically viable kimberlites / lamproites for conversion in to mines and leading increase of indigenous production.

5.2 Based on the available data, in most of the Reconnaissance Permits (RP's) for diamonds granted to various multinational and Indian mining companies, the preliminary exploration works have been completed. Based on the preliminary exploration the concerned companies have applied for Prospecting Licences (PL's) for detailed exploration. In most of the cases the total area applied for PL's in any state is more than 25 Sq. Km.

5.3 Though Hoda Committee has recommended to increase this limit for area for PL's from 25 Sq.Km to 100 Sq.Km, yet it may take time for approval and implementation of the report. It is therefore recommended that Central Govt. may consider the granting relaxation under section 6(1)b of MMDR act 1957 so that detailed exploration work will start in the areas applied for PL by various companies.

6 - GOLD AND PRECIOUS METALS

(Platinum group of metals and silver)

6.0 From overall evaluation it is seen India has a traditional and stable market for gold consumption. The demand for ornamental sector is increasing owing to the increase in purchasing power of emerging middle class. There is demand for growing electronic sector also. A huge gap exists between demand and indigenous production which is likely to continue. To bridge the gap thrust for gold exploration will continue in the country along with import.

6.1 The geological occurrences of gold have been reported from various parts of the country. Many of them have been explored and a number of deposits established. The deposits are generally of low grade and low tonnage which are not being exploited.

6.2 The mining sector calls for improved method of narrow vein mining for their economic exploitation. Introduction of small scale mining culture in gold industry is a need of the day. Adoption of modern gold extraction technology is an immediate need to treat low grade and complex ore type. For augmenting gold reserves in the country further detailed explorations have to be taken up for the deposits where preliminary assessment upto a shallow depth has been completed.

6.3 Wider application of latest techniques of remote sensing, regional geochemical methods and multi-sensor aerial surveys are necessary for fast scanning as well as delineation of favourable targets for detailed exploration. Although substantial progress has been made in the country in such studies, still a gap in technology appears to exist in determining exploration targets from the regional data base by these methods.

6.4 MNCs have to be inducted for this purpose with application of state-of-the art technology. The mining sector, which has been thrown open for private entrepreneurs and MNCs, has to provide with fast disposal and support from the Government so as to attract more and more investments.

6.5 During the eleventh plan period, in addition to the development of existing mines, the HGML will continue exploratory mine development and exploration by underground drilling in the Hutti South block over a strike length of 750m upto the southern limit of existing mining lease. A total of 9870m of mine develoment has been proposed in the Hutti mine including south block. Exploratory mine development will continue in Uti and Hira Buddini deposits. For furhter prospecting, HGML has applied for PL in Dharwar South Block, Chikanayakanahalli and Bellara blocks in Karnataka. In the XIth plan period HGML has projected maximum production at 3245 kg of gold during 2009-10.

6.6 Cluster mining of small gold deposits may also deserve consideration and should be encouraged. A case is that of Kunderkocha deposit in Potka block of East Singhbhoom District, Jharkhand which is being developed by M/s. Manmohan Mineral Industries Pvt. Ltd. (MMIPL) for a production target of 200 Kg. Gold per annum.

6.7 Replacement of gold extraction plant at Hutti Gold Mines Ltd. (HGML) by a new plant inclusive of Falcon Gravity Separator at a cost of around Rs. 70 crores need tobe done at the earliest in 11th plan.

6.8 To augment gold production in the country during XIth plan period Chigargunta and Bisanattam mines in KGF which were abandoned, deserve active consideration for reopening. A relook is required for the tailing dump lying in KGF area.

6.9 Potential Prospects for Exploitation

- **In KGF** - Chigargunta gold deposit, Tailing dump, Old Bisanattan mine
- **In Hutti belt** - Southern and northern extension within mining block, Wandalli block, Buddini block
- **In Jonnagiri Schist belt** - Dona East block
- **Ramagiri Schist belt** - Ompratima - Gantalappa Sector
- **Gadag Schist belt** - Hosur - Champion, Mysore Mine and Sangli Mine blocks
- **Nuggihalli schist belt** - Kempinkote
- **Dharwar Shimoga schist belt** - Chinmulgand, Rajasthan, Jagpura

6.10 **Small Deposits For Cluster Mining**

Archaean Greenstone Belt

- Wandalli-Chinchergi-Tuppadhur-Buddini blocks (Hutti Belt)
- Dona East, Dona Temple, Dona North, Dona South blocks (Jonnagiri Belt)
- Hosur champion East and West, Mysore mine and Sangli mine blocks (Gadag Belt)
- Ajjanahalli, G R Halli, C K Halli, Gonur-Kotemaradi blocks (Chitradurga Belt)

Proterozoic Fold Belt

- Bhukia West, Bhukia East, Timranmata East, Bhukia East Central and Jagpura blocks

6.12 **Areas identified for further search for gold**

- Dharwar craton in the states of Karnataka, A.P. and Tamilnaud (40,000 sq km + 1000 sq km in adjoining granitoids)
- Wynad, Nolambur and Attapady valley gold fields of Southern Granulite Terrain in the states of Tamilnadu and Kerala (450 sq km)
- Mahakoshal belt of Uttar Pradesh and Madhya Pradesh (8950 sq km)
- Kottri volcanic belt, Sonakhan belt, Bailadila Group and its equivalent rocks of Chhattisgarh (1600 sq km)
- Sakoli fold belt of Maharashtra (5500 sq km)
- Gorumahisani-Badampahar belt and Bonai - keonjhar belt of Orissa and Jharkhand (940 sq km)
- Singhbhum fold belt of Jharkhand and Orissa (21500 sq km)
- Aravalli fold belt of Rajasthan (30800 sq km)

6.12 A total of more than 1, 10,740 sq. km. area is potential for gold mineralisation.

6.13 Geomysore Services and associated companies have filed 81 PL applications for gold and platinum covering a total area of 2,057 sq km in 11 States and also 9 ML applications for gold over an area of 26.78 sq km. and investment of Rs. 37 crores by the GMSI is envisaged during the next 2-3 years. Also a modern gold-ore processing plant first in Jonnagiri Gold Fields, Karnool district, AP is proposed to be established by the Geomysore Services followed by another plant in Chhattisgarh.

6.14 However, lengthy and avoidable procedures in grant of prospecting licences need to be ensured by the Central/State Governments.

7 - DIMENSIONAL AND DECORATIVE STONES

7.0 Most of trucks in India are allowed to carry only 12 tonnes of load, which is grossly inadequate to meet the requirement of the heavy weight cargo of the dimension stone industry. There is a need to have a re look at the provisions of the Motor Vehicles Act for a realistic assessment of carrying capacity of trucks.

7.1 It is recommended that railway stockyards at various places should be created with Inland Container Service System (ICD) in operation. The railway stockyards with potential of handling stones should be equipped with crane facilities of minimum 50 tonnes. From these points, open wagons shall move to important ports and other destinations where the stone processing units are located.

7.3 The important destinations where stockyards and separate sidings as required, are Ongole, Khammam, Karimnagar, Narasipatnam, Warrangal, Srikakulam, Chittoor in Andhra Pradesh, Dharmapuri, Salem, Madurai, Mettur, Nagarkoil in Tamilnadu, Charnarajanagar, Kanakapura, Tumkur, Ilkal, Bellary in Karnataka, Tirvanantharnpuram in Kerala, Lalitpur, Katni, Chattarpur in Madhya Pradesh, Titlagarh, Berharnpur in Orissa, Nagpur, Ballarshah in Maharashtra, Raipur, Jagdalpur in Chattisgarh, Kund in Haryana and Jalore, Kisangarh in Rajasthan.

7.4 Suitable handling facilities in port infrastructure should be provided at major ports like Chennai, Tuticorin, Cochin, Mangalore, Karwar, Kandla, Mumbai, JNPT near Mumbai, Vizag

7.5 There is a strong need for well-planned, concerted and dedicated efforts towards export promotion of Indian stones in the International market. The emphasis needs to be on popularisation of Indian stones in the traditional markets and exploration of new markets through:

7.6 The other important aspect for ensured growth of the industry is providing incentives and benefits to support the exporters to remain competitive in International market and enable them to claim rightful share in world demand. One of them is 80 HHC benefit which has been withdrawn. It is felt that withdrawal of this support has created difficulties for exporters in the face of mounting competition from China and other countries which has literally everything subsidised right from mining, transportation and even international shipping.

7.7 EOU Exporters should get IT relief under 10B of the Income Tax Act 1961 as the manufactured item of EOU. The production of marble blocks, slabs and tiles by way of mining, dressing, polishing and sizing should be treated within the definition of production or manufacturing under various sections of the Income Tax Act such as Section 10B, 80HHC & 80I.

7.8 There is also a question of mineral royalty, which are increasing at different rates in different States, as the State Governments are free to fix the same. With the framing of Granite Conservation and Development Rules 1999, for granite, the periodicity of quarry leases have been made uniform, and with this progressive policy, tie-ups in different long-term projects will become reality for Indian exporters of granite. However for long-term tie-ups, there is an in built requirement of stability of various costs including the cost towards royalty. **There is a case for steady and stable uniform rates of royalty across the States, as in the case of major minerals**.

7.9 Granite and Marble quarries have requested for providing "industry" status to quarrying. Although stone quarries are recognised as industry for financial assistance under the relevant Statute, they have not been very successful in obtaining financial assistance, mainly because they could not offer any collateral by way of the quarry lease. It is felt that the State Governments could amend the state specific Minor Mineral Concession Rules to make hypothecation of Quarry Leases, so that the same could be offered as co-lateral for bank finances. **Stone quarries should be provided a status of small-scale industry and all the facilities extended to other SMEs should be extended to stone quarrying units.**

1 The potential mineral bearing areas falling in reserved forest areas with no forest resource should be identified, and opened up for commercial exploitation.

2 If any quarry lease area falls within the area of a genuine forest, the concerned quarry owners should be asked to plant trees in an area, at a place to be decided by the authority.

3 The barren areas where there is no forest growth, and yet have been classified as forest area, can be worked and after removal of the mineral (dimension stones) the same can be filled up with earth, and trees can be grown.

7.10 Test Certification would be **mandatory** for any exports to Europe in a couple of years. Suitable measures therefore should be taken for:

1 Encouraging testing of stones through awareness campaigns about the oncoming restrictions in Europe and elsewhere
2 Defining Selection Criteria of Stones for typical architectural applications
3 Standardisation and codification of sizes and physical attributes for typical architectural applications
4 Preparation of reference manuals on Installation, usage, maintenance and restoration of Stones
5 Knowledge dissemination on stones in architectural and engineering colleges.
6 Inclusion of prescribed standards and methods in Government Codes and Standards
7 In order to establish brand equity and quality of Indian stones in the global market - testing and export quality certification of Indian dimensional stones should be made mandatory for all exporters.

7.11 Government of India through Ministry of Mines may consider setting up a National Stone Technological Upgradation and Development Fund for sustainable development of Indian dimensional sector by imposing a cess of 2% of the royalty payable by quarry owners for marble, granite, sandstone, slate, flaggy limestone/ dimensional limestone and quartzite and to transfer this amount to **National Stone Technological Upgradation and Development Fund** for assistance.

7.12 In order to ensure sustainable development of Dimensional Stone Sector in India, following recommendations are made for strengthening the national support mechanism

- To declare existing Centre for Development of Stones (CDOS) at Jaipur as a National Centre of Excellence (N-CDOS) to support dimensional stones covering marble, sandstone, kotastone, slate etc. - with adequate financial support from Ministry of Mines and Ministry of Commerce, Government of India.
- Considering large resources of granite in South India (AP, Karnataka), Tamilnadu and Kerala) and major contribution of granites to Indian exports of dimensional stones, a National Centre of Excellence for Dimensional Stones, especially for granite be established in South India with the support of Ministry of Mines & Ministry of Commerce, Govt. of India, State Governments and UNIDO in association with AIGSA.
- To strengthen National Institute of Rock Mechanics and extending its services to granite quarrying areas in South India for R&D support.
- To constitute a separate Export Promotion Council for dimensional stones considering immense potential for boosting exports. Presently stones fall under purview of CAPEXIL.

- To assist and strengthen AIGSA in developing permanent infrastructure for international exhibitions at Bangalore.
- UNIDO under National Programme for development of Stone Industry (NPDSI) and ICMT along with Ministry of SSI and Department of Industrial Policy & Promotion. Government of India should continue their support and assistance to granite, marble and other stone segments through Centre for Development of Stones (CDOS) and AIGSA.
- CDOS should extend its activities to other stone producing states including North eastern states.

8 - INDUSTRIAL/NON-METALLIC MINERALS

8.1 Non-metallic/Industrial group of minerals are basically low value bulk materials having a large potential in the country. These constitute the raw materials for fertilizer industry, flux & construction and ceramic and refractory industries besides some of them being export potential minerals.

8.2 The reserves of chemical and fertilizer grades rock phosphate in India are very limited. Therefore detailed exploration is necessary for conversion of remaining resources into reserves. Also the search for new deposits of rock phosphate may have to be intensified in Andhra Pradesh, Rajasthan and Madhya Pradesh. Further, the Indian deposits are of low grades. Therefore, fertilizer and phosphoric acid plants that may be set up as replacement to the existing plants will have to be designed to accept indigenous ores as a feed. Beneficiation of domestic low-grade ores would need to be given a priority.

8.3 The resources of chrysotile variety of asbestos are very much limited in India. So there is an urgent need to go for detailed exploration, as the internal demand for asbestos in the country can not be met from indigenous production.

8.4 The resources of the refractory grade dolomite in the country are meager and is in short supply but very much required for making tar-bonded dolomite bricks for use in lining of LD steel furnaces. Intensive search is therefore needed in non-Himalayan regions for locating deposits of massive non-crystalline dolomite.

8.5 The grades of the fluorspar deposits other than Ambadungar in Gujarat do not meet the specifications of the chemical industry which is the bulk consumer of fluorspar. Hence to meet the requirements, domestic chemical industry will have to depend on imported fluorspar in the coming years.

8.6 India's domestic resources of gypsum are large to meet increased demand. However, steps would be necessary to find out suitable mining technology to exploit deep-seated gypsum resources in Rajasthan. Besides, the production of gypsum wallboard need to be encouraged.

8.7 There is an increasing demand for wollastonite in the international markets and therefore, there is scope for increasing the export of this mineral from India in value-added form as coated powders.

8.8 Though India has huge reserves of fireclay but a serious dearth is being felt in the refractory industry with respect to availability of high grade clay analysing 37% and above Al_2O_3 and having Fe_2O_3 and flux impurities less than 2%. In view of this, deposits of high grade fireclay may be explored and delineated.

8.9 The graphite reserves having +40% fixed carbon are rather limited in the country. Cost-effective beneficiation technologies for low grade graphite ore need to be developed alongwith new products by synthetic graphite.

8.10 India has surplus resources of barytes and it can meet comfortably not only the needs of the domestic industry but also the export market. Therefore, concerted efforts are necessary to boost up the export of barytes and its micronized products from the country, keeping in view the demand for exploration and development of oil wells that boost barytes consumption.

8.11 The Indian bentonite industry is expected to get on well in the coming years because of emerging demand for oil clarification and cat litter.

8.12 World demand for sheet mica is expected to decline. This is, however, compensated by the growing demand for scrap mica and value-added mica-based products. Therefore, the world market conditions are expected to be favourable for mica exports but to take full advantage of situation for boosting exports, it would be necessary for Indian mica industry to manufacture and export fabricated and value-added mica-based products, such as mica paper, micanite sheets and mica-based paper.

9 - HEAVY SAND MINERALS

(Ilmenite, Rutile, Leucoxene, Zircon etc.)

9.1 India's share in the world production of rare earth is estimated to be 2.6%. If

India’s rare earth industry has to improve its share, policy changes for creating enabling environment is obvious. Evolving and using “doing business indicators” in rare earth area could be useful for this purpose.

9.2 Policy on Exploitation of Beach Sand Minerals (Resolution of 6.10.1998) has to its objectives to encourage exploitation of the minerals through a judicious mix of public and private sector participation (including foreign investment); Maximisation of value addition within the country; Up-gradation of the existing process technologies to international standards; Attracting funds and new technology through participation of the Private Sector (domestic and foreign); Appropriate dispersal of the new production facilities with an eye on regional balance; and Regulating the rate of exploitation of reserves ensuring sustainability for hundred years – taking care of investors’ techno-economic considerations.

9.3 With the deletion of Ilmenite, Rutile and Leucoxene from the list of Prescribed Substances under the Atomic Energy Act, 1962, these minerals should be added in Part C of the First Schedule of the Mines & Minerals (Development & Regulation) Act, 1957 (MM(DR) Act) and they should be placed at par with other schedule minerals.

9.4 Monazite continues to be Atomic Mineral as well as ‘Prescribed Substance’ and Zircon also would continue as an Atomic Mineral. Both these being part of Indian beach mineral suits, doubts would arise as to the nodal agency (IBM and or AMD) for dealing with Mine Plans, MOM and or DAE for approval of Mining Leases etc. Multiple control by different regulatory agencies at the State and Central Govt. levels leads to confusion and delays. This has to be minimized. Unified Windows for clearances and permissions may have to be put in position.

9.5 With the removal of Ilmenite, Rutile and Leucoxene from the category of Atomic Minerals, applicability of Rule 66 A of Mineral Concession Rules (MCR) 1960 needs to be reviewed, i.e. it should not be applicable to these minerals. As a consequence, any requirements to obtain a licence from Atomic Energy Regulatory Board (AERB) to deal with Ilmenite tailings should be done away with and there should be only guidelines for handling / storage / disposal (including for landfill or other similar purposes).

9.6 Procedural requirement to obtain licence from DGFT for export of Ilmenite needs reconsideration.

9.7 Mandatory JVs with PSU participation, ceilings on equity holdings by foreign share holders may be revisited and liberalized. Clarity and consistency of policies are conducive of attracting Foreign Direct Investment (FDI), which are needed to modernize and induct the state of art technologies.

CHAPTER - I

COPPER

1.0 Present Status of Indian Mineral Industry vis-a-vis World Mineral Industry

While copper is found worldwide, 90% of reserves are located in four areas, the Great Basin of the western United States, Zambia, Central Canada, and the Andes of Peru and Chile. Antarctica too has copper ore deposits in many locations but a moratorium on mining was established in 1991 to last for 59 years to preserve the vast land.

1.1 Copper Resources in India

Copper is a strategic metal and in demand commands third number after iron and aluminum. India is not self sufficient in resources of the copper ore. The domestic demand of copper is mostly met through imports. Copper deposits are located mainly in Precambrian formations of the peninsula shield in India. Copper mineralization occurs in number of States but major and commercial deposits are located in Madhya Pradesh, Rajasthan, Jharkhand Karnataka, Orissa and Sikkim.

Hindustan Copper Limited (HCL), a public sector undertaking is the only vertically integrated manufacturer of primary copper.

There are other three copper manufacturers who are primary refined manufacturers. M/s Birla Copper and Sterlite Industries import copper concentrate for their smelters whereas Jhagaria Copper Limited (erstwhile SWIL) has smelter cum refinery based mainly upon copper scrap and about 15% concentrate.

Production of refined copper from Indian manufacturers in 2005 is given below:

S No.	Manufacturer	Installed capacity (t)	Production in 2005(p) (t)
1	Birla Copper	330,000	199892
2	Hindustan Copper Limited	47500	31711
3	Jhagadia Industries	50400	38000
4	Sterlite Industries	250000	245191
5	Total	677900	514794

Source: Reuters

1.1.1 **Reserves Status over past five years**

There has not been significant change in inventory of copper reserves over past five years in India as no major copper deposit was located during this period. According to IBM India has an estimated copper resources of 1394.43 million tones containing 11.42 million tones metal as on 1.4.2005 as per the exploration carried out so far. Of these, 28.03 million tones are above 1.85% Cu, 621.98 million tones between 1 to 1.85% Cu, 604.49 million tones between 0.5 to 1% Cu and remaining 139.92 million tones are less than 0.5% Cu.

There are 369.49 million tones of copper ore reserves containing about 4.38 million tonnes metal as per exploration carried out so far. Of these, 7.32 milluion tones are above 1.85% Cu, 346.65 million tones between 1 to 1.85% Cu, 3.43 million tones between 0.5 to 1% Cu and remaining 12.09 million tones are less than 0.5% Cu.

95% of the total reserves are in the states of Jharkhand, Rajasthan and Madhya Pradesh. Remaining 5% ore is located in other states like AP, Gujarat, Karnataka, Maharashtra, Meghalaya, Orissa, Sikkim, Uttaranchal, etc. Besides, there are 722 MT of conditional resources of copper ore in the country. Out of these about 92% conditional resources are located in Rajasthan, MP, Jharkhand and remaining 8% are in Haryana, Karnataka, Maharashtra, Orissa, etc. Table-I gives state-wise, category-wise and grade-wise in-situ reserves in the country.

Table I

State-wise, category wise and grade wise in-situ reserves in the country (as on 01.04.2000)

(Fig. In '000 tonnes)

Grade/State	Proved	Probable	Possible	Total
All India				
Ore (Total)	224601	222145	265145	711891
Metal	2981	3019	3448	9448
By Grates				
Ore with 1.85% and above Cu	2460	5835	19466	27761
Ore with 1.00% to below 1.85% Cu	221232	215432	245257	681921
Ore with >0.5% to < 1.0% Cu	909	878	1054	2841
By States				
Andhra Pradesh				
Ore	1398	6400	860	8658
Metal	21	108	7	136
Gujarat				
Ore	6194	1057	7131	14382
Metal	98	17	113	228
Jharkhand				
Ore	68120	73259	37445	178824
Metal	846	984	508	2338
Karnataka				
Ore	1272	4828	1048	7148
Metal	10	54	10	74
Madhya Pradesh				
Ore	106145	77070	111490	294705
Metal	1466	1084	1369	3919
Maharashtra				
Ore	--	1419	2342	3761
Metal	--	21	33	54
Meghalaya				
Ore	--	880	--	880

Metal	--	9	--	9
Orissa				
Ore	--	3234	1375	4609
Metal	--	40	18	58
Rajasthan				
Ore	37519	53778	103776	
195073				
Metal	4470	698	1383	2551
Sikkim				
Ore	783	106	150	1039
Metal	17	2	4	23
Uttaranchal				
Ore	3170	--	160	3330
Metal	53	--	3	56
West Bengal				
Ore	--	114	--	114
Metal	--	2	--	2

Reserves in HCL's leasehold areas:

HCL is holding lease in two states (Rajasthan and Madhya Pradesh) and has applied for renewal as well as new lease in third state (Jharkhand).

Total reserves in HCL leasehold areas is 315.51 tonnes of 1.32 % copper grade containing 4.16 million tonnes. Details of the reserves as on 01.04.2006 for each lease is given below:

Geological Reserves in million tonnes as on 1.4.2006

Rajasthan

Reserves	Khetri	**Kolihan**
Proved	7.50	11.62
Probable	8.48	2.08
Possible	43.02	7.98
Total	59.00x1.37	21.65x1.33
Lease area	395.07 Hect.	163.23 Hect.

Madhya Pradesh
Malanjkhand Mine

Reserves	**Reserves 412 to 376 ML ultimate pit depth**	**Up to (-) 8 m**
Proved	10.42	96.19
Probable	6.34	75.01
Possible	1.41	37.06
Total	18.17x 1.25% Cu	208.27 x 1.32% Cu
Lease Area	479.87 Hect.	

Reserves in the areas where HCL has applied for lease renewal/new lease

Jharkhand
Lease Renewal:
Surda Mine

HCL has submitted application for lease renewal for 388.68 hectare area. This contains total reserves of 26.09 Million tonnes of 1.20 % Cu.

New Lease
Rakha-Chapri Sideshwar Deposit

Lease for 581.365-hectare area containing 80.08 million tones ore of 1.24% grade at Rakha-Chapri Sideshwar Deposit has been submitted.

1.1.2 **Production from mines**

Hindustan Copper limited is sole producer of copper from mines. Production from mines in last five years is meager and has remained less than 30,000 ton per year as can be seen from the table below

S.No.	Year	Metal in concentrate (t)
1	2005-06	22984
2	2004-05	28926
3	2003-04	28306
4	2002-03	30824
5	2001-02	34282

1.1.3 **Exploration**

Not much exploration for copper has been done in recent past. There are ample indicated of finding copper reserves in depth as well as unexplored area. It is proposed that in addition to GSI and MECL, PSU like Hindustan Copper Limited who are primarily a copper mining organization, should also undertake exploration either independently or as a joint venture with overseas organizations.

1.2 World Scenario

Copper Events, Trends, and Issues: Copper prices trended upward throughout the year, and the COMEX spot price reached a record-high monthly average of $1.90 per pound in October. Despite a more than 3% estimated growth in world production of refined copper, production was insufficient to meet global demand, and the refined copper production deficit that had developed during the preceding 2 years continued through at least the first 3 quarters of 2005. Global inventories of refined copper held in metal exchange warehouses continued their downward trend, falling below 100,000 tons during the third quarter of the year. This shortfall occurred despite a decline in global consumption, which, according to estimates compiled by the International Copper Study Group,[6] declined slightly for the first 7 months of 2005 compared with that for the same period in 2004. Strong growth in China and India was more than offset by reduced use by other significant consumers. Global mine production fell short of its anticipated growth owing to production shortfalls in the United States and South America, and mine capacity utilization fell to its lowest level in recent years. New capacity and increased capacity utilization was expected to reverse the global production deficit, and a modest production surplus was anticipated for 2006.

In the United States, mine output fell to about 1,150,000 tons owing to unusually heavy spring rains, equipment shortages, and a strike by workers at one major producer that began in July and extended through the second week in November. Subsequent to the start of the strike, the company declared Chapter 11 Bankruptcy. Year-on-year U.S. consumption of refined copper fell during the first 9 months of 2005 owing to weaker demand and a surge in imports of wire rod in the first half of 2005. U.S. mine and refinery production were expected to increase in 2006 following settlement of the strike and the expected startup of a new electro winning facility by yearend 2005.

World Mine Production, Reserves, and Reserve Base: Countries producing 2 million tones copper or more.

	Mine production		**Reserves**	**Reserve base**
	2004	**2005**[e]	**('000 T)**	
United States	1,160	1,160	35,000	70,000
Australia	854	927	24,000	43,000
Canada	564	595	7,000	20,000
Chile	5412	5,320	140,000	360,000
China	742	651	26,000	63,000
Indonesia	842	1064	35,000	38,000
Kazakhstan	468	421	14,000	20,000
Mexico	399	429	27,000	40,000
Peru	1036	1009	30,000	60,000
Poland	531	523	30,000	48,000
Russia	767	805	20,000	30,000
Zambia	410	446	19,000	35,000
Other countries	1,610	1,750	60,000	110,000
World total (rounded)	14,600	15,012	470,000	940,000

Source: World Metal statistics June 2006 published by world bureau of metal statistics UK.

U.S. Geological Survey, Mineral Commodity Summaries, January 2006

[e] Estimated

World Resources: A recent assessment of U.S. copper resources indicated 550 million tons of copper in identified (260 million tons) and undiscovered resources (290 million tons), more than double the previous estimate. By extension, global land-based resources are expected to be much larger than the previously published estimate of 1.6 billion tons. Resources in deep-sea nodules were estimated to contain 700 million tons of copper.

This is based upon U.S. Geological Survey National Mineral Resource Assessment Team, 2000, 1998 assessment of undiscovered deposits of gold, silver, copper, lead, and zinc in the United States: U.S. Geological Survey Circular 1178, 21 p.

1.2.1 World mine production, reserves, and reserves base of copper

('000 Tonnes)

	Mine production		Reserves	Reserves base
	2004	2005		
United States	1160	1150	35000	70000
Australia	854	930	24000	43000
Canada	564	580	7000	20000
Chile	5410	5320	140000	360000
China	620	640	26000	63000
Indonesia	840	1050	35000	38000
Kazakhstan	461	400	14000	20000
Mexico	406	420	27000	40000
Peru	1040	1000	30000	60000
Poland	531	530	30000	48000
Russsia	675	675	20000	30000
Zambia	427	450	19000	35000
Other countries	1610	1750	60000	110000
World total (Rounded)	14600	14900	470000	940000

World resources of copper content

(' 000 tonne)

Countries	Reserves	Share(%)	Reserves base
World total (Rounded)	470000	100	940000
Chile	140000	30	360000
United States	35000	7	70000
Indonesia	35000	7	38000
Peru	30000	6	60000
Poland	30000	6	48000
Mexico	27000	6	40000
China	26000	6	63000
Australia	24000	5	43000
Russsia	20000	4	30000
Zambia	19000	4	35000
Kazakhstan	14000	3	20000
Canada	7000	1	20000
Other countries	60000	13	110000

World mines production of copper content

(' 000 tonne)

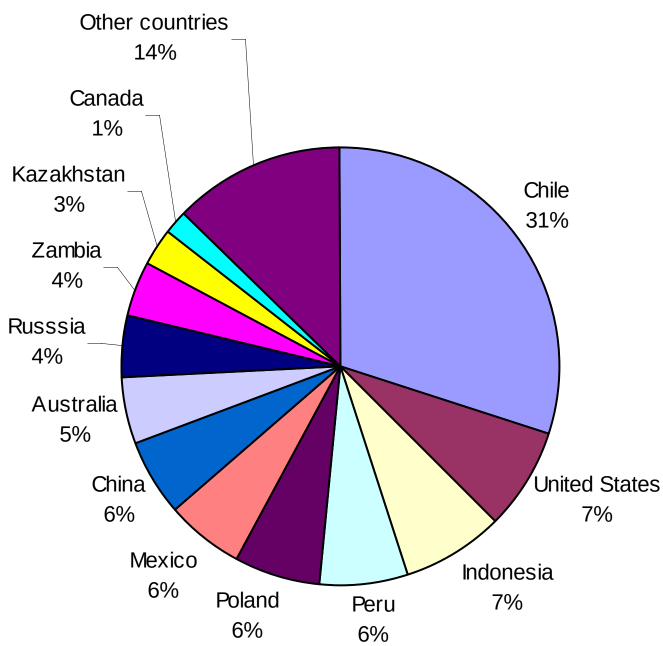
Countries	2004	2005	Share (%)
World Total (Rounded off)	14600	14900	100
Chile	5410	5320	36
United States	1160	1150	8
Peru	1040	1000	7
Australia	854	930	6
Indonesia	840	1050	7
Russia	675	675	5
China	620	640	4

Canada	564	580	4
Poland	531	530	4
Kazakhstan	461	400	3
Zambia	427	450	3
Mexico	406	420	3
Other countries	1610	1750	12

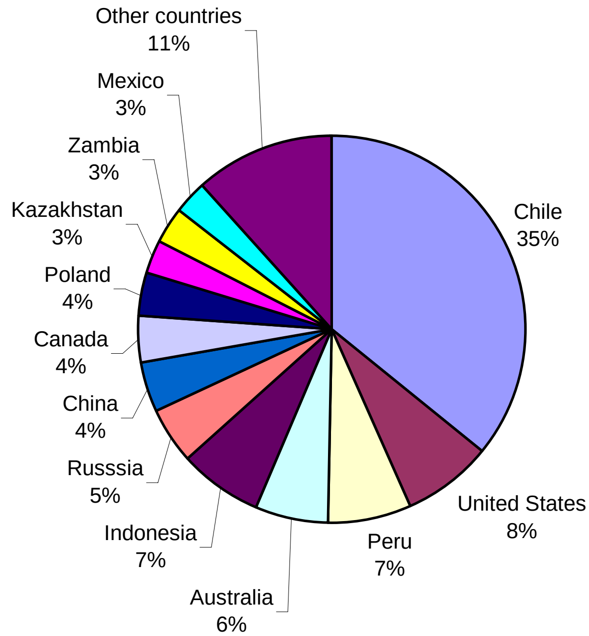
International Price of Copper

Year	Average LME price (US$/t)
2001-02	1527
2002-03	1586
2003-04	2046
2004-05	3000
2005-06	4097

World Resources of Copper Content



World Mines Production of Copper Content 2005



Review of present status of mineral base Industry in India

Copper

Production capacity

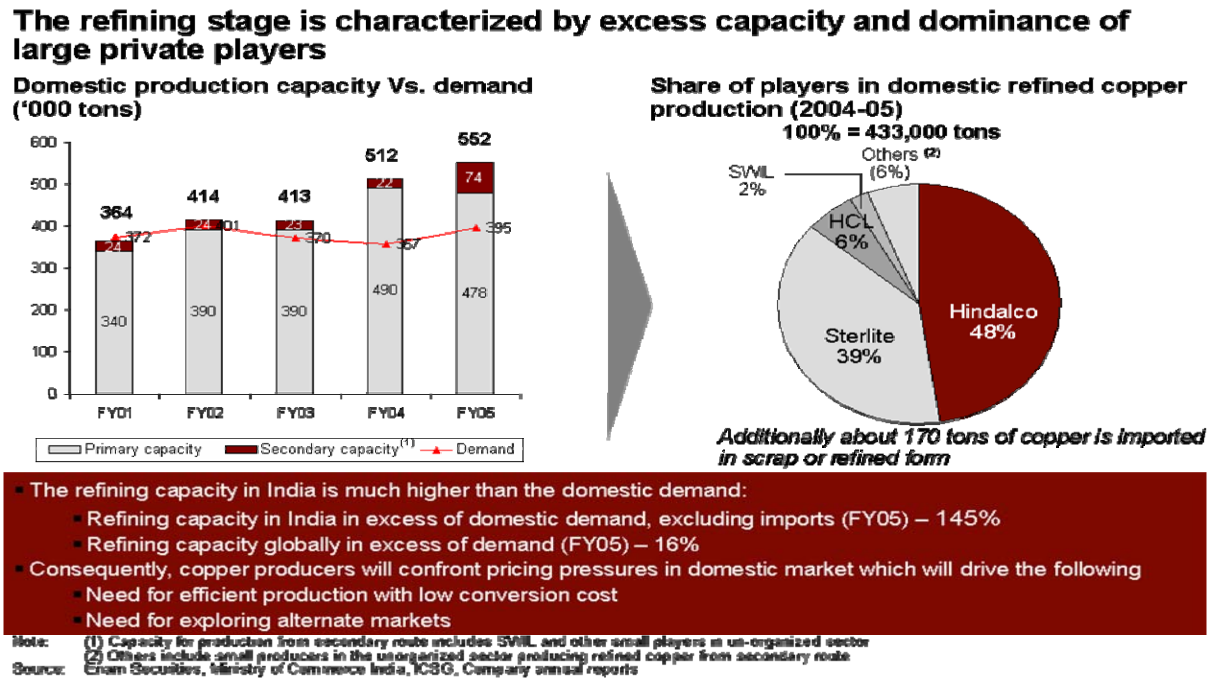
The past few years saw the Indian copper industry taking remarkable strides towards the goal of self-reliance. Hitherto the indigenous production capacity of 47,500 tonnes of copper of HCL met 25 to 30% requirement of the country before economic liberalization, while the rest was imported. After liberalization in 1992, two domestic private producers viz. M/s Sterlite industries & M/s Hindalco industries based on imported concentrates entered the primary refined copper market with smelter production capacities of 1,00,000 tonnes per annum each in 1997. Currently, the annual production capacities of these private producers is 5,00,000 tonnes & 3,00,000 tonnes. Besides another private player viz M/s. SWIL Ltd. has started operating its 50,000 tonnes plant based on secondary route. The capacity for production of primary copper in India has risen from a mere 47,500 tonnes per year till 1997 to approximately 8,97,000 tonnes in FY 2006-07; with the result that India is now a net exporter of refined copper.

Table 1
Production capacity of refined copper in India

Company	Capacity (tonnes per annum)
Hindalco industries	5,00,000
Sterlite industries	3,00,000
SWIL limited	50,000
HCL	47,500

Total **<u>8,97,500</u>**

Growth & demand projection of copper in India

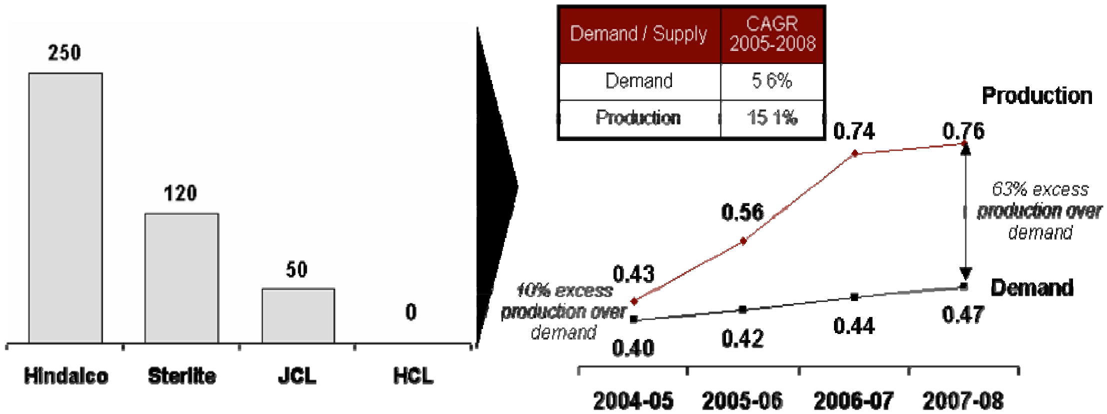


During the year, the demand for copper in global market has been growing steadily. Demand in Asian Countries, i.e. China & India driving the copper prices in the global market and trend is expected to continue in the near future. Growth of copper usage in the country is projected to be about 6% this year, exceeding the world average of about 4% but still we are far behind from China where the average growth rate during the last decade is more than 10 %. In 2004-05, the total refined copper usage in the country was ~ 3,95,000 MT; in the coming years, this is expected to rise to about 4,40,000 MT in 2006-07.

Capacity expansion

Domestic demand is expected to grow at about 6% per annum while production is expected to increase by 15.1% per annum on account of new capacities being added by private players.

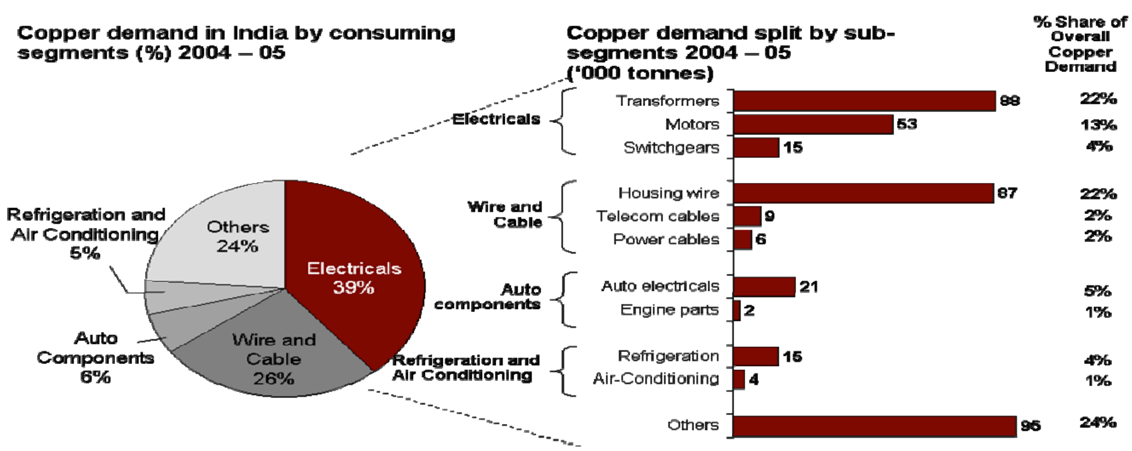
Incremental capacity expansion vis-à-vis growth demand



Sector-wise Consumption

Four industry sectors account for over 75% of the copper demand in the domestic market, viz. – electrical, wire and cables, auto components and refrigeration & air conditioning

Copper demand distribution by consuming industries



1 Electrical industry is the most dominant segment; accounts for about 40% of copper demand; is expected to grow by ~ 6.6% p.a.In the wire and cable industry, housing wire demand is increasing steadily

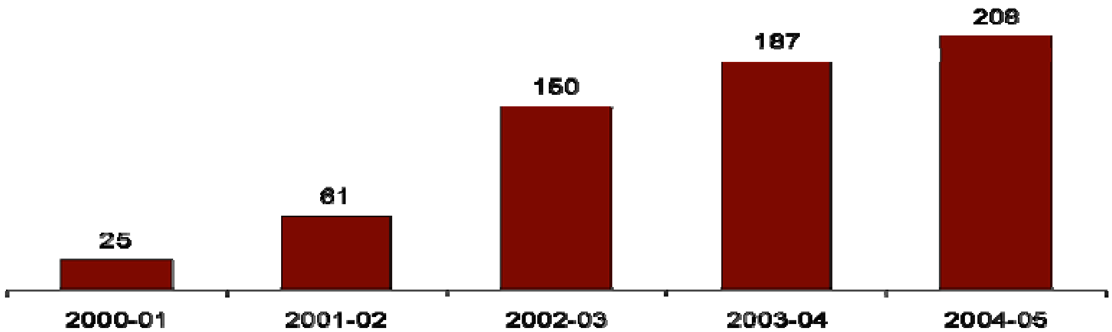
3 Growth in auto component industry has been driven by rapid growth of domestic automobile industry (CAGR: 10% in FY00 – FY04) as well as strong export demand of auto components (CAGR: 25% in FY00-FY04). Copper demand in the auto components sector is expected to grow by ~9.4% p.a.

4 Refrigeration & Air conditioning (RAC) segment: refrigerators is the most dominant copper consuming segment; Copper demand in the refrigeration and air conditioning segment is expected to grow by ~6.6% over next ten years

Export/ Import

Export

India exports refined copper largely to neighboring countries in the Middle East & Asia, such as UAE, Oman, Korea, Singapore, and Sri Lanka. These markets present good oppurtinuities for India on account of strong demand growth. Hindalco and Sterlite are the key exporters of refined copper; HCL made a maiden entry into the export market in 2005.

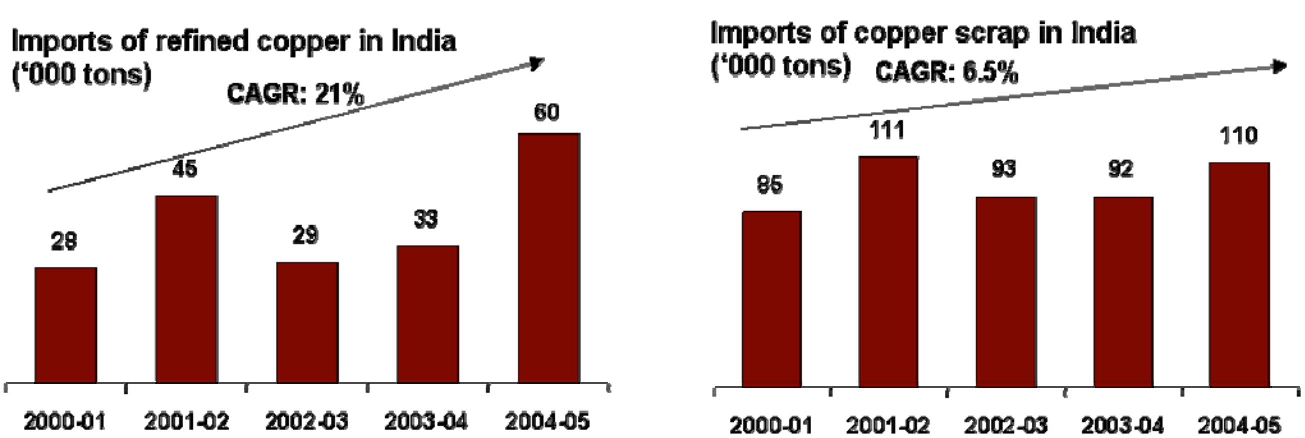


Exports of refined copper from India

('000 tonnes)

Import

Import of refined copper & copper scrap in India



Note: (1) Semis refers to fabricated copper products which includes rods, bars , sheets, strips, etc.
Source: Ministry of Commerce India, Indian Primary Copper Producers' Association

1.3 Cobalt

Indian scenario

Cobalt Production in India

Events, Trends, and Issues: The availability of refined cobalt worldwide increased during the first half of 2005 compared with that of the first half of 2004, as world refinery production was higher and shipments of cobalt from the National Defense Stockpile continued to contribute to supply. Cobalt prices trended downward during the first 10 months of 2005, reflecting adequate supply to meet demand.

In recent years, exports of cobalt-rich ores from Congo (Kinshasa) to refineries mainly in China have helped to balance cobalt supply and demand. Future export of these ores could be affected by declining cobalt prices, which could make their export less economical, and by efforts by the Government of Congo (Kinshasa) to require that cobalt ores be processed before being exported.

Health, safety, and environmental issues are becoming increasingly significant to metals such as cobalt. The European Commission's new chemicals policy, if implemented as proposed, would affect all suppliers of cobalt materials to the European market by requiring them to collect and submit risk assessment data on each material produced in or imported into the European Union.

World Mine Production, Reserves, and Reserve Base: Reserves and reserve base estimates for Australia were revised downward from those previously published based on information reported by the Government of Australia. Reserves estimate for Canada was revised downward based on information reported by major Canadian nickel sulfide ore producers.

	Mine production		**Reserves**	**Reserve base**
	2004	**2005^{e}**		
United States	—	—	NA	860,000
Australia	6,700	6,600	1,300,000	1,600,000
Brazil	1,400	1,400	35,000	40,000
Canada	5,200	5,700	130,000	350,000
Congo (Kinshasa)	16,000	16,000	3,400,000	4,700,000
Cuba	3,600	3,600	1,000,000	1,800,000
Morocco	1,600	1,600	20,000	NA
New Caledonia	1,400	1,400	230,000	860,000
Russia	4,700	5,000	250,000	350,000
Zambia	10,000	9,000	270,000	680,000
Other countries	1,800	2,100	200,000	1,500,000
World total (rounded)	52,400	52,400	7,000,000	13,000,000

U.S. Geological Survey, Mineral Commodity Summaries, January 2006

World Resources: Identified cobalt resources of the United States are estimated to be about 1 million tons. Most of these resources are in Minnesota, but other important occurrences are in Alaska, California, Idaho, Missouri, Montana, and Oregon. With the exception of resources in Idaho and Missouri, any future cobalt production from these deposits would be as a byproduct of another metal. Identified world cobalt resources are about 15 million tons. The vast majority of these resources are in nickel-bearing laterite deposits, with most of the rest occurring in nickel-copper sulfide deposits hosted in mafic and ultramafic rocks in Australia, Canada, and Russia, and in the sedimentary copper deposits of Congo (Kinshasa) and Zambia. In addition, millions of tons of hypothetical and speculative cobalt resources exist in manganese nodules and crusts on the ocean floor.

1.4 Molybdenum

Events, Trends, and Issues: U.S. mine output of molybdenum in 2005 increased about 37% from that of 2004. U.S. imports for consumption increased an estimated 38% from those of 2004, while the U.S. exports increased 33% from those of 2004. The increase in exports reflects the return to full production levels by the beginning of 2005 of most byproduct molybdenum producers and increased production by primary producers. U.S. reported consumption increased 10% from that of 2004. Mine capacity utilization in 2005 was about 77%.

China continued its high level of steel production and consumption, thus providing strong demand for molybdenum. High copper prices and a deficit of refined copper allowed the Bagdad and Sierrita Mines in Arizona to return to full production capacity, thus increasing byproduct molybdenum production. The Bingham Canyon Mine near Salt Lake City, UT, optimized its mill operation to maximize molybdenum recovery and began mining a high-molybdenum zone of the deposit. The mine was expected to triple its output of molybdenum in 2005 as compared with that of 2004. With the continuing high price of nickel-bearing stainless steel in 2005, consumers increasingly considered use of duplex stainless steel, with higher molybdenum content.

World Mine Production, Reserves, and Reserve Base:

	Mine production		**Reserves**	**Reserve base**
	2004	**2005[e]**	**(thousand metric tons)**	
United States	41,500	56,900	2,700	5,400
Armenia	3,000	2,800	200	400
Canada	5,700	9,800	450	910
Chile	41,483	45,500	1,100	2,500
China	29,000	28,500	3,300	8,300
Iran	1,500	1,500	50	140
Kazakhstan	230	210	130	200
Kyrgyzstan	250	250	100	180
Mexico	3,700	3,500	90	230
Mongolia	1,700	1,300	30	50
Peru	9,600	9,700	140	230
Russia [e]	2,900	3,000	240	360
Uzbekistan	500	500	60	150
World total (rounded)	141,000	163,000	8,600	19,000

U.S. Geological Survey, Mineral Commodity Summaries, January 2006

World Resources: Identified resources amount to about 5.4 million tons of molybdenum in the United States and about 13 million tons in the rest of the world. Molybdenum occurs as the principal metal sulfide in large low-grade porphyry molybdenum deposits and as an associated metal sulfide in low-grade porphyry copper deposits. Resources of molybdenum are adequate to supply world needs for the foreseeable future.

1.5 SELENIUM

Selenium production in India by HCL as byproduct

Year	**Production (kg)**
2005-06	7719
2004-05	-
2003-04	2357
2002-03	6648

2001-02	9750

Events, Trends, and Issues: The supply of selenium is directly affected by the supply of the materials from which it is a byproduct—copper, and to a lesser extent, nickel and cobalt. Continued concern about the adequacy of the selenium supply caused the price of selenium to rise to $53 per pound by the end of the first quarter 2005, where it remained through the end of the third quarter.

Estimated domestic selenium production decreased in 2005 as compared with that of 2004 owing to a labor strike at the major domestic producer that began in July and continued at least until October, when the producer announced that it had filed for bankruptcy protection. The future of U.S. production is therefore uncertain. Despite the declining domestic production, selenium exports rose to the highest level since 1996. It was believed that domestic exports shipped to Australia, Hong Kong, the Philippines, and other Southeast Asian countries were further processed and exported to China. It was estimated that more than 50% of domestic exports of selenium eventually were consumed in China.

China continued to use selenium as a fertilizer supplement, as an ingredient in glassmaking, and as a substitute for sulfur dioxide in the form of selenium dioxide in the manganese smelting process. It has been estimated that China's consumption of selenium increased in 2004 and in the first quarter of 2005. In the early part of 2005, however, consumption of selenium used by the electrolytic manganese metal producers dropped drastically as many of the manganese refineries were closed by the Chinese Government because of enforcement of new environmental practices. Other manganese refineries closed owing to higher selenium and electricity costs.

Domestic use of selenium in glass remained unchanged, while use in copiers continued to decline. The use of selenium as a substitute for lead in free-machining brasses continued to increase as more stringent regulations on the use of lead were implemented. Selenium's higher cost, however, has limited its use in many of its applications. The use of selenium in fertilizers and supplements in the plant-animal-human food chain and as human vitamin supplements increased as its health benefits were documented. Although small amounts of selenium are considered beneficial, it can be hazardous in larger quantities.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		**Reserves**[2]	**Reserve base**[2]
	2004	**2005**[e]		
United States	W	W	10,000	19,000
Belgium	200	200	—	—
Canada	250	250	6,000	10,000
Chile	40	84	16,000	37,000
Finland	40	40	—	—
Germany	100	14	—	—
India	12	12	—	—
Japan	600	650	—	—
Peru	21	26	5,000	8,000
Philippines	40	40	2,000	3,000
Serbia and Montenegro	10	9	1,000	2,000

Sweden	20	20	—	—
Other countries[1]	NA	NA	42,000	90,000
World total (rounded)	[2]1,330	[2]1,350	82,000	170,000

U.S. Geological Survey, Mineral Commodity Summaries, January 2006

World Resources: The reserve base for selenium is based on identified economic copper deposits. An additional 2.5 times this reserve base is estimated to exist in copper and other metal deposits that have not yet been discovered. Coal generally contains between 0.5 and 12 parts per million of selenium, or about 80 to 90 times the average for copper deposits. The recovery of selenium from coal, although technically feasible, does not appear likely in the foreseeable future.

Substitutes: High-purity silicon has replaced selenium in high-voltage rectifiers. Silicon is also the major substitute for selenium in low- and medium-voltage rectifiers and solar photovoltaic cells. Amorphous silicon and organic photoreceptors are substitutes in plain paper photocopiers. Organic pigments have been developed as substitutes for cadmium sulfoselenide pigments. Other substitutes include cerium oxide as either a colorant or decolorant in glass; tellurium in pigments and rubber; bismuth, lead, and tellurium in free-machining alloys; and bismuth and tellurium in lead-free brasses.

1.6 Tellurium

Tellurium production in India by HCL as byproduct

Year	Production kg
2005-06	nil
2004-05	nil
2003-04	31
2002-03	65
2001-02	67

Events, Trends, and Issues: Estimated domestic tellurium production decreased in 2005 as compared with that of 2004 owing to a labor strike that began in July and continued at least until October at the one domestic producer.

Domestic consumption, however, was estimated to have increased significantly during the same period. Though detailed information on the world tellurium market was not available, world tellurium consumption was estimated to have increased significantly in 2005. World production of tellurium, a byproduct of copper refining, was believed to have increased owing to an increase in world copper production. Russian tellurium production in 2005 reportedly was much higher than in 2004. Selenium, a co product which was in strong demand, experienced a surge in production from waste and anode slimes that contained tellurium. In 2005, the U.S. producer of tellurium announced that it had filed for bankruptcy protection. The future of American production is therefore uncertain.

Tellurium supply and demand has remained in fairly close balance for the past decade in the United States. In 2005, however, demand greatly outstripped supply. There was a significant increase in demand for high-purity tellurium for cadmium telluride solar cells. Tellurium consumption also increased in thermal elements for small ice packs and refrigerators. The large supply imbalance led to a large price jump starting in late 2004 and extending through 2005.

Currently, tellurium alloyed with germanium and antimony used in digital video discs (DVDs) consumes only small amounts of tellurium. New developments in coupling materials, however, which consist of bismuth, germanium, and tellurium and enable DVDs to be rewritable at high and low recording speeds, could have an impact on future world demand.

World Refinery Production, Reserves, and Reserve Base:

	Refinery production		**Reserves**	**Reserve base**
	2004	**2005[e]**		
United States	W	W	3,000	6,000
Canada	40	50	700	1,500
Japan	33	35	—	—
Peru	20	28	1,600	2,800
Other countries[1]	NA	NA	16,000	37,000
World total (rounded)	[2]93	[2]113	21,000	47,000

World Resources: The figures shown for reserves and reserve base include only tellurium contained in economic copper deposits. These estimates assume that less than one-half of the tellurium contained in unrefined copper anodes is actually recovered.

More than 90% of tellurium is produced from anode slims collected from electrolytic copper refining, and the remainder is derived from skimmings at lead refineries and from flue dusts and gases generated during the smelting of bismuth, copper, and lead ores. In copper production, tellurium is recovered only from the electrolytic refining of smelted copper. Growth in the global use of the leaching solvent extraction-electro winning processes for copper extraction has limited the growth of tellurium supply.

[1]In addition to the countries listed, Australia, Belgium, China, Germany, Kazakhstan, the Philippines, and Russia produce refined tellurium, but output is not reported, and available information is inadequate for formulation of reliable production estimates.

[2]Excludes refinery production from the United States.

U.S. Geological Survey, Mineral Commodity Summaries, January 2006

1.7 Recommendation

1. Introduction of Robotic mining: It is proposed that automation combined with remote operation should be adopted not only in the new mines but also in existing mines. It not only increases workplace safety and efficiency, but it also reduces production costs.

2. High Volume and Multi-metal Extraction: It is proposed that exploration and development activities should be based on polymetalic occurrences. Whereas these investments are perhaps smaller in terms of contained Copper, they are nonetheless important in the context of overall World Copper supply.

3. Adoption of SX-EW Technology: Copper deposits in India are distributed in a

scattered manner in widely separated areas & represented by unique blend of small scale and large-scale deposits. Considering the nature of deposits, we should go for SX-EW Technology. Initially, this process was meant to recover Copper from low-grade oxide ore which was not amenable to concentration by Conventional Forth floatation. But, now it has been conclusively established that even Sulphde ore can be successfully treated by accelerating leaching process through bacterial action at normal/elevated temperatures. The cost of production by SX-EW process works out to as low as 60% of that through Conventional Pyro-metallurgical route. This process also obviates environmental problems associated with Sulphur capture and dust emissions which is common in Smelters.

4. Strategic approach of PSUs: It is proposed that in addition to GSI and MECL, PSU like Hindustan Copper Limited who are primarily a copper mining organization, should also undertake exploration either independently or as a joint venture with overseas organizations.

5. R & D activities in mining: At present the R&D setup in the industry is largely working as an internal department with emphasis on problem solving and applied research. In order to updating of technology and developments of new technologies, strengthening of R&D department/organization with adequate budgetary support is necessary.

6. Re-opening of closed mines: In the present high copper prices scenario HCL may explore the possibilities of reopening of closed mines in joint Venture with overseas organisation

CHAPTER - II

ZINC AND LEAD

2.0 Introduction

After aluminium and copper, zinc and lead are among the most widely used non-ferrous metals in the world. Corrosion protection of steel by zinc coating is the most important use of zinc in the world. Zinc forms an important alloy - brass - which possesses a combination of versatile properties. Die-casting, chemicals and zinc semis are the other major zinc uses in the world. In case of lead, batteries are the important end-use sector for lead and their share in lead consumption has been increasing significantly over the years. The substantial increase in the batteries' share, to a large extent, has compensated the loss in consumption of lead in cable sheathing due to substitution by the synthetic cables and the loss in other sectors due to the environmental and health regulations.

Zinc and lead minerals often occur together in the mother earth. The most common zinc mineral is sphalerite, a sulfide of zinc and the lead mineral is galena, a lead sulfide. Some of the impurities of economic value present in the zinc-lead ore include cadmium, silver, copper, antimony, bismuth, arsenic, gallium, germanium, indium, and selenium.

2.1 World Scenario

2.1.1 **Resources**

The world's zinc resources are estimated at 460 million tonnes of contained metal and lead resources at 140 million tonnes of contained metal. USA, China, Australia and Canada together constitute about 64% and 66% of zinc and lead resources respectively.

India accounts for 5% of the world's total zinc-lead resources.

Zinc and lead resources in the world

(million tonnes of contained metal)

Country	Zinc	Lead
United States	90	20
Australia	80	28
Canada	31	9
China	92	36
Kazakhstan	35	7
Mexico	25	2
India	**24**	**7**
Peru	20	4
Other Countries	63	27
World Total	**460**	**140**

Source : *Mineral Commodity Summaries, USBM, January 2006; IBM*

2.1.2 **Mine Production**

The major zinc-lead mines are in China, Australia, USA, Peru and Canada with. around 64.5% of the total zinc mine production and 77% of the total lead mine production.

India is amongst the top ten mining countries and its share in zinc and lead mine production is nearly 4.5 and 2% respectively.

World Mine Production - Zinc & Lead

('000 tonnes)

	ZINC				LEAD			
Country	2002	2003	2004	2005	2002	2003	2004	2005
China	1,624	2,029	2,391	2,525	641	955	997	1,023
Australia	1,444	1,447	1,298	1,329	658	648	642	715
Canada	916	788	791	667	97	81	77	79
USA	784	768	739	747	449	458	439	434
Peru	1,219	1,369	1,209	1,202	297	308	306	311
Europe	910	1,019	1,021	1,053	248	216	219	239
India	**234**	**305**	**340**	**446**	**34**	**44**	**51**	**58**
Other Countries	1,773	1,854	2,003	2,050	407	389	402	447
World Total	**8,904**	**9,579**	**9,792**	**10,019**	**2,831**	**3,099**	**3,133**	**3,306**

Source: *ILZSG*

2.1.3 **Metal Production**

The leading zinc metal producing countries are China, Canada, Japan, Korea Rep and Australia. In case of lead, USA, China, Germany, UK, Italy, Japan and Korea Rep are the leading producing countries.

India’s share is nearly 3% for zinc and 1% for lead metal production.

World Metal Production - Zinc & Lead

('000 tonnes)

	ZINC				LEAD			
Country	2002	2003	2004	2005	2002	2003	2004	2005
China	2,155	2,319	2,720	2,772	1,325	1,564	1,934	2,334
Europe	2,904	2,744	2,721	2,592	1,762	1,573	1,557	1,679
USA	339	350	354	342	1,364	1,392	1,262	1,259
Canada	793	761	805	723	252	223	241	229
Australia	567	553	474	457	302	307	273	268
Japan	640	651	635	638	286	295	283	275
Korea Rep	608	645	669	647	243	230	243	257
India	**248**	**280**	**272**	**302**	**78**	**71**	**49**	**59**
Other Countries	1,456	1,568	1,707	1,790	1,058	1,093	1,113	1,195
World Total	**9,710**	**9,871**	**10,357**	**10,263**	**6,670**	**6,748**	**6,955**	**7,555**

Source: *ILZSG*

As regards secondary metal production, its contribution in the Western World is about 68% for lead and 31% for zinc metal.

Zinc Consumption

The global zinc metal consumption during 2005 was nearly 10.6 million tonnes. China, USA and Western European countries are the leading consumers.

India's share in the world zinc metal consumption is about 4%.

Zinc Consumption in the World

('000 tonnes)

Continent/ Country	2002	2003	2004	2005
Europe	**2,754**	**2,797**	**2,830**	**2,678**
Germany	526	539	514	501
America	**2,023**	**1,950**	**2,123**	**1,902**
USA	1,217	1,152	1,251	1,069
Asia	**4,147**	**4,660**	**5,247**	**5,601**
China	1,750	2,155	2,690	3,037
Japan	603	619	623	602
Korea Rep	476	482	445	503
India	***310***	***339***	***362***	***394***
Taiwan	302	330	342	306
Australia	**249**	**254**	**250**	**239**
Africa	**187**	**174**	**193**	**202**
World Total	**9,376**	**9,848**	**10,657**	**10,635**

Source: *ILZSG*

During 2002 to 2005, world zinc consumption increased at an average annual compounded rate of 4.3%. Asia recorded an annual average growth of 10.6% largely due to plus 20% in China and 8.3% in India.

Galvanizing is the main industrial application of zinc with about 47% share. Alloys and other zinc based alloys including Die-casting are the other major consuming industries. Zinc consumption is largely dependent on construction (48%) and transport (23%) sectors.

Zinc Consumption Pattern

End-usage	Share (%)
Galvanising	47
Brass & bronze	19
Zn based alloys	14
Chemicals	9
Semi-manufacture	8
Others	3

Source: LME website

Lead Consumption

The global lead metal consumption during 2005 was nearly 7.6 million tonnes. China, USA, Germany, Japan and Korea Rep are the leading consumers.

India's share in the world lead metal consumption is 2%.

During 2002 to 2005, world lead consumption increased at an average annual compounded rate of 4.6%. Asia recorded an annual average growth of 12% mainly due to plus 25% in China and 7% in India.

Lead Consumption in the World

('000 tonnes)

Continent/ Country	2002	2003	2004	2005
Europe	**2,027**	**1,925**	**1,969**	**1,975**
Germany	385	384	395	399
America	**2,066**	**2,030**	**2,040**	**2,096**
USA	1,536	1,513	1,502	1,552
Mexico	267	259	262	265
Asia	**2,408**	**2,712**	**3,095**	**3,397**
China	950	1,183	1,510	1,868
Korea Rep	343	349	371	378
Japan	303	311	292	291
India	***130***	***142***	***150***	***160***
Africa	**98**	**116**	**116**	**112**
Australia	**39**	**38**	**39**	**28**
World Total	**6,642**	**6,826**	**7,261**	**7,609**

The main industrial application of lead is for storage batteries with 71% share, followed by pigments and compounds with 12% share. Automobile sector is the major user of batteries.

Lead Consumption Pattern

End-usage	**Share (%)**
Batteries	71
Pigments & other compounds	12
Rolled & extruded products	7
Shot/ ammunition	6
Cable sheathing	3
Alloys	1

Source: LME website

Metal : Exports

The main *zinc metal* exporters are Canada, Australia, USA, Spain and Netherlands. On the other hand, China, Australia, Canada, Peru and Germany are the major lead metal exporting countries in the world.

Major Metal Exporters

Country	2002	2003	2004	2005 ('000 tonnes)
Zinc Metal				
Canada	598	591	614	527
Australia	483	461	325	463
Spain	79	246	295	334
Netherlands	197	421	285	320
Korea Rep	261	317	320	261
Finland	189	212	236	235
China	472	451	224	123
Lead Metal				
China	399	438	448	455
Australia	263	267	211	245
Canada	163	149	150	161
Peru	109	109	113	105
Germany	133	100	79	97

Source: *ILZSG*

Metal : Imports

The main *zinc metal* importers are USA, China and Malaysia. The major lead metal importing countries are USA, Spain and Korea Rep.

Table 3.7

Zinc and Lead Metal Exports - 2002 to 2005

Country	2002	2003	2004	2005 ('000 tonnes)
Zinc Metal				
Canada	598	591	614	527
Australia	483	461	325	463
Spain	79	246	295	334
Netherlands	197	421	285	320
Korea Rep	261	317	320	261
Finland	189	212	236	235
China	472	451	224	123
Lead Metal				
China	399	438	448	455
Australia	263	267	211	245
Canada	163	149	150	161
Peru	109	109	113	105
Germany	133	100	79	97

Concentrate : Exports

The main *zinc and lead concentrates* exporting countries are Australia, Peru and USA.

Major Concentrate Exporters

('000 tonnes MIC)

Country	2002	2003	2004	2005
Zinc Conc.				
Australia	1016	1007	955	932
Peru	906	900	879	900
USA	827	822	746	788
Ireland	249	417	445	410
Namibia	33	96	178	202
Sweden	140	150	188	185
Canada	409	258	228	155
Mexico	131	105	62	155
Lead Conc.				
USA	245	257	295	387
Australia	264	263	264	331
Peru	179	178	186	200
Ireland	31	49	64	65
Poland	47	52	54	55

Source: *ILZSG*

Concentrate : Imports

The principal *zinc concentrate* importing countries are Korea Rep., Belgium, Spain and Japan while the *lead concentrate* importers are China, Korea Rep. and Germany.

Major Concentrate Importers

('000 tonnes MIC)

Country	2002	2003	2004	2005
Zinc Conc.				
Korea Rep	582	616	627	642
Belgium	409	571	704	596
Spain	451	537	459	545
Japan	559	544	563	530
China	393	373	306	284
Finland	218	218	240	250
Canada	276	397	273	195
Lead Conc.				
China	216	374	454	567
Korea Rep	138	151	143	156
Germany	122	108	121	103
Japan	117	109	94	102
Italy	63	52	59	65

Source: *ILZSG*

LME Prices

The zinc and lead price movement at LME during the last 10 years from 1996 to 2005 has been varying substantially. After declining to record low levels in 2002, the prices started showing improving trend in subsequent years. The prices reached to new highs in the recent past and are still ruling at relatively higher levels.

Zinc & Lead Settlement Prices at LME

(US $/tonne)

Year	Zinc	Lead
1996	1,025	775
1997	1,317	624
1998	1,024	529
1999	1,076	503
2000	1,128	454
2001	886	476
2002	779	453
2003	828	515
2004	1,047	888
2005	1,382	977

The sharp recovery of zinc - lead prices to high levels was in tune with those of other non-ferrous metals. The main factors driving the non-ferrous metal prices including zinc - lead to such levels are emergence of strong Chinese and Indian demand growth, muted supply response by producers due to lack of investment in late 1990s, structural bottlenecks, running down of inventories to historically low levels etc. Economic growth acceleration in the first half of 2006 has provided renewed upward impetus to prices.

Since the domestic prices of zinc and lead are linked to the international prices, similar price movements have been reflected in the Indian zinc - lead market.

The price forecast for the next 5 years is given below.

Zinc & Lead Price Forecasts

(US $/tonne)

Year	Zinc	Lead	
2006	2,710	1,190	(Actual Jan-Aug : Zn - 2911, Pb - 1157)
2007	2,865	990	
2008	2,200	880	
2009	1,540	720	
2010	1,320	770	

Source: Macquarie Research Commodities, June 2006

2.2 **Indian Scenario**

The Indian zinc-lead industry comprises two primary producers - Hindustan Zinc Limited (HZL) and Binani Industries Limited (BIL), both in private sector.

HZL was earlier a Government of India enterprise and post disinvestment in April 2002, it has become a private sector and presently a group company of Vedanta Resources plc. HZL is a vertically integrated producer from mining to smelting with its major operations in Rajasthan, while BIL has a custom smelter located in the south-west coast.

2.2.1 **Reserve - Resource**

The zinc-lead reserve-resource status as on 1st April 2005, based on UNFC (United Nations Framework Classification) criteria, is given below.

Lead Zinc Resources (UNFC) in India as on 1st April 2005 (Provisional)

('000 tonnes)

State		Reserves	Remaining Resources	Total Resources
All India	Reserve/Resource	125,754	396,826	522,580
	Pb-metal	2,591	4,618	7,209
	Zn-metal	11,092	13,168	24,260
Rajasthan	Reserve/Resource	117,583	350,925	468,508
	Pb-metal	2,391	4,008	6,399
	Zn-metal	10,813	11,670	22,483

Source: *Indian Bureau of Mines*

The reserves are estimated to be around 126 million tonnes containing about 11 and 2.6 million tonnes of zinc and lead metals respectively. The remaining resources are estimated at 397 million tonnes with about 13 and 4.6 million tonnes of zinc and lead metals respectively. While the total all India resources are estimated at 522 million tonnes, about 89% of lead and 93% of zinc reserves are located in the state of Rajasthan.

Reserves in the operative mines of HZL, based on JORC (Joint Ore Reserve Committee) criteria, and their life span are presented below.

Mineable Reserves of HZL as on 1st April 2006

Mine/Deposit	JORC Reserves (million tonnes)	Avg. Production (million tonnes per annum)	Life in Years	Remark
Rampura Agucha	53.4	3.75 expansion to 5Mtpa by 2008	11	Open-pit
Rajpura Dariba (inclusive of Sindesar Khurd)	9.4	0.75 expansion to 1.25Mtpa by 2010	10	Underground
Zawar Group	5.8	1.02 expansion to 1.35Mtpa by 2010	6	Underground
Total	68.6			

Note: Resources in Possible/Inferred categories and other ore blocked in pillars are not considered for production planning.

In addition to these reserves, 109 million tonnes of resources have also been identified.

Exploration for up-gradation of the resources to mineable reserves during last two years has yielded net addition of 2 million tonnes of in-situ metal. Further focused exploration has been intensified at various mine sites which will result in to increased mine-life.

Looking at the present scale of operations and mine expansion under execution, the resource position will become critical to meet the concentrate requirement for the zinc metal production capacity which is projected at 9% CAGR during 11th Plan and beyond. Accordingly, perspective exploration plan is required to be formulated for new economic green field discoveries. Adequate funding, technological up-gradation, conducive regulatory frame work, expeditious clearances of licenses, collaborative efforts by various government and private organizations will accelerate exploration and finally to mine development.

2.2.2 Mine Production

HZL is the only company having captive zinc-lead mines in the country. All the mines are located in Rajasthan. HZL has been able to sequentially increase the production capacity of its world class Rampura Agucha open cast mine and beneficiation plant from 4,500 tonnes per day (tpd) to 6,000 tpd by 2003-04, mainly due to debottlenecking. The mine capacity was further enhanced to 11,400 tpd during 2005 along with state-of-art technology beneficiation plant using Semi Autogeneous Grinding (SAG) mills and advance process control system. Concurrent to this, debottlenecking in the underground mines has also resulted in the increase in capacity utilization of mines and beneficiation plants.

The present mine capacity of HZL stands at 5.85 million tonnes per annum (Mtpa). Further expansion of Rampura Agucha to 5 Mtpa mine is planned by 2008. HZL is also actively planning to open-up new deposit at Kayar by 2010, for which feasibility studies are in progress.

Zinc-Lead Mine Production

Mine Capacity (Ore)

	Mtpa
Rampura Agucha	3.75
Rajpura Dariba	0.90
Zawar Group	1.20
	5.85

Concentrate Production (tonnes)

	Zinc	**Lead**
9th Plan		
1997-98	292,235	60,800
1998-99	349,890	62,727
1999-00	359,512	62,615
2000-01	365,838	54,227
2001-02	398,332	52,106
10th Plan		
2002-03	486,027	55,806
2003-04	614,938	74,316
2004-05	666,424	84,251
2005-06	889,007	95,738
2006-07 (Est.)	992,000	122,000
11th Plan (Est.)		
2007-08	1,067,000	132,000
2008-09	1,316,000	159,000
2009-10	1,316,000	170,000
2010-11	1,316,000	170,000
2011-12	1,316,000	170,000

All the operating mines are certified for ISO 9001 (Quality Management System), ISO 14001 (Environment Management System) and OHSAS 18001 (Occupational Health and Safety Management System). This clearly shows that quality of lead-zinc concentrates produced in India is well comparable with global quality standards. Export of these concentrates in the past also establishes quality acceptance by the user smelters world over.

2.2.3 **Metal Production**

Zinc

The total primary zinc production capacity in India at the end of terminal year of the 9th Plan (2001-02) was 199,000 tonnes per annum (tpa). (HZL – 169,000tpa, BIL – 30,000tpa).

There has been progressive capacity build up by HZL during the early years of the 10th Plan through debottlenecking and modernization in its operating zinc smelters. This was followed by commissioning of a new 170,000 tpa hydromet zinc smelter at Chanderiya, Dist. Chittorgarh in Rajasthan which has been operationalised in 2005. This new smelter at Chanderiya is a world scale and state-of-art technology plant capable of producing zinc at much lower cost as compared to the old plants. With this capacity addition, HZL's zinc production capacity has surged from 169,000 tpa to 411,000 tpa and it is now the sixth largest producer of zinc in the world.

The country's total primary zinc production capacity stands at 449,000tpa including BIL's capacity of 38,000 tpa.

Zinc Production Capacity in India as on 1.4.2006

Location		Current Capacity (tpa)
HZL		
Chanderiya (Pyro)		105,000
Chanderiya (Hydro)		170,000
Debari (Hydro)		80,000
Vizag (Hydro)		56,000
	Sub-total	411,000
BIL		38,000
	Total (India)	449,000

All the operating zinc smelters in the country are certified for ISO 9001 (Quality Management System), ISO 14001 (Environment Management System) and OHSAS 18001 (Occupational Health and Safety Management System). This clearly shows that quality of zinc metal produced in India is well comparable with global quality standards. A step towards registration in the London Metal Exchange (LME) is also being contemplated with respect to quality product.

As a philosophy driven by commitment and business needs and to become globally competitive, the Indian zinc producers are constantly focusing on reducing the cost of production. They have been able to control costs due to improved operational efficiencies and capacity enhancement. On-going continuous improvement activities such as debottlenecking and meaningful sustainable capital expenditure have also improved the smelters' productivity, resulting in containment of cost, despite a significant increase in the prices of key inputs.

Looking to the rising demand of zinc in India and in the international market, HZL is coming up with another brownfield zinc smelter project of 170,000tpa capacity at Chanderiya, which is likely to be completed by 2008. Further debottlenecking and modernization will also be taken up by HZL in its existing capacities. This will raise HZL's capacity to around 6 lakh tpa and country's total primary zinc production to 6.4 lakh tpa.

India will be producing higher proportion of value added/better quality product viz., Special High Grade (SHG), after these capacity additions constituting about 65% of total zinc production compared to about 15% in the year 2005-06. In addition, zinc producers are contemplating to explore the possibility of further value addition to the virgin zinc metal by converting into Continuous Galvanizing Grade (CGG) zinc-aluminium alloy. The capacity to put such facilities will be worked out based on market potential of this alloy in the country.

Zinc metal production capacity in the secondary sector is estimated at 50,000tpa. Currently, about 25,000 to 30,000 tonnes of zinc per annum is being produced in the secondary sector. Present rising trend of zinc metal prices will be encouraging the recycling to enhance capacity as well as utilization besides investments in new facilities. Secondary zinc production is therefore, expected to increase to 40,000tpa during the 11th Plan period.

The production of zinc metal during 9th and 10th Plans and forecasts for 11th Plan are presented below.

Lead

HZL is the only primary lead producer in the country. It has a total lead production capacity of 85,000tpa at its two lead plants at Chanderiya, one of which has been operationalised in 2005 using eco-friendly Ausmelt technology with a capacity of 50,000tpa.

The secondary lead production in the country, in both organized and small scale sectors is estimated at 50,000tpa. With the enactment of Battery Management & Handling Rules (BMHR), 2002, the domestic collection of used batteries has increased. This has helped in substantial increase in secondary lead production.

Looking at the growth in the Automotive and Information Technology and Communication Technology sectors, the demand for lead is poised to increase. This in turn will result in more recycling of batteries. This is expected to enhance the production of secondary lead to around 75,000tpa during the 11th Plan period.

The production of lead metal during 9th and 10th plans and forecasts for 11th Plan are presented below.

Lead Metal Production in India (tonnes)

Year	Primary HZL	Secondary Estimates	Total
9th Plan			
1997-98	39,010	25,616	64,626
1998-99	35,766	26,152	61,918
1999-00	35,120	27,510	62,630
2000-01	34,840	24,173	59,013
2001-02	30,975	40,000	70,975
10th Plan			
2002-03	32,542	50,000	82,542
2003-04	25,089	50,000	75,089
2004-05	15,727	50,000	65,727
2005-06	23,636	50,000	73,636
2006-07 (Est.)	63,000	60,000	123,000
11th Plan (Est.)			
2007-08	74,000	75,000	149,000
2008-09	89,000	75,000	164,000
2009-10	95,000	75,000	170,000
2010-11	95,000	75,000	170,000
2011-12	95,000	75,000	170,000

9th Plan CAGR	**2.9%**
10th Plan CAGR	**14.8%**
11th Plan CAGR	**7.0%**

Demand

The present per capita consumption of zinc in India is about 0.4kg as against the world average of 1.3kg. Consumption of zinc during 2005-06 was nearly 430,000 tonnes. The zinc demand is riding the steel industry growth, mainly driven by galvanized sheets. Per capita consumption of lead in India is about 0.24kg. Consumption of lead during 2005-06 was nearly 239,000 tonnes. The lead demand is riding the automotive growth, mainly driven by storage batteries.

Down stream industry development, improvement in standard of living and consumer awareness is set to further increase the demand of zinc and lead in the forthcoming years. Based on these factors, coupled with global and domestic market analysis, the demand in the country during the 11th Plan period is projected to grow at compounded annual rate of 8% for zinc and 10% for lead.

Zinc Demand

The Zinc industry is expected to rise @ 8% compounded annual growth rate (CAGR) during the 11th Plan. There is significant export potential for zinc coated steel sheets to North American and European markets. In addition, zinc consumption is expected to grow in consonance with continued boom in domestic infra-structural and construction sectors. Apart from these, the demand for zinc in dry cell batteries, electronic gadgets and personnel digital assistants, zinc die-cast components in auto sector, builders' hardware and other applications are also expected to increase during the Plan period.

The demand of zinc metal during 9th and 10th Plans and forecasts for 11th Plan are presented below:

Zinc Demand in India
(tonnes)

Year	Actual/Estimate
9th PLAN	
1997-98	224,000
1998-99	237,000
1999-00	254,100
2000-01	270,000
2001-02	297,000
10th Plan	
2002-03	326,000
2003-04	375,000
2004-05	396,000
2005-06	420,000
2006-07 (Est.)	455,000
11th Plan (Est.)	
2007-08	491,000
2008-09	530,000
2009-10	572,000
2010-11	618,000
2011-12	667,000
9th Plan CAGR	**6.6%**
10th Plan CAGR	**9.0%**
11th Plan CAGR	**8.0%**

The demand-supply status of zinc metal during 9th and 10th Plans and forecast for 11th Plan is presented below.

Zinc Demand-Supply Scenario in India

(tonnes)

Year	Demand	Supply	Gap
9th PLAN			
1997-98	224,000	172,592	(51,408)
1998-99	237,000	181,958	(55,042)
1999-00	254,100	191,958	(62,142)
2000-01	270,000	206,065	(63,935)
2001-02	297,000	226,140	(70,860)
10th Plan			
2002-03	326,000	256,287	(69,713)
2003-04	375,000	274,882	(100,118)
2004-05	396,000	263,791	(132,209)
2005-06	420,000	324,668	(95,332)
2006-07 (Est.)	455,000	453,000	(2,000)
11th Plan (Est.)			
2007-08	491,000	528,000	37,000
2008-09	530,000	668,000	138,000
2009-10	572,000	678,000	106,000
2010-11	618,000	678,000	60,000
2011-12	667,000	678,000	11,000

There was supply deficit during 9th and first four years of the 10th Plan which was met mainly through imports. With the recent capacity addition of 170,000 tpa zinc production by HZL there would be considerable decline in imports, making the country self sufficient. The 11th Plan projections indicate surplus zinc metal availability which could be exported after fulfilling the domestic demand.

The demand estimates are computed on Y-o-Y compounded growth of 8%. Metal availability may fluctuate on account of any aberration in growth, performance of secondary sector and primary smelting capacity utilization. Consequently, there may be only marginal surplus availability of zinc metal in the 11th Plan. The terminal year of 11th Plan may require further capacity addition to meet the growing domestic demand.

Lead Demand

The lead industry is poised to rise @ 10% CAGR during the 11th Plan. There is significant upsurge expected in applications of lead storage batteries in defence, power, auto and IT-CT and other end user industries.

The demand of lead metal during 9th and 10th Plans and forecasts for 11th Plan are presented below.

The demand-supply status of lead metal during 9th and 10th Plans and forecast for 11th Plan is presented below.

Lead Demand-Supply Scenario in India

(tonnes)

Year	Demand	Supply	Gap
9th PLAN			
1997-98	94,400	64,626	(29,774)
1998-99	97,500	61,918	(35,582)
1999-00	114,600	62,630	(51,970)
2000-01	122,600	59,013	(63,587)
2001-02	132,000	70,975	(61,025)
10th Plan			
2002-03	155,000	82,542	(72,458)
2003-04	171,000	75,089	(95,911)
2004-05	215,000	65,727	(149,273)
2005-06	239,000	73,636	(165,364)
2006-07 (Est.)	275,000	123,000	(152,000)
11th Plan (Est.)			
2007-08	302,000	149,000	(153,000)
2008-09	333,000	164,000	(169,000)
2009-10	366,000	170,000	(196,000)
2010-11	403,000	170,000	(233,000)
2011-12	443,000	170,000	(273,000)

There continues to be supply deficit for lead metal, being met entirely through imports. This is basically due to inadequate lead resources limiting primary metal production capacity build-up. The demand-supply gap could only be reduced either by enhancing primary metal production once new resources are identified or upsurge in recycling of secondaries.

2.3 Down-Stream Industry

Zinc

Zinc consumption in India has been growing substantially in recent years. Consumption of zinc during 2005-06 was 430,000 tonnes approximately. The sectoral consumption of zinc in India is as follows:

Galvanizing	70%
Dry cell	10%
Die Casting	5%
Alloys, brass etc	5%
Chemicals and others	10%

Galvanizing: More than 300,000 tonnes of zinc finds application in the galvanizing sector. The Indian galvanizing industry consists of (a) sheet galvanizing (b) tube galvanizing (c) general galvanizing and (d) wire galvanizing. Market feedback indicates that sheet and tube galvanizing are the lead players in the galvanizing industry.

Sheet galvanizing	50%
Tube galvanizing	30%
General galvanizing	15%
Wire galvanizing	5%

The production of steel pipes and tubes in the country during 1999-2000 was nearly 1.5 million tonnes. Of the total tonnage of tubes produced, about 75% is galvanized and the balance is black pipes (un-galvanized). In the domestic market, the steel tubes face a stiff competition from rigid PVC tubes; a part of the galvanized pipes is also exported.

Originally the galvanized sheets were manufactured by integrated steel plants in the state-owned units as well as one private producer. In the eighties India used to be a major importer of thin gauge galvanized sheets which were used for roofing in hilly areas, appliances, trunks, room cooler bodies etc., Looking at this huge domestic demand, a number of private entrepreneurs set up manufacturing facilities for thin gauge galvanized sheets in the mid-eighties. The current capacity in the country is 4.0 million tonnes and this is expected to be 4.5 million tonnes by end of Eleventh Five Year Plan. The production of GP/GC sheets including colour-coated sheet during 2005-06 was 3.75 million tonnes. The interesting feature is that the sheet galvanizers, in addition to meeting domestic demand, are exporting a substantial part of their production at present.

The export of GP/GC sheets during 2005–06 was 1.70 million tonnes. Tata Steel recently set up a line for manufacture of galvannealed steel sheets, which provide a good base for painting, needed for manufacture of appliances, auto applications etc. There are few colour coating lines coming up in the country which will enhance the zinc demand in the coming years; The use of color coated steel sheets is increasing because of its aesthetics and are widely used in industrial construction, metro stations, architectural applications etc.

The consumption pattern of GP/GC sheets in various end-usage is as follows:

Roofing, panelling	57%
Trunks, drums, barrels etc.,	18%
White Goods	10%
Furniture	5%
Agricultural Implements	5%
Grain storage bins	3%
Automobiles	2%

Source : *JPC*

The general galvanizing sector consists of those units processing power transmission line towers, high mast lighting towers, highway guard rails, railway electrification towers, telecom towers, Hamilton poles etc., in addition to medium and small scale enterprises who galvanize fasteners, pipe fittings, cable trays, buckets etc., The approximate production of transmission line towers during 2005-06 was 300,000 tonnes. Govt. of India proposes to add 62,000 MW of transmission capacity by the end of the Eleventh Five Year Plan. Power Grid has planned to invest Rs.40,000 crores for augmenting the transmission network during the 11^{th} Plan period. The recent applications in the general galvanizing sector include railway sleepers, high mast lamp poles, and cell phone signal towers, guard rails etc.,

Ministry of Road Transport and Highways has identified eight projects totaling 1,405km under Phase V and VI for six laning and four laning of express highways and this would again require sizable quantities of galvanized guard rails, support structures etc.

Railway electrification structures are also processed by general galvanizers to some extent in India. Of late, there seems to be less emphasis on railway electrification structures as the Indian Railways are investing more on gauge conversion, track doubling, safety aspects etc. During 2005-06, less than 500 route km should have been electrified. Gradually the Indian Railways plan to phase out steam locomotives; it would be either electric or diesel engines that would find application for haulage purposes. A number of leading general galvanizers in India have been exporting or undertaking turnkey power transmission projects (from design to commissioning) in several overseas countries in South East Asia, America, Africa etc.

The zinc consumption in general galvanizing during 2005 was 51,600 tonnes, power accounting for 46%, telecom 12%, industrial projects 11%, railways 2.5% and miscellaneous 25%. The wire galvanizing sector manufactures barbed wires, plain wires, wire ropes, cable armouring etc.

Currently, the total output of galvanized products (in all forms) is of the following order:

Type of Product	Production (million tonnes)
Galvanized sheets	3.0

Galvanized tubes	1.5
General galvanized ware	0.5
Galvanized wires	0.3
Total	**5.3**

The current steel consumption in India is 43 million tonnes, of which only 5.30 million tonnes are coated with zinc, thus forming only 12% and indicating the immense, untapped potential. Per capita consumption wise, India at present exhibits very low levels, steel at 35 kg and zinc at 0.4 kg, (world averages being 125 kg and 1.3 kg respectively) which again reinforces the need for an aggressive market development and promotion by the zinc industry as well as the galvanizing industry.

In view of the current and proposed thrust on the infrastructure development in the forthcoming Plans, investment in construction is bound to increase significantly. This in turn will generate more demand for galvanized steel and hence the demand for zinc.

Die-casting: The die-casting industry, in general, caters mainly to the auto sector to the extent of 60%, the balance being taken by the electrical sector (15%) textiles (10%) household appliances (5%) electronics and business machines (5%) and others (5%).

Zinc die-cast components are used in automobiles, (carburetor components, auto locks, door handles etc.) consumer segment (LPG regulators, locks, toys, buckles etc.) zippers, construction hardware (door handles, knobs etc.) electrical fittings (coupling boxes, connectors etc.). For the year 2006, the zinc die-casting volume amounted to 25,000-30,000 tonnes approximately and the approximate shares, sector-wise, are zippers (29%), automobiles (20%) consumer segment (14%) automobiles (20%) electrical fittings (15%). This is due to the expected growth in demand for automobiles, LPG connections, improved living standards, increased construction activity etc. Apart from these there are newer application areas like builders hardware and auto components for export markets.

For stimulating zinc consumption in new and unconventional application areas like heat sinks, appliances, electronic fittings etc., intensive market development initiatives need to be pursued by zinc producers and the die-casting industry.

Dry cells: Dry cells or dry batteries have come to stay as easy, portable sources of instant electrical energy and therefore it finds ready application in radios/transistors, walkmans, shavers, toys, wall clocks, calculators etc. The per capita consumption of dry cell in India is around 2.1. The growth of this industry is directly linked to the purchasing power in the rural areas. Therefore, the dry cell industry has been witnessing fluctuating fortunes. There are about 3 big players and it appears that there are also a few units in the small scale/medium sector who cater to local markets. The current production capacity in the country is put at roughly 2.5 billion nos and the country may be producing anywhere around 2 billion nos. India produces various sizes of batteries, 67% large size, 29% pencil size and 4% medium size.

The trend in usage of dry cell batteries in India has shifted from rural areas to urban and semi-urban population in the recent years. The increase in the usage of modern electronic gadgets and the improved standards of living have led to an increase in the demand of zinc carbon dry cells.

Lead

Worldwide lead is widely used in diverse and critical applications such as batteries, chemicals, nuclear reactors, sound insulation etc. In India lead consumption has seen a robust growth after the introduction of economic liberalisation in mid-1991. During 2005-06, lead consumption was around 2,40,000 tonnes, including imports, recycling etc.

Despite its varied applications, the usage of lead has been subjected to several challenges from the environmental angle in recent years, because of its toxicity. In some applications, lead has been substituted by alternate materials, such as in the case of pigments, paints, solder alloys etc. in a phased manner. Lead use in cable sheathing has been substituted by plastics. However there are a number of applications for which no alternatives are available, at least for the next couple of decades such as lead batteries.

Applications wherein alternatives to Lead Metal are not available In the next 10 years

Applications	Remarks
Lead Acid Batteries	All known alternatives are technically or financially worse than lead.
Sound and Vibration	Alternatives have not been identified

The end-use wise consumption of lead in India at present is given below:

Batteries	75%
Alloys, Chemicals	20%
Cable Sheathing	5%

Lead acid battery industry is indeed growing steadily and continuously over the years to meet diverse and demanding applications such as automobiles, invertors, UPS, Railways, Telecom, Power etc., The major battery manufacturing units have already embarked upon capacity expansions to meet the growing demand.

Though the growth in lead acid batteries demand is more due to increase in vehicle population, the demand for stationary and industrial batteries has also been witnessing a remarkable growth due to severe power crisis in several parts of India. The expected growth rates for different segments of batteries in the coming years are as follows:

Application	% Growth
Automotive	20
Railways	15
Power	20
Telecom	15
UPS	30

Source : Battery Industry

In view of the immense growth potential of these two key sectors namely computers and televisions, lead consumption is bound to increase in the years to come. The premier IT Association namely, NASSCOM estimates that computer industry in India will grow at 15% per annum. This will increase the demand for UPS substantially. Similarly the power crisis in most parts of the country will generate substantial demand for inverters. Thus the demand for lead acid batteries is likely to go up because of the expanding industrial applications.

Several new applications of lead batteries are also emerging and they are:

Load Leveling Batteries: The use of large lead-acid batteries to meet peak time demand for electricity is currently assuming wide significance. The batteries are charged when demand is low and supply electricity during periods of high demand. This means that less power generating capacity is required, thereby eliminating the need to build large new power stations. It is expected that there will be an increasing demand for Lead batteries in these applications. Both the conventional and VRLA batteries are ideal for this application.

Electric Vehicle (EV) Batteries: While a number of battery systems are considered for this purpose, lead acid battery system seems to be the first choice. This is due to the fact that these batteries are not only economical but are also eco-friendly in nature. The steadily increasing oil prices and the dwindling fossil fuel resources have resulted in a renewed interest in EVs in the country. However, the main disadvantage is that they are too heavy and offer low cycle life. Not withstanding this fact, there has been a remarkable progress in this system for EV applications. The lead acid battery system has an environmental edge. This is primarily due to the facts: (a) Lead is confined in the battery case and (b) High recycling rate of lead in batteries. Lead acid battery powered electric vehicles are being used for “in-campus” use in many organizations like IITs, AIIMS etc., and are ideally suitable for tourist spots, postal vans, diary vehicles, airport uses etc.

Remote Area Power System (RAPS) Batteries: There is a considerable interest in the use of lead acid batteries to store energy produced from renewable energy sources such as photovoltaic, wind, hydro etc. These energy sources however provide fluctuating output and therefore need to be stored so as to provide a constant and stable power supply at times of need. Lead acid batteries have been found to be an excellent storage system for this purpose. The excessive maintenance that was needed has become a thing of the past with the invention and commercialization of so-called sealed maintenance free batteries. The prerequisites for batteries meant for this application are good cycling capability and long life. International Lead Zinc Research Organization (ILZRO) had successfully installed RAPS in the Amazon Basin Area, Peru.

2.4 Globalisation Efforts

Every country or organization is desirous of achieving global competitiveness, by devising appropriate strategies. The downstream industry viz., manufacturers of galvanized steel structurals, sheets, tubes as well as die-cast builders hardware, dry cells and lead acid batteries has been exporting on a regular basis, thus proving the cost advantages and competitiveness of Indian industry.

2.5 Value addition

The success of any organization depends on the “value addition” that they impart to a product or a service. Customers always look for value added goods and services. In a metal-producing organization, value is added at every stage from mining to manufacture by eliminating the undesirable impurities or by enhancing the final quality / grade. In the case of zinc-lead downstream industry, a greater value addition is imparted when galvanized steel products, die castings, dry cells, lead acid batteries, lead zinc chemicals are manufactured. These are ready to use products in the assembly or in the final structure and they have different life cycles. At the end of their life cycles, they still have so much intrinsic value that someone or the other (metal trader, recycler etc.,) is willing to pay for them.

2.6 Research & Development

The Ministry of Mines, Government of India has a Standing Scientific Advisory Group (SSAG) headed by the Secretary (Mines). This Group coordinates the Science and Technology (S&T) activities of the constituent companies and organizations. The schemes include:

1. Long-term projects carried out by the companies entirely from internal resources.

2. Projects at National Laboratories/Academic Institutions sponsored by the companies through the SSAG.

3. Projects funded by the Ministry partly or entirely from the S&T grants of the Ministry and carried out at in-house R&D centers of the companies or other laboratories.

At present the R&D set up in the industry is largely working on problem solving and applied research. In order to ensure technological upgradation/adoption and development of new techniques, strengthening of the R&D organization with talent identification and positioning, and adequate funding is necessary. In addition, the industry is also actively engaged in collaborative R&D projects with other institutes and academic centres like Indian Bureau of Mines' laboratories, National Metallurgical Laboratory (Jamshedpur), Central Electrochemical Research Institute, Kararikudi (Tamil Nadu), Regional Research Laboratories at Bhubaneswar and Bhopal,Central Mining Research Institute(Dhanbad),Tata Research Design and Development Center (Pune), Maharastra Association for Cultivation of Science(Pune) and Indian Institute of Science(Bangalore).

2.7 Major R&D projects in progress

Ore Dressing

1. Development of ore beneficiation process flow sheet for new zinc-lead mine at Sindesar Khurd
2. Optimization of Silver recovery from ore

3. Silver Recovery from waste products like Moore cake, Slag & Graphite concentrate through flotation route.

4 Improvements in Grinding and Classification circuits through modeling studies

Extractive – Metallurgy

- Recovery of metals – copper, nickel, cobalt - from polymetallic nodules of Indian Ocean
- Recovery of Cobalt from Waste Residue (Beta Cake)
- Optimization of metal recoveries in smelters using problem solving and applied research techniques
- Recovery of value metals such as zinc, lead, copper, silver, etc. from slag/wastes/ residues

Step Change Technologies

- Microwave aided ore grinding to reduce specific power consumption and increase in mill throughput
- Recovery of zinc values from Rampura Agucha Mill tailings using bio-technology
- Use of slag in construction & cement

2.8 Investments

There has been significant infusion of investment for capacity creation and increased operational efficiency by the Indian lead-zinc producing sector, mainly by HZL.

An investment of Rs. 2,600 crore is estimated during the 10th Plan period. The investment has been mainly towards mineral exploration; development of mines; debottlenecking and modernization of mines, beneficiation plants and smelters; new capacity additions, captive power plants (zinc smelting process being power intensive) etc.

The investment during the 11th Plan is projected at Rs. 2,400 crores, the major investment being on identification of new resources, development of new mines, capacity addition for zinc metal production with matching expansion in the mines along with captive power plant.

2.9 Associated Metals

Cadmium, silver, antimony, bismuth, mercury, indium and arsenic are generally associated as minor/trace elements with zinc-lead-copper deposits. Based on content in the ore, these are concentrated at ore beneficiation stage and finally some of these are recoverable during refining of main metals.

These metals and their alloys find extensive application in a wide range of industries like - electronic, pharmaceutical, pesticides, space and defence, photographic materials, batteries, electroplating, cosmetics, paints, industrial and laboratory chemicals.

2.9.1 World scenario

The world resources, production and major uses of these metals are summarised below.

World Scenario - Associated Metals
(tonnes)

	World Resources	World Refinery Production during 2005 (Est.)	Major Uses
Cadmium	600,000	18,000	Ni-Cd Batteries
Bismuth	330,000	5,200	Fusible alloys
Antimony	1,800,000	117,000	Pb-Sb alloys and Ammunition
Silver	280,000	20,300	Jewellery, Electronics
Indium	2,800	455	Gas Pressure and lamps
Arsenic	1,100,000	40,000 (As Arsenic trioxide)	
Mercury	600,000	1,100	

Source: *US Geological Survey, Mineral Commoditiy Summaries, January 2006*

Cadmium

The bulk of cadmium is obtained from zinc concentrates. Estimated production of cadmium in the world was nearly 18,000 tonnes during 2005. China, Japan, Kazakhstan, Korea Rep., Mexico, Canada and Russia are leading cadmium producers and account for about 3/4th of world's total output.

World Metal Production - Cadmium
(2005 Estimates)

Country	Tonnes
China	3,000
Japan	2,400
Kazakhstan	2,300
Korea Rep	2,200
Mexico	1,600
Canada	1,400
Russia	1,050
Peru	600
USA	550
Australia	460
Germany	420
India	***405***
Others	2,020
World Total	**18,000**

Source: *USGS, Mineral Commoditiy Summaries, January 2006*

The Restriction on the Use of Hazardous Substances (RoHS) – prohibits use of cadmium and other heavy metals in most electrical and electronic equipment sold in the European Union after July 1, 2006. Cadmium plating of electronic components is exempt from RoHS. Sale of certain types of portable NiCd batteries is baned. NiCd batteries are restricted to use in alarm and emergency systems, cordless power tools, and medical equipment.

Lithium-ion and nickel-metal hydride batteries are replacing NiCd batteries in some applications. Except where the surface characteristics of a coating are critical (e.g., fasteners for aircraft), coatings of zinc or vapour-deposited aluminum can be substituted for cadmium in many plating applications. Cerium sulphide is used as a replacement for cadmium pigments, mostly in plastics.

Silver

During 2005, the estimated production of silver was nearly 20,300 tonnes. Peru, China, Mexico, Australia, Chile, Canada, Poland and USA are leading silver producers and account for about 80% of world's total output.

Investment and fabrication demand of silver in jewelry and silverware market has been rising. Silver application in photography is continuously falling due to growth of digital photography in the amateur market. Antibacterial use of silver in trace amounts in wound care is increasing.

Silver use in mirrors and other reflecting surfaces may be replaced by aluminum and rhodium. Tantalum may be used in place of silver for surgical plates and pins.

World Metal Production - Silver
(2005 Estimates)

Country	Tonnes
Peru	3,060
China	2,800
Mexico	2,700
Australia	2,250
Chile	1,400
Canada	1,330
Poland	1,300
USA	1,300
South Africa	80
India*	***24***
Others	4,056
World Total	**20,300**

* HZL

Source: *USGS, Mineral Commoditiy Summaries, January 2006*

2.9.2 **Indian scenario**

In India, Hindustan Zinc Limited (HZL) is the major producer of Cadmium and silver metals which are recovered as by-products from the smelting of zinc-lead concentrates. Cadmium is also recovered in the plant of Binani Industries Ltd. (BIL) which is based on imported zinc concentrate. Small quantities of silver are also recovered in smelters of Hindustan Copper Limited (HCL). There is no commercial production for the other associated metals.

Production of cadmium and silver by HZL and BIL is given below.

Production of Silver and Cadmium
(' tonnes)

Year	Cadmium	Silver
10th Plan		
2002-03	483	47.2
2003-04	479	34.7
2004-05	475	10.7
2005-06	405	24.1
2006-07 (Est.)	470	60.0

It is estimated that the zinc-lead reserves of HZL contain nearly 27,600 and 3,700 tonnes of cadmium and silver metals respectively.

Estimated production of cadmium and silver in the terminal year of 10th plan will be of the order of 470 and 60 tonnes respectively. It is estimated that cadmium and silver production will rise to about 750 and 90tpa respectively from 2008-09 in the middle of 11th five year plan. This would be mainly on account of HZL's mining and smelting capacity expansion. In addition, the industry has taken up various measures to improve recovery efficiency through process flow-sheet modification, R&D projects for optimization of recovery of these metals both at beneficiation and smelting stages and recovery from wastes and residues.

Antimony and arsenic contents are too low in the Indian ore for recovery.

Demand

The envisaged demand projections (in tonnes) are as follows.

Year	Cadmium	Silver	Antimony	Bismuth	Arsenic
2006-07 (10th Plan)	593	870	2595	32	146
2011-12 (11th Plan)	775	1010	3082	38	180
2016-17 (12th Plan)	1010	1170	4030	50	220

The market for cadmium is shrinking due to environmental and health hazards. However, some envitable applications like NiCd batteries will continue till alternatives are found.

India is largest consumer of silver in the world and its demand is likely to increase steadily.

2.10 Other Metals

Nickel

2.10.1 **World scenario**

The land-based resources (reserve base) of nickel, averaging over 1% metal, are estimated at 140 million tonnes. Of these, about 60% is in laterites and remaining is in the form of sulfide deposits. In addition, extensive deep-sea resources of nickel are in manganese crusts and nodules covering large areas of the ocean floor, particularly in the Pacific Ocean.

Bulk of the world nickel resources is confined to Australia, Cuba, Canada, Indonesia, New Caledonia, South Africa, Brazil and China. Russia, Australia and Canada are the major producers of refined nickel in the world. The estimated world nickel mine production during 2005 was 1.5 million tonnes. The estimated world refined nickel production during 2005 was 1.30 million tonnes. The estimated world nickel consumption during 2005 was 1.32 million tonnes, reflecting a deficit of 20,000 tonnes. During 2006 also, a similar worldwide deficit is forecast.

Production and Reserves of Nickel ('000 tonnes)

Country	Mine production		Reserves	Reserve base
	2004	2005 (Est.)		
Russia	315	315	6,600	9,200
Australia	178	210	22,000	27,000
Canada	187	196	4,900	15,000
Indonesia	133	140	3,200	13,000
New Caledonia7	118	122	4,400	12,000
Cuba	72	75	5,600	23,000
Colombia	75	73	830	1,100
China	64	71	1,100	7,600
Dominican Republic	47	47	720	1,000
Brazil	45	46	4,500	8,300
South Africa	40	42	3,700	12,000
World total (rounded)	1,400	1,500	62,000	140,000

Source: *USGS, Mineral Commoditiy Summaries, January 2006*

2.10.2 **Indian scenario**

Main nickel occurrence in India is found in the Sukinda Valley in Orissa in the overburden of chromite. The nickel-ferrous limonites vary in composition from 0.5 to 0.9 Ni and is characterised by high iron content, low magnesia and occur as discontinue structures. Nickel also occurs in sulphide form along with copper mineralization in East Singhbhum district, Jharkhand.

The total resources of nickel in India are estimated at 189 Mt of which 42.1 Mt contains +0.9% Ni. Orissa hosts about 92% of the total resources.

Nickel Resources (UNFC) in India as on 1st April 2005 (Provisional)

('000 tonnes)

State	Reserves	Remaining Resources	Total Resources
All India	-	188,710	188,710
Orissa	-	174,480	174,480
Jharkhand	-	9,000	9,000
Nagaland	-	5,000	5,000
Karnataka	-	230	230

Source: *Indian Bureau of Mines*

So far, nickel is not produced from the primary source in the country and entire demand is met through imports. The sectoral uses of Nickel are given below:

Stainless Steel	65%
Alloys	12%
Plating	8%
Foundry	6%
Battery, others	9%

Tin

2.10.3 **World scenario**

Tin, one of the oldest commercially available materials, is used basically in tin plate, solders, bronze, brass, white metals, babbitt and chemicals. The important end-uses are in cans and containers, transportation, machinery, electrical, construction and chemicals. Tin plate, which used to be the largest consumer sector of tin till recently, is being substituted by aluminium and Tin-Free Steel (TFS) in beverage cans.

Tin resources in the world are estimated at around 11 million tonnes and about 82% of these are in China, Brazil, Malaysia, Peru and Indonesia.

Tin Resources in world

Country	**Reserve Base (‘000 tonnes)**
China	3,500
Brazil	2,500
Malaysia	1,200
Peru	1,000
Indonesia	900
Bolivia	900
Others	1,000
World total	11,000

Source: *Mineral Commodity Summaries, USBM, Jan, 2006*

About 91% of world’s tin mine production comes from Indonesia, China, Peru and

Bolivia. The estimated refined tin production during 2005 was about 330,000t. China, Indonesia, Malaysia and Peru together produced about 78% of refined tin. India's share in refined tin production was nearly 1%. The refined tin consumption during 2005 was about 348,000t, of which nearly 33% was in China. The other leading consuming countries are USA, Japan, Germany and Korea Rep.

Tin Mine Production in the World ('000 tonnes)

Countries	2002	2003	2004	2005
Indonesia	78.6	64	78.4	120
China	81	101.8	118.2	119.5
Peru	38.8	40.2	41.6	42.1
Bolivia	13.2	16.4	18.1	18.7
World Total	**245.8**	**253.2**	**285.2**	**330.3**

Tin Refined Production in the World ('000 tonnes)

Countries	2002	2003	2004	2005
China	81.8	98.1	115.3	119.4
Indonesia	58.8	62.5	86.9	78
Malaysia	30.9	18.3	33.9	41.2
Peru	33	39.2	40.6	38.3
India	***3.6***	***3.6***	***3.6***	***3.6***
World Total	**266.4**	**276.6**	**346.2**	**353.3**

Tin Refined Consumption in the World ('000 tonnes)

Countries	2002	2003	2004	2005
China	53.2	71.7	92.9	115.5
U.S.A	45.7	44.4	53.6	42.1
Japan	26.8	28.8	33.1	33.2
Germany	19.5	20.7	20.3	19.1
South Korea	17.7	17.2	16.2	17.9
India	***6.9***	***6.6***	***5.9***	***7.7***
Spain	6.7	8.2	7.7	7
Russia	5.5	6.1	5.3	6.6
World Total	**275.6**	**301.8**	**336.3**	**348.3**

Source: *Metal Statistics- Jan 2006*

2.10.4 **Indian scenario**

The total resources of tin in the country are placed at 87.34 million tonnes containing about 0.7 million tonnes of metal. Of this, about 12,700 tonnes containg 34.6 tonnes tin metal, located in Orissa, are classified as reserves. Most of the remaining resources are located in Haryana (61%), Chattisgarh (38%), and Orissa (1%).

There is meagre production of primary tin metal in the country and almost entire consumption is met by imports.

Demand for tin plate for packaging industry in the country is growing and the consumption is expected to grow at a moderate level of 5% per annum. The per capita consumption of tin plate in India is only 0.3kg compared with 10kg in USA, 8kg in Japan and 0,8kg in China. Lead-free solder are expected to find market for soldering of electronic and electrical devices in future. Motor vehicle industry is showing interest in tin-zinc coatings for fuel tanks to replace lead-based fuel tank coatings.

Tungsten

2.10.5 **World scenario**

Tungsten has outstanding physical properties such as high specific gravity, hardness and the highest melting point and has therefore become indispensable in strategic and industrial uses, particularly in defence armaments. Tungsten is mainly used in:

1	Metal working, mining, & construction, machinery and equipment and cemented carbide	74%
2	Electric bulb filaments, electrodes, x-ray tube anode and other electronic uses	19%
3	Chemicals, organic dyes, pigments etc.,	4%
4	Others including alloys	3%

The most important tungsten bearing minerals are wolframite and scheelite. Total world tungsten reserves are 2.9 million tonnes of metal content. About 62% of the tungsten reserves are in China. Canada and Russia each contain nearly 9% of reserves.

World Reserves of Tungsten
('000 tonnes of metal content)

Country	Reserves
China	1,800
Canada	260
Russia	250
United States	140
Bolivia	53
Portugal	25
Austria	10
Other countries	360
World total	2,900

Source: *USGS, Mineral Commoditiy Summaries, January 2006*

Except for primary exploitation at some deposits, it is a co-product or a minor by-product of other minerals. China accounts for about 90% of world's production. Russia, Austria, Portugal and Canada are the other main producers of Tungsten in the world. Tungsten mine (concentrate) production in the world during 2004 and 2005 is given below.

Table
World Mine Production of Tungsten
('000 tonnes of metal content)

Country	2004	2005 (Est.)
China	67	69
Canada	-	0.75
Russia	3	3
Bolivia	0.44	0.4
Portugal	0.75	0.85
Austria	1.4	1.4
Other countries	0.51	0.51
World total	73.7	76.5

Source: *USGS, Mineral Commoditiy Summaries, January 2006*

Marketing strategy of tungsten depends on a host of economic, political and technological factors. The major deciding country is China, by virtue of it being the single largest producer.

2.10.6 **Indian scenario**

The total resources of tungsten in the country are estimated at 87.3 million tonnes. Bulk of the resources are localised mainly in low-grade tungsten bearing granite at Degana in Rajasthan. It used to be the only operative mine for tungsten in India with a small production of about 10 tonnes of concentrate, but was closed in the early part of the 9th Plan on techno-economic consideration. Hence the entire quantity of tungsten is currently being imported.

Table
Tungsten Resources (UNFC) in India as on 1st April 2000

State		**Reserves**	**Remaining Resources**	**Total Resources**
All India	Total (Mt)	-	87.3	87.3
	Contained WO_3 (t)	-	141,736	141,736
Andhra Pradesh	Total (Mt)	-	14.8	14.8
	Contained WO_3 (t)	-	20,262	20,262
Haryana	Total (Mt)	-	2.2	2.2
	Contained WO_3 (t)	-	3,568	3,568
Karnataka	Total (Mt)	-	36.7	36.7
	Contained WO_3 (t)	-	6,235	6,235
Maharastra	Total (Mt)	-	8.1	8.1
	Contained WO_3 (t)	-	16,035	16,035
Rajasthan	Total (Mt)	-	23.9	23.9
	Contained WO_3 (t)	-	93,708	93,708
Tamil Nadu	Total (Mt)	-	0.3	0.3
	Contained WO_3 (t)	-	50	50
Uttranchal	Total (Mt)	-	0.7	0.7
	Contained WO_3 (t)	-	705	705
West Bengal	Total (Mt)	-	0.7	0.7
	Contained WO_3 (t)	-	1,173	1,173

Source: *IBM Mineral Year Book 2004*

The Tungsten concentrate demand forecast is as follows

Year	**Demand (tonnes)**
2006-07	11,900
2011-12	17,500
2016-17	25,800

The tungsten demand can only be met by the imports as there is no indigenous production. However, due to its strategic importance, following measures are suggested.

- Vigorous exploration to identify new economic resources and evaluation of existing potential reserves
- Continue the efforts on effective utilisation of scrap
- R&D for flotation, solvent extraction, plasma smelting and refining of the metal

2.11 Recommendations

The strong economic growth is set to continue in India during the 11th Plan and beyond with key growth drivers and major investment driven policies of Govt. of India. This would result in robust demand for metals/ emerging markets, particularly, in view of India's advantage as a natural resources destination. The zinc-lead industry will be no exception to this.

For significant growth of Indian zinc-lead industry, it would be necessary to carve out a way forward not only in attaining self sufficiency but also in establishing share in the global metals and mining map. In this regard, some of the key points requiring specific attention are recommended as under:

- Enabling & conducive environment to accelerate mineral exploration.
- Mining regulation framework revision to foster growth.
- Market Development and development of newer applications
- Infrastructure development
- Focus on Safe & eco-friendly Recycling
- Creating capacities with focus on global cost competitiveness and value addition
- Focused R&D efforts for recovery of minor/trace metals and development of cost effective newer applications
- Growth strategy for identification and development of resources of other metals like nickel, tin, tungsten etc.

It is recommended that to harness country's potential in metals industry, Central/ State Governments' support is solicited for the following:

11 Single window clearance for grant of permission from RP/PL/ML to mine operation/ closure. Process simplification on time bound grant of environment clearances through single empowered panel and single nodal agency for monitoring the compliance of environmental parameters/ issues as against a number of State & Central Departments. Clearances should be deemed to be granted after the expiry of the allotted time.

12 While opportunities exist, the metals industry is not able to grow to its full potential on account of inadequate exploration of the mineral resources and lack of enabling environment and specific infrastructure like power, water, roads etc.

13 To generate focus on mineral exploration, being fundamental for future development of metals industry. There is a need to evolve a framework of commitment to active exploration by mining companies.

14 To improve the Minerals Code – geo-scientific data availability, rationalization of tenements system/grant of larger areas under RP/PL/ML, licence security, preferential rights to reserve areas.

15 Relaxation of environmental site clearance for PL – not involving any damage to flora and fauna.

16 To operationalize and simplify the application of provisions regarding compensation, land etc, for fast track large projects to deal with mining lease related issues in reserve forests/ bio forests.

17 To attract large investments in metals sector by introducing tax concessions on "Exploration" in line with R&D activities, allowing duty free imports of

capital goods for setting up projects, incentivising “Mega projects”.

18 To rationalize royalty rates in line with international competitor countries.

19 Part of the royalty to be allocated towards infrastructure/ community development and also for funding fresh exploration.

20 Moratorium/ suitable structure for royalty deferment to support investment in mineral/ metal sector.

Some of these points have also been considered by the Hoda Committee and the same needs to be notified expeditiously.

Lead and Zinc Projections

Compound Growth rates of domestic production

Year	India Zinc	India Lead	GDP at 93-94p
15 yrs Gr 93-07	6.262	0.994	5.637
10 yrs Gr 97-07	11.974	6.952	5.922
5 yrs gr 93-8	4.466	0.159	6.687
5 yrs gr 98-03	8.228	5.016	5.501
5 yrs gr 02-07	14.906	11.625	5.936

Elasticity	India Zinc	India Lead	GDP at 93-94p
15 yrs Gr 93-07	1.111	0.176	1.000
10 yrs Gr 97-07	2.022	1.174	1.000
5 yrs gr 93-8	0.668	0.024	1.000
5 yrs gr 98-03	1.496	0.912	1.000
5 yrs gr 02-07	2.511	1.958	1.000

Growth rates		
8% GDP	8.888	1.408
9% GDP	9.999	1.584
10% GDP	11.11	1.76
11% GDP	12.221	1.936

	India Zinc production projections				India's Lead production projections		
GDP rate	8% GDP	9% GDP	10% GDP	11% GDP	8% GDP	9% GDP	10% GDP
Zinc Gr	8.888	9.999	11.11	12.221	1.408	1.584	1.76
2006-07	493263	498295	503328	508361	124732	124948	125165
2007-08	537104	542583	548064	553544	126488	126927	127368
2008-09	584842	590808	596776	602743	128269	128938	129610
2009-10	636823	643319	649817	656315	130075	130980	131891
2010-11	693424	700498	707573	714648	131907	133055	134212
2011-12	755055	762758	770462	778166	133764	135162	136574
2012-13	822164	830552	838941	847330	135647	137303	138978
2013-14	895238	904371	913506	922640	137557	139478	141424
2014-15	974807	984752	994698	1004644	139494	141688	143913
2015-16	1061448	1072276	1083107	1093937	141458	143932	146446
2016-17	1155790	1167580	1179373	1191166	143450	146212	149023
2017-18	1258516	1271355	1284196	1297037	145470	148528	151646
2018-19	1370373	1384353	1398335	1412318	147518	150880	154315
2019-20	1492172	1507394	1522619	1537845	149595	153270	157031
2020-21	1624796	1641371	1657950	1674528	151701	155698	159795
2021-22	1769208	1787256	1805308	1823360	153837	158164	162607
2022-23	1926455	1946108	1965764	1985421	156003	160670	165469

Based on actual data for the country, the following relationship was established

Log Zinc prod = -1.9042 + 1.1982 log GDP 93-4p ; R2 = 0.88; adj R2+ 0.87
(-2.57) (9.74)

Log Lead prod = 1.647 + log 0.529 Log GDP; R2= 0.497 adju R2= 0.437 Multipl R2= 0.69
(1.78) (3.447)

Log GDP = 2.977 + 0.930 log Zinc – 0.392 log Lead;
(5.097) (7.438) (-1.876)
R^2 = 0.952; Multiple R^2 = 0,906; Adju R^2 = 0.89 Std error = 0.0378

Using above models projections for domestic **Zinc** production

GDP rate	8% GDP	**9% GDP**	10% GDP	11% GDP
2006-07	496423	**501851**	507283	512705
2007-08	544008	**555969**	568071	580280
2008-09	596154	**615924**	636143	656761
2009-10	653299	**682344**	712372	743322
2010-11	715922	**755926**	797735	841292
2011-12	784547	**837444**	893328	952174
2012-13	859751	**927752**	1000375	1077671
2013-14	942163	**1027799**	1120250	1219708
2014-15	1032475	**1138635**	1254490	1380465
2015-16	1131444	**1261423**	1404815	1562410
2016-17	1239900	**1397452**	1573154	1768336
2017-18	1358752	**1548151**	1761665	2001403
2018-19	1488996	**1715100**	1972766	2265188
2019-20	1631725	**1900053**	2209162	2563739
2020-21	1788136	**2104951**	2473886	2901640
2021-22	1959540	**2331945**	2770332	3284076
2022-23	2147373	**2583417**	3102301	3716918

Domestic **Lead** Production Projections

GDP rate	8% GDP	9% GDP	10% GDP	11% GDP
Lead Gr	4.232	4.761	5.29	5.819
2006-07	128205	128856	129507	130157
2007-08	133631	134991	136358	137731
2008-09	139286	141418	143571	145746
2009-10	145181	148151	151166	154227
2010-11	151325	155204	159162	163201
2011-12	157729	162593	167582	172698
2012-13	164404	170334	176447	182747
2013-14	171362	178444	185781	193381
2014-15	178614	186940	195609	204634
2015-16	186173	195840	205957	216542
2016-17	194051	205164	216852	229142
2017-18	202264	214932	228324	242476
2018-19	210824	225165	240402	256586
2019-20	219746	235885	253119	271517
2020-21	229045	247115	266509	287316
2021-22	238738	258880	280607	304035
2022-23	248842	271206	295452	321727

CHAPTER-III

ALUMINIUM

(aluminium, gallium, vanadium, magnesium, titanium and silicon)

3.0 Introduction

3.0.1 The global aluminium industry has seen sea change in the last five years with an increasing demand for the metal as well as production expansions in tandom, to meet this growing demand. The metal as well as the alumina prices both in International and the domestic markets have been on a record breaking increased since beginning of 2004. The prices of the metal have reached to US $ 2860 and that of alumina 600 – 610 US $. Indian integrated aluminium producers are looking to take advantage and benefit from this higher global demand and prices. A notable development during this period is China's emerging demand for aluminium and it has become a net importer of alumina as well as producer of metal by doubling its capacity to a level of 5 million tonnes. It is set to double its production to nearly 12 million tonnes and planning its doubling capacity with a forecast of 9 kg per capita consumption of compared to about 4 kg at present. Therefore the aluminium industry is emerging as a promising industrial sector in the World and in India.

3.0.2 The 11^{th} plan document for the period 2007-2012, covers the aluminium sector starting from bauxite – the raw material, alumina – the intermediate product, primary metal, secondary recycling to downstream products. Reviewing the performance during 10^{th} plan, present trend and future prospects, the document evolves a prospective plan for a further period of 10 years.

3.0.3 While bauxite still continues to be the only ore used for commercial production of aluminium, the basic process of alumina refining and aluminium smelting ie., Bayer's process and Hall Herault process continue to be followed with improvements for better performance. In India, R&D efforts and technology improvement should continue to bring competitive advantage to the aluminium sector. There is also need to contemplate on the sustainable development, by taking appropriate measures to control environmental hazards.

3.0.4 Indian aluminium industry enjoys a number of competitive advantages over the producers in the world. Indian companies have captive resources of bauxite and the domestic demand for metal is expected to grow particularly in automobile industry and construction. For example, bauxite deposits in the states of Orissa and Andhra Pradesh are near to the coast and in these places thermal coal is available to generate power. With WTO regulations, aluminium sector in India has to rise to the occasion to improve its performance. Taking into account the expected increase in per capita consumption, growth in population, application of aluminium in new areas such as automobile, structural, packaging etc and export potential, the document foresees better prospects for aluminium in the coming years.

3.1 Bauxite

3.1.1 World Scenario

3.1.1.1 World bauxite resources are 55 to 75 billion tones. Except in Australia, the bauxite resources are mostly available in countries with developing economy which account for nearly 70% of the total bauxite reserves. The estimated reserves of all categories are placed at 34 billion tones.Country wise distribution of bauxite reserves given in Annexure-I

3.1.1.2 World production of metallurgical grade bauxite has reached 125 million tonnes in 1998 from 115 million tonnes in 1993.The world production of bauxite has reached 155 million tonnes in the year 2003.Countrywise bauxite production, and yearwise from 2001 to 2003 is given in Annexure-II Major producers are Australia, Guinea, Jamaica, Brazil, China,India, Venezuela, Surinam, Russia. Australia alone accounts for nearly 36 to 40% of World production. In the world the bauxite production has increased by about 7% from 2002 to 2003.This will further increase during 2007-2008 at the rate of 5% for year. The bauxite is also raw material besides aluminium industry, to other non-metallurgical industries, such as chemical, refractory and cement industries. Nearly 10% of total bauxite produced is used for these industries.

3.1.1.3 World trade in bauxite is less preferred compared to alumina.The developed countries having smelters prefer to import alumina instead of bauxite, to reduce freight costs. Bauxite from Africa, South America and Australia are dispatched to North America and Europe. Now, more refineries are planned in these bauxite exporting countries, to produce & export alumina.

The FOB Price of bauxite vary between 25-35 USD/tonne. The available world bauxite resources are adequate for 100 years at present production rate.

3.1.2 Indian Scenario

3.1.2.1 The overall resource position of bauxite in India is over 3 billion tonnes. India occupies 5th place with a share of 7% of world resources. State wise distributions of bauxite resources are given at Annexure-III. Out of this 80% of resources are of metallurgical grade.While Orissa and Andhra Pradesh account for more than 90% of country's metallurgical grade resources. The balance is distributed in Jharkhand, Chattisgarh, Karnataka and Maharshtra. The resources of metallurgical grade bauxite are quite adequate. While the chemical and refractory grade bauxites are mostly located in Gujarat, Karnataka, Chattisgarh, Jharkhand and Maharashtra. These chemical and refractory grade resources are very less considering the future requirements.

3.1.2.2 The estimated reserves of bauxite of all grades and categories in India are 2.5 billion tonnes. As per this, India's position is 4th in the world after Guinea, Australia and Brazil. Out of this established metallurgical grade reserve with higher confidence level of estimation are around 2.5 billion tonnes. These can be easily developed to meet the requirements of aluminium industries.

3.1.2.3 The production of bauxite in India has increased from 5.06 million tonnes in 1991-92 to 7.06 million tonnes in 2000-01.The year wise production of bauxite is given below:

Year	Production (in million tonnes)

1996-1997	6.04
2000-2001	7.06
2001-2002	8.60
2002-2003	9.86
2003-2004	10.90
2004-2005	11.69

There is an increase varying from 0.5 million tonnes to more than 1 million tonnes yearly.

3.1.2.4 Though there are more than 200 mines operating in the country, most of these are small, and manually operated in open cast method. 15 major deposits account for 75% of the country's production. These are mostly the captive bauxite mines of the major alumina players in the country like Nalco, Hindalco, Balco, Hindalco (Indal) and Malco and the mines of GMDC which are either fully mechanized or semi mechanized. Amongst these only the Panchpatmali bauxite mine of NALCO in Orissa accounts for about 40% of the country's production. This is the only world class fully mechanized bauxite mine in the country. Capacity of this mine is now increased from 2.4 million tonnes to 4.8 million tonnes per annum. In bauxite production , Orissa is followed by Jharkhand, Gujarat, Maharashtra and Chhattisgarh. Tamil Nadu, Goa and Karnataka produce very little bauxite. Aluminium Industry consumes about 90% of total bauxite produced and balance is consumed by cement, refractories and chemical plants. Iron and steel industry consumes very small quantity of bauxite.

3.1.2.5 Except for Nalco all the remaining companies are not having adequate bauxite reserves in their mining leases to meet the requirement of existing capacity of their alumina refineries. These companies are forced to purchase bauxite from domestic market from small mine owners of the locality. Bauxite in small quantities are purchased from the mines of Jharkhand and Chattisgarh by Hindalco, Balco and Indal's Muri plant, while Indal's Belgaum plant purchases bauxite from mines of Maharashtra. Such purchases of bauxite from small mines have resulted in several constraints in operations particularly with respect to quality control, logistics and cost. No new mines of proposed export oriented units in Orissa and Andhra Pradesh have come up so far. Only few small mines have been developed in Chattisgarh for Balco and Hindalco. Grant of mining lease, environmental clearance, land acquisition, forest clearance, etc. have been the major constraints for development of new mines.

3.1.2.6 With the abundance of resources , Eastern Ghats region of Orissa and AP would be the area of major bauxite mining activities in future. The potential metallurgical bauxite deposits of Eastern Ghats in Orissa and AP with their status of development are placed at Annexure-IV . The large deposits of these areas are with reserves of more than 50 million tonnes can be reserved for proposed export oriented alumina plants. Additional bauxite resources are required for the brownfield expansion of the existing alumina producers.The Chattisgarh and Jharkhand deposits are small and could be reserved for Balco, Indal Muri plant and Hindalco. Similarly the deposits of Karnataka and Maharashtra could be reserved for Indal's Belgaum plant.The constraints experienced in getting the mining leases need to be resolved expeditiously to promote the planned growth. Small deposits of Eastern Ghat in Orissa and Andhra Pradesh can also be leased to these parties for sustaining future expansions. Additional resources would be required also for future expansions of Nalco.

3.1.2.7 India exported about 0.9 million tonnes in 2003-2004 from 1.79 million tonnes in

2002-2003.of low grade bauxite to Middle East from Gujarat and imported about 37000 tonnes (2003-04) refractory grade bauxite from China. With the abundance of metallurgical grade resources, there is a scope for increasing bauxite mining of this grade. The refractory and chemical grade bauxites can be preserved for future use. The resources of China, being pre-dominantly monohydrates are exclusively used for refractory and other applications. India may have to depend on China for this grade in future. This will be negligible compared to the likely export of aluminium. The potential resources of Vietnam of 3 billion tonnes and Indonesia with 1.76 billion tonnes would be the main competitors for India in future. Matching the growth of aluminium- sector in the country, mining and production of bauxite is expected to increase.

3.2 Alumina

3.2.1 World Scenario

3.2.1.1 World alumina refining capacity has increased from 46 million tonnes in 1995 to about 58 million tonnes in 2000 with an annual growth of 5%. The major capacity additions include expansion of Worsley and Gove in Australia and Alunourte refinery in Brazil. Production expansions in refineries in India and other developing countries particularly, China, have taken place.

3.2.1.2 The world production of alumina was 45.9 million tonnes in 1997. The production of alumina Country wise for years 2001-2003 is given in the Annexure- V. The world Production of alumina in 2003 increased to 58.6 million tonnes from 55.5 million tonnes in 2002.Australia is the main producer (28%) and continued to be the leading country followed by China 10%.Nearly 95% of alumina was used for metallurgical applications. The current alumina production in 2005 is 61.1 million tonnes.

Australia is not only a major producer of alumina, but also a major exporter. Imports of alumina increased by 15% to 28,784 tonnes in 2003-04 from 24,993 tonnes in 2002-2003. China (70%) continued to be the major importer followed by Netherlands 7% followed by Canada 6% and U.S.A and Germany 4%.

3.1.2.3 About 18-20 million tonnes of alumina is traded annually in international market. The major international alumina giants like Alcoa, Alcan, Reynolds, Kaiser, Pechinery, Alusuiss and traders like Billiton, Comalco, Clarindon,WMC etc play a major role in alumina trade. They have also their say starting from operation of bauxite mines to smelter and finally in alumina and metal trade.

3.1.2.4 The developing countries which account for 70% of world bauxite resources, produce around 50% of world bauxite and share about 40% of world alumina production. The multinational companies and international traders having their stake in both smelters and alumina plants, the refineries are mostly captive for the smelters. As a result alumina is moved within the integrated company systems and only about 35% of merchandise is for third party market sale. Out of this major part is also traded with long term contracts.

3.1.2.5 The spot alumina prices have remained between USD 160 to USD 200 per tonne during 1997-99 with peak prices going up to USD 650 per tonne in mid 2006. Long term trading of alumina is done mostly based on LME prices. With the fluctuations in LME, the price of alumina varies. In the mid of 2006, the alumina cost has gone up to 640 USD Mostly alumina capacity exceeds the requirement of smelters. With closure of smelters, availability of alumina becomes surplus. Due to increase in price of caustic soda some alumina plants with high consumption of caustic soda or other reasons close down, the alumina prices get affected for these reasons too.

3.1.2.6 Inspite of capacity additions in Brazil, India and Australia, it is expected that alumina demand will grow between 1 to 1.5 million tonnes per annum and the price is likely to remain around USD 550-600. In all probability, the alumina market is likely to remain steady with demand and supply gap of 3.5 million tonnes by 2007, which would increase around 2010. New refineries are likely to come up in Guinea, Brazil, China, India and Australia to meet this demand.

3.2.2 Indian Scenario

3.2.2.1 India has six alumina refineries of the five aluminium companies i.e Nalco, Hindalco & Indal, Balco and Malco mostly close to their respective captive bauxite sources, while Indal has two refineries, the other have one each. The installed capacity of alumina refineries is given below in the Annexure-VI

3.2.2.2 Total alumina production capacity which was 1.8 million tonnes in 1996-97 was increased to 2.72 million tonnes in 2001-02. An increase in capacity have taken place by Brownfield expansions of refineries of NALCO, HINDALCO & INDAL. As a result the production of alumina registered 2.176 million tonnes in 2000-2001 registering a growth of 6%.

The Production of alumina in 2004-05, is 2.9 million tonnes. The present production of alumina in 2005 by India refineries is as follows.

Company	**Alumina (million tonnes)**
HINDALCO & INDAL [Aditya Birla Group]	1.20
NALCO	1.57
BALCO	0.20
MALCO	0.07
	3.04

3.2.2.3 The surplus alumina, of about 8 lakh tonnes (2002-03) was exported to China, Russia, and Iran by various producers, after meeting their consumption in their respective smelters. Nalco is the major exporter of alumina. Some alumina produced by Hindalco (Indal) is used to produce special grades. The export of alumina from India is likely to increase further with proposed Browfield expansions and Greenfield refineries under pipeline.

3.2.2.4 In case of India, with 7% of world resources, it produces only 4.3% of world alumina and its share in world trade is 3.5%. There is adequate scope for increasing production of alumina and its export. For over 12 years, Nalco has been exporting alumina and has earned reputation in international market for its quality.During the period in early 1990 when the spot prices went down to US$ 100/tonne, because of low cost of production, Nalco sustained in international market fulfilling the export commitments. Success of Nalco in producing alumina from East Coast bauxites has lead to various proposals for establishments of export oriented units in this area. Even 10 years after the steps were initiated in 1991-92,no such export oriented units have come up. As a result more than 1.5 billion tonnes of bauxite resources of this area continue to remain undeveloped. At present, there is a tremendous demand from China and India being nearest Country, there is a good market for export.

3.2.2.5 When the country has adequate resources of bauxite, the aluminium industry should prosper and grow. Leaving aside delays in export oriented Greenfield units, it is apprehended that brown field expansions of existing industries Hindalco,Indal and Balco would suffer also on account of non-availability of bauxite. Nalco also needs additional bauxite for its expansions. Keeping the future prospects in view, all the aluminium producers should have adequate bauxite resources for their refineries.

3.3 Aluminium

3.3.1 World Scenario

3.3.1.1 The world production capacity of primary aluminium has increased from 23.3 million tonnes in 1996 to 26.09 million tonnes in 2000. The production of primary metal during the same period has correspondingly increased from 20.85 million tonnes to 24.447 million tonnes registering a growth of about 4%. The trend of non utilization of about 2 million tonnes of capacity is due to constraints of power and shutting down of old smelters. The production of aluminium (primary) for 2001-2003 is given in the Annexure-VII. In spite of mergers, acquisitions and fluctuations in LME price, aluminium sector in global scenario has performed well. The major producing countries are USA, Russia,China and Canada followed by Australia, Brazil, Norway, South Africa, Venezuela, Germany, India and Bahrain. Inspite of high production of both the primary and secondary metal, USA is the major importer of metals, followed by Japan and China because of high consumption. It is expected that world aluminium production will increase steadily and by the end of 2007 it is expected to be around 32 million tonnes.

The world production of Primary metal was 31.2 million tonnes in the year 2005

3.3.1.2 Consumption of metal during this period has increased from about 27 million tonnes to more than 32 million tonnes. The balance consumption of 8 million tonnes representing about 25% of world production comes from scrap. In recent years. Recyling of secondary aluminium has increased significantly from 25% to more than 30%. The major countries producing secondary aluminium by recycling scrap are USA,Japan, and European countries.

3.3.1.3 The price of metal has varied between US$ 1505 / tonne in 1996 to US$ 1356/tonne in 1998-99 and increased up to US$1549/tonne in 2000. In June 2006,the price went up to 2860 USD and became stable to 2500 USD. The major international players and traders having more than 70% of world production, control the price of this metal by building up stock and hedging.

3.3.1.4 The recycling of scrap and closing down of uneconomic smelters may affect its trade. It is expected that growth in aluminium sector though has slowed down in USA and developed countries, it is likely to be steady in countries of Latin America, Africa and Asia. Particularly, developing countries will have higher growth rate of demand. Afro Asian countries including India are the potential consumers of aluminium in future. China has been steadily increasing its smelter capacity to avail this opportunity and would be a serious competitor to Indian aluminium and it's products, both in our domestic market and export.

3.3.2 Indian Scenario

3.3.2.1 Presently there are five primary aluminium producers in the country with 7 smelters. While Nalco, Balco, Hindalco and Malco operate one each, Hindalco (Ex-Indal) has three smelters. Because of constraints of power, smelting capacity utilization of Indal is very low. Details of the aluminium smelters with their capacities are given below.

Production of aluminium in 2005

Company	Location	Present capacity in tonnes
NALCO	Angul,Orissa	3,59,00
HINDALCO & INDAL [Aditya Birla Group]	Renukot,UP, Hirakud (Orissa)	4,27500
BALCO	Korba, Chattisgarh	1,39,350
MALCO	Mettur, Tamilnadu	36,600
	TOTAL	**9,62,450**

3.3.2.2 The production capacity of these smelters have increased from 610,000 tonnes in 1991-92 to 697,000 tonnes in 2001-02.The capacity is likely to be enhanced to 1.075 million tonnes by the year 2006-07 for which development and construction activities are underway. The production of metal has increased from 450,000 tonnes in 1991-92 to 522,000 tonnes in 1996-97 which has reached to 640,000 in 2000-01 registering a growth of about 5%. It is likely to be 660,000 tonnes in 2001-02. This enhancement has been possible due to brownfield expansion of smelters of Hindalco and Nalco. However,there has been increase in both namely matching export and imports from less than 100,000 tonnes to more than 150,000 tonnes during this period. The expected consumption during 2001-02 is likely to be around 700,000 tonnes compared to 500,000 tonnes during 1996-97. This indicates sudden rise in growth rate and consumption. Similarly, per capita consumption which was close to 0.5 kg for a long period has now increased to 0.68 kg. This has been due to increase in sectoral consumption by automobiles, packaging, building and structural areas. The consumption can easily grow and is expected to increase fast with the market economy. Domestic aluminium industries and down stream sector has to rise to the occasion and remain competitive to imports. The production of aluminium in the year 2003-04 is 8.11 lakhs tonnes and in the year 2005 touches almost 1 million tonnes.

3.4 Aluminium Consumption, Downstream Products and Secondary Aluminium

3.4.1 World Scenario

3.4.1.1 Per-capita consumption of aluminium has been, steadily increasing in developed countries with new application areas.

	1980	1990	2000(Kg.per-capita)
USA	25.7	26.9	36.2
Japan	19.5	31.4	26.6
Europe	13.9	17.2	21.9

3.4.1.2 While in India per-capita consumption after remaining around 0.5 kg for over a decade has now reached to around 0.68 kg which is much lower compared to other developing countries of Latin America, Asia and Africa.

3.4.1.3 In the developed countries of Europe and USA though the production of primary metal is high, the consumption being still higher is resulting in import and increasing trend in recycling for obtaining secondary metal.

		USA	Europe
Consumption (million tonnes)		8.0	5.8
Production	**-do-**	3.7	3.8
Recycling	**-do-**	3.3	3.7

3.4.1.4 Import and recycling has been increasing in Japan also.Production units of USA are being shifted to countries where power is cheaper. In many countries recycling provides more than 50% of metal required. While world averages of secondary metal utilization is around 30%,in India it is around 17% including recycling of imported scrap.

3.4.1.5 In Asia, Japan, South Korea and China are net importers of primary metal and are exporting value added downstream products, semis and finished goods. China particularly is developing fast in both consumption and production of aluminium with a growth rate of 14%.The export from China is increasing. In the market economy with the growth plan of China, it will be a major competitor to domestic industries of India.

3.4.2 Indian Scenario

3.4.2.1 As regards the sectoral consumption pattern of aluminium is concerned, it is quite different in India. With the existing trend of growth and development this is likely to change soon. Sectoral consumption pattern analysis and forecast for the future are placed below.

(Fugers in Percentage)

	W.World	USA	World average	India now	India in future	CAGR
Electrical	7	8	9	31	31	8.8
Transport	34	36	27	18	21	12.6
Consumer Durable	5	7	6	23	20	5.8

Building & Construction	19	14	19	8	10	13.8
Packaging	20	25	19	6	5	6.4
Industry & Machinery	9	10	10	10	10	7.7
Others	6		10	4	3	4.5

(Overall growth expected to be around 8%)

3.4.2.2 Future growth rate is likely to be high in transport, building and construction areas, while all other sectors would also simultaneously grow. With stress for infrastructure, power sector is also likely to grow. Packaging and Industrial machineries particularly automobile sector would have considerable growth. Overall growth is expected to be around 8%. As recycling would also increase to 20 to 30% and likely to increase further in due course to facilitate the down stream sector for availing metal at low cost, the demand and growth of primary metal would be between 5 to 8%.

3.4.2.3 Growth is expected to be higher in consumption of downstream products and semis, particularly for sheets, extrusions and castings. To meet this growth, primary producers and potential downstream producers together with new players are to consolidate, strengthen and expand their manufacturing process. R&D efforts for cost reduction, and better quality are to be put to remain competitive in both domestic as well as international market. With WTO regulations and likely competitive from Korea and China, the sector have to grow and develop.

3.4.3 Prospects of Downstream Semi-Fab Sectors

3.4.3.1 Production capacity of aluminium semis in the country exists in two district sectors i.e. primary producers having semis and original secondary producers. Though the capacity, production, market details etc. are well documented by the former, these details are difficult to be confirmed and compiled for the later. Besides the large number of secondary producers, their production and marketing have been very inconsistent. Even the multiple associations covering them do not have correct information about their members. As per Aluminium Association of India, the figures are:

Integrated primary producers having semis-5

Sheet
Big and medium :10
Small unorganized :>700

Foil
Major producers :3
New entrant :2
Extruders : >50
Casting plants :>400
Conductors :>100

I) **Conductors**

At present,out of total installed capacity, only 60% i.e. around 320,000 tonnes capacity is operational.Further, these plants are again being operated at low capacities.These are mostly sick,because the major buyers the SEBs are also financially weak. Total production today is around 150,000 tonnes.The existing capacity is more to meet the future demand.Only modernization to meet world standards, production of alloy conductors besides improvements in quality and productivity would be required.

II) Extrusions

Existing operating capacity as confirmed are:

Primary productions	- 30,000 tonnes
Secondary productions	- 90,000 tonnes
Small units	-35,000 tonnes
Defence Sector	- 25,000 tonnes

Actual capacity may be higher when un-accounted units of un-organised sector are added. The production today will be around 150,000 tonnes.Small quantity around 10,000 tonnes is exported. Capacity expansion in this area would be essential to meet future demand and export.

III) Rolled products

Capacity:

Hindalco (Ex-Indal)	90,000 tonnes
Hindalco	80,000 tonnes
Balco	43,000 tonnes
Nalco	50,000 tonnes
Malco	7,000 tonnes
	270,000 tonnes

Actual capacity including un-organised sector is likely to be around 400,000 tonnes.Production today is around 200,000 tonnes. Demand is likely to increase to 300,000 tonnes soon.The present export of around 10,000 tonnes can also be improved.The capacity is already higher.Additional capacity would be required around 2006-07 in view of the growth prospects.

IV) Foils

The existing capacity is:

Indal and Hindalco	- 17,000 tonnes
Sterlite	- 19,000 tonnes
	36,000 tonnes

The demand is around 30,000 tonnes and 60,000 tonnes is expected. More capacity would be required to meet the future domestic demand and for export as well.

V) Castings

Demand is for about 145,000 tonnes. No assessment for its sector is possible. This area needs proper assessment for future planning and increasing production and promoting exports.Automobiles and engineering industries with the likely growth in future would increase the demand.To meet this and organize export,R & D and technology development in a systematic manner is essential.

3.4.4 Domestic Consumption

3.4.4.1 As indicated above, with the limited information available,the domestic sectoral consumption are placed below.

Conductors	: 150,000 tonnes
Extrusions	: 150,000 tonnes
Rolled products including foil	: 250,000 tonnes
Castings	: 145,000 tonnes

3.4.4.2 Total domestic consumption is around 700,000 tonnes. Taking into account domestic production with export and import remaining nearly same and adding reported 40,000 tonnes being obtained from the domestic recycling, the consumption figure also works out to 700,000 tonnes.With this the per-capita consumption is confirmed to be around 0.68 kg.

3.4.5 Recycling

3.4.5.1 About 80,000 tonnes of scrap is being imported and used for recycling besides 40,000 tonnes secondary metal production by recycling of domestic scrap.The only organized recycling unit in the country of Indal is under utilized. Obviously, the secondary producers and unorganized sector are carrying out recycling for which details are not available.

3.4.5.2 The recycling process not only by-passes the use of valuable bauxite and consumption of costly inputs, it also required 90% less energy than primary smelting. Most of the recycling units today need to be increased to 30% of total metal consumption to meet the growing demand. This area is to be addressed for increasing production at low cost, energy saving, and ensuring availability for domestic consumption.

Review of 10th Plan and Future Prospects

3.5.1 Review of 10th plan and achievements

3.5.1.1 Achievements during the 10th Plan period from 2002-2007 have been reviewed to evaluate the performance of aluminium sector. The downstream areas with many small units are mostly in the un-organised sector. The correct assessment of this area has been difficult. The same is true also for secondary recycling. However, on the basis of available information, desired analysis for future forescast has been attempted. After slow growth for over a long period, there has been all around growth of aluminium sector. The per capita consumption remaining around 0.5 kg. For over a decade is now approaching 0.8 kg. With the continuing trend of economical growth, per capita income is likely to increase. At the higher level of income, sudden rise in demand and consumption of aluminium is expected. This will be due to higher consumption levels in packaging, building and structural,automotive and consumer durable sectors, besides normal consumption in electrical, transport and other industrial sectors. Taking into account the population growth and per capita consumption increasing to 0.8 kg, it is expected that the domestic consumption would be around 0.92 million tonnes around around 2007 by the end of 10th Plan.The production of aluminium in 2005 is 0.96 million tonnes as below

Company	**Aluminium Production (In million tonnes)**
HINDALCO & INDAL (Aditya Birla Group)	0.42
NALCO	0.36
BALCO	0.14
MALCO	0.04
	0.96

3.5.1.2 This present production matches the growth plan of 8% projected by the Planning Commission. Continuing with this trend it is likely to increase to 1.28 million tonnes and 1.5 million tonnes by 2012 and 2017 respectively. In the past there has been sudden increase in growth of aluminium sector during 1984 and 1988 which had not sustained to achieve the desired growth on continuous basis. Various steps are to be taken for promotion of aluminium sector and facilitating its growth. Hence it is necessary to have yearly review of aluminium sector to assess the achievement and for taking remedial measures to meet the demand for solving the constraints faced.

3.5.1.3 The overall growth in aluminium sector has been around 5% to 6% which has prevailed in bauxite and alumina refinery as well.Export of alumina and metal both have also registered increases.ad the projected Greenfield export oriented alumina plants come up, the export of alumina would have further increased.

3.5.1.4 While Greenfield projects for bauxite and alumina refinery have been getting delayed, the domestic aluminium sector has gone ahead with brownfield expansion of bauxite mines and alumina plants matching the requirement of brown field expansion of smelters.Adequate success has been achieved and there is plan to continue with brownfield expansions during the 11th Paln period also.The rowfield projects are reported to give competitive advantage to Indian exports with low cost in production of both alumina and metal.The acquisitions and merges during the 10th Plan have developed three aluminium and metal. The acquisitions and merges during the 10th Paln have developed three major players i.e.Nalco, Hindalco and Balco/Sterlite.All the three will be able to share the domestic market with nearly identical production capacities and product ranges. These three major players have now control over downstream areas sharing about 90% of rolled products, 100% of foils and a majority of extrusions. In addition to these companies Vedanta Alumina is likely to commission refinery in Orissa using Lanjigarh bauxite by March 2007.Their entry in the field and joint collaborations with the downstream sectors, may lead to development in downstream areas.In the interest of aluminium sector , this may be helpful.

3.5.1.5 For the convenience of planning and forecast,the details have been worked out from aluminium downwards to alumina and bauxite.

3.5.2 Aluminium

3.5.2.1 Aluminium smelting being power intensive and due to constraints in availability of power, and its high cost, aluminium sector ahs suffered in the country. Indal and Malco have been forced to produce at low capacities.Belgaum plant of Indal is now closed down. Over all capacity utilization of this sector has been low for a considerable period. With the capative power plants,Nalco, Balco, Hindalco and Hirakud Plant of Indal are now operating smoothly and are able to increase capacity by expansions. For the same reason of non-availability of assured steady power supply and high cost of power, no Greenfield smelter has come up so far. Even with the captive power plants, Greenfield smelters may not be economically viable as the cost and are able to export by remaining competitive. For this reason, these two industries and Balco have planned for browfield upto to the 11th plan (2011-12) would be able to meet the increasing domestic demands while continuing with exports. As reported, there is no scope for further expansion of the units.

3.5.2.2 Proposed capacity expansion of aluminium smelter in 11th Plan and beyond are placed below:

('000 tonnes)

Company	**Planned for 10th Plan (2006-07)**	**Likely to achieve (2011-121)**
Nalco	345	460
Hindalco	356	356
Indal	100	100
Balco	250	400
Malco	025	025
Total	**1076**	**1291**

3.5.2.3 It is expected that per capita consumption would rise up to 0.8 kg. 1 kg and 1.1 kg by end of 10th Plan, 11th Plan and 12th Plan respectively. With optimistic assessment, the domestic consumption of 0.7 million tonnes of aluminium in 2001-02 would increase upto to 0.92 million tonnes by 2006-07. With 1 kg per tonne it is likely to be 1.28 million tonnes by 2011-12 and with 1.1 kg it may reach 1.5 million tonnes around 2016-17 i.e. the end of 12th Plan. However, realistic figure with slow growth would be respectively 0.8 million tonnes, 1.5 million tonnes and 1.35 million tonnes. This matches also to the domestic demand after sectroral uses of semi-fabs and proposed growth rate of 5 to 8%. The export and import from present level of 15,000 tonnes to 200 to 300 thousand tonnes by 2006-07 and may reach to 400,000 tonnes in another 5 years time. The aluminium metal forecast is placed below:

('000 tonnes)

	2001-02	**2006-07**	**2011-12**	**2016-17**
Capacity	697	1076	1291	1291
Production	660	950	1250	1280
Consumption	700	920	1280	1500
(likely range of demand)		(800-1024)	(1150-1350)	(1370-1600)
Export	150	200	300	400
Import	150	120	270	300+250*

Secondary metal (Domestic)	40	50	60	70

* For meeting the shortfall and reducing the import there should be additional capacity about 400,000 tonnes around 2011-12. To meet the requirement of 12th Plan period, necessary steps have to be initiated in XI Plan period.

3.5.2.4 To meet these projected demand of 11th & 12th Plan, there are already proposals for Greenfield investments as well a brownfield expansions from both the present Indian Companies as well as International Companies such as Alcan,Dubai Aluminium and Russian Aluminium Company in Joint Venture captal investments. Some of the new projects under proposals is given at Annexure VIII However the deficit/balance metal requirements will be met by secondary recycling for which domestic and imported scrap will be utilized.Today there is only one recycling unit of Indal in organized sector at Taloja with 25,000 tonnes capacity. This capacity is underutilized due to non-availability of desired quality scrap and cost of import.The reduction in import durty would promote re-cycling and may increase production of secondary metal. All efforts with low energy consumption to meet the domestic shortfall in future.even the downstream industries can get benefit out of increased secondary aluminium. Secondary aluminium.Secondary production with less energy consumption will be available at a reasonable low price to bring competitiveness to downstream sectors.

3.5.2.5 The shortfall in domestic production availability of primary metal needs attention to initiate steps immediately.

1 Green field smelters of about 400,000 tpy capacity to be planned now for the future.
2 Secondary recycling should be promoted to contribute 30% of domestic metal requirements.
3 Import of scrap to be increase4d with low duty which in turn can be exported as value added item. This will increase both import and export simultaneously giving benefit in international trade.
4 Where power is cheap abroad,smelters can be established to produce metal at low cost.
5 Tolling of low alumina and getting back metal after smelting abroad where power is cheaper, can also be planned.

3.5.2.6 For increasing the consumption to develop aluminium sector in the country, the steps required are:

a) To make primary metal available for domestic consumption at a competive cost for secondary producers, excise –duty for domestic aluminium and custom duty for imported aluminium could be reduced to make both at par and matching international price so that the option can be used when metal is not available for some reason.
b) Capacity development would be required for foils, extrusions and rolled products besides reorganizing castings.
c) To promote consumption in the country, the duty can be further reduced for extrusions used in building and structural areas to reduce consumption of wood from environmental considerations. Similarly,the tubes used for irrigation should get preference.

d) Attention has to be given also for development of semi-fab production by improving quality and reducing cost.

3.5.3 Alumina

3.5.3.1 During the 10th Paln period only the proposed brown field expansions 0f existing refineries have taken place to achieve the capacity of 27.20 thousand tonnes. Proposed green field export oriented alum9ina plants have not come up. As per the industry, in the 11th Plan there are proposals for expansions to meet the demand of respective smelters and surplus for export by Nalco and Indal.

3.5.3.2 The Alumina capacity additions during 10th plan period and proposed capacitor for 11th plan are placed below.

Company /Plant capacity	Total Capacity planned in 10th plan(million tonnes) Planned	Achieved 2005	Proposed for XI th Plan
Nalco,Damanjod (Orissa)	2.10	1.57	
Hindalco, Renukoot (UP)	0.66		
Muri (Jharkhand) Plants	0.50	1.20	From the Existing
Indal Belgaum (Karnataka) Indal	0.65		
Balco, Korba (Chattisgarh) Vedanta	0.25	0.20	
Mettur (Tamil Nadu) Malco	0.075	0.07	
	4.24	3.04	4.24
Vedanta Aluminium Langigarh (Orissa) (to be commissioned in April 07)			1.40
TOTAL			5.64

The Country is today producing surplus alumina, which is being exported. This trend is likely to continue with the establishment of green field export oriented alumina refineries. As such with the surplus availability of alumina, the aluminium smelters in the country would not suffer. The projected capacities of alumina domestic consumption by smelters and surplus availability for export are placed below:

(Million tonnes)

	2001-02	2006-07	2011-2012
Capacity	2.72	4.24	5.64
Aluminium Production	2.4	4.00	4.50
Internal Consumption	1.3	1.90	2.50
Likely Export	1.1	2.10	2.00*

* EOU plans to likely add 2 million tonnes. Total export around 3.8 million tonnes during 2011-12 and to increase by another 2 million tonnes around 2016-17.

3.5.3.3 As India would not prefer export of bauxite, there can be plans for increase in alumina production to export more of alumina, specially grade alumina and hydrates as value added products.

3.5.3.4 India has certain advantages of being a low cost area for production of alumina, as reviewed from performances of Nalco. With this advantage steps should be taken for export oriented alumina plants. In case of delays competitors would take advantage and the export market might be lost. Timing could thus be an important factor.

3.5.3.5 The constraints of red mud disposal would be the problem of future alumina plants. Utilization of this waste has to be taken care through R&D efforts. Caustic soda, from domestic sources may pose problems. Efforts should be made for setting up plants outside India where power is cheap, for importing back the product to India. Long term contracts with caustic soda plants abroad also need to be explored.

3.5.3.6 Port facilities and infrastructure could be other areas, which need attention development in these areas would facilitate the growth of large-scale export oriented alumina refineries.

3.5.4 Bauxite

3.5.4.1 Bauxite resources of metallurgical grade being in abundance in the country, development of bauxite mining in future would depend upon growth of aluminium sector i.e. the capacity of aluminium refining. With the brown field expansions already planned by the existing industries, the refining capacity at the end of 10th Plan would be 4.24 million tonnes. This should increase bauxite production to around 13 milion tonnes by 2006 and 2007.

Plant	Capacity of refinery (2006-2007 (million tonnes)	Buaxite requirements (million tonnes)
Hindalco	0.66	2.0
Indal	1.10	3.0
Balco	0.25	1.0
Nalco	2.10	6.3
Malco	0.75	0.20
Total	4.24	12.50*

* Including other uindustries it would be around 13 million tonne

3.5.4.2 With another two green field export oriented units of one million tonnes capacity each, bauxite production may reach 25 million tonnes by the end of 11th Plan.During the subsequent five years with addition of two million tonnes alumina plant for export, the bauxite mining capacity may reach to 30 million tonnes. The resources of the country are adequate to sustain the future requirements.

Period	Projected bauxite production (million tonnes)
2001-02	0.8
2006-2007	19.0 (6 million tonnes for EOUs)
2011-2012	25.0 (12 million tonnes for EOUs)
2016-2017	30.0 (15 million tonnes for EOUs)

Out of over 1.8 billion tonnes of metallurgical grade bauxcite resources in the country, only 400 million tonnes have been operating leases, while additional about 400 million tonnes are being planned for development of mines for green field plants.The balance resources can be planned for utilization.

i) Small deposits with less than 50 million tonnes can be earmarked for brown field expansions of exisiting refineries.
ii) Large deposits to be planned for future green field projects for which capacity of mine would be minimium 3.0 million tpy.
iii) The promblem now faced by hindalco, Balco and Indal in getting lease and operating new captive mines in Chattisgarh, Jharkhand , Karnataka and Maharashtra need to be immediately resolved so that the brown field expansions of existing refineries during the 10th Palan do not delayed.Details of their requirements are placed in Annexure-1.11
iv) Nalco should have additional 100 million resources to meet the future requirements of its proposed expansion of Damanjodi Refinery to 2.1 million tonnes.Additional 100 milion tonnes would be requirement for future i.e.new plant.
v) Shervroy Hill deposits in Tamil Nadu to be totally left for development and expansion of Malco's refinery.
vi) The Ganghamardan Bauxite deposit of Orissa having reserves of more than 200 million tonnes still remains virgin after Balxco woithdrew.It can be planned for development.
vii) In Gujart and Chattisgharh,where chemical and refractory grade bauxite are mined, aerior grade which can be used as metallurgical grade is considered as waste and is not utilized properly.Additional Gujarat also has sufficient resources of Metallurgical grade for future use, if required.

3.6 Research & Development and Other Areas

3.6.1 R& D activities

R& D Activities are felt necessary in the following areas:

i) For alumina refinery, it is necessary to have a pilot plant to carry out experiments starting from bauxite digestion to precipitation.

ii) For energy conservation and efficiency improvement in smelting and carbon technology, it is essential to have experiment electrolysis cell. This would enable a number of processes such as current distribution, heat balance magnetic filed, impurity balance between the metal and the bath, effect of change of bath composition on current efficiency and properties of the materials in the pot to be studied.

iii) Alloy development including development of new applications, Waste utilization and improved pollution control would be possible by involvement and association of industries with research institutions and R&D laboratories.

iv) Mathematical modeling would help in calculating heat losses in a pot for improving performance.

v) Alternative to scarce and expensive inputs.

vi) Developing cost effective technology in existing plants and small capacity Greenfield plant (25 to 100 KT)

vii) Popularisation of aluminium usage in India.

- Stress should be put on new product development.
- Standardisation of extruded products for use of aluminium in building /construction industry
- Improving the quality of downstream products.
- Development of can stock material.
- Eco-friendly refining technology for aluminium scrap re-melting.
- Extrusion die design)finite element analysis)
- Alloy development including metal atrix Composites for specialized applications.
- Modern processing technologies such as semi-solid processing
- Master alloys for grain refining in A1 castings

viii) Suggested R & D projects

- New application developments, both traditional and unique to Indian situation ,though integration between product design, end-uses and manufacturing processes.
- New alloys to permit down gauging yet with improved run ability on customers' machines for overall gains.
- Standardise designs for D-1-Y application assembly kits for ease of consruction and erection, especially for building and transport sectors.
- Doubling of aluminium usage in transport sector for higher payload and reduced pollution.
- Innovative product packaging for enhanced shelf life of perishable food products.
- New surface coating materials and processes for decorative panels, air conditioning fins,etc.for enhanced performance.
- Introduce aluminium, for marine applications, both passenger ferry and sporting activities.
- Use of mathematical modeling as a tool for process/product improvement for efficiency gains and /or product attributes.
- Develop appropriate product linkage for recycled metal from contaminated scrap
- Facilitate new technology absorption and improve there upon

continuously with respect to consistency, productivity and end-use performance.

- Explore opportunities for some break-through research like reduction in scaling rate in Bayer plant, destruction of undesirable organic compounds in plant liquor,hydrate precipitation in the form of boehmite, wettable cathode and dimensionally stable inert anode, metal matrix composites etc.
- In addtion, the aluminium industry may adapt the collaborative research concept in line with CSIRO module, which is reportedly very successful and cost-effective in Autsralia.Industry-Institute partnership will be critical success factor in making this model work. Also, the role of CSIR laboratories needs to be aligned to address and support industry needs through inter-active collaboration for building process expertise.
- Finally, at national level, attempts should be made to tie-up with reputed international research establishment, with specialization in the field of aluminium, to provide a low-cost research base in India; this will help building expertise in respective disciplines for futuristic neds and aspirations of a vibrant aluminium industry in India.
- The existing enter of excellence for aluminium research, Jawahar Lal Nehru research Development Centre can take up research activities for allied elements like gallium,vanadium,titanium,magnesium and silicon, for which an R&D center is felt essential to take up projects for development of non defence commercial industries for these metals in India.

3.6.2 Infrastructure

Bauxite mining areas are mostly located in underdeveloped regions of the country.

- The Greenfield alumina plants and mining would require infrastructure development of road and rail systems.
- Railway have to gear up for required wagons and power for rail movement of raw materials and finish products
- The bauxite mining belts of chattisgarh and Jharkhand also need improvements for the brownfield expansions of existing plants.
- Even though K-K and K-R rail line would facilitate the proposed industries, the load carrying capacity has to be enhanced. The Andhra Pradesh deposits would require extension of rail line nearer to the deposits.
- Port facilities in the eastern region ie., Orissa and Andhra Pradesh need immediate attention to improve bulk handling and inland traffic. New ports like Gopalpur and Machlipatnam require to be developed.
- For steady power supply the grid system has to be strengthened.

3.6.3 Raw Materials

Caustic soda capacity needs to be enhanced to meet the additional requirements. In case the cost is higher, plants can be set up in counties where power is cheaper and caustic soda so produced could be brought back. CP coke, CT Pitch, aluminium fluoride industries of matching capacities are required in the country to meet the future requirement.

3.6.4 Manpower

The country has adequate technical, skilled and unskilled manpower. It would not be a constraint for growth. Rather the planned growth would offer opportunities for employment. Better work culture would help the industries to grow.

3.6.5 Constraints / thrust areas

1 The availability of bauxite and development of mine.
2 Availability of power
3 Railways including wagons and locomotives.
4 Port facilities
5 Raw materials e.g. caustic soda, CT Pitch and CP coke.
6 Forest and environment cleanances.
7 Forest and environment clearances
8 High custom duty on scrap and essential raw material imported.
9 High custom and excise duty.

3.7 **Gallium**

3.7.1 General

3.7.1.1 Gallium is used with “phosphorous” and “arsenic” for advanced semi conductor material development. It is used for manufacture of light emitting diode (LED) IC circuit components, opto-electronic components etc.

3.7.2 World Scenario

3.7.2.1 There is no primary source of gallium. It is produced mostly as a by-product from alumina refineries and partly from other non-ferrous metal industries.

3.7.2.2 World gallium installed capacity is about 153 tonnes. The major producers are Australia (50 tonnes), Kazakhstan (20 tonnes), Germany (20 tonnes), France (20 tonnes), Russia (15 tonnes) China (8 tonnes), Japan (7 tonnes), Ukraine (3 tonnes) and USA (3 tonnes)

3.7.2.3 The global consumption during 1999-2000 has been of the order of 176 tonnes which as increased from 157 tonnes in 1998-99. At this rate, it is likely to increase in coming years due to rise in demand of electronic components.

3.7.2.4 The primary production during 1999-2000 has been around 70 tonnes against 60 tonnes in the previous year. While the balance demand to the tune of 95-100 tonnes has been met through secondary recycling. Major consumers and recyclers of gallium are France, Japan and USA.

3.7.2.5 Around 2020, the total global demand of gallium may reach around 350 tonnes. Minimum 60 to 70% will continue to be obtained through secondary recycling process. The total installed capacity will not be able to meet the demand. Even at present, the short supply of gallium has resulted in an increasing trend in the market price.

3.7.3 Indina Scenario

3.7.3.1 There is no large scale gallium production facility in operation in India. M/s. Malco and Hindalco had operated bench scale plants in the past based on mercury amalgamation technology of 30 and 40 kg capacity respectively. However, both these units have ceased to operate since 1996-97. There are also no know units engaged in secondary production of gallium in India.

3.7.3.2 The demand for gallium in India was reported to be of the order of 700 kg in 1995-96. No further consolidated figures are available on this account. Japan has supplied major requirements during subsequent periods. USA is the other major supplier. There has been imports also in the form of compounds and components.

3.7.3.3 The demand for gallium is likely to increase with the growth of electronic industry in the country.

3.7.4 Future Plans

3.7.4.1 Nalco has been pursuing plans to produce raw and refined gallium in association with the Ministry of Defence and Dept of Science and Technology. However, the project suffered a set back in 2000 on account of environmental clearances for mercury based technology of CECRI selected for the plant. This plant at least of one tonne capacity would commence production within the 10^{th} plan period.

3.7.4.2 With The vast bauxite resources, india has potential for increasing the alumina production with green field export oriented refineries. These refineries can contribute substantially by putting up gallium recover units to meet the growing domestic demand. Simultaneously, there is also scope for exports. India should produce gallium to the tune of at least 1 tonne during the 10^{th} plan and 3 tonnes aroung 2015-2020.

3.7.5 ACTION PLAN

3.7.5.1 Gallium is of strategic importance. In India this can be easily produced. To meet the increasing domestic demand and to avail export opportunities, gallium production in the country should be given priority. Considering this collaboration with foreign technology suppliers and indigenous technology development for gallium, refining is essentially required. Aluminium industries should take initiative in this regard.

3.8 Vanadium

3.8.1 General

3.8.1.1 Vanadium is used as an alloying element for iron and steel. It is used also as a catalyst in chemical industries and for glaze and enamel in ceramic industries.

3.8.2 World Scenario

3.8.2.1 The major vanadium producing countries in the world are South Africa, CIS, USA, China, Finland and Norway. It is mostly produced from titaniferrous magnetite ores where vanadium is present as a minor element. It is also recovered as a by-product of chemical processing of bauxite and uranium ore. World production and use of vanadium has been increasing steadily with the rapid expansion in oil and gas transportation and increased use of special steel. World consumption in 1998 was 44,000 tonnes. SA contributes 40% in production 60% of world trade.

3.8.3 Indian Scenario

3.8.3.1 In India, vanadium is recovered as sludge from alumina plants to the tune of 4,000 to 6000 tonnes per annum. Vanadium sludge production by aluminium industries in india contains 8-10% V_2O_5 by BALCO, 19% by Hindalco, 6-20% by Hindalco (Ex-INDAL)

Year	**Balco**	**Indal (Conc)**	**Hindalco**
1998-1999	4175	9.23	1703.41
1999-2000	4059	7.15	1911.00
2000-2001	3280	10.34	1823.7

3.8.3.2 Vanadiferrous magnetite resources are estimated at 20 million tonnes, but there are many known resources not estimated so far. Small quantities of vanadifferous magnetite was used by ferro alloy and iron and steel industries but is is very insignificant. Due to less production in the country, there has been import of vanadium ore and ferro – vanadium over the years for a value of around Rs. 20 crores.

3.8.3.3 Ferro-vanadium industries was about 16 tonnes. Alloy steel and iron and steel industries consume around 128 tonnes and 183 tonnes respectively. India imports (concentrate) about 7504 tonnes which has decreased from 11,5000 tonnes Australia (66%), S.A (17%) Netherlands (9%) and Belgium (7%) are the major exporters.

3.8.4 Future Plan

3.8.4.1 The future alumina plants being mostly based on East Coast bauxite having very low percentage of vanadium in the bauxite sources, will not be able to generate adequate quantity of vanadium sludge to meet the internal demand for ferro vanadium is expected to increase. This has to be met by import.

3.9.1 Recommendation

3.9.1.1 Except for Nalco all the remaining companies are not having adequate bauxite reserves in their mining leases to meet the requirement of existing capacity of their alumina refineries. These companies are forced to purchase bauxite from domestic market from small mine owners of the locality. Bauxite in small quantities are purchased from the mines of Jharkhand and Chattisgarh by Hindalco, Balco and Indal's Muri plant, while Indal's Belgaum plant purchases bauxite from mines of Maharashtra. Such purchases of bauxite from small mines have resulted in several constraints in operations particularly with respect to quality control, logistics and cost. No new mines of proposed export oriented units in Orissa and Andhra Pradesh have come up so far. Only few small mines have been developed in Chattisgarh for Balco and Hindalco. Grant of mining lease, environmental clearance, land acquisition, forest clearance, etc. have been the major constraints for development of new mines.

3.9.1.2 India exported about 0.9 million tonnes in 2003-2004 from 1.79 million tonnes in

2002-2003 of low grade bauxite to Middle East from Gujarat and imported about 37000 tonnes (2003-04) refractory grade bauxite from China. With the abundance of metallurgical grade resources, there is a scope for increasing bauxite mining of this grade. The refractory and chemical grade bauxite can be preserved for future use.

3.9.1.3 In case of India, with 7% of world resources, it produces only 4.3% of world alumina and its share in world trade is 3.5%. There is adequate scope for increasing production of alumina and its export. For over 12 years, Nalco has been exporting alumina and has earned reputation in international market for its quality.

3.9.1.4 Growth is expected to be higher in consumption of downstream products and semis, particularly for sheets, extrusions and castings. To meet this growth, primary producers and potential downstream producers together with new players are to consolidate, strengthen and expand their manufacturing process. R&D efforts for cost reduction, and better quality are to be put to remain competitive in both domestic as well as international market. With WTO regulations and likely competitive from Korea and China, the sector have to grow and develop.

3.9.1.5 The recycling process not only by-passes the use of valuable bauxite and consumption of costly inputs, it also required 90% less energy than primary smelting. Most of the recycling units today need to be increased to 30% of total metal consumption to meet the growing demand. This area is to be addressed for increasing production at low cost, energy saving, and ensuring availability for domestic consumption.

3.9.1.6 The shortfall in domestic production and availability of primary metal needs attention to initiate steps immediately.

- Green field smelters of about 400,000 tpy capacity to be planned now for the future.
- Secondary recycling should be promoted to contribute 30% of domestic metal requirements.
- Import of scrap to be increased with low duty which in turn can be exported as value added item. This will increase both import and export simultaneously giving benefit in international trade.
- Where power is cheap abroad,smelters can be established to produce metal at low cost.
- Tolling of low alumina and getting back metal after smelting abroad where power is cheaper, can also be planned.

3.9.1.7 For increasing the consumption and to develop aluminium sector in the country, the steps required are:

a) To make primary metal available for domestic consumption at a competitive cost for secondary producers, excise –duty for domestic aluminium and custom duty for imported aluminium could be reduced to make both at par and matching international price so that the option can be used when metal is not available for some reason.

b) Capacity development would be required for foils, extrusions and rolled products besides reorganizing castings.

c) To promote consumption in the country, the duty can be further reduced for extrusions used in building and structural areas to reduce consumption of wood from environmental considerations. Similarly,the tubes used for irrigation should get preference.

d) Attention has to be given also for development of semi-fab production by improving quality and reducing cost.

3.9.1.8 Out of over 1.8 billion tonnes of metallurgical grade bauxite resources in the country, only 400 million tonnes confine to the operating leases. In view of this, the following would deserve consideration.

a) Small deposits with less than 50 million tonnes can be earmarked for brown field expansions of existing refineries.
b) Large deposits to be planned for future green field projects for which capacity of mine would be minimum 3.0 million tones per annum.
c) The problem now faced by Hindalco, Balco and Indal in getting lease and operating new captive mines in Chattisgarh, Jharkhand , Karnataka and Maharashtra need to be immediately resolved so that the brown field expansions of existing refineries during the 10th Plan do not delayed.
d) The Gandhamardan Bauxite deposit of Orissa having reserves of more than 200 million tonnes still remains virgin after Balco withdrew. It can be planned for development.
e) In Gujart and Chattisgharh, where chemical and refractory grade bauxite are mined, inferior grade which can be used as metallurgical grade is considered as waste and is not utilized properly. Gujarat also has sufficient resources of Metallurgical grade for future use, if required.

3.9.1.9 The constraints of red mud disposal would be the problem of future alumina plants. Utilization of this waste has to be taken care through R&D efforts. Caustic soda, from domestic sources may pose problems. Efforts should be made for setting up plants outside India where power is cheap, for importing back the product to India. Long term contracts with caustic soda plants abroad also need to be explored.

ANNEXURE – I

Country-wise distribution of bauxite reserve in the world

Sl.No.	Country	Mine Production	Production as % of the World Total	Reserve Base	Reserve Base as % of World Total
1	Australia	62.00	39	7400	21.76
2.	Guinea	17.40	10.94	8600	25.29
3	Brazil	16.20	10.20	4900	14.41
4	Jamaica	15.00	9.43	2500	7.35
5.	China	10.67	6.71	2000	5.88
6.	India	9.28(6th rank)	5.84	2300 (4th rank)	6.76
7.	Venezuela	5.10	3.21	350	1.03
8.	Surinam	4.64	2.92	600	1.76
9.	Russia	4.64	2.92	250	0.74
10.	Guyana	2.32	1.46	900	2.55
11.	USA	NA	NA	40	0.12
12.	Other Countries	11.83	7.44	4700	13.82
	World Total	**159.00**	**100**	**34000**	**100**

ANNEXURE - II

World production of Bauxite (By principal countries) **[in '000 tonnes]**

Sl.No.	Country	2001	2002	2003
1	Australia	53799	54134	55602
2	Brazil	13388	13148	18457
3	China	8650	9990	10989
4	Greece	2047	2492	2418
5	Guinea	17192	17480	17044
6	Guyana	2011	1639	1716
7	India	8689	9867	10957
8	Jamaica	12370	13119	13445
9	Kazakhstan	3685	4377	4737
10	Russia	4805	4498	5442
11	Surinam	4394	4002	4215
12	Venezuela	4585	5191	5446
13	Other Countries	4385	4062	4532
	World Total	**140000**	**144000**	**155000**

ANNEXURE-III

State-wise Insite Resources and Recoverable Reserves of Bauxite

Sl.No.	State	Insite Resources	Recoverable Reserves
1.	Orissa	1530	1370
2.	Andhra Pradesh	613	552
3.	Chattisgarh	198	102
4.	Gujarat	185	144
5.	Madhya Pradesh	129	666
6.	Maharastra	125	105.5
7.	Jaharkhand	117	67
8.	Goa	64	51
9.	Karnataka	46	28
10.	Tamil Nadu	27	21
11.	Uttar Pradesh	18	9
12.	Kerala	14	8
13.	Bihar	4	2
14.	Jammu & Kashmir	2	0.2
15.	Rajasthan	0.5	0.3
	Total	**3074**	**2527**

ANNEXURE-IV

Potential deposits of Eastern Ghats

Sl.No.	Deposit	State	Total Reserves in million tones	Status of Development.
	Anantagiri	Andhra Pradesh	54.48	UD
	Chintapalli (Gudem)	Andhra Pradesh	109.60	UD
	Jarella (Korukonda)	Andhra Pradesh	204.47	UD
	Saparla	Andhra Pradesh	181.92	UD
	Panchpatmali	Orissa	310.00	D
	Gandhamardan	Orissa	202.26	UD
	Karlapat	Orissa	59.00	UD
	Baphilimali	Orissa	195.73	UD
	Pottangi	Orissa	75.12	UD
	Kutrumali & Sijimali	Orissa	120.80	UD
	Sasbohumali	Orissa	81.00	UD
	Kodingamali	Orissa	91.00	UD
	Lanjigarh	Orissa	47.36	UD

D = Developed & Exploited
UD = Undeveloped

ANNEXURE-V

Production of Alumina (By principal countries) [in ‘000 tonnes]

COUNTRY	**2001**	**2002**	**2003**
Australia	16313	16429	16529
Brazil	3520	3855	4714
China	4717	5450	6114
India	2120	2556	2856
Irish Republic	1449	1400	1500
Jamaica	3542	3631	3844
Kazakhstan	1231	1386	1419
Russia	3046	3131	3230
Spain	1199	1350	1380
Surinam	1893	1903	2005
Ukraine	1343	1351	1434
USA	4340	4338	4834
Venezuela	1833	1901	1882
Other Countries	6624	6819	6859
World Total	**53200**	**55500**	**58600**

ANNEXURE-VI

Installed capacity of Alumina in India

Sl.No	**Producer**	**Plant**	**Capacity (tpy)**
1	National Aluminium Co.Ltd	Damanjodi (Orissa)	1575000
2	Hindalco Industries Ltd.	Renukoot (Uttar Pradesh)	660000
3	Hindalco Industries Ltd (INDAL)	Belgaum (Karnataka) Muri Jharkhand)	240000 72000
4	Bharat Aluminium Co.Ltd	Korba (Chattisgarh)	200000
5	The Madras Aluminium Co.Ltd	Mettur (Tamil Nadu)	50000
TOTAL		**2797000**	

ANNEXURE - VIII

Projects & Investments

New Projects: Alumina & Aluminium

Company	Location	State	Capacity (Lakh tpa)		Invetsment	Latest Development
			Alumina	Aluminium	(Rs.crore)	
Raykal (L&T + Dubal)	Rayagada	ORI	30.00	----	15,000	Joint venture formed in late 2005
Hindalco	Ambalpur	ORI	10.00	2.60	11,000	MoU signed in April 2005
Aditya Alumina	Rayagada	ORI	10.00	2.60	8,000	Land identification complete
Hindalco	Latehar	JHA	-----	3.25	7,800	MoU signed in March 2005
Vedanta Alumina	Jharsuguda	ORI	----	5.00	7,000	Board approval received in December 2005
JSW Aluminium	Vizag	AP	15.00	2.50	6,750	Proposal stage
Utkal Aluminium	Jharsuguda	ORI	15.00	----	4,796	Revived in 2005,still in planning stage
Russian Aluminium	-----	ORI	10.00	-----	4,300	Proposal stage
Vedanta Alumina*	Lanjgarh	ORI	14.00	-----	4,000	Completion by March 2007
Balco*	Korba	CHH	----	2.50	4,000	Completion by March 2006
Nalco*	Angul	ORI	5.25	1.15	4,000	Under active implemention
Hindalco*	Hirakud	ORI	----	0.81	1,038	Civil work in progress
Hindalco*	Belgaum	KAR	3.00	-----	843	Environmental clearance received
Hindalco*	Muri	JHA	3.40	------	796	All clearances in place

* Under Execution, capacity expansions

CHAPTER – IV

CEMENT AND LIMESTONE

4.1 Introduction

Limestone occupies the top position among non-fuel solid mineral deposit In the volume of annual extraction. The mining of about 225 million tonnes of limestone for cement industry is next only to coal (380 m.t). Limestone is the primary and major constituent for cement, 1 tonne of cement needs 1.5 tonnes of carbonate for its manufacture. In fact location of a Greenfield cement plant is dictated by availability of requisite quality and quantity of limestone, besides a market.

All over the world, Cement continues to be the major building material for civil and industrial constructions, as no other material is likely to be its substitute in the near future. Indian cement industry has been serving the nation's construction industry since 1914 and now has achieved a remarkable status with total installed capacity of 159.80 million tonnes as on 01.01.2006 and Cement Production of 136.67 mt (excluding mini cement plants), which is second largest in the world only after China. Cement is perhaps the only industry where liberalization was put into concrete practice, even before the open market policy was adopted as a policy. From controls to partial control in 1982 to total decontrol in 1989, the cement industry has passed through all the phases and today its track record both in capacity creation and utilization has been quite remarkable. It is one of the few industries which can turn out a product conforming to international standards without tie-ups or collaborations. The per capita consumption of cement has been considered as an important index of the country's economic growth.

4.2 World Scenario

China is the largest producer of cement in the world followed by India. During the last one decade cement production in the world has gone up by 45%. The consumption level of Cement in the Asian countries is increasing rapidly. In view of the growth of economies in the Asian region the consumption is projected to rise further by 4-5% per annum for the next 10 years.

The world cement production for the year 2005 is given in Table 1

Table 1
World Cement Production (2005)

Country	Cement Production* (Mn.t)	% to Total*	Per Capita cement consumption**(kg)
China	1000	44	659
India	143	6	125*
USA	106	5	394
Japan	74	3	474
Russia	65	3	288
Korea	62	3	1217
Thailand	50	2	372
Other Countries	759	34	**World Average 267**
Total	**2259**		

Source-CMA Basic Data 2006,** Global Cement Report 3rd Edition

Paradoxically, India's per capita cement consumption is one of the lowest among major cement producing countries. But it cannot obviously remain the same in the face of escalating growth of infrastructure development. The industry which is growing at the present CAGR of + 10% has to gain further momentum to meet the demands and aspirations of the growing population. Growth of cement industry will spur a proportionate demand on limestone availability. Limestone security is therefore vital for sustainable growth of the cement industry. This postulate is borne out from a review of the growth pattern of the industry and cement consumption in previous Plan period. This will define the future limestone demand to meet the growth of cement industry.

4.3 National Scenario

4.3.1 Review of the Status of Cement Industry during X Five Year Plan

The working Group on Cement Industry for X Five Year Plan - 2002 -07 set a production target of 150.47 mn.t. for the year 2005-06. This has however been revised to 142 mn.t. by the Deptt. of IPP, Ministry of Commerce and Industry, on the basis of the economic situation of the country.

The industry has shown much improved performance and not only crossed the production target set by the Deptt. of IPP but also almost reached the target set by the Working Group for X Five Year Plan, failing short of only around 2 mn.t. Export performance has, however, been better as over 6 mn.t. of cement was exported during the year 2005-06 as against the target of 4.5 mn.t. set by the Working Group for X Five Year Plan.

The following table provides a quick comparison of the performance of the Cement industry with the X Plan projected figures.

Table - 2
Performance of Cement Industry during X Plan

(mn.t)

Year	Capacity		Production			Demand		Cement Exports			
	As per the working Group	Actual	As per the working Group	Revised by IPP	Actual	As per the working Group	Actual Consumption	As per the working Group	Actual		
									Cement	Clinker	Total
2001-02 (End IX Plan)	135.00	145.99	113.00	111.00	106.90	109.00	103.51		3.38	1.76	5.14
X Plan 2002-03	139.53	151.17	113.17	115.45	116.35	109.67	112.59	3.50	3.47	3.45	6.92
2003-04	152.72	157.74	124.38	126.00	123.50	120.63	119.86	3.75	3.36	5.64	9.00
2004-05	168.86	165.39	136.70	133.00	133.57	132.70	129.08	4.00	4.07	5.99	10.06
2005-06	185.06	171.34	150.47	142.00	147.81	145.97	141.56	4.50	6.01	3.18	9.19
2006-07	202.64	174.99*	165.56		162.00**	160.56	152.00**	5.00	7.00**	3.00	10.00

CAGR		**3.69**			**8.67**		**8.00**				**14.24**

***Capacity : As in June 2006** ** **Estimated** *(Extracts from the Draft Report of Sub Group I for Cement Industry)*

4.3.2 Cement Production

Cement production during the X Plan has recorded a growth of 8.67% (CAGR). While the target has been crossed by around 3 mn.t. in year 2002-03 and fell short of the target marginally for the 2^{nd} year, there was a shortfall of around 3 mn.t. in the remaining years of the Plan. However, when compared with the low demand scenario, the actual production crossed the targets by 5 - 12 mn.t. Production always depends on demand and the demand for cement has been satisfied all the years of X Plan.

With the average capacity utilization increasing from 82% in 2001-02 to 90% in 2005-06 and around 95% in April-June 2006, the industry has been producing to meet the growing demand and will continue to do so with addition of capacities each year.

4.3.3 Capacity Utilization

Capacity utilization for large plants during the 1^{st} two years was 81% but subsequently increased to 90% in the 4^{th} year. In the first quarter of 2006-07, it averaged at 95% and this is inclusive of public sector plants. In fact, average capacity utilization of private sector plants in 1^{st} quarter of 2006-07 was around 97% while that of the public sector was 46%.

4.3.4 Cement Consumption - Regionwise – Statewise

Cement consumption during the year 2005-06 increased over the previous year in all the regions, though the growth in the central region was less than 1%.

(mn.t.)

Region	2004-05	2005-06	% Change
North	24.26	27.06	+11.54
East	20.40	22.66	+11.08
South	33.43	39.37	+17.77
West	24.58	25.90	+5.37
Central	20.41	20.57	+0.78
All India	**123.08**	**135.56**	**+10.14**

Source: CMA Basic Data - 2006

A positive growth has been noticed in most of the states except Delhi which recorded a negative growth of 6.6%, Assam 2.9%, N.E. States 19.1% and the Union Territory of Goa, Daman, Diu 37.6%. The highest growth of

51% has been recorded by Union Territory of Andaman & Nicobar, followed by Chhattisgarh 47.3%, Chandigarh 40.2% and Andhra Pradesh 34.1%. Uttar Pradesh is the only state, which witnessed a growth of less than 1%.

4.3.5 Exports

Indian cement industry has been exporting cement, the final product and also clinker, which is an intermediate product, to countries across the globe for the last one and a half decades.

Year	Cement Export	Clinker Export	Total Export
01 - 02	3.38	1.76	5.14
02 - 03	3.47	3.45	6.92
03 - 04	3.36	5.64	9.00
04 - 05	4.07	5.99	10.06
05 - 06	6.01	3.18	9.19

Source: CMA Basic Data - 2006

The Tables above confirm that both increasing cement consumption and growth in exports are to be met by increasing production of cement. In its turn, it will need a survey of cement grade limestone availability, vis-à-vis the limestone reserves distribution throughout the country.

4.4 Availability of Cement Grade Limestone Reserves in India

The assurance for availability of the material, limestone is continuously monitored through compilation and updating of National Inventory of Cement Grade Limestone – a task to which National Council for Cement and Building Materials(NCB) has dedicated itself since 1974. NCB has estimated the availability of total reserves as 97.43 billion tonnes as on 31 March 2006.

In the year 1974, the total limestone reserves as estimated were of the order of 44,000 mn.t, with only 3020 mn.t (6.8%) of proved category. As on 31 March 2006, the country's estimated gross reserves of cement grade limestone stand at 97430 mn.t. Out of this, 22476 mn.t (23%) of **proved** category, 19031 mn.t (20%) of **probable** category and 55923 mn.t (57%) of **possible** category reserves. The zone-wise status of cement grade limestone reserves is shown in the table below. The **proved equivalent** reserves of all the categories have been estimated as 63760 mn.t. The substantial increase in reserves has been possible due to the continuous proving of limestone deposits by various national and state level geological agencies.

On the eve of ushering of the X Plan in March 2001, the gross reserves of cement grade limestone was 95939 mln tonne, but estimates showed that only 35585 mln tonnes of gross reserves were available for meeting the present and future demand of cement production. Lesser availability was primarily due to environmental and technological constraints.

This situation has not shown any improvement in course of the X Plan. The gross reserves of cement grade limestone stood at 97430 mln tonne, i.e. an increase of 1490 mln tonnes or 1.5%

State-Wise Status of Cement Grade Limestone Reserves in India
As on March 2006

Zone	State	Reserves in Million Tonnes			Total	Proved Equivalent
		Proved	Probable	Possible		
NORTH	HARYANA	31.22	1.93	2.42	35.57	33.78
	H P	1809.60	000	4269.70	6079.30	3945
	J & K	123.22	524.37	5009.53	5657.12	2995.04
	RAJASTHAN	563.80	3321.29	3748.97	7634.06	4763.19
	UTTARANCHAL	188.20	1227.19	453.43	1868.82	1273.95

Zone	State	Reserves in Million Tonnes			Total	Proved Equivalent
		Proved	Probable	Possible		
	UTTAR PRADESH	327.90	412.02	225.25	965.17	728.94
TOTAL OF NORTH ZONE		**3043.94**	**5486.80**	**13709.30**	**22240.04**	**13739.90**
EAST	ASSAM	338.83	244.00	906.20	1489.03	962.73
	MANIPUR	11.02	2.68	7.86	21.56	16.83
	MEGHALAYA	547.42	980.41	4779.90	6307.73	3623.66
	ARUNACHAL	0.00	108.00	275.50	383.50	213.35
	ORISSA	87.36	95.83	410.55	593.74	359.72
	BIHAR	120.22	67.14	658.74	846.10	496.59
	WEST BENGAL	6.40	3.20	0.00	9.60	8.64
	JHARKHAND	54.58	55.65	114.16	224.39	150.62
	NAGALAND	10.48	113.57	896.63	1020.68	538.30
TOTAL OF EAST ZONE		**1176.31**	**1670.48**	**8049.54**	**10896.33**	**6370.44**
WEST	CHHATTHISGARH	2540.49	797.72	1177.86	4516.07	3687.82
	GUJARAT	3709.96	6707.99	0.00	10417.95	8405.55
	M P	1592.49	251.68	736.80	2580.97	2137.07
	MAHARASHTRA	890.78	111.02	812.33	1814.13	1374.66
	DIU	48.84	0.00	0.00	48.84	48.84
TOTAL OF WEST ZONE		**8782.56**	**7868.41**	**2726.99**	**19377.96**	**15653.94**
SOUTH	A P	959.41	1442.38	28032.60	30434.39	15985.38
	KARNATAKA	7718.37	2270.53	2820.12	12809.02	10717.80
	KERALA	44.58	9.35	40.37	94.30	71.31
	TAMIL NADU	750.46	282.75	454.27	1487.48	1175.52
	ANDAMAN	0.00	0.32	0.51	0.83	0.48
	LAKSHDWEEP	0.00	0.00	90.00	90.00	45.00
TOTAL OF SOUTH ZONE		**9472.82**	**4005.33**	**31437.87**	**44916.02**	**27995.49**
GRAND TOTAL(GROSS)		**22475.63**	**19031.02**	**55923.70**	**97430.35**	**63760**

The gross limestone reserves of 97430.35 mn.t. include 19031.02 mn.t. of probable and 55923.70 mn.t. of possible reserves, that are converted into proved equivalent category. The total proved equivalent reserves are estimated at 63760 mn.t. However, 23% of proved equivalent reserves, i.e. 21,718 mn.t falls under forest areas and 7.5% i.e. 5754 mn.t are restricted under Coastal Regulation Zone (CRZ). Thus the net Proved Equivalent Reserves of 35,585 mn.t are available during XI Plan.

4.5 Demand and Forecast of Limestone for the XI Plan

The approach paper for XI Five Year Plan suggests that the economy could grow between 8 and 9% per year. The paper has also considered three scenarios of GDP growth at 7%, 8% and 9%. The expected growths of the Manufacturing sector to achieve such a growth for the three scenarios have been mentioned as 9%, 10% and 11%.

Further, it has been found by examining growths of GDP and cement consumption over the last 10 years that the cement consumption is always higher with rare exceptions. The ratio as noticed happens to be 1 : 2.2 / 1.3. In other words for every 1% growth of GDP, cement growth should be 1.2 to 1.3 times. This also supports the assumption of the approach paper for the XIth Plan by Planning Commission that cement growth should be 2% over the GDP growth.

On the above assumptions three scenarios of cement demand estimates and corresponding limestone requirement for the XI Plan years are being put forward:

i) The low growth scenario assuming that the factors supporting such growth show a poor performance leading to a GDP growth of 7% annually.

ii) The average growth scenario assuming that the factors responsible to achieve the required performance be conducive to such 8% GDP growth.

iii) The high growth scenario under the assumption that the various factors responsible perform better than expected, leading to GDP growth of 9%.

Accordingly, the limestone requirement based on the growth scenarios of Cement Sector @ of 9%, 10% and 11% have been projected as follows:

Low Demand Scenario (9%)

(mn.t)

Year	Domestic Demand	Export	Production Required	Capacity* Needed	Limestone Requirement** (Developed Reserved)
2006 - 07	152.00	10.00	162.00	180.00	310.50
2007 - 08	165.14	11.00	176.14	195.71	337.60
2008 - 09	179.46	12.10	191.56	212.85	367.17
2009 - 10	195.07	13.31	208.38	231.54	400.00
2010 - 11	212.09	14.64	226.73	251.92	434.60
2011 - 12	230.64	16.11	246.75	274.17	473.00

Average Demand Scenario (10%)

(mn.t.)

Year	Domestic Demand	Export	Production Required	Capacity* Needed	Limestone Requirement** (Developed Reserved)
2006 - 07	152.00	10.00	162.00	180.00	310.50
2007 - 08	166.60	11.00	177.60	197.33	340.40
2008 - 09	182.66	12.10	194.76	216.40	373.30
2009 - 10	200.33	13.31	213.64	237.37	409.50
2010 - 11	219.76	14.64	234.40	260.44	449.30
2011 - 12	241.13	16.11	257.24	285.83	493.00

High Demand Scenario (11%)

(mn.t)

Year	Domestic Demand	Export	Production Required	Capacity* Needed	Limestone Requirement** (Developed Reserved)
2006 - 07	152.00	10.00	162.00	180.00	310.50
2007 - 08	168.06	11.00	179.06	198.96	343.20
2008 - 09	185.89	12.10	197.99	219.99	380.00

Year	Domestic Demand	Export	Production Required	Capacity* Needed	Limestone Requirement** (Developed Reserved)
2009 - 10	205.67	13.31	218.98	243.32	420.00
2010 - 11	227.64	14.64	242.28	269.20	464.40
2011 - 12	252.02	16.11	268.13	297.92	514.00

******Limestone requirement has been worked out considering the consumption factor of 1.5 tonnes and converting the quantity into developed category by multiplying with a factor of 1.15 as per NCB norms (following UNFC guidelines) for proving limestone deposits (SP-9-03).

The total limestone requirement in the XI Plan (2006-07, 2011-12) with the growth scenario of cement at 9%, 10% and 11% for the GDP growth of 7%, 8% and 9% and balance life of reserves is projected below:

Limestone Requirement during 11th Plan projected for various growth Scenarios (mn.t)	**Scenario - I (9%)**	**Scenario - II (10%)**	**Scenario - III (11%)**
	2322.87	2376.00	2432.10
Life of the residual limestone reserves excluding the reserves falling under forest & CRZ beyond terminal year of XI Plan (Years)	70	67	64

It is alarming to note from the estimates given above that the residual limestone reserves, after meeting the existing capacities and their logical expansion , will be able to support cement industry for 64 years (at 11% annual growth) and 70 years (at 9% annual growth)

Limestone availability for sustainable development of the cement industry in meeting the fast-track demand growth of infrastructure development is thus not assured beyond 65 years. Mitigation of this crisis will need several radical steps; the important recommendations arising therein are listed below:

4.6 Recommendations

The mining of about 225 million tonnes of limestone for cement industry is next only to coal (3.80 mn.t). In view of the rapid growth of cement industry with an average CAGR of more than 8% and substantial increase in the capacity of single location plant from 0.4 MTPA to 2.25 MTPA, the availability of cement grade limestone to meet the requirement of projected cement capacity beyond XI Plan period has to be ensured through the appropriate measures. These are:

i) As only 23% of total limestone reserves are in proved category, there is, urgent need to convert 77% of probable and possible reserves into proved category by intensifying exploration activity through central and state level exploration agencies.

ii) There has not been substantial increase in total reserves of limestone during X plan period. The need to identify potential limestone deposits for green-field projects, preferably away from the existing clusters are therefore paramount.

iii) The availability of potential limestone deposits of hill states and northeastern states is restricted due to Forest Conservation Act. Efforts have to be made to release the deposits for exploitation on selective basis.

iv) The exploitation of offshore / onshore deposits has been restricted by declaring coastal stretches as coastal regulation zone (CRZ). Review of the provisions of the CRZ is essential to enable eco-friendly use of enormous reserves of cement grade limestone blocked along Gujarat coast and to save operating plants from gradual demise.

v) Efforts have to be intensified to utilize 27% of marginal grade limestone. This will improve the life of mine and mine environment by drastically reducing the waste dumps presently lying in the existing quarries and occupying precious land.

vi) In order to ensure rational utilization of reserves of various grades available in the mining lease area and to assess the shortfall, if any, for expansion of existing cement plants, periodic re-assessment of captive limestone reserves has to be made mandatory.

vii) The Royalty rates of limestone need be rationalized following one standard norm. The royalty rates have increased from Rs. 4.5 in 1982 through Rs. 10 in 1987 to Rs. 45 in 2004. The rise in royalty rate is abnormally high in comparison to other minerals like iron ore mined in large volumes.

CHAPTER – V

DIAMOND AND PRECIOUS STONES

5.1 Introduction

Diamonds have been known longer in India than in any other Country and the most famous, beautiful and many of the large stones were found in India. The fact that diamonds were known and prized by, the ancient inhabitants of India is proved by the adornment of the deities of oldest temples of the region with diamonds and other precious stones. This also shows that the art of diamond cutting and polishing has been long understood and practiced in India. Until the discovery of the Brazilian gravel deposits in 1728; supply of the whole world was derived mostly from the Indian source.

India has very large skilled man power for diamond cutting and polishing (small & rough) and other precious stones. Indian production of diamonds as against the requirement for cutting and polishing industry is almost negligible (0.04%).

This industry has to rely very heavily on import of diamonds. After value addition by cutting & polishing and manufacture of jewellery, major % of the finished products is exported.

5.2 Diamond Production – World vs India

5.2.1 World Production of Diamonds

Diamonds are now produced from 22 countries, as compared to one country (India) in the ancient period. Kimberlites and associated secondary deposits of gravel and conglomerates are reported from all the continents, except Antarctica. The total Diamond production of 156 Million carats in 2004 came mostly from 14 countries, 10 in Africa, one in North America one in South America, one in Asia (Asian part of Russia) and Australia and rest from other countries. Africa still contributes around 60% of the total world production. The world diamond production for every decade since 1870 is given in Table No.1.

Table 1

SL.No	Year	World diamond production (Mct)
1	1870	1
2	1880	4
3	1890	3
4	1900	3
5	1910	6
6	1920	4
7	1930	8
8	1940	12
9	1950	15
10	1960	26
11	1970	50
12	1980	51

13	1990	111
14	2000	117
15	2004	156

Mct : Million carats
Source: Mineral commodity summary – 2006, USGS

The latest world production with average price of diamonds and total value is given in Table – 2 and the world reserve and reserve base of diamonds is given in Table – .12

Table 2
World Diamond Production by Country, 2004

Producer Country	Carats (000)	Average Price US$/carat	Value in Million US $
Angola	7500	173	1300
Australia	20,673	17	343
Botswana	31,125	94	2940
Brazil	700	50	35
Central African Republic	500	190	95
Canada	12,618	130	1646
Congo(Democratic Republic)	29,000	27	790
Ghana	900	29	26
Guinea	350	251	88
Namibia	2,011	347	698
Russia	35,000	57	1989
Sierra Leone	600	333	200
South Africa	14,233	102	1458
Tanzania	286	129	37
Others	631	209	132
Total	156,127	75.4	11,777

Source: Mineral Commodity Summary-2006, USGS

The twelve years country-wise diamond production is given in Table 3

5.2.2 **Indian Diamond Production**

The Indian diamond production never crossed one lakh carat figure in the last ten years. The main production comes from Majhgawan, Panna district, Madhya Pradesh which is 98-99% of the Indian production.

The value of Indian diamonds (rough) produced since 1995 till 2006 with average price of Rs.5300 (source: IBM) has been calculated and is given in Table.4.

Table – 4
Value of Diamonds Produced in India

Year	Diamonds(Cts)	Value of Diamonds@ Rs.5,300 per carat
1995-96	29463	156153900
1996-97	31561	167273300

Year	Diamonds(Cts)	Value of Diamonds@ Rs.5,300 per carat
1997-98	30591	162132300
1998-99	34201	181265300
1999-2000	40230	213219000
2000-01	56955	301861500
2001-02	81251	430630300
2002-03	84348	447044400
2003-04	71163	377163900
2004-05	78217	414550100
2005-06	43894	232638200

98-99% of the country's production is from Majhgawan

5.2.3 Indian Diamond Industry

Indian diamond industry relies on supply of rough diamonds directly from the producers.

India can/may soon become trading centre for rough and polished diamonds.

There is a proposal to set up a FTZ (Free Trade Zone) or EPZ (Export processing Zone) in Gujarat.

The gem and jewellery industry employs about 10 to 12 lakh work force of which about 80% is engaged in diamond cutting and polishing industry (see Table 5)

Table 5
Major Diamond Cutting Countries

Country	Workforce (2004)
India	7,00,000
China	25,000
Thailand	9000
Russia	5000
Armenia	3500
Sri Lanka	3000
Israel	2000
Belgium	1500
USA	400

Rough diamonds are imported from distributing centres in Antwerp (Belgium) and London (UK) or from diamond mining centres in Russia, Angola, Botswana and Namibia. Cut and polished diamond are exported to USA, Hongkong, Belgium, Japan, Israel, Singapore, Switzerland, and UAE etc.

5.2.4 Consumption of Diamonds in India

1. Diamond cutting & polishing Trade
2. Jewellery manufacture based on cut & polished diamonds, gold and precious stones.
3. Manufactures of drill bits.
4. Grinding tools.

5.2.5 Diamond cutting and polishing in India-Share in Global Trade

1. 50% share by value
2. 80% in terms of caratage
3. 90% in terms of diamond pieces sold

5.3 Diamond Imports and Exports in India

A steady growth of diamond imports and exports has been established between 1994-95 to 2003-04. The imports have risen from Rs.4,960 crores in 1994-95 to Rs.32,251 crores in 2003-04. The export figures have risen from Rs.12,357 crores in 1994-95 to Rs.38,145 crores in 2003-04.

The growth in this industry could certainly go up further and is huge production of cheap low-quality diamonds from Argyle mine, much of which could not have been cut profitably in any centre other than India; greater direct access to the American consumer market throw Indo-Argyle Diamond Council;, establishing an international presence through De Beers “Supplier of Choice”, including a number of strategic partnership with US and European companies; development of new diamond processing technology by younger generation of diamond manufacturers as a means taking the industry to higher levels in terms of quality and speed with greater precision and cheap, abundant, skilled and industrious workforce.

Indian Imports

Year	**2001-02**	**2002-03**	**2003-04**
Crores	28,206	27,806	38,145

Country wise Indian Imports (major)

Country	**Belgium**	**UK**	**Hong Kong**	**UAE**
%	54%	22%	9%	6%

Exports

Year	**2001-02**	**2002-03**	**2003-04**
Crores	21,635	28,932	32,251

Country wise Exports (major)

Country	**Hong Kong**	**Belgium**	**UAE**	**Israel**	**Japan**
%	25	14	6	5	5

The main threat for Indian Diamond Industry in future may be from China because today China has also started cutting and polishing of small diamonds.

The Diamond Import/Export Trade of India and % of added value with respect to import is given in Table 6

5.3.1 Value of diamonds Production & Imports of India during the period 1999-2000 to 2006-2007 is given in Table – 7. To assess the demand for ores / Minerals and its likely growth during 11th plan period, Diamonds Production, Imports and its value projections worked out wrt 10%, 9%,8% and 7% are given in Tables. 8,9,10 &11.

5.3.2 **Further Growth of Indian Diamond Sector**

Indian diamond industry handles 80% of the global polished diamond market, and earned us $ 8 billion in 2004 (compared to software's US $ 10 billion). So why do we hear so much about IT and so little about the diamond business? Well, try talking to someone in the diamond industry.

India's diamond industry is expected to be worth same 75 billion rupees ($1.66 billion) in 2006, compared to 66 billion rupees ($1.47 billion) in 2005, reports times of India. This makes India the world's fastest growing market and puts it on a par with the Gulf region, although the United States still leads the world with a 52% share of the global market. De Beers has developed special diamond jewellery brands just for India including Nakshatra, Sangini, Arisia and Asmi [Antwerp Facets News Service, January 2006]

The best recent news for Indian industry was the decision by RIO TINTO to extend mining at the Argyle Mine in Western Australia underground, which will mean the mine, will keep producing tough for another 10 years or so after the open pit is exhausted in 2008. The mine is then expected to produce at about 60% of the 34 million carat per year figure.

Baikul Mehta, Chairman of India's Gems and Jewellery Export Promotion Council said that this move could generate further investment for India's diamond industry. About 2500 jobs in India are dependent on the Argyle Production.

Indian cut and polished diamond manufacturing industry is expecting a growth of 20% in 2005. The industry earns 90% of its revenue through the finished products. The $11 billion diamond industry has accounted for 85 percent of the total global business last year. The global business is worth almost $ 12.5 billion. The sector has witnessed a remarkable growth rate ranging from 15 to 20 percent in 40 years. Interestingly, global growth is in the range of 6 to 8 percent.

The Bharat Diamond Bourse (BDB), set up in 1984, as a service oriented non-profit company is one of the main platforms of the diamond industry. It was accepted as the member of the World Federation of Diamond Bourses (WFDB) in 2000. BDB has helped industry by providing infrastructure and other facilities.

India is maintaining the lead mainly because of the pragmatic policies of the government and sustained efforts of the exporters.

Policy change such as creation of Special Economic Zones (SEZ) could boost exports further. Several diamond polishing companies have already established offices in India for trading in rough and polished diamonds. India has been obtaining rough diamonds from Belgium, Israel, Honkong etc. and has been seeking opportunities establish direct trade ties with mining countries and companies.

Diamond Import and Export Policy in India

1. Diamond is freely importable item and the present applicable basic duty is 25%. The basic customs duty on cut and polish diamonds have been reduced from 15% to 5% (vide notification No.21/2002 dated 01.03.2002 as amended by notification No. 26/2003 dated 1.3.2002).
2. The rough coloured gemstone half cut, broken diamonds and semi processed pieces have been fully exempted from basic customs duty.
3. Foreign Direct Investment (FDI) in Diamond Mining is now up to 100% under automatic approval of Reserve Bank of India (RBI).

5.3.4 Reserves and Reserve Base of Diamonds (World vs India)

5.3.5 World Reserves & Reserve Base Of Diamond

Table 12

(In Million Carats)

Country	Reserves	Reserve Base
United States	NA.	N.A
Australia	90	230
Botswana	130	225
China	10	20
Congo (Kinshasa)	150	350
Russia	40	65
South Africa	70	150
Other Countries	85	210
World Total (Rounded)	580	1,250

Source: Mineral Commodity Summary-2006, USGS

5.3.6 Occurrences And Resources Of Diamonds In India

India has three diamond provinces i.e. Central Indian Diamond Province, East Indian Diamond Province and South Indian Diamond Province where the primary and diamond host rocks and the secondary occurrences are found.

The Reserves and Reserve base of diamond, ruby and sapphire is given in Table-13.

Table 13

Statewise Resources of Diamond as on 1.4.2005(Provisional) (in Carats)

STATE NAME	RESERVE	RESOURCES	TOTAL RESOURCES
Andhra Pradesh	0	1822955	1822955
Chhattisgarh	0	1304000	1304000
Madhya Pradesh	1205577	249381	1454958
Total:	1205577	3376336	4581913
Statewise Resources of Ruby as on 1.4.2005(Provisional) (in Kg.)			
STATE NAME	**RESERVE**	**RESOURCES**	**TOTAL RESOURCES**
Orissa	1925.1	3345.64	5270.74
Statewise Resources of Sapphire as on 1.4.2005(Provisional) (in Kg.)			

STATE NAME	RESERVE	RESOURCES	TOTAL RESOURCES
Jammu & Kashmir	0	450	450

5.3.7 Central Indian Diamond Province

5.3.7.1 Panna Kimberlite/Lamproite Field

The main panna belt stretches for 80 km in a ENE-WSW direction and is ~10 to 15 Km wide. It is located on the northern margin of Vindhyan plateau of Bundelkhand cration. The sediments of Vindhyan Super group (Upper Proterozoic age) lie unconformably over the Bundelkhand basement complex. The complex consists of migmatites and polyphase granitic intrusives which are compositionally granite to tonalite. The Panna diamonds are from three sources (i) kimberlite/lamproite pipes from primary source rocks eg. Majhgawan and Hinota (ii) conglomerates and (iii) quaternary gravels.

Besides there are several other ultrabasic bodies found around Panna like Angore, Bariapur, Dongraha, Biharpur, Harsa and Bonda which are emplaced in the Bundelkhand granitic massif and reports show that diamonds have been recovered from their vicinity.

5.3.8 East Indian Diamond Province

5.3.8.1 Raipur Kimberlite / Lamproite field

Four Kimberlite pipes have been discovered in the Raipur district of Madhya Pradesh. The area infact, is a part of Archean Bastar Craton. The rocks are high grade metamorphic being close to the Eastern Ghat Mobile Belt (EGMB). In this area the Upper Proterozoic platformal cover sediments are deposited in two cycles of 1100-900 Ma and 700-450 Ma in separate sub basins over the Bastar craton. The K/L intrusive rocks are found sandwiched between the two sedimentation cycles along the western part of Khariar syncline, as evidenced by the presence of xenoliths. This fractured granitic cration is covered by the sediments mainly sandstones of Upper Proterozoic, Khariar Group of Chattisgarh Super group. In this area the kimberlite bodies are oval to semicircular in shape and have undergone intensive weathering.

5.3.8.2 Tokapal Kimberlite / Lamproite Field

Both the occurrences of the Tokapal K/L field ie. Tokapal and Bejripadar are emplaced into the Bastar Craton located between Godavari and Mahanadi grabens in Chattisgarh State. The cration comprises o crustal metamophics of Archean age, acid and basic extrusives and intrusives overlain by Upper Proterozoic plat formal sediments and is known as Indravati Group. Apart from two K/L bodies several ultramafic and ultrapotassic bodies have been reported in the Bastar Craton.

5.3.9 South Indian Diamond Province

Wajrakarur Kimberlite Field (WKF) occurs in Dharwar cration of South Indian Peninsular shield this field forms a part of Archaean granite – greenstone complex. The Peninsular Gneissic complex is composed of grey colored granite tonalite banded gneisses and migmatite. Here, curvilinear Penakacherla schist belt trends in the NS to NW-SE direction and there are younger granite intrusives and gabbro of Archaean age and dolerite dykes. There are 13 kimnberlite pipes in Wajrakarur kimberlite field. The diamonds in this field are found in the kimberlite/lamproite pipes, dyke like bodies and colluviums and alluvium derived from these and

Chigicherla kimberlite field (CKF) occur about 60 km SE of Wajrakarur area in Anantapur district. This area has Peninsular Gneissic complex, Ramagiri schist belt and intrusive granitic bodies. In addition to this, there is emplacement of younger dolerite dykes in NE-SW and NW-SE directions. Due to red soil and calcrete cover the K/L bodies are rarely exposed. The Kalyandurg area has two sets of mafic dykes trending NNW-SSE and ENE-WSW intruding the Closepet granite. The area is treasured by a number of NNW-SSE faults parallel. The other important areas lie in Narayanpet, Maddur areas of A.P., Gulbarga and Raichur areas of Karnataka.

5.4 The geological distribution and occurrences of host rocks of diamonds are given in Tables 14 & 15.

Table 14

Geological and Geographical Distribution of Diamond Host Rocks in India

Age	Formation/Group	Rock type	Location
Neoproterozoic	1) Wajrakarur	Kimberlite	Wajrakarur- Chigicherla-
~1000 to ~1100 My	Kimberlite Field (WKF)		Kalyandurg-Gooty area, A.P.
	2) Narayanpet Kimberlite Field (NKF)		Maddur-Kotakonda-Narayanapet- Guntakal, A.P. &Karnataka.
	3) Raichur Kimberlite Field (RKF)		Raichur-Siddampalle-Mantralayam area, Karnataka & A.P.
	4) Majhgawan Lamproite Field (MLF)	Lamproite	Panna Area, M.P.
	5) Mainpur Kimberlite Field (MKF)	Kimberlite	Payalkhand, Behradih-Kodomali area, Chhattisgarh
	6) Tokpal Kimberlite Field (TKF)	Kimberlite	Tokpal area, Chhattisgarh
	7(Mahghawan rocks(?)	Kimberlite/Lamproite	Bundelkhand granite area, MP
	8)Naupara Lamproite field (NLF)	Lampriote	Dharambandh – Kariar paikamal area, Orissa
~ 1350 My	1)Chelima Lamproite Field (CLF)	Lamproite	Chelima – Zangamraju palle area, AP
	2) Jaggyyapeta Lamproite Field(JLF)	Lamproite	Ramannapeta, Jaggyyapeta area, Krishna valley, AP
	3) Ramadugu Lamproite Field(RLF)	Lamproite	Ramadugu area, AP
(?) Meso Properozoic	Cumbum formation	Pebbly sandstone	Kolluru area, Krishna Valley AP
(?) Paleo Properozoic	Sakoli group	Conglomerate	Vajragarh area, Maharashtra

5.5 Status of Diamond Exploration in India

The liberalization of our National Mineral Policy in 1993 has resulted in the entry of private entrepreneurs and Multinational Companies from overseas, for carrying out diamond exploration. A few renowned companies equipped with the state-of-the-art technology and backed by sound financial resources are working/worked in a total of 1,62,640 sq km area in various diamond provinces covering various companies and a few kimberlites / lamproites have been discovered. The status of the Reconnaissance Permits and Prospecting Licences in India are given in Tables 16 to 19.

Table 16
Company-wise Reconnaissance Permits
(As on August 2005 – Source: IBM)

Name of the company	No, of RPs Granted	Total area granted (sq.km)
De Beers	30	49,248
RioTinto	23	39,112
BHP	18	28,727
AMIL	09	10,953
GMSR	11	5,442
NMDC	02	4,310
Phelps Dodge	04	6,940
B.V.C.E Pvt Ltd.,	02	7,000
Diamond Prospecting Ltd.	03	5,408
Jindal Steel Power	01	2,500
Emperor Granite	02	3,000
Total	105	1,62,640

Table 17
State-wise Reconnaissance Permits
(As on August 2005 – Source: IBM)

State	No. of RPs granted	Total area under RPs (sq.km)
Andhra Pradesh	34	45,513
Orissa	12	18,277
Madhya Pradesh	11	21,825
Karnataka	22	33,048
Chhattisgarh	21	39,128
Uttar Pradesh	05	4,899
Total	105	1,62,640

Table 18
Status of the Reconnaissance Permits (As on August 2005)
(Source IBM)

State	Name of the Company	No. of RPs granted	Total area under RPs (Sq.Kms)	Commodity
Andhra Pradesh	GMSI	7	3380	Base metals/noble metals & diamond
	DeBeers	8	9929	Diamond & Associated Minerals

State	Name of the Company	No. of RPs granted	Total area under RPs (Sq.Kms)	Commodity
	Rio-Tinto	4	9330	Gold, Diamond & Associated minerals
	NMDC	1	2300	Diamond
	BHP	4	7112	Diamond & Base metals/Noble metals
	AMIL	6	6522	Gold, Diamond & other associated minerals
	Phelps Dodge	4	6940	Base metals/noble metals/diamond and other associated minerals
Orissa	DeBeers	5	9613	Diamond & associated minerals
	Rio-Tinto	3	4183	-do-
	AMIL	1	4431	-do-
Madhya Pradesh	NMDC	1	2010	Diamond
	BHP	3	4577	Diamond, Base metals/Noble metals
	Rio-Tinto	3	7650	Diamond & Associated Minerals
	DeBeers	4	7588	-do-
Karnataka	DeBeers	7	11753	-do
	Rio-Tinto	6	9989	-do-
	GMSI	4	2062	Diamond, Gold & Associated Mierals
	Diamond Prospecting Pvt. Ltd.	3	5408	-do-
	BHP	2	3936	-do-
Chhattisgarh	Vijay Kumar Chattisgarh exploration	2	7000	Diamond
	DeBeers	5	8975	Diamond
	Rio-Tinto	6	7960	Diamond & Associated Minerals
	BHP	5	9693	Diamond, Gold & Associated minerals
	Emperor Granite	2	3000	-do-
	Jindal Steel Power	1	3509	Base metals/Noble Metals & Diamond
	DeBeers	1	1390	Diamond & other precious stones
	BHP	4	3509	Base metals/Noble metals & Diamond
NMDC - National Mineral Development Corporation Limited				

State	Name of the Company	No. of RPs granted	Total area under RPs (Sq.Kms)	Commodity
De-Beers -DeBeers India Prospecting Private Limited DeBeers India Surveys Private India Ltd. Rio Tinto – Acc Rio-Tinto Exploration Limited Rio-Tinto –Exploration Limited BHP – BHP Khanij Anveshan Pvt. Limited BHP Minerals India Limited AMIL – AMIL Mining India Pvt. Limited GMSI – Geo-Mysore Services India Limited				

Table 19
State-wise details of the party applied for PL in various states

Sl.No.	Name of the company	Area granted under RP(Sq.Kms)	Mineral	District/State
1.	GMSI	240	Copper,Lead-Zinc,Gold, Diamond	Anantapur, AP
2.	GMSI	375	-do-	Chittoor, AP
3.	DeBeers India Minerals Pvt.Ltd.	2000	Gold, Diamond & other minerals	Kurnool & Mehaboob-nagar, AP
4.	DeBeers India Minerals Prosp.Pvt Ltd.	843(538 executed)	Diamond &associated	Kurnool, AP
5	CRA Exploration India Pvt. Ltd.	2240	Gold, Diamond & Associated Minerals	Anantapur, AP
6.	-do--	2760	-do-	Kurnool & Anantapur, AP
7.	-do-	2170	-do-	Anantapur, AP
8.	-do-	2160	-do-	Kurnool & Anantapur, AP
9.	NMDC	2300 2010	Diamond Diamond	Anantapur, AP Panna/Satna, M.P
10.	Phelps Dodge Exploration India Pvt. Ltd.	2700	Cu – Pb – Zn, Au, Ag, Diamond and other associated minerals	Cuddapah, AP
11.	-do-	2560	-do-	-do-
12.	DeBeers Survey Pvt. Ltd.	2000	Diamond & Associated Mierals	Gulburgah, Karnataka
13.	GMSI	315	Au, Cu, Pb, Zn, Mo etc.	Koppal (Old Raichur), Karntaka.

Diamond exploration is a high investment- high-risk venture. Based on the available data (world) on the number of kimberlites / lamproite pipes known and number of diamond producing mines out of the six thousand kimberlites (approx.) discovered, twenty have resulted into major mines and an additional 70-100 have become smaller mines. The general figures indicate that out of every 100 kimberlites only 10 turn out to be diamondiferous and only one out of these is economically viable. These figures eloquently reflect the magnitude of risk involved.

Based on the exploration practices and activities which are multidisciplinary in nature (involving Airborne Geophysical Survey, Remote sensing, Stream Sediment sampling and other ground geological, geochemical & geophysical surveys) new kimberlites / Lamproites may be discovered. This may result in discovering a new mine and if so production may be expected only by 2015. The production from such economically viable kimberlites / Lamproites discovered may only meet a fraction of the industry's requirement. Therefore, for a long time to come, India has to depend on imports of rough stones.

5.6 Recommendations

It is evident that presently diamond and precious stones cutting & polishing and jewellery industry of India relies mostly on import of rough diamonds, which after value addition (in the form of cutting and polishing and jewellery manufacture) are mostly exported. It is therefore essential to continuously review the diamond import and export policy so as to continuously make available the roughs to the industry and to facilitate the export of finished products.

All out efforts should be made to increase production of rough diamonds from India to partly meet the requirement of Indian diamond industry. At present the only mechanized mine producing diamonds in India is Majhgawan diamond mine of NMDC. Exploration activity in different states is required to be boosted. This will help in discovering new economically viable kimberlites / lamproites for conversion in to mines and leading increase of indigenous production.

Based on the available data, in most of the Reconnaissance Permits (RP's) for diamonds granted to various multinational and Indian mining companies, the preliminary exploration works have been completed. Based on the preliminary exploration the concerned companies have applied for Prospecting Licences (PL's) for detailed exploration. In most of the cases the total area applied for PL's in any state is more than 25 Sq. Km.

Though Hoda Committee has recommended to increase this limit for area for PL's from 25 Sq.Km to 100 Sq.Km, yet it may take time for approval and implementation of the report. It is therefore recommended that Central Govt. may consider the granting relaxation under section 6(1)b of MMDR act 1957 so that detailed exploration work will start in the areas applied for PL by various companies.

Table 3
WORLD DIAMOND PRODUCTION

S.No.	Country														
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1.	Australia	36	36	40	42.2	40	38.5	38	36	40.92	29.78	26.7	26.2	33.64	33.1
2.	Zaire	24	19	15	15	19	19	20.6	n.a	n.a	n.a	n.a	n.a	n.a.	n.a.
3.	Botswana	17.3	16.5	15.9	17	14.73	15.55	16.9	17.85	19.8	21.35	24.65	26.4	28.4	30.4
4.	Russia(USSR)	15	13	11.25	16	15	13.65	13.5	13.4	15.1	23	23	23.2	23	24
5.	South Africa	8.5	8.2	10	10.3	10.62	11	9.98	9.9	10.65	10.02	10.78	11.17	10.88	12.67
6.	Namibia	0.8	1.4	1.6	n.a.	1.08	1.3	1.34	1.44	n.a.	n.a.	1.6	1.49	1.35	1.65
7.	South America	1.7	2	2.6	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a		n.a.	n.a.	n.a
8.	Ghana	0.2	0.2	0.5	n.a.	0.5	1	0.82	0.74	0.5	0.5	0.88	1.17	0/96	1
9.	Central African Republic	0.5	0.5	0.4	n.a.	0.5	0.64	0.65	0.6	n.a.	n.a	n.a.	n.a.	n.a	n.a
10.	Sierra Leone	0.7	0.6	0.55	7.1	0.27	0.44	1.2	0.5	n.a.	n.a.	n.a.	n.a	n.a	n.a
11.	Liberia	0.3	0.1	n.a.	n.a	n.a.	0.2	0.25	0.2	n.a.	n.a.	n.a	n.a	n.a	n.a
12.	Tanzania	n.a	n.a	n.a.	n.a.	0.06	0.06	n.a.	0.13	n.a.	0.23	0.32	0.25	0.21	0.23
13.	Angola	1.3	1.3	2.7	n.a	2	4.43	2.5	5.34	5.09	4.1	6	5.17	5.02	5.3
14.	Geinea	0.1	0.1	0.1	n.a	0.1	0.64	0.9	0.75	n.a	n.a	n.a	n.a	n.a	n.a
15.	Demo Repl of Cango	n.a	n.a	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	21.36	20.12	17.5	18.24	28.24	20
16.	Other Countries	0.3	1.3	0.4	-	2.77	5.14	4.41	26.97	6.3	7.9	6.37	7.32	8.8	8.85
	Total	106.7	100.2	101	107.6	106.63	111.55	111.05	113.82	119.72	117	118	120.6	130.5	137.2

Table 6
Diamond Import/ Export Trade of India

S.No.	Year	IMPORT			EXPORT			ADDED VALUE		
		Cts.in lakhs	. Rs. In Crores	US $ in Millions	Cts .in Lakhs	Rs.in Crores	US $ in Millions	Rs. In Crores	US $ in Million	% of Added value Wrt. Import
1.	1990-1991	371.26	3544.00	1975.00	83.35	4739.00	2641.00	1195.00	666.00	33.72
2.	1991-1992	545.93	4678.00	1882.00.	87.21	6163.00	2500.00	1485.00	618.00	31.74
3.	1992-1993	722.86	6678.00	2186.00	110.32	8316.00	2868.00	1548.00	682.00	22.87
4.	1993-1994	696.09	8081.00	2562.00	139.90	11410.00	3649.00	3329.00	1087.00	41.20
5	1994-1995	729.08	8810.00	2792.00	158.07	12573.00	2041.00	3763.00	1229.00	42.71
6	1995-1996	899.01	10993.00	3274.00	192.11	15501.00	4662.00	4508.00	1388.00	41.01
7	1996-1997	1029.01	12038.00	3382.00	188.83	14916.00	4235.00	2878.00	853.00	23.91
8	1997-1998	1066.12	11254.42	3036.15	205.55	16579.45	4492.66	5325.03	1456.51	47.32
9	1998-1999	1526.95	14127.93	3343.18	267.99	21074.12	5026.11	6946.19	1682.93	49.17
10	1999-2000	1337.02	20924.77	4812.3	331.17	28706.51	6647.82	7781.74	1835.52	37.19
11	2000-2001	1003.83	19832.96	4349.80	299.06	28041.80	6186.70	8208.84	1836.90	41.39
12	2001-2002	1292.24	20098.84	4205.48	328.86	28346.49	5971.91	8247.65	1766.43	41.04
13	2002-2003	2082.43	30504.17	6270.99	372.30	34297.89	7110.57	3793.72	839.58	12.44
14	2003-2004	1991.40	33064.03	7141.04	376.76	39550.56	8627.48	6486.53	1486.44	19.62
15	2004-2005 (Provision)	1762.41	34241.95	7595.31	479.43	50073.60	11181.53	15831.65	3586.22	46.23

Table 7

Value of Diamonds Production & Imports during 1999-2000 to 2006-2007

Year	Indian Production Cts. In Lakhs	Production Growth %	Value Rs.in Crores	Value Growth %	Imports Cts in Lakhs	Imports Growth %	Value Rs. In Crores	Imports Value Growth %	Total Production + Imports	Total Value of Imports+ Production	Growth % of Total Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1999-2000	0.40	--	21.32	--	1337.02	--	20924.77	--	1337.42	20946.09	--
2000-2001	0.57	41.57	30.19	41.57	1003.83	-24.92	19832.96	-5.22	1004.40	19863.15	-5.17
2001-2002	0.81	42.66	43.06	42.66	1292.24	28.73	20098.84	1.34	1293.05	20141.90	1.40
2002-2003	0.84	3.81	44.70	3.81	2082.43	61.15	30504.17	51.77	2083.27	30548.87	51.67
2003-2004	0.71	-15.63	37.72	-15.63	1991.40	-4.37	33064.03	8.39	1992.11	33101.75	8.36
2004-2005	0.78	9.91	41.46	9.91	1762.41	-11.50	34241.95	3.56	1763.19	34283.41	3.57
2005-2006 (Projected)	0.44	-43.88	23.26	-43.88	1935.44	9.82	37603.77	9.82	1935.88	37627.03	9.75
2006-2007 (Projected)	0.47	6.41	24.91	7.08	2125.46	9.82	41295.65	9.82	2125.93	41320.56	9.82

Table 8

11 th Five Year Plan (2007-2008 to 2011-2012)

Projected Value of Diamonds Production & Imports wrt to 10 %, GDP Growth

Year	Indian Production Cts. in Lakhs	Production Growth %	Value Rs.in Crores	Value Growth %	Imports Cts in Lakhs	Imports Growth %	Value Rs. Rs.in Crores	Imports Value Growth %	Total Production + Imports	Total Value of Imports+ Production	Growth % of Total Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)

2007-2008	0.52	10.64	30.32	21.72	2338.01	10.00	49967.82	10.00	2338.52	49998.14	21.00
2008-2009	0.57	10.00	33.35	10.00	2571.81	10.00	54964.60	10.00	2572.38	54997.95	10.00
2009-2010	0.63	10.00	36.68	10.00	2828.99	10.00	60461.06	10.00	2829.61	60497.75	10.00
2010-2011	0.69	10.00	40.35	10.00	3111.89	10.00	66507.17	10.00	3112.57	66547.52	10.00
2011-2012	0.76	10.00	44.39	10.00	3423.07	10.00	73157.89	10.00	3423.83	73202.27	10.00

Table 9

11 th Five Year Plan (2007-2008 to 2011-2012)

Projected Value of Diamonds Production & Imports wrt to 9 %, GDP Growth

Year	Indian	Production	Value	Value	Imports	Imports	Value	Imports	Total	Total	Growth %
	Production	Growth %	Rs.in	Growth %	Cts in	Growth %	Rs.	Value	Production	Value of	of Total
	Cts. in		Crores		Lakhs		Rs.in	Growth %	+ Imports	Imports+	Value
	Lakhs						Crores			Production	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2007-2008	0.51	8.51	29.46	8.51	2316.75	9.00	49063.33	9.00	2317.26	49092.79	18.81
2008-2009	0.56	9.00	32.11	9.00	2525.26	9.00	53479.03	9.00	2525.82	53511.15	9.00
2009-2010	0.61	9.00	35.00	9.00	2752.53	9.00	58292.14	9.00	2753.14	58327.15	9.00
2010-2011	0.66	9.00	38.16	9.00	3000.26	9.00	63538.44	9.00	3000.92	63576.59	9.00
2011-2012	0.72	9.00	41.59	9.00	3270.28	9.00	69256.90	9.00	3271.01	69298.49	9.00

Table 10

11 th Five Year Plan (2007-2008 to 2011-2012)

Projected Value of Diamonds Production & Imports wrt to 8 %, GDP Growth

Year	Indian Production Cts. In Lakhs	Production Growth %	Value Rs.in Crores	Value Growth %	Imports Cts in Lakhs	Imports Growth %	Value Rs. Rs.in Crores	Imports Value Growth %	Total Production + Imports	Total Value of Imports+ Production	Growth % of Total Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2007-2008	0.51	8.51	29.19	8.51	2295.50	8.00	48167.31	8.00	2296.00	48196.50	16.64
2008-2009	0.55	8.00	31.53	8.00	2479.14	8.00	52020.69	8.00	2479.68	52052.22	8.00
2009-2010	0.59	8.00	34.05	8.00	2677.47	8.00	56182.35	8.00	2678.06	56216.40	8.00
2010-2011	0.64	8.00	36.77	8.00	2891.66	8.00	60676.94	8.00	2892.30	60713.71	8.00
2011-2012	0.69	8.00	39.71	8.00	3123.00	8.00	65531.09	8.00	3123.69	65570.81	8.00

Table 11

11 th Five Year Plan (2007-2008 to 2011-2012)

Projected Value of Diamonds Production & Imports wrt to 7 %, GDP Growth

Year	Indian Production Cts. in Lakhs	Production Growth %	Value Rs.in Crores	Value Growth %	Imports Cts in Lakhs	Imports Growth %	Value Rs. Rs.in Crores	Imports Value Growth %	Total Production + Imports	Total Value of Imports+ Production	Growth % of Total Value
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2007-2008	0.50	6.38	28.36	13.85	2274.24	7.00	47279.34	14.49	2274.75	47307.70	14.49
2008-2009	0.54	7.00	30.34	7.00	2433.44	7.00	50588.90	7.00	2433.98	50619.24	7.00
2009-2010	0.58	7.00	32.46	7.00	2603.78	7.00	54130.12	7.00	2604.36	54162.58	7.00
2010-2011	0.62	7.00	34.74	7.00	2786.04	7.00	57919.23	7.00	2786.66	57953.97	7.00
2011-2012	0.66	7.00	37.17	7.00	2981.07	7.00	61973.58	7.00	2981.73	62010.74	7.00

Table 15
Geological and Geographic Distribution of Diamond – Host Rocks in India (Secondary)

AGE	FORMATION/ GROUP	ROCK TYPE	LOCATION
Quaternary		Gravel	1.Krishna – Pennar – Sagileru – Kundir- Hagari –Hindri river areas, AP
			2. Ken – Ranj – Baghain River areas, MP
			3. Maini – Mand – Ib River areas, MP
			4. Mahanadi – Ib – Tel River areas, MP
			5. Koel – Sankh River areas, Jarkhand
		Lateritic gravel	Panna Diamond Belt, MP
Cretaceous	Damodar Group	Lamproitic(?) rock	Damodar Valley Coal Fields, Jharkhand
(?) Jurassic	(?) Gollalapalle Sandstone	Conglomerate	Mallavelli area, Krishna District, AP
Neo-petrozoic	Banganapalle Quartzite (Kurnool Group)	Conglomerate	Kurnool and palnad basins, AP
	Rewa Group		Panna Diamond Belt, MP (Vindhyan Basin)
	a)Gahadra Sandstone	Conglomerate	Panna Diamond Belt, MP (Vindhyan Basin)
	b)Jhiri Shale	Conglomerate	Panna Diamond Belt, MP (Vindhyan Basin)
	c) Itwa Sandstone	Conglomerate	Panna Diamond Belt, MP (Vindhyan Basin)

CHAPTER – VI

GOLD

6.0 Indian Scenario

Gold is a relatively scarce metal in the world and a scarce commodity in India. India is a minor producer of gold against a huge demand in the country. Domestic demand is mainly met with import and partly through recycled gold. India is the world's biggest market, importing bulk of its annual consumption of more than 800 tonnes, making gold market with one-fifth of the global demand.

Gold occurs in India as primary and placer deposits. The primary deposits mainly occur in the states of Karnataka, Andhra Pradesh, Rajasthan, Madhya Pradesh and Jharkhand where as placer deposits occur in Kerala only. Production of gold in the country is in two forms, namely primary gold and secondary or by product gold. Primary gold is produced mainly from Hutti, Uti and Hirabuddini mines in the Hutti Gold field, Karnataka. The other small quantity of production of primary gold has commenced recently from Kunderkocha Gold Mines, Jharkhand. Secondary by product gold is recovered from smelting and refining of copper concentrates in Jharkhand. Currently by-product gold production from Jharkhand has come to a halt. Major portion of by-product gold exceeding primary gold production of the country is from imported copper concentrate by Hindalco Industries Ltd. from copper smelter located at Dahej, Gujarat.

Gold ore as mined is not used directly in the industry. The ore is converted into metal and then marketed. Therefore the estimation in inventory as on 1.4.2005 has been classified as ore and metal.

6.1 Categorisation of Reserve/Resource

As per UNFC, total resources (reserves and remaining resources) of gold ore (primary) in the country as on 1.4.2005 were estimated at 390.28 million tonnes. Out of these, 19.25 million tonnes are placed under reserves category and the rest 371.03 million tonnes under resources category.

The total resources of gold (primary) in terms of metal stand at 491 tonnes. Out of these, 85 tonnes are under reserves category and remaining 406 tonnes under resources category.

Besides, the total resources of gold ore of placer type in the country as on 1.4.2005 were estimated at 26.12 million tonnes, all in the resources category. The resources of gold in terms of metal (placer) are 6 tonnes.

Table -1 gives the details of all India, state wise and category wise reserves/resources of gold as on 1.4.2005.

Table 1
Reserves/Resources of Gold as on 1.4.2005

(in tonne)

Grade/state	Reserves (A)	Resources (B)	Total resources (A+B)
All India: Total			
Ore (Primary)	19,253,951	371,035,286	390,289,237
Metal (Primary)	85	406	491
Ore(Placer)	0	26,121,000	26,121,000
Metal (Placer)	0	6	6
By States			
Andhra Pradesh			
Ore (Primary)	1,544,648	10,553,699	12,098,347
Metal (Primary)	6	25	31
Bihar			
Ore (Primary)	0	222,884,860	222,884,860
Metal (Primary)	0	38	38
Chhattisgarh			
Ore (Primary)	0	900,000	900,000
Metal (Primary)	0	3	3
Jharkhand			
Ore (Primary)	92,850	254,000	346,850
Metal (Primary)	1	2	3
Karnataka			
Ore (Primary)	17,616,453	48,555,934	66,172,387
Metal (Primary)	78	75	153
Kerala			
Ore (Primary)	0	558,460	558,460
Metal (Primary)	0	0	0
Ore(Placer)		26,121,000	26,121,000
Metal (Placer)	0	6	6
Madhya Pradesh			
Ore (Primary)		7,322,000	7,322,000
Metal (Primary)		8	8
Maharashtra			
Ore (Primary)		1,517,000	1,517,000
Metal (Primary)		4	4
Rajasthan			
Ore (Primary)		65,589,000	65,589,000
Metal (Primary)		126	126
Tamil Nadu			
Ore (Primary)		67,000	67,000
Metal (Primary)		1	1
West Bengal			
Ore (Primary)		12,833,333	12,833,333
Metal (Primary)		124	124

State wise principal districts where gold resources have been established

Andhra Pradesh:	= Anantapur, Chittor, Kurnool.
Bihar:	= Jamui.
Chhattisgarh:	= Raipur.
Jharkhand:	= East Singhbhum.
Karnataka:	= Chitradurga, Dharwar, Gulbarga, Hassan, Haveri, Kolar, Raichur and Tumkur.
Kerala:	= Malappuram, Palakkad.
Madhya Pradesh:	= Sidhi, Jabalpur
Maharashtra:	= Nagpur, Bhandara
Rajasthan:	= Banswara, Sirohi, Udaipur ,Bhilwara, Dausa.
Tamil Nadu:	= Dharmapuri.
West Bengal	= Purulia.

The details of inventory as on 1.4.2005 are produced in Table-2 which incorporates the data on summary of reserves and resources. A Summary of the previous inventory as on 1.4.2000 is also included in the table which gives idea about significant changes in the inventory.

As against the present status of the inventory it is seen that during last five years there was augmentation of gold ore reserves and resources in the country with increase in the metal content. Augmentation was mainly in the resource category. It is to be recorded that although in Bihar huge amount of resources have been augmented the grade is too poor. Resource augmentation figure vis-à-vis metal yield expected in West Bengal requires a relook.

Table- 2
Salient features of gold mineral inventory as on 1.4.2000 vis-à-vis 1.4.2005

State		Reserve				**Resource**			
		As on 1.4.2000		As on 1.4.2005		As on 1.4.2000		As on 1.4.2005	
		Ore (MT)	Metal (Tonne)	Ore (MT)	Metal (Tonne)	Ore (MT)	Metal (Tonne)	Ore (MT)	Metal (Tonne)
Andhra Pradesh		1.72	6.6	1.54	6	6.82	19.99	10.55	25
Bihar						128.88	21.6	222.88	38
Chhattisgarh						0.9	2.7	0.9	3
Jharkhand				0.09	1	0.008	0.1	0.25	2
Karnataka		8.36	52.35	17.51	78	15.87	50.02	48.55	75
Kerala	Primary					0.55	0.2	0.55	0
	Placer					26.12	5.86	26.12	6
Madhya Pradesh						12.29	15.72	7.32	8
Maharashtra						1.51	3.55	1.51	4
Rajasthan						7.46	13.10	65.58	126
Tamil Nadu						0.067	1	0.067	1
West Bengal								12.83	124
Total	Primary	**10.08**	**58.95**	**19.25**	**85**	**174.39**	**127.98**	**371.03**	**406**
	Placer					**26.12**	**5.86**	**26.12**	**6**

6.1.1 **Production**

Table 3
Production of gold in India 2001-02 to 2004-05 (By States)

(Quantity in kg)

State	2001-02	2002-03	2003-04	2004-05
India	2810	3153	3363	3526
Primary gold	2475	2799	3167	3526
* Karnataka	2475	2799	3167	3501
Jharkhand	-	-	-	25
Secondary gold	335	354	196	-
+ Jharkhand	335	354	196	-
Total India including by –product recovered from copper concentrate from Hindalco Industries Ltd.	10302	8500	10364	8680

* Includes gold recovered incidental to exploratory operation.
+ Gold is recovered as by-product from copper slime.

Although in last few years there was significant ore resource augmentation but the country has not witnessed any radical change in gold production from primary gold ore. It is worth mentioning that mining of gold was primarily in the state of Karnataka and reserves augmentation was also only in the same state. However, significant augmentation of gold resources has been taken place by other states, where no investment has been made for mining. In order to enhance the gold production existing gold resources in other parts of the country have to be converted to reserves through detailed exploration and feasibility studies. This will help to open up new mines in the country. If new mines are opened the gold production will increase otherwise from the existing mines the annual production will remain between 3 and 3.5 tonnes during XIth plan period. The major producer will be the HGML from its three existing mines.

6.1.2 **Consumption and demand of Gold in India**

India's share in the total world consumption of gold was 855.2 tonnes and 1053 tonnes accounting for 26% and 27% of world consumption of gold during 2000 and 2001 respectively.

Jewellery accounted for major consumption of gold, i.e. 85% followed by electronics 6%, metal and coins 2% and the remaining 7% by other sectors. The consumption of gold is far exceeding than the production owing to the continued consumption in ornament industry and increase in electronic industry.

Table 4
Demand of Gold in India vis-à-vis World

(in tonne)

Year	World	India
2001	3900	830.2
2002	3972	669.8
2003	4142	684

There is a temporary fall in the demand of gold in the country (table 4). However, no proper estimation of gold demand in the country could be attempted due to lack of proper consumption data of the end-use industry. Moreover, high levels of price instability have affected the price sensitive Indian consumer who has currently opted cut down jewellery consumption. This is perhaps a temporary phase. Sharp increase always chokes off purchase of new gold for which until consumers and the traders feel that the price has settled down. Once there is feeling of the price stability again there will be purchase of gold which is the basic form of saving of million of people. In addition to import some amount of gold is recycled in the country. In India recycling industry is not in organized sector. Many ornaments are recycled in huge quantities but details of this are never recorded.

Import of Gold in India

(Unit in kg.)

2001-02	**2002-03**	**2003-04**
471407	606662	766596

6.2 Gold -World Scenario

The world reserve base of gold have been placed at 89000 tonnes of metal content (table 5). Out of the total reserve base of gold metal about 40% is located in South Africa. The other countries which are endowed with gold reserves are Australia and USA (6.8% each), China (4.6%), Canada and Russia (3.9% each) and Indonesia (3.1%).

Table 5
World mine production and reserve base of gold

(in tonnes)

Name of the country	**Mine Production**		**Reserve Base**
	2002	**2003**	
Australia	300	282	6000
Canada	149	141	3500
China	190	202	4100
Indonesia	135	140	2800
Peru	138	172	650
Russia	170	170	3500
South Africa	399	373	36000
USA	298	277	6000
Other Countries	798	830	26000
World Total	2520	2520	89000

The world mine production of gold remained same during 2002 and 2003. The production was 2520 tonnes. The Republic of South Africa continued to be the world leader, contributing 13.92% of the world production followed by USA (10%), Australia (9.8%), China (8.5%), Russia (7.82%), Canada (6.92%) and Peru (6.47%) and Indonesia (4.02%).

6.3 Strategy to be adopted

From overall evaluation it is seen India has a traditional and stable market for gold consumption. The demand for ornamental sector is increasing owing to the increase in purchasing power of emerging middle class. There is demand for growing electronic sector also. A huge gap exists between demand and indigenous production which is likely to continue. To bridge the gap thrust for gold exploration will continue in the country along with import.

The geological occurrences of gold have been reported from various parts of the country. Many of them have been explored and a number of deposits established. The deposits are generally of low grade and low tonnage which are not being exploited.

The mining sector calls for improved method of narrow vein mining for their economic exploitation. Introduction of small scale mining culture in gold industry is a need of the day. Adoption of modern gold extraction technology is an immediate need to treat low grade and complex ore type. For augmenting gold reserves in the country further detailed explorations have to be taken up for the deposits where preliminary assessment upto a shallow depth has been completed.

Wider application of latest techniques of remote sensing, regional geochemical methods and multi-sensor aerial surveys are necessary for fast scanning as well as delineation of favourable targets for detailed exploration. Although substantial progress has been made in the country in such studies, still a gap in technology appears to exist in determining exploration targets from the regional data base by these methods.

MNCs have to be inducted for this purpose with application of state-of-the art technology. The mining sector, which has been thrown open for private entrepreneurs and MNCs, has to provide with fast disposal and support from the Government so as to attract more and more investments.

During the eleventh plan period, in addition to the development of existing mines, the HGML will continue exploratory mine development and exploration by underground drilling in the Hutti South block over a strike length of 750m upto the southern limit of existing mining lease. A total of 9870m of mine develoment has been proposed in the Hutti mine including south block. Exploratory mine development will continue in Uti and Hira Buddini deposits. For furhter prospecting, HGML has applied for PL in Dharwar South Block, Chikanayakanahalli and Bellara blocks in Karnataka. In the XIth plan period HGML has projected maximum production at 3245 kg of gold during 2009-10.

Cluster mining of small gold deposits may also deserve consideration and should be encouraged. A case is that of Kunderkocha deposit in Potka block of East Singhbhoom District, Jharkhand which is being developed by M/s. Manmohan Mineral Industries Pvt. Ltd. (MMIPL) for a production target of 200 Kg. Gold per annum.

6.4 Recommendations

Replacement of gold extraction plant at Hutti Gold Mines Ltd. (HGML) by a new plant inclusive of Falcon Gravity Separator at a cost of around Rs. 70 crores need tobe done at the earliest in 11th plan.

To augment gold production in the country during XIth plan period Chigargunta and Bisanattam mines in KGF which were abandoned, deserve active consideration for reopening. A relook is required for the tailing dump lying in KGF area.

Potential Prospects for Exploitation

- **In KGF** - Chigargunta gold deposit, Tailing dump, Old Bisanattan mine
- **In Hutti belt** - Southern and northern extension within mining block, Wandalli block, Buddini block

- **In Jonnagiri Schist belt** - Dona East block
- **Ramagiri Schist belt** - Ompratima - Gantalappa Sector
- **Gadag Schist belt** - Hosur - Champion, Mysore Mine and Sangli Mine blocks
- **Nuggihalli schist belt** - Kempinkote
- **Dharwar Shimoga schist belt** - Chinmulgand, Rajasthan, Jagpura

Small Deposits For Cluster Mining

Archaean Greenstone Belt
- Wandalli-Chinchergi-Tuppadhur-Buddini blocks (Hutti Belt)
- Dona East, Dona Temple, Dona North, Dona South blocks (Jonnagiri Belt)
- Hosur champion East and West, Mysore mine and Sangli mine blocks (Gadag Belt)
- Ajjanahalli, G R Halli, C K Halli, Gonur-Kotemaradi blocks (Chitradurga Belt)

Proterozoic Fold Belt
- Bhukia West, Bhukia East, Timranmata East, Bhukia East Central and Jagpura blocks

6.4.1 **Areas identified for further search for gold**
- Dharwar craton in the states of Karnataka, A.P. and Tamilnaud (40,000 sq km + 1000 sq km in adjoining granitoids)
- Wynad, Nolambur and Attapady valley gold fields of Southern Granulite Terrain in the states of Tamilnadu and Kerala (450 sq km)
- Mahakoshal belt of Uttar Pradesh and Madhya Pradesh (8950 sq km)
- Kottri volcanic belt, Sonakhan belt, Bailadila Group and its equivalent rocks of Chhattisgarh (1600 sq km)
- Sakoli fold belt of Maharashtra (5500 sq km)
- Gorumahisani-Badampahar belt and Bonai - keonjhar belt of Orissa and Jharkhand (940 sq km)
- Singhbhum fold belt of Jharkhand and Orissa (21500 sq km)
- Aravalli fold belt of Rajasthan (30800 sq km)

A total of more than 1, 10,740 sq. km. area is potential for gold mineralisation.

Geomysore Services and associated companies have filed 81 PL applications for gold and platinum covering a total area of 2,057 sq km in 11 States and also 9 ML applications for gold over an area of 26.78 sq km. and investment of Rs. 37 crores by the GMSI is envisaged during the next 2-3 years. Also a modern gold-ore processing plant first in Jonnagiri Gold Fields, Karnool district, AP is proposed to be established by the Geomysore Services followed by another plant in Chhattisgarh.

However, lengthy and avoidable procedures in grant of prospecting licences need to be ensured by the Central/State Governments.

6.5 Platinum Group of Elements (PGE)

6.5.1 PGE-Indian Scenario:

Platinum is naturally occurring precious metal that is scarce in India. Although there is no production of platinum there is demand of the metal in the country. The development of Indian platinum jewellery market is increasing steadily. The demand continues to grow with increasing consumer awareness. In India, incidence of platinum group of element (PGE) have been noted from the Pre-Cambrian mafic/ultramafic complexes in Baula - Nuasahi sector in Orissa, Sittampundi in Tamil Nadu, Hanumalapura in Karnataka and Usgaon area in South Goa. The resources of PGE ore in the country have been estimated only from Baula- Nuasahi area in Orissa. The resources as per UNFC system are given in Table 1.

Table 1
Resource of PGE ore in India as on 1.4.2000

(in million tonnes)

State	Reserve	Resources		
		Pre-feasibility(222)	Inferred (333)	Total
Orissa	Nil	7.70	6.50	14.20
Total India	**Nil**	**7.70**	**6.50**	**14.20**

6.5.2 **PGE -World Scenario**

The largest reserve of PGE is located in Bushveld Complex in South Africa. The world reserve base of PGE is estimated at 80 million tonne concentrated mostly in South Africa (87.5%), followed by Russia (8.25%), USA(2.5%) and Canada (0.5%). Country wise reserves are given in table 2.

Table 2
World Resources of PGE (tonne)

Country	Reserve base
Canada	390
Russia	6600
South Africa	70000
USA	2000
Other countries	850
Total	**80,000**

6.5.3 **Production**

Platinum supply in the world remained deficit as strong demand from the automotive sector outstripped supply. Demand for palladium remained unchanged. The world mine production by principal countries of PGE is furnished in table 3.

Table 3
Mine Production of PGE (By principal countries)

(in tonnes of metal content)

Country	2001	2002	2003
World Total	**459**	**395**	**453**
Canada	21.80	25.60	19.50
Russia	189.90	105.00	139.30
South Africa	228.75	239.59	266.16
USA	16.36	19.20	18.17
Other Countries	2.19	5.16	9.87

6.5.4 **Consumption of PGE in India**

Import : In India import of platinum registered an increase of more than 50% from 2,234kg in 2002-03 to 3,352kg in 2003-04. Import of other metals of PGE increased manifold from 62 kg in 2002-03 to 2655 kg in 2003-04 where as imports of platinum (powder, unwrought and others) decreased to 697 kg in 2003-04 from 1332 kg in 2002-03.

Future Demand : The demand for platinum will continue to rise with tighter emission controls, robust growth of diesel engines and emerging Indian market for platinum jewellery. The demand of palladium is expected to rise in autocatalysts for petrol engines. Growth of rhodium will also be more in automotive industry.

Strategy to be adopted : At present facilities for ore beneficiation and extraction of PGE do not exist in the country. The metallurgical technique for extraction of platinum group elements from low grade ore is a closely guarded secret with a few enterprises in advanced countries. Technology has to be imported for extraction of PGE and this should be promoted.

In addition, the PGE environment established in the country will have to be covered by regional exploration to identify prospects for detailed exploration. Foreign fund has to be inducted in the country for search of PGE through application of state-of-the art technology.

6.6 Silver

6.6.1 **Indian Scenario**

Silver is recovered as co-product as well as a by-product in the country. It occurs generally in association with lead, zinc, copper and gold ores and its extraction is as a by-product from electrolysis or chemical methods. Economically viable native silver deposits have not been reported in the country. Silver was recovered in the past as a co-product in gold refining at Kolar Gold field complex and Hutti Gold Mines in Karnataka and as a by product in smelting and refining of lead, zinc and copper concentrates. The present production of silver comes from Chanderiya lead –zinc smelter of HZL and gold refinery of HGML.

6.6.2 **Categorisation of Reserves/ Resources**

As per UNFC system the total resources of silver ore in the country as on 1.4.2000 were estimated at about 198.17 million tonnes. Out of these, 91.98 million tones were placed under reserves category and 106.18 million tonnes under the resource category. The reserves were further divided into 54.29 million tonnes under proved and 37.69 million tonnes under probable category.

However, in terms of silver metal in the country as on 1.4.2000 were estimated at 6,082.29 tonnes. Out of which, 2843.41 tonnes belong to reserve category. State wise resources are funished in table1. The major resources of silver come from Rajasthan which accounted for about 80.83% resources, followed by Jharkhand (12.3%). Karnataka (2.73%), Uttarnanchal (1.71%) and Orissa (0.88%).

Table-1
Reserves/Resources of Silver as on 1.4. 2000 (By Grades/States)

Grade/States	Reserves	Resources	Total Resources
All India: Total Ore Metal	 91982629 2843.91	 106184729 3238.88	 198167358 6082.29
By States			
Andhra Pradesh Ore Metal	 791250 5.98	 90000 1.08	 881250 7.06
Jharkhand Ore Metal	 0 0	 23840000 5.22	 23840000 5.22
Karnataka Ore Metal	 5094889 1.64	 314150 2.92	 5409039 4.56
Maharshtra Ore Metal	 0 0	 235000 0.23	 235000 0.23
Meghalaya Ore Metal	 0 0	 880000 19.8	 880000 19.8
Orissa Ore Metal	 1079500 30.83	 670000 34.17	 1749500 65
Rajasthan Ore Metal	 84663600 2798.03	 75525579 2952.92	 160189179 5750.95
Sikkim Ore Metal	 353390 6.93	 450000 41.4	 803390 48.33
Timil Nadu Ore Metal	 0 0	 790000 42.55	 790000 42.55
Uttaranchal Ore Metal	 0 0	 3390000 138.59	 3390000 138.59

6.6.3 **Production**

Production of silver in 2004-05 was 10,955 kg which has decreased by 31% from that in the previous year due to captive consumptions of high silverised lead metal for manufacturing anodes. Production of Jharkhand has come to a halt. Production of silver in India by states is furnished in table-2.

Table-2
Production of Silver 2003-04 and 2004-05 (By States/Districts)

(Qty. in kg)

State/District	2003-04	2004-05
India	**37870**	**10955**
Jharkhand- Singhbhum (East) dist.	2987	0
Karnataka- Raichur dist.	338	385
Rajasthan- Chittorgrah dist.	34545	10570

6.6.4 **World Scenario**

The total reserve base of silver is estimated at 570,000 tonnes of metal. Poland, China, USA, Mexico and Peru are the main countries in terms of resources. World resources (reserve base) are given in table -3. World mine production of silver by principal countries (table -4) indicates that the Peru topped the world to reach 2921 tonnes production in 2003. China stands as Asia's largest producer of silver to the tune of 2500 tonnes.

Table-3
World Resources of Silver (By Principal Countries)

(In tones of metal content)

Country	Reserve base
World: Total	**570000**
Australia	37000
Canada	35000
China	120000
Mexico	40000
Peru	37000
Poland	140000
USA	80000
Other Countries	80000

Table-4
World Mine Production of Silver (By Principal Countries)

(In tonnes of metal content)

Country	2001	2002	2003
World: Total	18984	18847	18825
Australia	1970	2077	1868
Bolivia	410	461	466
Canada	1320	1408	1309
Chile	1349	1210	1313
China	2013	2200	2500
Kazakhstan	943	856	805
Mexico	2760	2747	2569
Peru	2674	2687	2921
Poland	1232	1343	1296
Russia	400	400	700
USA	1740	1421	1239
Other counties	2173	2037	1839

CHAPTER – VII

DIMENSIONAL AND DECORATIVE STONES

7.0 Introduction

Dimensional Stones form a major component of Indian construction sector, which accounts for 5% of the GDP and is the second highest employer after agriculture. India and China are expected to experience highest growth in the construction industry. India's anticipated growth rate in construction is 10% by 2007. With the higher anticipated spending in the private construction (housing) in coming years due to increased financing options, tax benefits and favourable interest rates, the stone sector is bound to have a leap forward.

Dimensional Stones are the mainstay of the economy of Indian states like Andhra Pradesh, Tamilnadu, Karnataka and Rajasthan. India is endowed with vast natural resources of granite in several States predominantly in Southern India, Uttar Pradesh, Rajasthan, Madhya Pradesh, Gujarat and Bihar.

Some of the colours and types of Indian granites are unique in the world and have no parallel and have regular demand in the world market. Indian Marbles and Sandstones have their own pride of place and one can see these stones in exotic beauty at Taj Mahal in Agra, Ranakpur, Delwara Temple, Abu, Red Fort and many other historical monuments. Similarly, in many War Memorials and several other memorials in U.S.A., several buildings of large corporate giants in Japan, China, South Korea and Europe. So is the case in Gulf countries, where Indian Natural Stones are preferred and used extensively.

Majority of marble, sandstone, flaggy limestone produced in India comes from Rajasthan. The state also produces slate. Rajasthan is the hub of stone activity in India accounting for approximately 65% of India's stone production. The State accounts for over 90% of Country's production of marble, sandstone and flaggy limestone. Indian Green Marble, Sandstones, Slates have found acceptance the world-over and can be seen in every nook & corner of the world.

7.1 Global Scenario

The global stone production is over 98 million tons. India is the largest producer of dimensional stones followed by China and Italy.

Table 1
World Stone Production

(thousand tons)

	1999	2000	2001	2002	2003
India	20982	21502	21566	23986	27449
Italy	10548	10176	10522	10001	10000
China	13000	13000	16800	18000	18600
Spain	5600	6200	8770	7616	7760
Portugal	2694	2733	3186	2833	2785
Brazil	2458	2836	3060	3710	4000

	1999	2000	2001	2002	2003
France	1245	1249	1249	1235	1200
Turkey	2304	2453	2625	3150	6200
South Africa	669	977	870	758	750
Mexico	744	1035	1000	1000	1100
Others	6478	8937	7607	19101	18990
Total	66722	71098	77255	91390	98834

India, Italy and China together contribute to more than half the stone production in the world. The other major stone producers are Spain, Portugal, Brazil, Greece, France and Turkey. India accounts for about 28% of global stone production.

The major importers of stones in the world are Germany, Italy, China, Japan, Taiwan and USA. China and other EU countries like France, Spain, Belgium and Netherlands also contribute significantly to the world stone imports.

The major exporters of stones and stone products in the world are Italy, China, India and Spain closely followed by Brazil and South Africa. Other major exporters are Turkey, USA and Finland. Italy, China, India and Spain account for more than half of the world exports. There are however many countries which account for less than 1 % of the export share, but together account for over 24%.

The increasing market share of China, India and Brazil stand out, in view of their vast resources and a great number of varieties; as well as the low cost of production.

7.2 Indian Scenario

India is one of the largest producers of dimensional stones in the world. India is endowed with vast resources of granite, marble, sandstone, flaggy limestone (kotastone), slate and quartzite. Some of the colours and types of Indian granites are unique in the world and have no parallel and have regular flow of demand in the world market.

- Indian Stone Industry accounts for
    - a sales turnover of over Rs. 15,000 crores
    - exports over Rs. 3,400 crores (2003-04) and provisional exports of Rs. 3,500 crores (2005-06)
    - employs over 1.5 million workforce
- The rural economy of many developing states like *M.P., UP, Orissa, and the North Eastern states* is dependent on this industry
- Plays a vital role in the economy of states like *Tamilnadu, Andhra Pradesh, Karnataka and Rajasthan*
    - Stone Industry employs over 0.5 million workforce in Rajasthan alone
        - Udaipur, Rajsamand, Chittor, Dholpur, Ajmer (Kishangarh, Makrana) and Jhalawar districts are primarily dependent on stone industry
        - Major economic role in local economy of Jaipur, Jodhpur, Dungarpur, Banswara, Alwar, Bharatpur, Nagaur and Rajsamand

- Stone sector accounts for export of Rs. 400 crores

7.2.1 Production and Exports

The Indian stone production is estimated at 31059 thousand tons.

Table 2
Indian Stone Production

(in Thousand Tons)

	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06 (P)
Marble	3761	4754	6831	6318	7511	8469	9608	12000
Granite	5000	5300	5900	6205	6710	7059	7759	9000
Sandstone	6310	9297	6659	6861	6363	8153	9313	11000
Flaggy Limestone	1428	1619	2096	2164	3387	3757	4268	4850
Slate	7	12	16	18	14	11	110	150
Total	**16506**	**20982**	**21502**	**21566**	**23986**	**27449**	**31059**	**37000**

India is a leading exporter of stones and ranks third (in terms of tonnage) after Italy and China, with Spain as a close competitor on 4^{th} rank. India's position in the global export trade (in terms of tonnage) is:

- 3rd in world stone exports with a share of around 10% in the global market
- 1st in Raw Siliceous product (Granite & Sandstone) exports. India is a global leader in terms of granite exports and has consistently maintained its position
- 5th in Raw Calcareous product (Marble, flaggy limestone) exports.

Indian Stone Exports comprise mainly Granite Cut Blocks, Granite Slabs and Tiles. The share of marble, slate and sandstone are steadily increasing for the past few years. The major importers of Indian stones are USA, Italy, Taiwan, Japan, Germany and China.

Indian Stone exports was approximately Rs. 3,408 crores during 2003-04, with Granite alone accounting for Rs. 2653 crores.

Table 3
Indian Stone Exports

(Million Rupees)

	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
Granite and Products thereof	10130	16712	19540	20463	24606	26538
Marble and Products thereof	1111	1580	2362	2085	2292	1993
Slate	867	1101	1436	934	1391	1460
Sandstones & other stone products thereof	911	1401	1530	2664	3502	4096
Total	**13019**	**20794**	**24868**	**26146**	**31791**	**34087**

Source: CAPEXIL

India has done well in exports of granites in the world market in last few years. However, severe competition is posed from countries like China, South Africa, Brazil, Zimbabwe, Spain and Italy.

Export figures of Indian granite are provided in **ANNEXURE I**. Similarly, destination-wise exports from India is tabulated in **ANNEXURE II**.

India is the **Second** largest exporter of granite after China. Next in line are **Brazil and South Africa.** With all the progress in granite processing industry (value added finished products), India is yet far behind i.e. at 5th place in the world (**ANNEXURE - III**). Prior to 1987, the exports of Indian processed granite products was hardly 10% of the total granite exports, but in recent years, the share of value added finished products has touched **75-80%** of the total granite exports. Thus, the trend has reversed favaourably in favour of finished value added products.

India has abundant resources, technical know-how, large quarrying base and processing capacity and can safely ensure export growth @ 20% per annum during the 11th Plan period.

The exports and domestic production are complimentary and supplementary in every aspect and thus the domestic industry will also grow simultaneously with the development of exports. It is estimated that domestic industry shall grow @ 20% per year during the 11th Plan period.

7.2.2 **Indian Stone Resources**

Granite

The total estimated / projected resources of granite in India by Indian Bureau of Mines (including Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Karnataka, Kerala, Maharashtra, Orissa, Rajasthan, Tamil Nadu, and West Bengal) is as follows:

Proved	Probable	Possible	Total (in thousand tonnes)
11,114	**332,457**	**683,850**	**1,027,421**

India's granite resources are very large which can last for hundreds of years and meet the demand for a long time.

Marble

Indian Bureau of Mines assessed marble resources in India in the year 2000. Subsequently, extensive deposits spread over 65 sq. km. area were discovered in Madhya Pradesh and are now being actively exploited. A consolidated statement indicating resources / reserves established by GSI, IBM, State departments of Mines & Geology is indicated below:

State-wise Marble Resources	Total (In million tons)
Rajasthan	1144
Jammu & Kashmir	405
Madhya Pradesh (estimated)	400
Gujarat	95
Chhattisgarh	83
Maharashtra	59
Haryana	22
Uttaranchal	6
Sikkim	2
Total	2216

Sandstone

Sandstone resources in India are spread over the states of Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Madhya Pradesh, Meghalaya, Mizoram, Karnataka, Orissa, Punjab, Rajasthan, Uttar Pradesh, Tamilnadu and West Bengal. Over 90% of the deposits of sandstone are in Rajasthan, spread over the districts of Bharatpur, Dholpur, Kota, Jodhpur, Sawai-Madhopur, Bundi, Chittorgarh, Bikaner, Jhalawar, Pali and Jaisalmer.

Flaggy Limestone

'Kotastone' of Kota district and 'Yellow Limestone' of Jaisalmer district of Rajasthan are the prime limestone occurrences. Other deposits are Shahabad Stone of Bijapur, Belgaum districts of Karnataka, 'Cuddapah Stone' of Kurnool, Anantpur and Guntur districts of Andhra Pradesh, 'Milliolitic Limestone' from Saurashtra Region, Gujarat, 'Yellow Limestone' of Kuchch district of Gujarat, amongst others.

Slate

Slates resources are found in Rajasthan, Haryana, Himachal Pradesh and Andhra Pradesh and Madhya Pradesh. Deposits in Rajasthan are spread over the districts of Alwar, Ajmer, Bharatpur, Tonk, Sawai Madhopur, Pali, Udaipur, Churu & Chittorgarh.

7.3 Projections for domestic consumption and exports

Indian stone is widely accepted world over and also in the domestic market. The demand is growing rapidly with the boom in the construction sector.

The demand for granite and other decorative stones is increasing and is anticipated that the annual growth would be ***around 20%***, Indian granite, marble and other stones have established very well in world market where our share of world requirement is 12% of the total world market, which is Rs. 25,620 crores and 18% in terms of tonnage. India has abundant resources, sufficient technical know-how, large quarrying and processing capacity, and can safely ensure export growth at the rate of 20% per year in coming 15 years or more.

Domestic consumption of Granite stones is around Rs. 7,000 crores. It is anticipated that the dimension stone industry for the domestic sector will also grow simultaneously with the development of Export industry. Our country in the last few years is having a phenomenal growth in building activities and other infrastructural areas where the demand has picked up. The growth is continuing in domestic granite consumption and shall remain growing in the coming next 15 years.

The projections for exports for next 15 years are provided in **ANNEXURE IV**. Similarly, projections for domestic demand for next 15 years are provided in **ANNEXURE V** considering growth rate of 20%.

7.4 Projections for Investment in Dimensional Stone Industry

Present investment in dimensional & decorative stone industry in India is estimated at Rs. 10,000 crores. It is expected that given the policy support, the total sales turnover of all the stones, which is today at around Rs. 15,000 crores will increase to over Rs. 44,788 crores by

2012, Rs. 1,11,444 crores by 2017 and Rs. 2,77,304 crores by 2022 considering an estimated growth rate of 20%. In order to meet the projections in next 15 years, it is estimated that further investment have to go up by about Rs. 2,00,000 crores (including foreign investment) by 2022.

7.5 Indian Stone Industry vis-a-vis Global Practices

India is facing severe competition from important granite processors like China, Italy, Brazil, Taiwan, Greece, South Korea, East European countries etc. India is facing stiff competition in marketing of Indian marble and granite day by day.

On one hand, the Indian stone industry has to equip itself adequately to meet the growing competition and on the other hand, the policy environment governing the Indian dimension stone industry needs to be made more conducive to facilitate the growth of the industry, which is largely in unorganized sector and falling predominantly in Cottage/Small Scale Sector.

In the context of the Eleventh Plan, therefore, the corrective action shall have to be taken in respect of some bottlenecks in Indian dimension stone industry vis-à-vis the international practices.

7.5.1 Mineral royalty

For Granite, there is no mineral royalty in China and there is negligible levy of royalty in Brazil. Important factor is that long term quarry leases of 30 to 99 years are given in these countries with fixed rate of royalties which are not variable, whereas in India, the states increase royalty every two to three years and increases are so steep that Indian exporters are unable to take up major projects on a long term basis. This creates problems for Indian exporters, as it is not able to match the prices internationally. In India, dimension stones are grouped as minor minerals and in the Federal structure, the State Governments are fully empowered to fix and revise the rates of royalty on dimension stones which are only a meagre source of revenue for the States. In order to make Indian dimension Stones competitive internationally and to achieve the rates of growth as envisaged in the Eleventh Plan, **there is a case for bringing about some kind of reduction in the rates of royalty and ensuring uniformity of royalty in all the states and to consider providing long tenure of leases.**

7.5.2 Financial assistance

The prevailing rates of interest in the competing countries range between 4 to 6 per cent. Even though interest rates have been lowered now, however, the trend of increase is now continuing. There is strong need to provide long-term low interest finance to the industry. In India, the rates of interest are much higher and the dimension stone industry and financial institutions shy in financing projects. The interest rate in India should be made comparable to interest available in foreign countries

7.5.3 **Power, Fuel & Water**

Most of the quarry areas in India do not have infrastructure for power facilities. Almost every mine is dependent on DG set, whereas, infrastructure in the competing countries does not pose such problems. **Fuel like Diesel, Petrol, LPG, Acetylene Gas, Electricity should be made available at a low price for stone mining industry.** Quarries outside India have developed infrastructure. A similar model be adopted in India by extending infrastructure for power and water in stone belts.

7.5.4 Infrastructure

The transportation of raw blocks and finished goods to and fro quarries and factories are severely hampered due to lack of proper roads and rail connectivity from major stone clusters.

Internationally, more than 90% internal movements of dimension stones to ports and other destinations are made by rail. However, in case of India, transportation is totally dependent on high cost road transport and there is no rail facility for transporting dimensional stone blocks at all. **Granite, marble and sandstone being dead weight/heavy weight cargo, low cost transportation, preferably rail is much needed.** Adequate railway transport including container facilities needs to be provided at various centers producing decorative & dimensional stones.

7.6 Recommendations for Sustained Growth and Investment

7.6.1 **Road Infrastructure**

Transportation of granites by trucks has its peculiar problems, being heavy weight cargo. Single dimensional blocks of 15 to 30 tonnes are required to be transported for export market and even for large factories within the country for economic production.

However, most of trucks in India are allowed to carry only 12 tonnes of load, which is grossly inadequate to meet the requirement of the heavy weight cargo of the dimension stone industry. There is a need to have a re look at the provisions of the Motor Vehicles Act for a realistic assessment of carrying capacity of trucks. In cases of inter-State movement, in particular, the industry was getting unduly harassed about the weight of granite being transported, since the methodology of measurement varied from State to State and measurements are converted into tonnage to ascertain weight.

Practical solution to this problem is badly needed.

Countries like China, South Africa, or Zimbabwe do not have such problems and they are able to transport their large blocks with additional support of railways.

Road network should also be extended to rural mining belts including decorative & dimensional stone producing centers, thereby providing linkages to highways / expressways.

7.6.2 **Rail Infrastructure**

This Indian dimension stone industry is totally dependent on road transport with practically no support from the railways. Most of the competing countries have vast network of rail transportation supporting their stone industry through which they are able to offer any quantity in any size at very competitive prices in International market. Thus it is necessary for the Indian stone industry to have proper rail links nearest to the quarrying areas.

It is recommended that railway stockyards at various places should be created with Inland Container Service System (ICD) in operation. The railway stockyards with potential of handling stones should be equipped with crane facilities of minimum 50 tonnes. From these points, open wagons shall move to important ports and other destinations where the stone processing units are located.

A list of destinations where stockyards and separate sidings are required is given below. In fact, granites can very well be transported in open racks as far as dimensional blocks are concerned.

Places where stockyards & separate railway sidings are required:

		Quantity handled (in tonnes per year)	Future prospects (per year)
1.	ANDHRA PRADESH		
	Ongole	2,50,000	5,00,000
	Khammam	2,00,000	4,00,000
	Karimnagar	2,00,000	4,00,000
	Narasipatnam	2,00,000	4,00,000
	Warrangal	1,80,000	4,00,000
	Srikakulam	1,00,000	2,00,000
	Chittoor	75,000	2,00,000

Tandur, Cuddapah, Markapur — These towns are handling lakhs of tonnes of Cuddapah stones, which are exported and which are also required for internal consumption.

2.	TAMIL NADU		
	Dharmapuri	2,00,000	4,00,000
	Salem	2,00,000	4,00,000
	Madurai	3,00,000	6,00,000
	Mettur	1;00,000	2,00,000
	Nagarkoil	1,00,000	2,00,000
3.	KARNATAKA		
	Charnarajanagar	2,00,000	4,00,000
	Kanakapura	3,00,000	6,00,000
	Tumkur	1,00,000	2,00,000
	Ilkal	4,00,000	8,00,000
	Bellary	1,00,000	2,00,000
4.	KERALA		
	Tirvanantharnpurarn	1,00,000	2,00,000
5.	MADHYA PRADESH		
	Lalitpur	2,00,000	4,00,000
	Katni	2,50,000	5,00,000
	Chattarpur	2,00,000	4,00,000

6.	<u>ORISSA</u>		
	Titlagarh	2,00,000	4,00,000
	Berharnpur	1,00,000	2,00,000
7.	<u>MAHARASHTRA</u>		
	Nagpur	2,00,000	4,00,000
	Ballarshah	2,00,000	4,00,000
8.	<u>CHATTISGARH</u>		
	Raipur	1,00,000	2,00,000
	Jagdalpur	1,00,000	2,00,000
9.	<u>HARYANA</u>		
	Kund	1,00,000	2,00,000
10.	<u>RAJASTHAN</u>		
	Dholpur	2,50,000	5,00,000
	Sawai-Madhopur	1,00,000	2,00,000
	Chittorgarh	1,00,000	2,00,000
	Bundi	2,50,000	5,00,000
	Kisangarh /Makrana	2,50,000	5,00,000
	Jalore	1,00,000	2,00,000
	Udaipur / Rajsamand / Abu Road	2,50,000	5,00,000
	Alwar	50,000	1,00,000
	Banswara	50,000	1,00,000
11.	*UTTAR PRADESH*		
	Agra	1,00,000	2,00,000

Movement from these areas is approximately 6,00,000 tonnes per month. Hence material amounting to more than 70 lakhs tonnes per year from these centres is handled. Many quarries have been closed because of high transportation cost by trucks. Hence proper siding arrangements, railway stockyards with CD arrangements is the only answer for reducing their transportation cost. Also there appear bright prospects for railways to have additional earnings.

Such facilities of rail movement will also facilitate transportation of other natural stones like Marbles, Sandstones, Kotastone, Slate etc., with additional tonnage.

Adequate railway transport network including container facilities and railway sidings should be extended at prominent centers producing stones.

7.6.3 **Port Infrastructure**

Suitable handling facilities should be provided at major ports like

- Chennai
- Tuticorin

- Cochin
- Mangalore
- Karwar
- Kandla
- Mumbai
- JNPT near Mumbai
- Vizag

Arrangements are required to be made in these ports of stockyards for stones, where wagons / racks can be unloaded and also from there to the vessels for loading, with proper handling facilities. It is a matter of concern that the mother vessel calls only at the JNPT Bombay harbour. Containers, which are loaded in India, are taken to Singapore or Colombo to catch the mother vessel, which entails holding of cargo and delays shipment. The Government, on 2nd May 2001 has notified the seaports at Mumbai, JNPT, Kolkata, Chennai, Vizag and Cochin; airports at Delhi, Mumbai, Chennai and Kolkata and ICDs. Tughlakabad, New Delhi as the only ports eligible for import of inter alia marble and granite. The move is laudable and if these ports are upgraded to handle import of stones, the facilities could simultaneously be upgraded for exports as well, so that these ports may receive the mother vessels.

7.6.4 **Hiring facilities for machinery**

Creation of hiring facility for heavy machinery and equipment in all quarrying areas at reasonable cost is very much desired. Such hiring facilities are available to agriculture sector and if facilities are extended, to stone sector, quarries in all areas can work with much better advantage and results.

7.6.5 **Aggressive Export Promotion Efforts and Establishing Brand Equity of Indian Stones**

There is a strong need for well-planned, concerted and dedicated efforts towards export promotion of Indian stones in the International market. The emphasis needs to be on popularisation of Indian stones in the traditional markets and exploration of new markets through:

- Organisation of International Stone trade fairs and international conferences / workshops in India at regular intervals

- Direct mail campaign to select countries by way of brochures for image promotion of Indian stones.

- Image promotion of Indian stones through distribution of literature in the International market. This exercise could be augmented through the Internet by creation of an interactive website on Indian stones.

- Setting up of export trade consultancy and stone technology & trade information centre for stones so as to act as a nodal point for stone industry especially the small entrepreneurs

- *Encouraging regular group participation of Indian companies in major international fairs*: Brazil, Portugal, Greece and Turkey have very successfully followed this strategy. *This would encourage small entrepreneurs to venture into the International market and expand their horizons*. Country pavillions in International trade fairs need to be organised regularly by the nodal stone agencies and associations in India

- *Promoting group business meets in emerging and unexplored markets so as to pre-empt the other competitors:* This activity could include aggressive promotion through linkages with industry associations and through organisation of buyer-seller meets

- *Establishing long-term linkages with important world organisations, chambers of commerce, associations etc. in major markets:* Linkages need to be maintained and nurtured with leading international organisations abroad so as to build long term trade relations with them.

- *Establishment of processing and export clusters:* Setting up of dedicated industrial parks/ areas where all such stone processing and export oriented units could be established at one place, would help in aggressive promotion and export of stones from India.

- Sufficient funding is required for holding International Fairs within India and participation of Indian Stone Industry collectively through Industry Associations and Export Organisations. Similarly, market survey, buyers / sellers meet and display of Indian decorative stones ***on a permanent basis*** in major buying countries, are required to be organised.

- It is felt that inter-Ministerial coordination for very aggressive collective efforts would be necessary and strategies have to be devised for funding and programming market promotion projects.

- Promotional drives are strongly recommended by sponsoring trade delegations confined with support of Indian Trade Commissions to establish long term links with stone industries and trade in each country, wherever there is good potential.

7.6.6 **Incentives and Taxation**

The other important aspect for ensured growth of the industry is providing incentives and benefits to support the exporters to remain competitive in International market and enable them to claim rightful share in world demand.

One of them is 80 HHC benefit which has been withdrawn. It is felt that withdrawal of this support has created difficulties for exporters in the face of mounting competition from China and other countries which has literally everything subsidised right from mining, transportation and even international shipping.

The Schemes of duty drawbacks and exemption from sales tax and other commercial taxes and local taxes are required to be implemented. All necessary relief to support the export industry has to be considered at par with international standards to make it a level playing field. Continuation of 100% Export Oriented Unit – scheme is very much needed to achieve export targets and survive mounting competition.

EOU Exporters should get IT relief under 10B of the Income Tax Act 1961 as the manufactured item of EOU.

The production of marble blocks, slabs and tiles by way of mining, dressing, polishing and sizing should be treated within the definition of production or manufacturing under various sections of the Income Tax Act such as Section 10B, 80HHC & 80I.

The green marble (serpentine) should be categorized as ‘marble‘ towards discharge export obligations for advance license issued for import of consumables such as diamond tools, blades, segments, abrasives, resins etc. against export of marble under the EXIM policy therefore providing benefits under Advances Licensing Scheme.

There is also a question of mineral royalty, which are increasing at different rates in different States, as the State Governments are free to fix the same. With the framing of Granite Conservation and Development Rules 1999, for granite, the periodicity of quarry leases have been made uniform, and with this progressive policy, tie-ups in different long-term projects will become reality for Indian exporters of granite. However for long-term tie-ups, there is an in built requirement of stability of various costs including the cost towards royalty. **There is a case for steady and stable uniform rates of royalty across the States, as in the case of major minerals**.

There is no royalty on stones in China and a very low royalty is charged in countries like Brazil, South Africa, Zimbabwe etc. Royalty is **one of the sources** of revenue, however, in case **royalty paid could be made eligible for duty draw back scheme by the Government,** the export thrust industry could get some relief. It is therefore recommended that this suggestion be considered for adoption of a uniform policy throughout the country.

7.6.7 **Financial assistance**

Proper low cost financing at par with international rates of interest is needed for Indian Stone Export Oriented Industries. In the case of granite and marble, venture capital and working funds for quarrying, which are not available at this point, may have to be provided, both for quarrying and processing. Even for machinery and other long-term loans interest rates at present are very high and should be brought into low cost, long-term loans with easy repayment system.

Granite and Marble quarries have requested for providing "industry" status to quarrying. Although stone quarries are recognised as industry for financial assistance under the relevant Statute, they have not been very successful in obtaining financial assistance, mainly because they could not offer any collateral by way of the quarry lease. It is felt that the State Governments could amend the state specific Minor Mineral Concession Rules to make hypothecation of Quarry Leases, so that the same could be offered as co-lateral for bank finances. **Stone quarries should be provided a status of small-scale industry and all the facilities extended to other SMEs should be extended to stone quarrying units.**

7.6.8 **Forest areas**

The Supreme Court had taken a decision that all the State Governments should make a fresh mapping of the mineral bearing areas and exclude them if they are in forest zone. It is established however that geologically, if there is existence of hard stone like granite, marble etc. there cannot be growth of forest. Prima facie therefore, these mineral areas need to be excluded from maps of the Forest departments.

Therefore, this calls for a comprehensive national policy incorporating the following:

a) The potential mineral bearing areas falling in reserved forest areas with no forest resource should be identified, and opened up for commercial exploitation.

b) If any quarry lease area falls within the area of a genuine forest, the concerned quarry owners should be asked to plant trees in an area, at a place to be decided by the authority.

c) The barren areas where there is no forest growth, and yet have been classified as forest area, can be worked and after removal of the mineral (dimension stones) the same can be filled up with earth, and trees can be grown.

Therefore, a clear demarcation of stone and genuine forest belts should be made.

7.6.9 **Infrastructure Development around Stone quarries**

All State Governments earn regularly revenue from royalty from the quarry leases of decorative stones. It is suggested that the State Governments may earmark at least **10%** of the revenue towards infrastructure development in mining areas. Concerned state governments should set up a **State Stone Development Fund** by earmarking 10% of the royalty collection for the fund. The Government of India should also make contribution of 5% to the State Development Fund from the Plan funds, every year for the duration of Eleventh Plan.

As well as other utilities are concerned viz. water & power, the Rural Water Supply Scheme of the Central Government should be extended to stone mining belts to meet the water supply requirement of SMEs. Government should also take a conscious decision to make industry available supply of electricity to remotely located stone quarries especially for small & medium sized quarries.

7.7 Promotion of Stone Handicrafts and Artifacts

Alternative option for exporting granite and marble (decorative stones) in processed form to maximize export earnings is to develop and promote artifacts and special decorative and ornamental items of high value addition. There is tremendous skill in the country, which can be explored and supported with special incentives. This can certainly bring about substantial foreign exchange addition.

Indian craftsmen are very talented and gifted. So far, this sector has contributed on their own initiative with little or no help from the Government. This sector utilises the Stone waste and secondary stones to best advantage and in turn create more job opportunities in rural area. Some of the highly specialised products of this sector are:

- Ball fountain, Dancing & Rotating pillar fountain, Rotating cube fountain, Pillar over Pillar fountain, Ball over disc fountain, Dancing doll fountain etc.
- Fruit bowl, Flower vases, Wash basin, Pillar, Pillar cladding, Table ware (Crockery), Balusters, Handrail, Fire place (Moldings), Center table legs / Statue stands etc.
- Innovative small products where maximum waste stones can be utilized

This stone segment holds great potential in India both for domestic consumption as well as exports. The traditional skill of the Indian artisans needs to be supported, motivated, preserved and developed. Suitable measures need to be taken for:

- Uniform sales tax exemption be provided to all stonecraft items irrespective of their level of mechanisation.
- Refresher courses for skill upgradation and use of new tools and machinery be provided to the artisans with reference to Pneumatic and power tools, Innovative design concepts, and use of templates
- Support be provided to artisans for group participation in International fairs
- Workshops need to be organised to educate *entrepreneurs* about new technologies in stonecraft; and their adaptability to Indian conditions.
- Define Selection Criteria of Stones for typical artistic applications
- Standardisation and codification of sizes and physical attributes for typical architectural applications
- Adoption of best practices for production
- Compilation and publication in the form of exhaustive reference material

7.8 Research & Development

As far as Granite, Marble & Decorative Stone are concerned; the present indigenous R & D sector is negligible. Entrepreneurs have been able to get the technical R & D help from their overseas counterparts and clients all these years. Best of the technology has come to Granite and Stone industry through aggressive marketing by overseas manufacturers of machinery and processing industry of stones.

For granite, it is generally acknowledged that the industry has to meet the cost for commercial information and R&D. It was decided that there should be a permanent arrangement for addressing the R&D related issues of granite through National Institute of Rock Mechanics – a research institute of Ministry of Mines.

Government of Rajasthan with the support of Ministry of Commerce & Industry and Ministry of Mines, Govt. of India, RIICO and UNIDO has established a centre of excellence at the national level for the development of dimensional stone sector especially marble, sandstone, kotastone, slate and granite. The state-of-art facilities including R&D setup for testing of all the types of stones is operational now at Jaipur. There is need to establish regional R&D centers through NIRM and CDOS in prominent stone areas. AIGSA too has plans to have R&D facilities at Bangalore.

The quarrying for marble and granite has been developed on scientific lines in India. However, so far sandstone quarrying is yet undertaken mostly manually thereby resulting into excessive wastage. Suitable efforts should be made by CDOS jointly with the state department of Mines & Geology and UNIDO to develop and promote mechanized quarrying for sandstone blocks in

Rajasthan.

7.8.1 Testing and Quality Certification on Stones

Testing of stones is essential for identifying the right stone for the right application worldwide. The architects if aware of the properties of stones would be able to use stones in structural applications in large complexes. The structural analysis of stones would also assist stones in competing with alternative materials like ceramics etc.

Test Certification would be **mandatory** for any exports to Europe in a couple of years. Suitable measures therefore should be taken for:

- Encouraging testing of stones through awareness campaigns about the oncoming restrictions in Europe and elsewhere
- Defining Selection Criteria of Stones for typical architectural applications
- Standardisation and codification of sizes and physical attributes for typical architectural applications
- Preparation of reference manuals on Installation, usage, maintenance and restoration of Stones
- Knowledge dissemination on stones in architectural and engineering colleges.
- Inclusion of prescribed standards and methods in Government Codes and Standards
- In order to establish brand equity and quality of Indian stones in the global market - testing and export quality certification of Indian dimensional stones should be made mandatory for all exporters.

7.9 Uniformity in Policies of State Governments

In order to provide a level playing field in all the states, there must be uniform policies for mineral leasing, taxation, royalty, incentives etc. at the state level.

7.10 "National Stone Technological Upgradation and Development Fund"

Government of India through Ministry of Mines may consider setting up a National Stone Technological Upgradation and Development Fund for sustainable development of Indian dimensional sector by imposing a cess of 2% of the royalty payable by quarry owners for marble, granite, sandstone, slate, flaggy limestone/ dimensional limestone and quartzite and to transfer this amount to **National Stone Technological Upgradation and Development Fund** for assistance in following key areas:

- Technological upgradation and modernization of mining/quarrying and processing for granite, marble, sandstone, slate and limestone for increasing its global competitiveness, including indigenisation of globally accepted technologies

- Environmental protection and management through promotion of eco-friendly technologies aimed at increasing productivity, reduction in waste including utilization of waste and support for rehabilitation of mined areas etc.

- Capacity building for Human Resource Development through training and skill upgradation programmes aimed at value addition, better quality management, productivity and safety
- Operationalising and strengthening testing & standardization facilities, establishing export inspection agency & quality certification services, technical consultancy etc.

- Providing technology and design interventions for stone artifacts and other value added products

- Market development and increasing export competitiveness of Indian Stone Industry in the global market

- Development support for stone clusters

- Support for technological upgradation and modernization of technologies for stone finishing, material handling, product packaging, stone installation & cladding etc.

- Strengthening institutional development mechanism for stone sector

7.11 Strengthening national support institutions

In order to ensure sustainable development of Dimensional Stone Sector in India, following recommendations are made for strengthening the national support mechanism

- To declare existing Centre for Development of Stones (CDOS) at Jaipur as a National Centre of Excellence (N-CDOS) to support dimensional stones covering marble, sandstone, kotastone, slate etc. - with adequate financial support from Ministry of Mines and Ministry of Commerce, Government of India.

- Considering large resources of granite in South India (AP, Karnataka), Tamilnadu and Kerala) and major contribution of granites to Indian exports of dimensional stones, a National Centre of Excellence for Dimensional Stones, especially for granite be established in South India with the support of Ministry of Mines & Ministry of Commerce, Govt. of India, State Governments and UNIDO in association with AIGSA.

- To strengthen National Institute of Rock Mechanics and extending its services to granite quarrying areas in South India for R&D support.

- To constitute a separate Export Promotion Council for dimensional stones considering immense potential for boosting exports. Presently stones fall under purview of CAPEXIL.

- To assist and strengthen AIGSA in developing permanent infrastructure for international exhibitions at Bangalore.

- UNIDO under National Programme for development of Stone Industry (NPDSI) and ICMT along with Ministry of SSI and Department of Industrial Policy & Promotion. Government of India should continue their support and assistance to granite, marble and other stone segments through Centre for Development of Stones (CDOS) and AIGSA.

- CDOS should extend its activities to other stone producing states including North eastern states.

ANNEXURE – I

INDIAN EXPORTS OF GRANITE DIMENSIONAL BLOCKS AND POLISHED GRANITE PRODUCTS

(In Million Rupees)

SL. No.	**YEAR**	**GRANITE DIMENSIONAL BLOCKS**	**% SHARE**	**POLISHED GRANITE**	**% SHARE**	TOTAL
1	2000/01	5862.00	30%	13678.00	70%	19540.00
2	2001/02	6139.00	30%	14324.00	70%	20463.00
3	2002/03	7382.00	30%	17223.00	70%	24605.00
4	2003/04	7691.00	30%	17947.00	70%	26538.00
5	2004/05	7687.00	30%	17935.00	70%	25622.00
6	2005/06	5280.00	20%	21120.00	80%	26400.00*

*Projected exports
Source: AIGSA

ANNEXURE – II

MAJOR STONE IMPORTING COUNTRIES FROM INDIA - PERCENTAGE SHARE

COUNTRY	**PERCENT (%)**
ITALY	26
TAIWAN	18
HONG KONG	10
JAPAN	7
CHINA	7
U.S.A.	5
GERMANY	4
BELGIUM	3
FRANCE	2
SPAIN	1
OTHERS	17
TOTAL	100

Source: AIGSA

ANNEXURE – III

STATEMENT SHOWING WORLD EXPORTS OF GRANITE FINISHED PRODUCTS
(Quantity in thousand tonnes)

COUNTRIES	FINISHED PRODUCTS
ITALY	2583
CHINA	2232
PORTUGAL	840
SPAIN	411
INDIA	366
BELGIUM	324
POLAND	245
TURKEY	240
CZECH REP	188
GERMANY	126
FRANCE	133
GREECE	153
USA	84
MEXICO	109
BRAZIL	104
NETHERLAND S	122
SOUTH AFRICA	21
SOUTH KOREA	31
CANADA	153

Source: AIGSA

ANNEXURE – IV

STATEMENT SHOWING PROJECTED EXPORTS OF GRANITE BLOCKS & FINISHED PRODUCTS FOR NEXT 15 YEARS
(At an anticipated growth rate of 20 % per annum)

	Year	**Rupees (in Crores)**
	2005/06	3583
	2006/07	4300
1	2007/08	5100
2	2008/09	6192
3	2009/10	7430
4	2010/11	8916
5	2011/12	9459
1	2012/13	10500
2	2013/14	11351
3	2014/15	13621
4	2015/16	16345
5	2016/17	19615
1	2017/18	23578
2	2018/19	28245
3	2019/20	33895
4	2020/21	40674
5	2021/22	48808

Source: Ministry of Commerce and AIGSA

ANNEXURE – V

STATEMENT SHOWING PROJECTED DOMESTIC CONSUMPTION OF GRANITE PRODUCTS
(at an anticipated growth rate of 20% per annum)

Sl. No.	**Year**	**Projected consumption (in Rupees Crores)**
	2006	4000
1	2007	4800
2	2008	5760
3	2009	6912
4	2009	8294
5	2010	9953
1	2011	11944
2	2012	14333
3	2013	17199
4	2014	20639
5	2015	24767
1	2016	29720
2	2017	35664
3	2018	42797
4	2019	51356
5	2020	61628

Source: AIGSA

CHAPTER – VIII

INDUSTRIAL/NON-METALLIC MINERALS

8.0 Introduction

Under this Working Group on Industrial/Non-Metallic minerals, all important minerals have been grouped into the 4 categories. These are :

1. Rock Phosphate 2. Potash 3. Sulphur and Pyrites	**Fertiliser Minerals**
4. Asbestos 5. Dolomite 6. Fluorspar 7. Gypsum 8. Wollastonite	**Flux & Construction Minerals**
9. Quartz & other silica minerals 10. Fireclay 11. Chinaclay & Ballclay 12. Magnesite 13. Graphite 14. Pyrophyllite 15. Kyanite 16. Sillimanite 17. Vermiculite	**Ceramic & Refractory Minerals**
18. Barytes 19. Bentonite 20. Fuller's Earth 21. Mica 22. Talc, Soapstone and Steatite	**Export Potential Minerals**

The Terms of Reference cover the entire gamut from the stage of resource evaluation to its ultimate utilisation. Such a wide spectrum of events necessarily involve coverage of all the activities of the number of organisations, both in the government and private sector. Therefore, there was need for gathering the available information from all these sources and for having interaction as far as possible within the timeframe given to it.

Since these group of minerals were not dealt by the Working Group set up by the Planning Commission for 8th, 9th and 10th Five Year Plans, the availability of relevant data was a difficult task. However, the best efforts have been made by the Core Group to obtain the data and to analyse the same in line with the terms of reference. The category-wise minerals are dealt in the following pages. The statistical data regarding production, export, import, apparent consumption, projected production and life indices is given in Annexures 1 to 4.

8.1 Fertiliser Minerals

8.1.1 Rock Phosphate

The rock phosphate or phosphorite is mainly fossiliferrous calcareous sandstone exhibiting reddish-brown colour at places, being ferruginous.

World Scenario

The world reserves and reserve base of rock phosphate is given in a Table below:

Country	Reserves	Reserve Base
United States	1,200,000	3,400,000
Australia	77,000	1,200,000
Brazil	260,000	370,000
Canada	25,000	200,000
China	6,600,000	13,000,000
Egypt	100,000	760,000
India	90,000	160,000
Israel	180,000	800,000
Jordan	900,000	1,700,000
Morocco and Western Sahara	5,700,000	21,000,000
Russia	200,000	1,000,000
Senegal	50,000	160,000
South Africa	1,500,000	2,500,000
Syria	100,000	800,000
Togo	30,000	60,000
Tunisia	100,000	600,000
Other Countries	800,000	2,000,000
World Total (rounded)	**18,000,000**	**50,000,000**

Production

World production of marketable phosphate rock was 147 million tonnes in 2005, a 4% increase compared with that of 2004. The United States with 36.3 million tonnes, China with 30.4 million tonnes and Morocco with 25.2 million tonnes were the leading producing countries, accounting for 63% of the production. India's production is a meager 1.18 million tonnes. As a result, India will continue to rely on imports to meet its demand.

Indian Scenario

The total resources of rock phosphate as per UNFC system in the country as on 1.4.2000 are placed at 289 million tonnes. Out of these resources, the exploitable resources are only 75 million tonnes. Remaining 214 million tonnes are resources which cannot be mined and utilised under present conditions. Out of 75 million tonnes reserves, bulk; i.e. about 66% are located in Rajasthan, followed by Madhya Pradesh (23%). The remaining 11% reserves are available in Uttaranchal and Uttar Pradesh. Out of 75 million tonnes reserves, 13 million tonnes are of chemical and fertilizer grades (+30% P_2O_5), 15 million tonnes blendable grade

(25-30% P_2O_5), 15 million tonnes soil reclamation grade (+16% P_2O_5) and 32 million tonnes beneficiable grade (+10% P_2O_5).

The total production of phosphorite at 11,84,000 tonnes in 2004-05 decreased by 18% from that in the previous year due to closure of Jharkhand mine for want of permission from the Pollution Control Board and poor lifting of ore at crushing plant of Jhamarkotra mine in Rajasthan but during 2005-06, the total production increased to 13,83,000 tonnes. There were 8 reporting mines in both the years. Rajasthan continued to be the principal producing State, contributing 93% to the production, followed by Madhya Pradesh (7%). About 90% production of phosphorite was of grade 30-35% P_2O_5, 3% of grade 25-30% P_2O_5, about 2% of grade 20-25% P_2O_5 and 5% of grade 15-20% P_2O_5.

The main producers of phosphorite are Rajasthan State Mines and Minerals Ltd. (RSMML) in Rajasthan and Madhya Pradesh State Mining Corporation Ltd., Bhopal from Chhattarpur and Jhabua districts of Madhya Pradesh. The total production of phosphorite during the last five year is as follows :

Qty. in tonnes

Year	Rajasthan	Madhya Pradesh	Total
2001-02	-	-	1239000
2002-03	1127214	74194	1201408
2003-04	1370959	65000	1435059
2004-05	1097512	86839	1184351
2005-06	-	-	1383000 (P)

P – Provisional

The production rock phosphate and apatite is estimated at 1.34 million tonnes by 2006-07 and at 2.06 million tonnes by 2011-12 (Annexure – I)

The consumption of Rock Phosphate including that of Apatite as reported during last 3 years by the industries is as follows :

Industry	2001-02 (R)	2002-03 (R)	2003-04 (p)
All Industries	**1774200**	**2581000**	**2693400**
Chemical	115100 (6)	106200 (6)	106200 (6)
Fertilizer	1658200(28)	2473900 (30)	2586300 (30)
Others (glass, sugar, iron & steel)	900 (3)	900 (4)	900 (4)

***Note**: Figures rounded off*

Figures in parentheses denote the number of units in organised sector reporting consumption.

Besides, rock phosphate, imported phosphoric acid is consumed for manufacturing phosphatic fertilizers. Apatite and rock phosphate in ground form are also used directly in acidic soil.

The apparent consumption of apatite and rock phosphate is estimated at 4475 thousand Tonnes by 2006-07 and at 6695 thousand tonnes by 2011-12 (Annexure II and III).

Only about 35-40% requirement of raw material for phosphate fertiliser production is met through indigenous sources. The remaining requirement is met through import in the form of rock phosphate, phosphoric acid and direct fertilizers. In India, the finely-ground rock phosphate containing 16% P_2O_5 is used directly on the soil for soil amendment.

Exports of rock phosphate to Nepal, Oman, USA and Bangladesh in 2003-04 increased to 1235 tonnes from 603 tonnes in the previous year whereas imports decreased to 2.3 million tonnes from 3.9 million tonnes in the previous year. Imports were mainly from Jordan (62%), China & Morocco (10% each) and Togo (9%).

The reserves of chemical and fertilizer grades apatite and rock phosphate in India are very limited. Therefore, detailed exploration is necessary for conversion of remaining resources into reserves. Secondly, the search for apatite and rock phosphate may have to be intensified in Andhra Pradesh, Rajasthan, Madhya Pradesh, Jharkhand, Tamilnadu, Meghalaya, Gujarat, Uttar Pradesh, Uttaranchal, West Bengal etc. Till the domestic resources of these two minerals are improved, the country has no alternative but to depend on their imports.

Value Addition

In India, most of the existing phosphatic fertilizer and phosphoric acid plants have been designed for high-grade imported rock phosphate, mainly from Morocco and Jordan. The Indian deposits are of low grade. Therefore, the fertilizer and phosphoric acid plants that may be set up as replacement to the existing plants will have to be designed to accept indigenous ores as a feed. Beneficiation of domestic low-grade ores would-be a step in the right direction.

Demand of phosphatic fertilizer will continue to rise due to growth in population and corresponding increase in food requirements. There is no substitute for phosphorus in agriculture.

8.1.2 Potash : Potash is an essential nutrient for protein synthesis and it aids plants to use water more efficiently.

World Scenario

Country	Reserves	Reserve base
United States	90,000	300,000
Belarus	750,000	1,000,000
Brazil	300,000	600,000
Canada	4,400,000	9,700,000
Chile	10,000	50,000
China	8,000	450,000
Germany	710,000	850,000
Israel	40,000	580,000
Jordan	40,000	580,000
Russia	1,800,000	2,200,000
Spain	20,000	35,000
Ukraine	25,000	30,000
United Kingdom	22,000	30,000
Other countries	50,000	140,000
World total	**8,300,000**	**17,000,000**

Production

World production of potash was 32.1 million tonnes of K_2O content in 2004. About 93% of the world potash production was consumed by the fertilizer industry. The principal producers were Canada, Russia, Germany, Belarus and Israel. The rising trend of potash consumption that began in 2004 is likely to continue in the future because of increased demand of fertilizers for crop production.

About 93% of world potash production is used by the fertilizer industry to provide potassium which is essential plant nutrient. Potassium chloride (KCL) is the principal fertilizer product equivalent to 60-62% K_2O. Other salts for fertilizer use are potassium sulphate, potassium magnesium sulphate & potassium nitrate. Potassium chloride & potassium nitrate are used in manufacture of glass, ceramic, soap, synthetic rubber and chemical industries. Potassium nitrate is used in explosive manufacture.

Indian Scenario

Bedded marine evaporite deposits and surface & subsurface potash-rich brines are the principal sources of potash. The principal ore is sylvinite, a mixture of sylvite (KCL) and rock salt (NaCl).

As per UNFC, the total resources of Potash as on 1.4.2000 are estimated at 21,815 million tonnes in the country. Rajasthan alone contributes 94% resources followed by Madhya Pradesh (5%) and Uttar Pradesh, a very negligible quantity. Any estimation of the reserves has not yet been made mainly because of lack of exploration in depth and high cost involved in this task. Presently there is no production of potash in the country.

Reported consumption of potash in the 10th plan period has been around 7 lakh tonnes in fertilizer industry. Department of Fertilizers, Ministry of Chemicals and Fertilizers, has launched “Potash Promotion Project” on 1.4.2003 which was conceptualized after a MoU was entered into between International Potash Company (IPC), Moscow and Indian Potash Ltd. (IPL), New Delhi. The project comprises a comprehensive programme for increasing the consumption of potash in India to achieve N:K ratio of 4:1 in long run and at least 6:1 by the end of 2006-07.

8.1.3. **Sulphur and Pyrites**

World Scenario

Resources of elemental sulphur in evaporite and volcanic deposits and sulphur associated with natural gas, petroleum, tar sands and metal sulfides amount to about 5 billion tonnes. The sulphur in gypsum and anhydrite is almost limitless, and some 600 billion tonnes is contained in coal, oil shale and shale rich in organic matter, but low cost methods have not been developed to recover sulphur from these sources.

Production

World production of sulphur and pyrites in 2004 was 60.4 million tonnes and 5.9 million tonnes, respectively. USA (10 million tonnes), Canada (9.5 million tonnes), Russia (6.5 million tonnes), China (3.8 million tonnes), Japan (3.4 million tonnes) and Saudi Arabia (2.2 million tonnes) were the principal producers of sulphur. Whereas China (5.1 million tonnes), Finland (0.3 million tonnes), Russia (0.3 million tonnes) and South Africa (0.15 million tonnes) were the principal producers of pyrite.

Indian Scenario

In India, there are no mineable elemental sulphur reserves. Pyrirtes was used as a substitute for sulphur in the manufacture of sulphuric acid by M/s. Pyrites Phosphates and Chemicals Ltd. (PPCL). There was no production of pyrite since 2003. The production of elemental sulphur is limited to by-product recoveries from petroleum refineries and fuel oil used as feedstock for manufacturing fertilizer. Sulphur is also obtained as by-product sulphuric acid during the manufacture of non-ferrous metals form sulphide minerals. The sulphuric acid is further used for manufacturing single superphosphate (SSP) from rock phosphate imported from Jordan, Senegal, South Africa and China.

Total resources of pyrites in the country as per UNFC system as on 1.4.2000 are placed at 1,674 million tonnes of which about 27 million tonnes are under proved category. Out of the total resources, soil reclamation grade are about 6 million tonnes, beneficiable grade 62 million tonnes and low grade 1,553 million tonnes. Major resources are located in Bihar.

The production of sulphur recovered as a by-product from fertilizer plants and oil refineries was at 114 thousand tonnes in 2004-05. Two fertilizer plants and six oil refineries, all in public sector, reported production of sulphur in 2004-05. Of the total quanity produced in 2004-05, Haryana accounted for 27%, Uttar Pradesh 19%, West Bengal 18%, Tamilnadu 17%, Gujarat 11% and the remaining 8% was contributed by Bihar and Punjab. The production of sulphur is estimated at 128,000 tonnes by 2006-07 and at 197,000 tonnes by 2011-12.

The production activities of Amjhore Phosphate Fertilizer Project of PPCL had been suspended since May 1999. The company had been referred to Bureau of Industrial Finance and Reconstruction (BIFR) by the Government of India. However, this project used to produce three products namely Agriculture Grade Pyrite (AGP), Sulphuric Acid and Single Superphosphate (SSP).

The total consumption of elemental by-product sulphur in 2003-04 was 1,500 thousand tonnes. The main consumer of sulphur was fertilizer industry which accounted for about 77 percent. Chemical industry, the next important consuming industry, accounted for about 16% consumption for manufacturing carbon disulphide & dye-stuffs. Other industries like explosives, iron & steel, paint, paper, pesticides and sugar consumed about 7 percent. The apparent consumption and sulphur and pyrites is estimated at 1,320,000 tonnes by 2006-07 and at 2,031,000 tonnes by 2011-12 (Annexure II and III). The country will continue to rely on imports to meet its domestic demand.

8.2 Flux & Construction Minerals

8.2.1 **Asbestos**

Asbestos is a group of fibrous minerals. The physical properties, besides fibrous characters, such as fineness, flexibility, tensile strength of fibres, infusibility, low heat conductivity and high resistance to electricity, sound and corrosion by acids, make asbestos commercially important. Commercial asbestos is classified into two main mineralogical groups: serpentine asbestos or chrysotile asbestos and amphibole asbestos. The latter group includes asbestos minerals, such as tremollite, actinolite, anthophyllite, amosite and crocidolite.

World Scenario

The world has 200 million tonnes of identified resources. The important countries where resources of asbestos are available are United States, Brazil, Canada, china, Kazakistan, Russia and Zimbabwe.

Production

The world production of asbestos was 2.4 million tonnes in 2004. The important producers were Russia (923 thousand tonnes), China (510 thousand tonnes), Kazakistan (34 thousand tonnes) and Brazil (252 thousand tonnes). Canada and Zimbabwe are major producers of chrysotile variety. India's production was about 6 thousand tonnes.

Indian Scenario

As per United Nation's Framework Classification (UNFC) system, total resources (reserves and remaining resources) of asbestos in the country as on 1.4.2000 are placed at 18.46 million tonnes. Of these, 3.67 million tonnes are reserves and 14.79 million tonnes are remaining resources. Out of total resources of 18.46 million tonnes, Rajasthan accounts for 54% and Karnataka 45%.

The production of asbestos at 5,619 tonnes in 2004-05 decreased by about 44% from that in the previous year. The decrease in production reported by some mine owners in Rajasthan was because of lack of demand and closure of mines. There were 16 reporting mines in 2004-05 as against 23 mines in the preceding year. Three mines, each producing more than 500 tonnes annually accounted for about 67% production. Barring a small quantity of about 14% output of chrysotile variety produced in Andhra Pradesh, the entire output was of amphibole variety. As far as the value is concerned, the chrysotile variety constituted about 96% value. The remaining 4% value was from amphibole variety produced in Rajasthan. The entire production of asbestos was from private sector. About 63% of the chrysotile variety was contributed by Padma Minerals (Pvt.) Ltd., a principal producer. The production of asbestos is estimated at 6000 tonnes by 2006-07 and at 9000 tonnes by 2011-12 (Annexure I).

The internal consumption of asbestos was about 86,000-90,000 tonnes per annum, almost entirely in asbestos-cement and asbestos-based products manufacturing. Minor quantity was utilised for insulation purpose in some industries. The available consumption data relate almost entirely to imported chrysotile asbestos. Reliable data on consumption of amphibole asbestos were not available as the consuming industries were mostly in small-scale sector, producing low pressure asbestos-cement pipes used in construction industry as given under:

(In tonnes)

Industry	**2001-02**	**2002-03 (R)**	**2003-04 (p)**
All Industries	**87500**	**86600**	**86100**
Asbestos-cement and products	86600 (25)	85700 (25)	85200 (25)
Refractory	100 (6)	100 (7)	100 (7)
Textile	700 (3)	700 (3)	700 (3)
Others (foundry, paint and paper)	100 (12)	100 (12)	100 (12)

Figures rounded off.
Figures in parentheses denote the number of units in organised sector reporting consumption.

The apparent demand of asbestos is estimated at 227,000 tonnes by 2006-07 and at 349,000 tonnes by 2011-12 (Annexure II and III).

There has been a concern about the role of asbestos causing lung diseases. Research in this area has been hampered by the long period between asbestos exposure and symptoms, known as latency period which can exceed 30 years. Results obtained so far suggested that chrysotile, most widely used asbestos, was less dangerous than amphibole asbestos minerals.

There are no restriction on exports of asbestos in the Foreign Trade Policy, 2004-09 effective from 1 April, 2005. Ministry of Environment and Forest, vide notification dated 13.10.1998, under sections 3(1) and 6(2) (d) of Environment (Protection) Act, 1986 and Rule 13 of Environment (Protection) Rules, 1986, has prohibited the imports of waste asbestos (dust and fibre), being a hazardous waste detrimental to human health and environment. As per the new Foreign Trade Policy, asbestos under heading 2524 can be freely imported. However, the imports of crocidolite, actinolite, anthophyllite, amosite and tremolie are restricted in terms of Interim Prior Informed Consent Procedure of Rotterdam Convention for Hazardous Chemicals and Pesticides.

Exports of asbestos increased to 2,547 tonnes in 2003-04 from 162 tonnes in previous year. whereas imports increased to 182,762 tonnes from 98,772 tonnes.

The resources of chrysotile variety of asbestos are very much limited in India. So, there is an urgent need to go for detailed exploration of chrysotile which is required mainly in the manufacture of asbestos-cement products. To meet the domestic demand the country will continue to rely on imports.

8.2.2 **Dolomite**

World Scenario

World resources of dolomite are large.

Production

The statistics on world production of dolomite is not available.

Indian Scenario

Iron and steel including mini-steel plants and ferro-alloys are the main-stay of dolomite mining. Other imortant consumers are - glass industry. Impure dolomite in powder form finds some applications as fertiliser carrier, for supression of dusts in coal mines and in making dry paints. The manufacturers of flooring tiles use it as chips as well as in powder form. However, over 95% of the total production find outlet mainly in iron and steel and allied industries. With the advent of LD process of steel making importance of high purity dead-burnt dolomite bricks for lining LD furnaces has gained ground. At the same time, a few of the steel plants have dispensed with the use of dolomite in blast furnace. Dolomite used in the preparation of self-fluxing sinters is found adequate for the blast furnace charge. Mini-steel plants generally require dolomite for fettling and refractory purposes only.

Dolomite occurrences are widespread in almost all parts of the country. As per UNFC, total reserves and resources of all grades of dolomite are placed at 7084 million tonnes, out of which total reserves are 992 million tonnes and the balance; i.e. 6092 million tonnes are the resources. The share of proved reserves is 2.57%, probable reserves 11.43% and remaining resources 86 percent. Of the total resources in India, the major share of 88% is distributed in seven States; namely, Madhya Pradesh (26%), Andhra Pradesh (16%), Chhattisgarh (12%), Orissa (12%), Gujarat (9.0%) Karnataka (8%), Maharashtra (5%) and balance, i.e; 12% in other States.

The production of dolomite at 4.3 million tonnes in 2004-05 increased by 6% from that in the previous year. Share of public sector has been 58% whereas the leading producing state has been Orissa accounting for 29% production followed by Chhattisgarh (26%), Andhra Pradesh (20%), Karnataka (6%) and Jharkhand (5%). The production and consumption of dolomite during the 10th plan is given in table below. The production of dolomite is estimated at 4.84 million tonnes by 2006-07 and at 7.5 million tonnes by 2011-12 (Annexure-I).

(million tonnes)

Year	Production	Consumption
2001-02	3.25	3.42
2002-03	3.63	3.81
2003-04	4.05	3.83
2004-05	4.31	NA

The apparent domestic demand is estimated at 4799 thousand tonnes by 2006-07 and at 7383 thousand tonnes by 2011-12 (Annexure II and III).

Exports of dolomite decreased substantially in 2003-04 which were mainly to the neighbouring countries i.e. Bangladesh and Nepal.

The resources of the refractory grade dolomite in the country are meager and this type of material is in short supply but very much required for making tar-bonded dolomite bricks. Therefore, intensive search is needed in non-Himalayan regions for locating deposits of massive non-crystalline dolomite, containing less than 2.5% R_2O_3 for use in tar-dolomite bricks required for lining of LD steel furnaces. The total demand for various grades of dolomite including refractory grade by 2006-07 was estimated to 5.2 million tonnes at 6.5% growth rate and 6.1 million tonnes at 9.0% growth rate. This indicates demand-supply gap.

8.2.3 **Fluorspar**

Fluorspar is an indispensable material to aluminium metallurgy. It is an important fluxing agent and a source of fluorine chemicals which in turn find a variety of application. The utility of fluorspar can be grouped under four heads: (I) as fluxing agent for iron and steel, ferro-alloys, foundries and in the manufacture of electrodes; (ii) as vitrifying agent in glass industry; (iii) as an additive to cryolite bath in aluminium metallurgy and (iv) in the manufacture of fluorine compounds and chemicals both inorganic and organic.

World scenario

Country	Reserve	Reserve Base
United States	N.A.	6,000
China	21,000	110,000
France	10,000	14,000

Country	Reserve	Reserve Base
Kenya	2,000	3,000
Mexico	32,000	40,000
Mangolia	12,000	16,000
Morocco	N.A.	N.A.
Namibia	3,000	5,000
Russia	Moderate	18,000
South Africa	41,000.	80,000
Spain	6,000	8,000
Other countries	110,000	180,000
World total	**230,000**	**480,000**

Production

World production of fluorspar was 4.6 million tonnes in 2004. China (2.4 million tonnes), Mexico (0.84 million tonnes) and South Africa (0.27 million tonnes) were the principal producers. India's production is negligible in the world context.

Indian Scenario

Production of fluorspar in the country is from Gujarat, Maharashtra and Rajasthan. In addition to the natural fluorspar production, synthetic fluorspar can be recovered as a by-product of uranium processing, petroleum alkylation and stainless pickling. By-product fluorosilicic acid obtained form phosphoric acid plants while processing phosphate rock also supplements fluorspar as a source of fluorine.

As per the UNFC, the total resources (reserves and remaining resources) of flluorite in the country as on 1.4.2000 were estimated at 12.77 million tonnes. Out of these, 2.23 million tonnes were placed under reserves category and 10.54 million tonnes under remaining resources category. The reserves were classified into 0.86 million tonnes under proved category and 1.37 million tonnes under probable category. By States, Gujarat having 6.66 million tonnes accounted for 52.1% of the total resources, followed by Rajasthan 5.18 million tonnes (40.6%), Chhattisgarh 0.54 million tonnes (4.2%) and Maharashtra 0.39 million tonnes (3.1%). Gradewise classification of the resources was done taking into consideration the grade of run-of-mine ore and beneficiated product. Accordingly, the resources were classified into three grades; namely, usable grade which accounted for 72.4% of the total resources, low grade (25%) and unclassified grade (2.6%).

Fluorite (graded) is reported from three States; viz., Gujarat, Maharashtra and Rajasthan. The entire production of fluorite (graded) in Gujarat is beneficiated in their plant and converted into concentrates. The total production is given below:-

(Qty. in tonnes)

Year	Fluorite (graded)	Fluorite (concentrates)	Total
2002-03	8825	4198	13023
2003-04	6555	5838	12393
2004-05	3733	7717	11450

The average total consumption of fluorspar by all industries has been around 62,200 tonne per annum. The exports of fluorspar has increased to around 600 tonnes whereas imports have considerably increased to around 1 lakh tonnes during 10th Five-Year Plan period mainly from China. The apparent domestic demand of fluorspar is estimated at 126,000 tonnes by 2006-07 and at 194,000 tonnes by 2011-12.

The resources of fluorspar in India are limited and grades of the fluorspar produced do not meet the specifications of the chemical industry which is the bulk consumer of fluorspar. Ambadungar fluorspar mine of GMDC is the only domestic source of acid grade fluorspar, a slightly inferior quality with high phosphorus content. Hence, to meet the requirements domestic chemical industry the country will have to depend both qualitatively and quantitatively on imported fluorspar in the coming years, both for direct use and for blending with the domestic acid grade fluorspar.

8.2.4 **Gypsum**

Gypsum ($CaSO_4.2H_2O$) is a hydrated calcium sulphate used widely in industry because of its special property of losing three-fourths the combined water of crystallization when moderately heated (calcined) to about 130^oC. Besides, calcined gypsum when cooled, finely ground and made plastic with water can be spread out, cast or moulded to any desired surface or form. On drying, it resumes its original state and sets into a hard rock-like form. Raw uncalcined gypsum is used for controlling the setting time of Portland cement (i.e. as a retarder to prevent quick set). It is added to the clinker just before final grinding to finished cement. Ground pure white gypsum is also used as a filler in paper, paints and textile goods. Ground low grade gypsum is used in mine dustings, manufacture of blackboard chalks, as a manure in agriculture mainly for correcting black alkali soils, and as a filler in insecticides.

World Scenario

World resources of gypsum are large.

Production

World production of gypsum was 111.6 million tonnes. The major producers were USA (17.2 million tonnes). Iran (14.4 million tonnes), Canada (9.9 million tonnes), Mexico (9.2 million tonnes), Thailand (7.6 million tonnes), Spain (11.5 million tonnes), India with a production of (3.5 million tonnes) ranked 11th position in world production.

As per UNFC, the total resources of mineral gypsum in India as on 1.4.2000 were estimated at 1,243 million tonnes. Of these resources, 87 million tonnes have been placed under ‘reserves’ and 1,156 million tonnes under ‘remaining resources’. Categorywise, 62 million tonnes were proved reserves and 25 million tonnes probable reserves. Of the total reserves, about 0.7 million tonnes were of surgical plaster grade, 28.3 million tonnes of fertilizer/pottery grade, 47.1 million tonnes of cement/paint grade, 2.4 million tonnes of soil reclamation grade and 8.3 million tonnes of unclassified grade.

The production of gypsum at 3.55 million tonnes in 2004-05 increased by 28% from that in the previous year. There were 42 reporting mines in the country, two main principal producers accounting for around 99% production. These are Rajasthan State Mines and Minerals Ltd. and Fertilizer Corporation of India Ltd. Rajasthan continued to be the leading producing State.

The production and consumption performance of gypsum during the 10th Plan period is as follows:

(**Qty: Million tonnes)**

Year	Production	Total Consumption
2001-02	2.86	3.96
2002-03	2.65	4.02
2003-04	2.86	4.22
2004-05	3.55	
2005-06	3.65	

The production of gypsum is estimated at 4 million tonnes by 2006-07 and at 6.15 million tonnes by 2011-12 (Annexure I).

The exports and imports of gypsum have also shown a rising trend. The exports being at 65,000 tonnes and imports at 18,500 tonnes per annum during the 10th Plan period.

The apparent domestic demand of gypsum is estimated at 3437 thousand tonnes by 2006-07 and at 5289 thousand tonnes by 2011-12 (Annexure II and III).

India's main focus in near future is creation of more infrastructure with a view to infuse momentum in its economy together with attracting foreign direct investment and participation in its industrial development. These activities will keep the cement industry to grow and accordingly, the consumption of gypsum will increase. India's domestic resources of gypsum are large to meet increased demand. Steps would be necessary to find out suitable mining technology to exploit deep-seated gypsum resources in Rajasthan. Production of gypsum wallboard in India is negligible. Because of its lightweight and many other characteristics, its domestic demand as lightweight and attractive partition designing material in high-rise buildings has to be explored. In view of the environmental problem arising from huge accumulation of phospho-gypsum at different fertilizer plants, increasing utilisation of phospho-gypsum is necessary. Low-grade mineral gypsum being cheaper should be utilised more as a soil conditioner in the reclamation of alkaline soils.

International Competitiveness

India occupies a comfortable position as regards the resources of gypsum. However, since gypsum is a low value high bulk mineral, there does not exist much prospects to increase exports of gypsum.

Value Addition

Production of gypsum wallboard which is negligible in India should be increased so that gypsum is used in value added form.

8.2.5 **Wollastonite**

Wollastonite, a metasilicate of calcium ($CaSiO_3$), contains theoretically 48.3% CaO and 51.7% SiO_2. It occurs as aggregates of bladed or needle-like crystals. Ceramic industry uses substantially domestic production of wollastonite as a filler. Some other uses of wollastonite are as a filler in ceramic floor and wall tiles, marine wallboard, paint, plastic and in refractory liners in steel mills, and as a partial replacement for short-fibre asbestos in certain applications, such as brake-lining. Technical improvements in filler properties in plastic and rubber have been made in recent years. A better compatibility between the polymer and the filler is achieved by chemical surface treatment of the mineral filler. Wollastonite, when treated in such a manner, results in improved flexural modules in polyprophylene and improved reinforcement in nylon.

World Scenario

No authentic information on world resources of wollastonite is available. However India's is a leading producers.

World production of wollastonite was 733 thousand tonnes in 2004. China (395 thousand tonnes) and India (172 thousand tonnes) were the major producers.

Indian Scenario

Major deposits of wollastonite have been found in Sirohi and Dungarpur districts in Rajasthan. Besides, in Ghoda area, Banaskantha district in Gujarat and in Dharmapuri and Tirunelveli districts in Tamil Nadu, a few deposits occur. As on 1.4.2000, the resources of wollastonite in India as per UNFC system are placed at 12.4 million tonnes. Out of which 84% (10.4 million tonnes) are in Rajasthan and the remaining 16% in Gujarat (1.99 million tonnes). Meagre resources are located in Tamil Nadu(3,533 tonnes).

There are 3 reporting mines and the total production is at around 173,000 tonnes in 2004-05, this has registered an increase of 14% over the previous year. The production is estimated at 194,000 tonnes by 2006-07 and at 298,000 tonnes by 2011-12 (Annexure I). The consumption at around 6000 tonnes per annum is also registering the marginal increase.

The apparent domestic demand of wollastonite is estimated at 170,000 tonnes by 2006-07 and at 262,000 tonnes by 2011-12 (Annexure II and III).

Presently, the existing mines in the country are in a position to meet the domestic requirements of the industry as well as export demand. There is an increasing demand for wollastonite in the international markets, especially in ceramic and plastic industries and in construction activities. Since, wollastonite is mined and exported by only a few countries in the world, there is a scope for increasing the exports of this mineral from India in value-added form as coated powders, since Indian wollastonite is in tough competition from China and USA.

International Competitiveness

The largest market for wollastonite in the world is ceramics followed by asbestos substitution, metallurgy and paints. Wollastonite is marketed under two grades viz. High aspect ratio wollastonite and powdered (milled) wollastonite. The former type relies mainly on physical accicularity while the later one depends on the chemical composition of the mineral. Exports of processed wollastonite with high aspect ratio and powdered wollastonite for better unit value realisation may be encouraged.

8.3 Ceramic & Refractory Minerals

8.3.1 **Quartz and Other Silica Minerals**

Quartz, silica sand, moulding sand and quartzite are different forms of silica minerals and differ from each other only in their physical characteristics. These group of minerals constitute the largest volume of all the minerals. These are used in several industries especially in glass, foundry, ferro-alloy, iron & steel, cement, refractory & ceramics and sodium silicate.

World Scenario

Sand, and gravel resources of the world are large. However, because of their geographical distribution, environmental restrictions and quality requirements for some industries, extraction of these resources become sometimes un-economic. Quartz rich sand and sandstone, the main source of industrial silica sand occur throughout the world.

Production

World production of quartz is not available separately. But the world production of sand and gravel (industrial) during 2005 was 117 million tonnes. The major producers were USA (31.3 million tonnes), Slovakia (11 million tonnes), Germany (7.5 million tonnes), Austria (6.8 million tonnes), France and Spain (6.5 million tonnes each).

The important varieties of crystalline quartz are vein quartz (massive crystalline quartz); milky quartz (white, translucent to opaque); ferruginous quartz (containing brown limonite and red haematite and almost opaque); aventurine quartz (containing glistening flakes of mica or haematite); cat's eye (opalescent greenish quartz with fibrous structure); rock crystal (clear, colourless, well-crystallised transparent quartz); amethyst (clear-purple or violet-blue), transparent quartz, rose quartz; smoky quartz; etc. Large occurrences of massive crystalline quartz in veins or pegmatite have been recorded in almost all the States.

As per the UNFC system of resource classification, the total resources of quartz and silica sand as on 1.4.2000 are estimated at 2,910 million tonnes, out of which 22%, i.e. 626 million tonnes are placed under reserves category while 78%; i.e. 2,284 million tonnes are placed under remaining resources category. Resources of foundry and moulding grades are 16%, glass grade 9% and ferro-silicon and ceramic and pottery grades 4% each. More than 67% resources are of unclassified, others and not know grades. Haryana alone accounts for about 60% Indian resources, followed by Jharkhand, Maharashtra, Tamil Nadu and Rajasthan (5% each), Kerala and Andhra Pradesh (4% each), Uttar Pradesh and Orissa (3% each) and others (6%). The total resources of quartzite as per the UNFC system in the country as on 1.4.2000 are estimated at 1,083 million tonnes, of which reserves are about 174 million tonnes and remaining resources are 909 million tonnes. Bulk resources of about 57% are located in Haryana followed by Bihar (22%), Punjab (8%), Jharkhand (4%), Orissa (3%) and others (6%). Resources of refractory grade are 24%, ceramic and pottery grade 19% and flux grade 6%. Remaining 51% resources are of unclassified, others and not known grades.

The production of quartz at 295,719 tonnes in 2004-05 showed a marginal increase of 3% over the preceding year. Andhra Pradesh continued to be the major producing State of quartz accounting for 44% production followed by Gujarat, Karnataka, Rajasthan, Jharkhand and Tamil Nadu.

The production of silica sand at 1,904,771 tonnes in 2004-05 decreased by about 25% over the previous year due to closure of mines for want of environmental clearance and lack of demand. However, Andhra Pradesh, the major producing State reported a growth of about 13% over the production in the previous year. The other leading producing States are Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, Karnataka and Jharkhand. About 61% production of silica sand was contributed by 17 mines, each producing more than 25,000 tonnes annually.

Production of quartzite at 92,641 tonnes in 2004-05 increased by about 39% from that in the previous year owing to favourable market conditions. Orissa was the leading producing State contributing about 41% to the total production followed by Chhattisgarh, Bihar, Jharkhand and Rajasthan. The production of sand at 1.40 million tonnes in 2004-05 registered an increase of about 16% over the previous year. The production of agate at 15 tonnes was also reported in 2004-05 which has a declining trend.

The production of quartz and other silica minerals is estimated at 2.57 million tonnes by 2006-07 and 3.96 million tonnes by 2011-12 (Annexure I).

In India, quartz, quartzite and silica sand are used mainly in glass, foundry, ferro-alloys, refractory industries and also as building materials. According to its suitability for different purposes, it may be named as building sand, paving sand, moulding or foundry sand, refractory sand or furnace sand and glass sand, etc. However, the main use of silica minerals is in the manufacture of different types of glasses, natural silica sand being preferred material in the glass industry.

The consumption of quartz and silica sand in the organised sector was estimated at 1.30 million tonnes in 2003-04. Major consuming industries were glass (39%), cement (21%), ferro-alloys (14%), foundry (10%) and fertilizer (7%). Other industries like iron and steel, ceramic, alloy steel, insecticide, refractory, abrasive, etc. consumed the remaining 9%. The consumption of quartzite in the organised sector was estimated at 250,800 tonnes out of which iron and steel industry consumed over 40%, followed by ferro-alloys (21%), refractory (20%) and cement (18%). Consumption of moulding sand in the organised sector in 2003-04 was estimated at 59,900 tonnes. Major industries were foundry (89.6%), followed by mining machinery (6.77%), iron and steel (2.31%) sugar and textile industries (1.32%). The total ferro-silicon consumed by various industries in 2003-04 was estimated at 39,300 tonnes. Major industries were iron and steel (75%), alloy steel (18%) and foundry (6%).

The domestic demand of quartz and silica minerals is estimated at 3.33 million tonnes by 2006-07 and at 5.12 million tonnes by 2011-12 (Annexure II and III).

The demand for quartz, silica sand, moulding sand and quartzite is increasing over the years to cater to the requirement of ferro-silicon, silico-manganese, silico-chrome, silica refractories, glass and for moulding and casting purposes. The requirements of these products are linked up directly with iron and steel industry including alloy steel production. Further, setting up foundries and enhancing their capacities are also linked with metallurgical industry.

International Competitiveness

The total resources of quartz and other silica minerals are 3084 million tonnes. There are very good prospects of increasing the exports of quartz and silica minerals to the neighbouring countries.

8.3.2 **Fireclay**

World Scenario

The world resource of clay minerals including fireclay are large. However no authentic data on world resources and production is available.

Fireclay is one of the most important minerals used in the refractory industry. Almost the entire production in the country is consumed in the manufacture of refractories and about 80% of these refractories are used by the iron and steel industry. India has huge reserves of this mineral and there does not seem to be any problem of supply to the refractory industry in the future. However, a serious dearth is being felt in the refractory industry with respect to availability of high grade clay analysing 37% and above Al_2O_3 and having Fe_2O_3 and fluxing impurities less than 2%.

In India, fireclay deposits are spread over many parts of the country. The best deposits occur in association with the coal seams in the Lower Gondwana coalfields of Andhra Pradesh, Jharkhand , West Bengal, Madhya Pradesh and Neyveli lignite fields in Tamil Nadu. Notable occurrences of fireclay, not associated with coal measures, are known in Gujarat, Jabalpur region, Madhya Pradesh and Belpahar-Sundergarh areas, Orissa. Reserves and resources of fireclay as per UNFC as on 1.4.2000 are estimated at 695 million tonnes. Out of these, 49 million tonnes are grouped under reserves category while bulk; i.e., 646 million tonnes are classified in resources category. Out of the total, 15 million tonnes are proved reserves and 34 million tonnes are probable reserves. The reserves of fireclay are substantial but reserves of high grade (non-plastic) fireclay containing more than 37% alumina are limited.

The production of fireclay at 559,000 tonnes in 2004-05 decreased by 15% from that in the previous year due to stoppage of work by High Court order in Rajasthan. Further, the production in 2005-06 is reported to be 499,000 tonnes only showing a declining trend. Rajasthan, the major producing State contributed 23% production followed by Gujarat, Orissa, West Bengal, Madhya Pradesh, Tamil Nadu, Andhra Pradesh, Karnataka and Jharkhand. The production of fireclay is estimated at 628,000 tonnes by 2006-07 and at 966,000 tonnes by 2011-12 (Annexure I).

The total consumption of fireclay in organised sector increased to 499,000 tonnes in 2003-04 from 435,800 tonnes in 2002-03. Cement industry has emerged as a major consumer of fireclay accounting for 54% consumption followed by refractory and ceramic industries. The apparent domestic demand of fireclay is estimated at 781,000 tonnes by 2006-07 and at 1.2 million tonnes by 2011-12 (Annexure II and III). The exports of fireclay increased to 1,513 tonnes in 2003-04 from 795 tonnes in the previous year. The exports were mainly to UAE, Kenya, Nepal, Bangladesh, USA, Saudi Arabia, etc. The exports of fire bricks also showed an increasing trend

International Competitiveness

Since fireclay is low-value high bulk minerals, there does not appear much prospects for increasing the exports.

Value Addition

Use of fireclay in fireclay bricks as an export commodity should be encouraged.

8.3.3 **Kaolin (China Clay) and Ball Clay**

China clay, also known as Kaolin, is one of the most essential raw materials for the manufacture of ceramic products, which accounts for about 50% of the total china clay consumption in the country. Refractory industry consumes another 25% of china clay, while the remainder is used in rubber, paper, cement, insecticides, textile etc. industries. All industries except refractory, cement and insecticide consume washed china clay.

Ball clay is a high plastic variety of china clay. It possesses high binding power tensile strength and considerable shrinkage, and is generally utilised after mixing with non-plastic clays to impart the desired plasticity. It is used for the same purposes as china clay, the main use being ceramic industry which consumes about 80% of total consumption. Ball clay and china clay are used for similar purposes. Ball clay and china clay differ only in the degree of plasticity. China clay is less plastic than ball clay. Ball clay is a highly plastic variety of kaolin having high binding power, tensile strength and shrinkage ability. It is utilised generally after mixing with non-plastic clay to impart the desired plasticity in pottery, porcelain and refractory materials. It also helps in the preparation of glaze, enamels and for imparting a dense vitrified body.

World Scenario

Resources : The world resources of all clays are extremely large.

Production

Kaolin : The estimated world production of kaolin was 44.5 million tonnes in 2005. USA was the principal producer, contributing (16%), followed by CIS (14%), Czech Rep (9%), Germany (8%), Korea Rep (6%) and United Kingdom (5%). India's production was of the order of 905,000 tonnes in 2004-05.

Indian Scenario

China clay resources in the country as per UNFC system as on 1.4.2000 have been placed at 2302 million tonnes, of which the reserves are only about 8% of the total resources at 181 million tonnes. Out of the total reserves, 33% (about 60 million tonnes) reserves are under proved category whereas 67% (about 121 million tonnes) reserves falls under 'probable' category. The resources are spread over in a number of States of which Kerala holds about 20% all India resources, followed by West Bengal (18%), Rajasthan (14%), Orissa (12%) and Karnataka (11%). The distribution of reserves do not correspond with the resource availability in various States. About 66% reserves are confined to three States; namely, Rajasthan (27%), Orissa (22%) and Jharkhand 17%. The total resources of china clay have been classified into ten different grades. About 81% or 1866 million tonnes resources falls under mixed grade, others, unclassified, non-known categories and the remaining resources are classified under textile/paper coating, insecticide, chemical, ceramic/pottery, paper filler and rubber grades. There is an urgent need for classifying the resources into specific grade and bringing huge 'resources' into 'reserve' category.

The production of china clay at 905,000 tonnes in 2004-05 increased by 1% from the previous year. During the year 2005-06, the production was 1007,000 tonnes. Twenty-five principal producers accounted for about 77% output, mainly from the private sector mines. The contribution of natural and processed china clay was 76% and 25%. Kerala was the leading producing State of china clay, accounting for 34% production followed by Gujarat (25%), Rajasthan(16%), West Bengal and Andhra Pradesh (7%) each. The production of china clay and ball clay is estimated at 1.61 million tonnes by 2006-07 and at 2.5 million tonnes by 2011-12 (Annexure I)

The consumption of china clay in organised sector increased to 343,300 tonnes in 2003-04 and cement was the major raw china clay consuming industry accounting for 51% followed by ceramic (24%) and pesticides (7%), paint (7%), refractory (5%) and paper (4%).

The total resource of ball clay as on 1.4.2000 in the country are placed at 69.3 million tonnes. Out of these resources, the reserves are about 25 million tonnes and remaining resources are 44 million tonnes. More than 68% resources are in Andhra Pradesh, followed by Rajasthan 32% and in Gujarat 0.4%. Out of the total resources, ceramic/pottery grade constitute over 93%.

The production of ball clay at 528,000 tonnes in 2004-05 decreased by 37% from the previous year which further decreased to 313,000 tonnes in 2005-06. Rajasthan continued to be the leading producing State contributing 65% to the production followed by Andhra Pradesh 34%.

The consumption of ball clay in the organised sector increased to 315,900 tonnes in 2003-04 from 285,300 tonnes in 2002-03. About 97% consumption was accounted for by ceramic industry and the remaining by the refractory and abrasives industries. In 2003-04, exports increased to 6279 tonnes from 662 tonnes in 2002-03, mainly due to increase in exports to Bangladesh whereas the imports of ball clay decreased from 39,511 tonnes in 2002-03 to 17,742 tonnes in 2003-04.

The apparent demand of china clay and ball clay is estimated at 2045 thousand tonnes by 2006-07 and at 3147 thousand tonnes by 2011-12 (Annexure II and III).

International Competitiveness

The resources of kaolin in India are abundant. With large resource base and limited domestic demand, there are prospects to increase exports of kaolin. The world markets are favourable for processed chinaclay in various industries like paper, plastic paints, rubbers, ceramics, etc. The paper industry continues to be the major market for processed chinaclay in the world. For this purpose the international market demand high quality standard market especially that of paper coating grades. Efforts are to be made in future to capture the potential markets like Egypt, Zimbabwe, Iran and neighbouring countries.

Value Addition

India has abundant resources of china clay which can easily meet both internal and external demands. The future requirements of processed china clay in the domestic market is expected to grow substantially. Most of the processing of china clay in the country is done by conventional methods like levigation and washing. Hence hi-tech processing techniques will be necessary for generation of processed china clay in future. New practices for processing have to be established and existing capacities are to be augmented in the country to meet the increased requirement of processed china clay in the future. Efforts are to be made in future to capture the potential markets like Egypt, Zimbabwe, Iran, Malaysia, Jordan and Pakistan, besides increasing the exports to the traditional neighbouring markets like Bangladesh, Sri Lanka and Nepal and other markets like Kenya, UAE, Saudi Arabia and Bahrain.

8.3.4 **Magnesite**

Magnesite($MgCO_3$) is a very important mineral for the manufacture of basic refractories, which are largely used in the steel industry.

World Scenario

Resources : The world resources of magnesite are 3,600 million tonnes. The world reserves and reserve base of magnesite is given below:

(Qty. in million tonnes)

Country	Reserves	Reserve Base
Austrlia	100	120
Austria	15	20
Brazil	45	65
China	380	860
Greece	30	30
India	14	55
Korea North	450	750
Russia	650	730
Slovakia	45	324
Spain	10	30
Turkey	65	160
U S A	10	15
Other Countries	390	440
World Total (Rounded)	**2200**	**3600**

Note: As per NMI, prepared by IBM, the resources are placed at 369 million tonnes.

Production

The world production of magnesite was 22.3 million tonnes in 2004, an increase of about 4% compared with that of 2003. China was the principal producer, contributing about 45%, followed by Turkey (17%), Russia (12%), Slovakia (7%) and Austria (3%). India's production was of the order of 381 thousand tonnes in 2004.05.

Indian Scenario

The total reserves/resources of magnesite as per UNFC system as on 1.4.2000 are about 369 million tonnes of which reserves and remaining resources are 123 million tonne and 246 million tonnes, respectively. Substantial quantities of resources are established in Uttaranchal (66%), followed by Tamil Nadu (18%) and Rajasthan (14%). The remaining resources are in Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir, Karnataka and Kerala. Magnesite of Tamil Nadu is low in lime and high in silica whereas that of Uttaranchal is high in lime and low in silica.

Production of magnesite in 2004-05 at 381,000 tonnes registered an increase of about 18% from that in the previous year. During the year 2005-06, the total production was 400000 tonnes, that is an increase by 19,000 tonnes. There were 17 reporting mines as against 15 in the previous year. Five principal producers accounted for 83% output in 2004-05. About 70% production of magnesite was contributed by public sector. Tamil Nadu continued to be the major producing State, having a maximum share of 81% output, followed by Uttaranchal 12% and Karnataka 7%. A very nominal production of magnesite was reported from Rajasthan. The production of magnesite is estimated at 428,000 tonnes by 2006-07 and at 659,000 tonnes by 2011-12.

The consumption of magnesite in the organised sector increased to 226,000 tonnes in 2003-04 because of higher consumption reported by refractory industry. The apparent domestic demand of magnesite is estimated at 485,000 tonnes by 2006-07 and at 745,000 tonnes by 2011-12 (Annexure II and III). The exports of magnesite increased to 7,441 tonnes in 2003-04 from 5,219 tonnes in the previous year. The imports also increased to 90,544 tonnes in 2003-04 from 71,665 tonnes in the previous year. Out of the total imports, magnesite(calcined) were 2,794 tonnes only. The imports were mainly from People's Republic of China, Israel and Japan.

India has large resources of magnesite. However, because of cheap imports the domestic resources are not being exploited optimally. There is a need to reduce imports of magnesite and encourage more use of domestic resources.

8.3.5 **Graphite**

Graphite is used as a raw material in a large number of industries such as crucible, foundry facing, dry cell battery, lubricants, pencils, paints, etc.

Natural graphite is devided into two commercial varieties: (i) crystalline graphite, and (ii) amorphous graphite. Both flaky and amorphous varieties of graphite are produced in the country. Whereas synthetic graphite is manufactured on a large-scale in electric furnaces.

World Scenario

Resources : The world resources are of the order of 290 million tonnes. The word reserves and reserve base of Graphite are furnished in a Table below:

(Qty. in '000 tonnes)

Country	Reserves	Reserve Base
Brazil	360	1,000
China	64,000	220,000
Czech Rep	11,400	13,000
India	800	3,800
Madagascar	940	960
Mexico	3,100	3,100
U S A	-	1,000
Other Countries	5,100	44,000
World Total (Rounded)	**86,000**	**290,000**

Note: As per NMI prepared by IBM, the total resource are 159 million tonnes.

Production : The world production of graphite was 1,700 thousand tonnes in 2004. China was the principal producer contributing about 82% of the total production, followed by India (6%), Brazil (4%) and Korea Dem. Peoples Rep. (2%).

Indian Scenario

As per the UNFC system, the total resources (reserve and remaining resources) of graphite in the country as on 1.4.2000 are placed at about 159.27 million tonnes, comprising 4.80 million tonnes in the reserves category and remaining 154.47 million tonnes under resources category. The reserves are further classified into 1.24 million tonnes proved reserves and 3.56 million tonnes probable reserves. Of the total, resources containing +40% fixed carbon constitute about 0.28 million tonnes and resources analysing 10-40% fixed carbon 19.52 million tonnes. Graphite deposits of economic importance are located in Andhra Pradesh, Jharkhand, Karnataka, Kerala, Orissa, Rajasthan and Tamil Nadu.

The production of graphite at 100,000 tonnes in 2004-05 increased by 15% from the previous year. About 79% production was accrued from six mines, each producing more than 5,000 tonnes annually and Tamil Nadu was in the leading position contributing about 44% output followed by Orissa and Jharkhand. The production of graphite is estimated at 112,000 tonnes by 2006-07 and at 173,000 tonnes by 2011-12 (Annexure I).

Consumption of various grades of graphite in the organised sector ranged from 10,600 tonnes to 9,800 tonnes per annum during the last three years of 10th Plan. Out of total consumption, the refractory and crucible industries accounted for 35% each and foundry industry 10%. The consumption in refractory industry has decreased by 25%. The apparent domestic demand of graphite r.o.m. is estimated as 113,000 tonnes by 2006-07 and at 174,000 tonnes by 2011-12 (Annexure II and III).The exports and imports showed an increasing trend; the export being 2818 tonnes of natural graphite in 2003-04 as against 906 tonnes in the previous year and the imports of 5587 tonnes from 2799 tonnes in 2002-03. However, exports and imports of graphite crucibles decreased.

The graphite reserves having +40% fixed carbon are rather limited in the country. Detailed exploration of graphite deposits in Orissa, Jharkhand, Jammu & Kashmir and Kerala should be carried out.

Value Addition

Cost-effective beneficiation technologies for low-grade graphite ore need to be developed. Age-old application of graphite in clay-bonded graphite crucibles has to be substituted by silicon carbide-graphite crucibles to improve upon the use of inferior grade material with less quantity and at the same time ensuring longer life of crucible. Some important higher applications have emerged in exfoliated graphite which are for making sealings, gaskets, braids and brushed. New products by synthetic graphite are graphite fibres/ropes and graphite insulation blankets. Carbon-composite materials are used in very high technology areas, such as, aerospace and production of these advanced materials is done at Hyderabad in a pilot plant. On world scenario, a potential large-volume end-use for natural graphite has emerged in heat sinks also called spreader shield, which is a graphite foil material conducting heat only in two directions. It has thermal conductivity above aluminium and almost equal to copper. These are used for carrying away heat in laptop computers, flat-panel displays, wireless phones, digital video cameras, etc.

8.3.6 **Pyrophyllite**

Pyrophyllite is different in chemical composition from steatite but they resemble in many of their physical properties and are used more or less for the same purposes. Since pyophyllite is somewhat harder than steatite and does not flux when heated, it is also used in refractory industry.

World Scenario

Resources : The world resources of pyrophyllite are large.

Production

The whole production of pyrophyllite was 1.69 million tonnes. Korea Republic (828 thousand tonnes), Japan (402 thousand tonnes) were principal procedures. India occupied third position in world production of pyrophyllite.

Indian Scenario

Pyrophyllite occurs mainly in Chhatarpur, Sagar, Shivpuri and Tikamgarh districts of Madhya Pradesh; Bhandara district of Maharashtra; Keonjhar district of Orissa; Udaipur, Alwar, Jhunjhunu and Rajsamand districts of Rajasthan and Jhansi, Lalitpur and Hamirpur districts of Uttar Pradesh. The total resources of pyrophyllite in India as per UNFC system as on 1.4.2000 are placed at 18.19 million tonnes of which more than 67%; i.e. 12.15 million tonnes are in reserves category.

Production of pyrophyllite at 270 thousand tonnes in 2004-05 increased by 53% from the previous year. Five principal producers accounted for 79% production in 2004-05.The share of public sector in the total production was 6%. Madhya Pradesh continued to be the leading producing state accounting for 73% output, followed by Orissa and Uttar Pradesh. The production of pyrophyllite is estimated at 303,000 tonnes by 2006-07 and at 466,000 tonnes by 2011-12 (Annexure I).

The consumption of pyrophyllite in the organised sector was 2,500 tonnes and ceramic was the main consuming industry (76%) followed by refractory (24%).

The apparent domestic demand of pyrophyllite is estimated at 210,000 tonnes by 2006-07 and at 323,000 tonnes by 2011-12 (Annexure II & III).

The use of pyrophyllite in ceramic industry seems to be static whereas that in the refractory applications is facing the problems like the most other refractory minerals due to change in technology and reduction of refractory consumption per tonne of metal. Pyrophyllite will continue to face competition from bentonite and atapulgite in carrier applications. However, use in filler applications appears to be stable.

8.3.7 **Kyanite :** Kyanite is known as \`super-refractory' in view of special refractory properties.

World Scenario

Resources : The World resources of kyanite and related minerals are large.

Production

The estimated world production in 2004 was 126,400 tonnes. The USA, China, India, Zimbabwe were the leading producers of kyanite. India's production of kyanite was 7,710 tonnes in 2004-05 and ranked third.

Indian Scenario

The total resources of kyanite as per UNFC system in the country as on 1.4.2000 are placed at 102 million tonnes. Out of these resources, only 1.4 million tonnes are the reserves and 101 million tonnes are remaining resources. Out of 1.4 million tonnes reserves, gradewise, high and medium-grade reserves together are merely 4%; high and medium, mixed 11%; low grade, 26%; high, medium and low, mixed 6%, and others and not known 52 percent. The bulk reserves (over 68%) are located in Jharkhand and Karnataka (25%). The remaining 7% reserves are accounted by Maharashtra, Rajasthan and Andhra Pradesh.

Production of Kyanite at 7,710 tonnes in 2004-05, decreased by 15% from the previous year due to lack of demand. There were only 8 reporting mines. About 21% production was of grade above 40%. The production of kyanite is estimate at 9,000 tonnes by 2006-07 and at 14,000 tonnes by 2011-12 (Annexure I). The consumption of Kyanite in organised sector is estimated at 11,900 tonnes remains static. The apparent domestic demand is estimated as 11,000 tonnes by 2006-07 and 170,000 tonnes by 2011-12 (Annexure II & III).

Although India has substantial resources of kyanite, grade details of bulk of these are not available. There is a need for systematic sampling of kyanite deposits for grade analysis.

8.3.8 **Sillimanite**

World Scenario : World resources of silimanite are large.

Production

Authentic data on world production is not available. However, Australia, China, India are the major producers of sillimanite. India's production of sillimanite was 28,761 tonnes in 2004-05, and was leading producer in the world.

Indian Scenario

The total resources of sillimanite as per UNFC system in the country as on 1.4.2000 are placed at 63 million tonnes. Out of these resources, the actual reserves are only 15 million tonnes. About 48 million tonnes are the remaining resources. Out of 15 million tonnes reserves, more than 94% are granular high-grade while unclassified and not known grade are 5 percent. Reserves of massive sillimanite of all grades are less than 1 percent. The reserves are located mainly in Orissa (51%) and Kerala (43%). Tamilnadu and Maharashtra account for the remaining reserves.

The production of sillimanite at 28,761 tonnes in 2004-05 and 29,000 tonnes in 2005-06 reported an increase by 46% from the previous year. There were 4 reporting mines only and 77% production was by the public sector. The Orissa is the main producing state followed by Maharashtra and Kerala. The production of sillimanite is estimated at 32,000 tonnes by 2006-07 and at 50,000 tonnes by 2011-12 (Annexure II & III).

The consumption of sillimanite in organised sector is around 6,000 tonnes, mainly consumed by the refractory industry. The apparent domestic demand of sillimanite is estimated at 22,000 tonnes by 2006-07 and at 35,000 tonnes by 2011-12 (Annexure II & III). The exports of sillimanite increased to 822 tonnes in 2003-04 from 394 tonnes in the previous year.

8.3.9 **Vermiculite :** Vermiculite is a term applied commercially to micaceous materials (essentially hydrated silicates of Al, Mg and Fe), usually alteration products of biotite or phlogopite mica formed by the removal of much alkalies and addition of water. Vermiculite differs from mica in its characteristic property of exfoliating.

World Scenario

Resources: The world resources of vermiculite were about 200 million tonnes. Reserves have been reported in Australia, Brazil, China, Russia, South Africa, Uganda, USA, Zimbabwe and some other countries. The reserves and reserve base of vermiculite are given in a Table, below:

Country	Reserves	Reserve Base
South Africa	14,000	80,000
U S A	25,000	100,000
Other Countries	N.A.	N.A.
World Total	**N.A.**	**N.A.**

Production

The world production of vermiculite was 500,000 tonnes in 2004, a 2% increase compared with that of 2003. South Africa is the principal producer, contributing about 39% of the total production, followed by China and USA (20% each), Russia (5%), etc. India's production of vermiculite was 3273 tonnes in 2004-05.

Indian Scenario

The reserves/resources of vermiculite in India as on 1.4.2000 as per UNFC system are placed at 2.6 million tonnes. Major deposits are located in Tamilnadu (81.8%), followed by Madhya Pradesh (7.9%), Andhra Pradesh (4.2%), Karnataka (3.7%), Jharkhand (1.1%) and Rajasthan (1.0%). The remaining reserves/resources are accounted by West Bengal (0.2%) and Gujarat (0.1%).

Production of vermiculite at 3,273 tonnes in 2004-05 decreased by 27% form that in the previous year due to lack of demand and temporary closure of one mine. There were 2 reporting mines only. One principal producer each from Tamilnadu and Andhra Pradesh recorded 69% output in 2004-05. The remaining 31% production was contributed by mines for associated minerals. The share of public sector was 57% as compared to 32%. The production of vermiculite is estimated at 4,000 tonnes by 2006-07 and at 5,600 tonnes by 2011-12 (Annexure I).

The reported consumption of vermiculite in the organised sector was 300 tonnes. The refractory and asbestos product industries were the main consumers of vermiculite. The apparent domestic demand for vermiculite is estimated at 5,000 tonnes by 2006-07 and at 7,000 tonnes by 2011-12 (Annexure II & III). Exports of vermiculite in 2003-04 decreased to 566 tonnes from 665 tonnes in the previous year whereas the imports increased to 138 tonnes from 7 tonnes.

International Competitiveness

India's resources of vermiculite are limited and need to be conserved.

8.4 Export Potential Minerals

8.4.1 **Barytes**

Barytes, as a high specific gravity mineral (weighting agent) finds use largely in oil and gas well drilling. It makes an ideal material for preparation of drilling mud in view of its properties mainly high specific gravity, low abrasiveness, insolubility in water, lack of magnetic property and high chemical stability. Next to oil drilling, the next important consumer of barytes is the chemical industry for manufacture of barium chemicals like carbonate, chloride, oxide, hydroxide, nitrate, peroxide and sulphate salts. Paint, rubber, asbestos products, glass and other like abrasives and as filler in heavy paper and card are the other industries consuming small quantities of barytes, in order of importance. Long term demands and production of barytes, however, depend solely on growth in oil well drilling.

World Scenario

The reserves and reserve base of barytes is given in table below:

Country	Reserves	Reserve Base
United States	25,000	55,000
Algeria	9,000	15,000
Brazil	2,100	5,000
China	62,000	360,000
France	2,000	2,500
Germany	1,000	1,500
India	53,000	80,000
Mexico	7,000	8,500
Morocco	10,000	11,000
Russia	2,000	3,000
Thailand	9,000	15,000
Turkey	4,000	20,000
U.K.	100	600
Other countries	14,000	160,000
World total	**200,000**	**740,000**

Note: As per NMI, prepared by IBM, the total resources of India are 80 million tonnes.

Production

World production of barytes was 7.2 million tonnes in 2004. The important producers were China (3.4 million tonnes), India (1.1 million tonnes), USA (0.5 million tonnes), Morocco (0.34 million tonnes) and Mexico (0.3 million tonnes) were the principal producers. India occupies second position.

Indian Scenario

The total resources of barytes in India as on 1.4.2000 as per UNFC are placed at 80 million tonnes constituting 49% reserves and 51% remaining or additional resources. Andhra Pradesh alone accounted for more than 99% country's reserves as well as more than 90% country's remaining resources of barytes.

The production of barytes at 1161,000 tonnes in 2004-05 increased by about 61% from that in the previous year in spite of closure of three mines. During the year 2005-06, the production is reported to be 1308,000 tonnes and the projections for 2011-12 are placed at 1618,000 tonnes. Andhra Pradesh continued to be the premier State accounting for almost the entire production followed by Rajasthan and Himachal Pradesh with nominal production. Almost the entire production of barytes was of off-colour variety. The production of barytes is estimated at 1.3 million tonnes by 2006-07 and at 2.0 million tonnes by 2011-12 (Annexure II & III).

The domestic consumption of barytes in the organised sector decreased to 134,800 tonnes in 2003-04 as against 159,600 tonnes in 2002-03. Oil and gas drilling industry, the main consumer of barytes in India, accounted for 70% consumption followed by chemical industry (25%). The apparent domestic demand of barytes is estimated at 378,000 by 2006-07 and at 581,000 tonnes by 2011-12 (Annexure II & III). The exports of barytes increased to 405,833 tonnes in 2003-04 as against 314,546 tonnes in the previous year. USA was the main buyer followed by UAE, Mexico, Saudi Arabia and Egypt. Imports were 92 tonnes only mainly from Germany.

India ranks second in the production of barytes in the world after China and is one of the important exporters in the world market. India has surplus resources of barytes and it can meet comfortably not only the needs of the domestic industry but also of the export market. Therefore, concerted efforts are necessary to boost up the export of barytes and its micronized products from the country. The world-wide demand for barytes may probably continue to grow till petroleum products endure to be the energy source of choice. Demand for oil and gas remained strong and the oil price remained high, encouraging exploration and development of wells that boost barytes consumption.

Value Addition

The world barytes market mainly depends on oil/gas drilling activity which is influenced by the price of oil, the state of world economy and political factors. Approximately 85% of the world's baryte is used in the petroleum industry as one of the key ingredients in drilling mud for oil and gas wells. Despite the growing use of non-hydrocarbon energy sources, the demand for petroleum is expected to continue to be high and as a result the demand for barytes will continue. Although China produces more barytes than India, but all over the world, market has a preference for Indian barytes because of its high quality. The unit realisation from powder barytes is nearly twice that of lumpy barytes. Therefore, exports of powdery barytes be encouraged for better unit realisation. For this purpose, more processing plants are required to be set up near the mining areas.

8.4.2 **Bentonite**

Bentonite is essentially high plastic clay containing not less than 85% clay mineral, montmorillonite. Bentonite is of a great commercial importance possessing inherent bleaching properties like fuller's earth, hence, it is known as bleaching clay. There are two types of bentonites; namely, swelling-type or sodium bentonite and non-swelling-type or calcium bentonite. Sodium bentonite is usually referred to simply as bentonite whereas calcium bentonite is called Fuller's earth. The commercial importance of bentonite depends more on its physico-chemical properties rather than its chemical composition. Excellent plasticity and lubricity, high dry-bonding strength, high shear and compressive strength, low permeability and low compressibility make bentonite important. Bentonite is valued in foundry and binding, drilling mud, iron ore pelletization and as waterproofing and sealing agent in civil engineering. Processing is a prerequisite for bentonite marketing. Bhavnagar and Kachchh districts of Gujarat and Barmer district of Rajasthan are the major producers of bentonite. Sporadic occurrences are reported in Jharkhand. Bentonite is a “minor mineral declared under Mines and Minerals (Development and Regulation) Act, 1957”.

World Scenario

World resources of bentonite are extremely large.

Production

The world production of bentonite was 13 million tonnes in 2004. USA was the main producer of bentonite accounting for about 35% of the world production. China (12%), Greece (8%) Turkey (6%) and Mexico (5%) were the other important producers. India’s production is a meager 440 thousand tonnes.

Indian Scenario

Total reserves and resources of bentonite in the country are about 527 million tonnes out of which large quantity, i.e. 420 million tonnes comprising 80% are in Rajasthan, 97 million tonnes (18%) in Gujarat and the remaining in Tamil Nadu, Jharkhand and Jammu & Kashmir. About 9 million tonnes,51 million tonnes and 19 million tonnes are placed under drilling fluid, foundry and poor/blendable grades, respectively. Substantial quantity (448 million tonnes or 85%) of reserves/resources are placed under ‘unclassified’ and ‘not known’ categories.

Quantitative data on production of bentonite is not available.

The value of bentonite produced in India in 2003-04 increased by 27% from the previous year. Gujarat continued to be the leading producing State and accounted for 88% followed by Rajasthan. The total consumption of bentonite in 2003-04 decreased marginally to 146,300 tonnes from that in the previous year because of less demand in pulverizing and oil well drilling. The consumption in other industries remained almost static. Foundry industry accounted for 33% consumption, followed by pelletization 22%, civil construction 19%, oil well drilling 12% and other industries 14%. India has entered the market with bentonite from Kuchchh in Gujarat. The Ashapura Minechem (P) Ltd., Kuchchh has commissioned a bentonite pulverizing plant of 60,000 tpy capacity near Bhuj. The company has also installed a new Pellet Strength Test (PST) grade bentonite plant of 100,000 tpy capacity. Ashapura Volclay, a joint venture company is the leading bentonite exporter and there were other 30 pulverizing units in Gujarat and 27 in Rajasthan. The exports of bentonite decreased from 91,958 tonnes in 2002-03 to 80,664 tonnes in 2003-04. UAE, Saudi Arabia, Italy and Netherlands were the major buyers.

International Competitiveness

The biggest market for bentonite in both North America and European countries are foundry, cat litter, iron ore pelletizing and drilling. Civil engineering and environmental applications, such as land fills, require bentonite for use as a sealant and lubricant. The global bleaching clay market is estimated at 860,000 tpy of which 700,000 tpy is used for bleaching edible oils, 150,000 tpy for petroleum and the remaining 10,000 tpy for clarifying beverages, such as wines and fruit juices. Ashapura Volclay produces and sells more than 20,000 tpy of bleaching clays which can be used for refining all kinds of vegetable oils, industrial oils, fats and waxes. The Indian bentonite industry is expected to get on well in the coming years because of emerging demand for oil clarification and cat litter.

Value Addition

Bentonite is one of the exportable commodities in India. Bentonite is exported both in unprocessed (crude) and processed (including activated) forms. Exports of crude bentonite account for the bulk quantity. But exports of processed bentonite fetch higher value than the crude bentonite. There is a pressing need to develop various processing techniques to suit our available resources for making the product to suit the international standards. There is scope to establish bentonite processing granulation and paint grade grade processed bentonite units in the country to meet the indigenous demand as well as in the international market.

8.4.3 **Fuller's Earth**

Fuller's earth, like bentonite, is also known as 'bleaching clay' due to its inherent bleaching properties. It has great commercial importance like bentonite. Bentonite is a swelling-type clay but Fuller's earth is a non-swelling-type clay. This property difference is because of their chemical composition. Bentonite contains sodium whereas fuller's earth contains calcium. Calcium bentonite, sometimes called Fuller's earth can be converted into sodium bentonite by cation exchange process or acid activation. Activated Fuller's earth is used mainly in bleaching and refining of vegetable and mineral oils. Fuller's earth is a "minor mineral declared under Mines and Minerals (Development and Regulation) Act, 1957".

World Scenario: World resources of fuller's earth are large.

Production

The world production of fuller's earth (including attapulgite and sepiolite) was 4,600 thousand tonnes in 2004, which decreased by 5,000 thousand tonnes compared to the previous year. The USA was the top producer accounting for about 71% of the world production. Other principal producers were Spain (12%), Senegal (4%), Mexico (3%) and United Kingdom (1%).

Indian Scenario

The reserves/resources of Fuller's earth in India as per UNFC are placed at 256 million tonnes. Out of these, negligible reserves are placed under 'probable' category while about 99.98% are placed under 'resources' category. About 74% resources are located in Rajasthan. The remaining resources are in Andhra Pradesh, Arunachal Pradesh, Assam, Karnataka and Madhya Pradesh.

Quantitative data on production of fuller's earth is not available.

The value of Fuller's earth produced in India in 2003-04 was Rs.6.1 crores and it was 9.3% higher than that in the previous year. Production was reported from Andhra Pradesh, Karnataka and Rajasthan; with substantial production from Andhra Pradesh.

The consumption of Fuller's earth in the organised sector was at 10,100 tonnes in 2003-04. Fertilizer industry, the largest consumer, accounted for about 72% consumption. A sizeable quantity is also consumed in rural/urban areas for non-industrial uses like plastering mud walls, washing of hair, etc. Exports of Fuller's earth increased to 66,078 tonnes in 2003-04 from 52,079 tonnes in the previous year. Malaysia was the main buyer followed by Indonesia. Imports were 1,227 tonnes in 2003-04 mainly from Indonesia.

International Competitiveness

India is one of the important exporter of fuller's earth in the world and needs to maintain its leading position.

8.4.4 **Mica**

The mica group represents 34 phyllosilicate minerals that exhibit a layered or platy structure. Commercially important mica minerals are muscovite and pholgopite.

World Scenario

Resources: Large deposits of mica bearing rock are known to exist in countries such as Brazil, India and Madagascar, and some small resources of sheet mica in the USA . The reserves and reserve base are given in Table, below:

Country	Reserve	Reserve Base
India	Very Large	Very Large
Russia	Moderate	Large
USA	Very small	Small
Other countries	Moderate	Large
World Total	**Very large**	**Very large**

Production

The World production of mica was 330,000 tonnes in 2004, about 14% increase compared with that of 2003. China is the principal producer, contributing about 25%, followed by USA (23%), Korea Rep. (18%), Canada (9%), etc. India's production of crude mica was 1,366 tonnes in 2004-05.

Indian Scenario

Over hundred years, India has enjoyed the monopoly in the production and export of sheet mica in the world. But recently, production of mica has showed a continuous declining trend due to slow down in the demand of natural mica in the world market because of technological developments in use of mica and emergence of mica substitutes. However, there are sufficient resources in the country to meet the domestic requirement and export demand.

Most important mica-bearing pegmatites occur in Andhra Pradesh, Bihar, Jharkhand and Rajasthan. Occurrences of mica pegmatites are also reported from Gujarat, Haryana, Karnataka, Kerala, Maharashtra, Orissa, Rajasthan, Tamilnadu and West Bengal. As per UNFC system, the total resources of mica in the country are estimated at 59,890 tonnes out of which only 15 tonnes are placed under reserves category. Remaining resources estimated at 59,875 tonnes include inferred (57,667 tonnes) and reconnaissance (2,208 tonnes) categories. Andhra Pradesh accounts for about (67%) resources, followed by Bihar (22%), Rajasthan (8%) and Jharkhand (3%).

The production of mica (crude) at 1,366 tonnes in 2004-05 increased by 27% from the previous year. However the production of mica(waste and scrap) at 2,802 tonnes in 2004-05 decreased by 4% from the previous year. There were 35 reporting mines. Six mines, each producing above 100 tonnes annually accounting for 80% output. The entire production was in the private sector and Andhra Pradesh continued to be the leading state contributing 97% production followed by Rajasthan. The production of mica is estimated at 5,000 tonnes by 2006-07 and 7,200 tonnes by 2011-12 (Annexure I).

Complete picture regarding the consumption of mica is not available. Sheet mica is used mainly in electrical and micanite industries while scrap mica is used in the manufacture of mica paper . The estimated consumption of various types of mica was around 8,000 tonnes per annum during Xth plan period.

Exports of mica increased to 1,23,566 tonnes in 2003-04 from 34,705 tonnes in the previous year. Exports were mainly to China, Hong Kong, Japan, Netherlands and Germany etc. whereas imports of mica also increased to 2,552 tonnes in 2003-04 from 1,296 tonnes in the previous year.

International Competitiveness

World demand for sheet mica is expected to decline. This is, however, compensated by the growing demand for scrap mica and value-added mica-based products. Therefore, the world market conditions are expected to be favourable for mica exports but to take full advantage of situation for boosting exports, it would be necessary for Indian mica industry to manufacture and export fabricated and value-added mica-based products, such as mica paper, micanite sheets and mica-based paper.

Value addition: Some of the mica deposits in the country contain lithium mica and substantial concentration of rubidium and cesium. Process know-how needs to be developed for recovery of these values.

There appears to be good demand for wet ground mica especially in the manufacture of pearlescent pigments which are increasingly used in the automotive industry. Therefore, establishment of wet ground mica plants based on imported know-how in the country needs to be encouraged.

The quality of Indian ground mica powder is acceptable to foreign buyers. However, they prefer that the material should be free from iron and consistency in the mesh size in the powder. Efforts are necessary in this direction.

8.4.5 **Talc, Soapstone and Steatite**

Talc is a hydrous magnesium silicate. In trade, talc often includes: (I) the mineral talc in the form of flakes and fibres; (ii) steatite, the massive compact cryptocrystalline variety of high-grade talc; and (iii) soapstone, the massive talcose rock containing variable talc (usually 50%), soft and soapy to feel. Commercial talc may contain other minerals like quartz, calcite, dolomite, magnesite, serpentine, chloride, tremolite and anthophyllite as impurities. The properties that give talc a wide variety of uses and markets are its extreme softness and smoothness, good lustre and sheen, high slip and lubricating property, low moisture content, ability to absorb oil and grease, chemical inertness, high fusion point, low electrical and heat conductivity, high dielectric strength, good retention for filler purposes, whiteness, good hiding power as pigment and high specific heat. In addition, it has the advantage of being relatively abundant. It can be mined and prepared easily for market.

World Scenario

The world resources of talc-steatite are large.

(Qty. in '000 tonnes)

Country	Reserves	Reserve Base
Brazil	180,000	250,000
China	Large	Large
India	4,000	9,000
Japan	100,000	160,000
Korea Rep of	14,000	18,000
U S A	140,000	540,000
Other Countries	Large	Large
World Total	**Large**	**Large**

Production

World production of talc was about 8 million tonnes in 2004. Major producers were China, USA, Brazil, Finland and France.

Indian Scenario

The total reserves/resources of talc/steatite/soapstone as on 1.4.2000 are assessed at 269 million tonnes of which reserves and remaining resources are 130 million tonnes and 139 million tonnes, respectively. Substantial quantities of resources are established in Rajasthan (50%) and Uttaranchal (30%). The remaining 20% are in the States of Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Jharkhand, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Orissa, Sikkim and Tamilnadu.

Production of steatite in 2004-05 at 750 thousand tonnes increased by about 3% from the previous year. The entire production was from private sector mines. About 59% production was of grade other than insecticide and the remaining 41% was of insecticide/DDT grade. Rajasthan, the main producing state accounted for as much as 77% production followed by Uttaranchal and Andhra Pradesh. Production of talc-steatite is estimated as 843,000 tonnes by 2006-07 and at 1.29 million tonnes by 2011-12 (Annexure I).

Talc/Soapstone is mainly used in pulverised form as a filler in various industries. The non-pulverised is used in refractory, sculpturing etc. The total consumption in the organidsed sector is around 270,000 tonnes per annum, of which 68% was in paper industry followed by pesticide (16%), paints (8%) and cosmetics (4%). The apparent domestic demand for talc-steatite is estimated at 831,000 tonnes by 2006-07 and 1.28 million tonnes by 2011-12 (Annexure- II & III). The exports of steatite (total) is around 29,300 tonnes whereas imports were 485 tonnes in 2003-04.

International Competitiveness

India is one of the principal source of sawn shaped talc and 'lava' grade of talc. The lava grade is well suited for specialised purposes like low ceramic materials. In the world market, talc is free from grit, having high whiteness and high degree of soapy feeling are very much sought after for cosmetic, filler and weighting application. Indian talc minerals of good quality are comparable with the best quality available in other countries. Indian talc is considered to be the second best in the world next to 'Italian talc'.

Value Addition

The world market conditions for talc minerals are steadily growing. Therefore, concerted efforts are necessary to increase exports by adopting modern pulverising techniques for Indian talc. In view of India's large resource base, and well developed production facilities, there is considerable scope for boosting the exports of talc-steatite.

8.5 Recommendations

1. Non-metallic/Industrial group of minerals are basically low value bulk materials having a large potential in the country. These constitute the raw materials for fertilizer industry, flux & construction and ceramic and refractory industries besides some of them being export potential minerals.

2. The reserves of chemical and fertilizer grades rock phosphate in India are very limited. Therefore detailed exploration is necessary for conversion of remaining resources into reserves. Also the search for new deposits of rock phosphate may have to be intensified in Andhra Pradesh, Rajasthan and Madhya Pradesh. Further, the Indian deposits are of low grades. Therefore, fertilizer and phosphoric acid plants that may be set up as replacement to the existing plants will have to be designed to accept indigenous ores as a feed. Beneficiation of domestic low-grade ores would need to be given a priority.

3. The resources of chrysotile variety of asbestos are very much limited in India. So there is an urgent need to go for detailed exploration, as the internal demand for asbestos in the country can not be met from indigenous production.

4. The resources of the refractory grade dolomite in the country are meager and is in short supply but very much required for making tar-bonded dolomite bricks for use in lining of LD steel furnaces. Intensive search is therefore needed in non-Himalayan regions for locating deposits of massive non-crystalline dolomite.

5. The grades of the fluorspar deposits other than Ambadungar in Gujarat do not meet the specifications of the chemical industry which is the bulk consumer of fluorspar. Hence to meet the requirements, domestic chemical industry will have to depend on imported fluorspar in the coming years.

6. India's domestic resources of gypsum are large to meet increased demand. However, steps would be necessary to find out suitable mining technology to exploit deep-seated gypsum resources in Rajasthan. Besides, the production of gypsum wallboard need to be encouraged.

7. There is an increasing demand for wollastonite in the international markets and therefore, there is scope for increasing the export of this mineral from India in value-added form as coated powders.

8. Though India has huge reserves of fireclay but a serious dearth is being felt in the refractory industry with respect to availability of high grade clay analysing 37% and

above Al_2O_3 and having Fe_2O_3 and flux impurities less than 2%. In view of this, deposits of high grade fireclay may be explored and delineated.

9. The graphite reserves having +40% fixed carbon are rather limited in the country. Cost-effective beneficiation technologies for low grade graphite ore need to be developed alongwith new products by synthetic graphite.

10. India has surplus resources of barytes and it can meet comfortably not only the needs of the domestic industry but also the export market. Therefore, concerted efforts are necessary to boost up the export of barytes and its micronized products from the country, keeping in view the demand for exploration and development of oil wells that boost barytes consumption.

11. The Indian bentonite industry is expected to get on well in the coming years because of emerging demand for oil clarification and cat litter.

12. World demand for sheet mica is expected to decline. This is, however, compensated by the growing demand for scrap mica and value-added mica-based products. Therefore, the world market conditions are expected to be favourable for mica exports but to take full advantage of situation for boosting exports, it would be necessary for Indian mica industry to manufacture and export fabricated and value-added mica-based products, such as mica paper, micanite sheets and mica-based paper.

ANNEXURE I

SALIENT FEATURES OF ESTIMATED DOMESTIC PRODUCTION, RESOURCES SITUATION & LIFE INDEX DURING XITH PLAN PERIOD

Unit:`000 tonnes (unless otherwise specified)

Minerals	**Estimated Domestic production** --- **2006-2007 being Terminal Year of the 10th Plan projections based on growth rates**				**2011-2012 Terminal Year of 11th Plan**	**Total estimated balance of reserves/resources as on 1.4. 2012, based on NMI as on 1.4.2000 (Proved & Probable reserves in parentheses)**	**Life Index (Proved + Probable reserves beyond 1.4. 2012)**
	7%	8%	9%	10%	7%		
I Fertilizer Minerals							
Rock Phosphate	1479	1494	1507	1521	2076	288957(75395)	31
*Potash	0	0	0	0	0	21815000	
Sulphur	131	133	133	135	184	1674401(56726)	303
II Flux & Construction Minerals							
Asbestos	6	7	7	7	8	18456(3667)	453
Dolomite	4619	4662	4706	4749	6478	7084209(991964)	148
Fluorspar (graded)	4	4	4	4	6	12776(2234)	367
Gypsum	3907	3943	3980	4016	5121	124325(86853)	12
Wollastonite	121	122	123	124	169	12424(2077)	7
III. Ceramics & Refractory Minerals							
Quartz & Silica sand	3079	3111	3143	3175	4318	2909561(625575)	140
Fireclay	480	485	489	494	674	695027(49247)	68
Ball Clay	335	338	341	344	470	69273(24895)	48
China Clay	1077	1088	1098	1108	1510	2302426(180795)	115
Magnesite	428	432	436	440	600	368657(122701)	200
Graphite	114	117	119	121	161	159267(4796)	25
Pyrophyllite	309	315	320	327	434	18194(12153)	23
Kyanite	9	9	10	10	14	102491(1391)	94
Sillimanite	31	31	32	32	43	63496(15299)	351
Vermiculite	3	3	4	4	4	2622(136)	29
IV. Export Potential Minerals							
Barytes	1400	1413	1426	1439	1963	80059(3276)	Negligible resource
**Bentonite	0	0	0	0	0	526655(24243)	
**Fuller's Earth	0	0	0	0	0	256652(58)	
Mica (crude)	1	1	1	1	1	60 (less than half of the unit)	
Talc/Steatite	644	650	656	662	903	269317(129956)	139

* Remaining resources

** It has not been possible to workout the life indices in respect of bentonite and fuller's earth because the production figures are not available.

ANEXURE I (contd.)

SALIENT FEATURES OF ESTIMATED APPRENT CONSUMPTION, DOMESTIC PRODUCTION, RESOURCES SITUATION & LIFE INDEX DURING XITH PLAN PERIOD

Unit:`000 tonnes (unless otherwise specified)

Minerals	Estimated apparent consumption: 2006-07 Terminal Year of 10th Plan	Estimated apparent consumption: 2011-2012 Terminal Year of 11th Plan 10%	Estimated domestic production: 2006-07 Terminal Year of 10th Plan	Estimated domestic production: 2011-2012 Terminal Year of 11th Plan 10%	Total estimated balance of reserves/resources as on 1.4.2012, based on NMI as on 1.4.2000 (Proved & Probable reserves in parentheses)	Life Index (Proved + Probable reserves beyond 1.4.2012)
I. Fertiliser Minerals						
Rock Phosphate	3584	5772	1521	2449	288957(75395)	26
*Potash	926	1492	0	0	21815000	
Sulphur	1998	3219	135	218	1674401(56726)	255
II. Flux & Construction Minerals						
Asbestos	116	188	7	12	18456(3667)	301
Dolomite	5096	8208	4749	7648	7084209(991964)	125
Fluorspar	83	133	4	7	12776(2234)	314
Gypsum	5616	9046	4016	6469	124325(86853)	8
Wollastonite	95	155	124	200	12424(2077)	57
III. Ceramic & Refractory Minerals						
Quartz & Silica sand	1731	2786	3175	5115	2909561(625575)	117
Fireclay	664	1068	494	795	695027(49247)	57
Ball clay	421	678	344	554	69273(24895)	40
China clay	457	736	1108	1785	2302426(180795)	96
Magnesite	301	486	440	708	368657(122701)	168
Graphite	13	21	121	195	159267(4796)	20
Pyrophyllite	4	8	327	528	18194(12153)	18
Kyanite	15	25	10	15	102491(1391)	88
Sillimanite	9	14	32	52	63496(15299)	289
Vemiculite	0.30	0.64	4	7	2622(136)	14
IV. Export Potential Minerals						
Barytes	180	290	1439	2318	80059(3276)	Negligible resource
**Bentonite	195	316	0	0	526655(24243)	
**Fuller's Earth	13	21	0	0	256652(58)	
Mica (crude)	0	0	1	2	60 (less than half of the unit)	
Talc/Steatite	358	576	662	1066	269317(129956)	116

* Remaining resources

** It has not been possible to workout the life indices in respect of bentonite and fuller's earth because the production figures are not available.

ANEXURE I (contd.)

ESTIMATED DOMESTIC PRODUCTION DURING XTH PLAN FOR 2005-06 & 2006-07 AND DURING XITH PLAN (7% GROWTH RATE)

Thousand Tonnes (Unless otherwise Specified)

Sr.No.	Mineral	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-02
1.	Rock Phosphate & Apatite	1446	1193	1264	1340	1423	1523	1630	1744	1866
2.	Sulphur & Pyrite	109	114	121	128	137	146	157	168	179
3.	Asbestos (T)	10107	5619	5956	6313	6012	6432	6882	7364	7879
4.	Dolomite	4051	4309	4567	4841	5180	5543	5931	6346	6790
5.	Fluorspar (Total)	9013	11450	12137	12865	13765	14728	15759	16862	18042
6.	Gypsum	2774	3555	3768	3994	4274	4573	4893	5236	5602
7.	Wollastonite	151	172	183	194	207	222	237	254	272
8.	Quartz & Other silica minerals	2899	2293	2431	2577	2757	2950	3156	3409	3647
9.	Fireclay	657	559	592	628	672	719	769	823	880
10.	Ballclay & Chinaclay	1735	1433	1519	1610	1723	1843	1972	2110	2258
11.	Magnesite	324	381	404	428	458	491	525	562	601
12.	Graphite	87	100	106	113	121	129	138	148	158
13.	Pyrophyllite	176	270	286	303	324	347	371	397	425
14.	Kyanite (T)	9507	7710	8173	8663	9269	9918	10612	11355	12150
15.	Sillimanite(T)	19729	28761	30487	32316	34578	36998	39588	42359	45324
16.	Vermiculite (T)	4493	3273	3469	3677	3934	4209	4504	4819	5156
17.	Barytes	723	1161	1231	1305	1396	1494	1598	1710	1830
18.	Mica (T)	3574	4168	4418	4683	5011	5362	5737	6139	6569
19.	Talc – Steatite	726	750	795	843	902	965	1032	1104	1182

ANEXURE I (contd.)

ESTIMATED DOMESTIC PRODUCTION DURING XTH PLAN FOR 2005-06 & 2006-07 AND DURING XITH PLAN (8% GROWTH RATE)

Thousand Tonnes (Unless otherwise Specified)

Sr. No.	Mineral	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-02
1.	Rock Phosphate & Apatite	1446	1193	1264	1340	1447	1563	1688	1823	1969
2.	Sulphur & Pyrite	109	114	121	128	138	149	161	174	188
3.	Asbestos (T)	10107	5619	5656	6313	6068	6503	7077	7643	8254
4.	Dolomite	4051	4309	4567	4841	5229	5647	6099	6587	7114
5.	Fluorspar (Total)	9013	11450	12137	12865	13894	15005	16205	17501	18901
6.	Gypsum	2774	3555	3768	3994	4314	4659	5032	5434	5869
7.	Wollastonite	151	172	183	194	210	226	244	264	285
8.	Quartz & Other silica minerals	2899	2293	2431	2577	2783	3005	3246	3486	3765
9.	Fireclay	657	559	592	628	678	732	791	854	922
10.	Ballclay & Chinaclay	1735	1433	1519	1610	1739	1878	2028	2190	2365
11.	Magnesite	324	381	404	428	463	500	540	83	629
12.	Graphite	87	100	106	113	122	132	142	153	166
13.	Pyrophyllite	176	270	286	303	327	353	382	412	445
14.	Kyanite (T)	9507	7710	8173	8663	9356	10104	10912	11785	12728
15.	Sillimanite(T)	19729	28761	30487	32316	34901	37693	40708	43965	47482
16.	Vermiculite (T)	4493	3273	3469	3677	3971	4289	4632	5003	5403
17.	Barytes	723	1161	1231	1305	1409	1522	1644	1775	1917
18.	Mica (T)	3574	4168	4418	4683	5058	5463	5900	6372	6882
19.	Talc – Steatite	726	750	795	843	910	973	1051	1135	1225

Annexure I (Concld.)

ESTIMATED DOMESTIC PRODUCTION DURING XTH PLAN FOR 2005-06 & 2006-07 AND DURING XITH PLAN (9% GROWTH RATE)

Thousand Tonnes (Unless otherwise Specified)

Sr.No.	Mineral	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-02
1.	Rock Phosphate & Apatite	1446	1193	1264	1340	1461	1592	1735	1891	2062
2.	Sulphur & Pyrite	109	114	121	128	139	152	166	181	197
3.	Asbestos (T)	10107	5619	5956	6313	6124	6675	7276	7931	8625
4.	Dolomite	4051	4309	4567	4841	5277	5752	6270	6834	7449
5.	Fluorspar (Total)	9013	11450	12137	12865	14023	15285	16660	18159	19793
6.	Gypsum	2774	3555	3768	3994	4354	4746	5173	5638	6146
7.	Wollastonite	151	172	183	194	211	230	251	274	298
8.	Quartz & Other silica minerals	2899	2293	2431	2577	2808	3061	3337	3637	3964
9.	Fireclay	657	559	592	628	684	746	813	886	966
10.	Ballclay & Chinaclay	1735	1433	1519	1610	1755	1913	2085	2272	2477
11.	Magnesite	324	381	404	428	467	509	555	605	659
12.	Graphite	87	100	106	113	123	134	146	159	174
13.	Pyrophyllite	176	270	286	303	330	360	392	428	466
14.	Kyanite (T)	9507	7710	8173	8663	9443	10293	11219	12229	13330
15.	Sillimanite(T)	19729	28761	30487	32316	35224	38394	41849	45615	49720
16.	Vermiculite (T)	4493	3273	3469	3677	4008	4369	4762	5191	5658
17.	Barytes	723	1161	1231	1305	1422	1550	1690	1842	2008
18.	Mica (T)	3524	4168	4418	4683	5104	5563	6064	6610	7205
19.	Talc – Steatite	726	750	795	843	918	1001	1091	1189	1297

T: Tonnes

ANNEXURE-II

SALIENT FEATURES OF ESTIMATED APPARENT CONSUMPTION, DOMESTIC PRODUCTION, RESOURCE SITUATION & LIFE INDEX DURING XITH PLAN PERIOD

Thousand Tonnes

Sr. No.	Minerals	**Estimated Apparent Consumption**		**Estimated Domestic production**		Resources as on 1-4-2000		Production during 2000-01 to 2006-07 (C)
		2006-07 terminal year of Xth Plan	**2011-12 terminal Year of XIth plan 9%**	**2006-07 terminal year of Xth Plan**	**2011-12 terminal Year of XIth plan 9%**	Total Resources (A)	Resources considered for Life Index (B)	
1.	Rock Phosphate & Apatite (Chemical and fertilizers)	4475	6695	1340	1866	13121	13121	9067
2.	Potash	--	--	--	--	--	--	--
3.	Sulphur & Pyrites	1320	2031	128	179	--	--	--
4.	Asbestos	227	349	5.6	7.9	89.59	43.43	--
5.	Dolomite	4799	7383	4841	6790	7084209	1920204	27681
6.	Fluorspar	126	194	12.86	18.04	12775	10950	82
7.	Gypsum	3437	5289	3994	5602	1243600	815830	22270
8.	Wollastonite	170	262	194	272	12424	9075	1136
9.	Quartz and other Silica minerals	3330	5124	2577	3677	3992438	1559872	17175
10.	Fireclay	781	1201	628	880	695027	163919	3933
11.	China clay & Ball Clay	2045	3147	1610	2258	2285027	774531	10567
12.	Magnesite	485	745	428	601	368657	241504	2421
13.	Graphite	113	174	113	158	159267	11566	743
14.	Pyrophyllite	210	323	303	425	18194	12951	1480
15.	Kyanite	11	17	8.66	12.1	102491	7196	48
16.	Vermiculite	5	7	3.7	5.1	2621	158	30
17.	Sillimanite	22	35	32	45	63496	44116	154
18.	Barytes	378	582	1305	1830	80059	68220	6860
19.	Talc-Steatite	831	1278	843	1182	269317	138047	4996
20	Mica	N.E.	N.E.	4.7	6.6	59.8	--	--

ANNEXURE-III

SALIENT FEATURES OF ESTIMATED APPARENT CONSUMPTION, DOMESTIC PRODUCTION, RESOURCES SITUATION AND LIFE INDEX DURING XITH PLAN PERIOD

(Thousand Tonnes)

Minerals	Estimated domestic production			Production of the terminal year of XIth plan at			Total Resources as on 1.4.2000 (Resources considered for calculating life index (in parenthesis)	Life index as on	
	2004-05	2005-06	2006-07	7%	8%	9%		1.4.2007	1.4.2012
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
I. Fertilkzer Minerals									
Rock phosphate & Apatite (chemical & fertilizer grade)	1193	1264	1340	1866	1969	2062	13121 (13121)	Negli-gible	Negli-gible
Potash	-	-	-	-	-	-	-	Technically not yet developed	
Sulphur	114	121	128	179	188	197	-	-	-
Pyrite	-	-	-	-	-	-	-	As by-production	
II Flux and construction minerals									
Asbestos (chrysotile variety)	6	6	6	8	8	9	89.59 (46.15)	5	Negli-gible
Dolomite	4309	4567	4841	6790	7114	7449	7084209	369	249
Fluorspar	11.4	12.13	12.86 4	18 -	19 -	20 -	12275 (10950) -	906	539
Gypsum	3555	3768	3994	5602	5869	6146	1243600 (815,830)	199	125
Wollastonite	172	183	194	272	285	298	12424 (9075)	41	22
III Ceramic & refractory minerals									
Quartz & other silica minerals	2293	2431	2576	3647	3765	3964	3992438 (1,559,855)	599	385
Fireclay	559	592	628	880	922	966	69,5027 (1,63,919)	254	161
Chinaclay and ballclay	1433	1519	1610	2258	2365	2477	2285076 (774531)	474	304
Magnesite	381	404	428	601	629	659	368,657 (241,504)	558	358
Graphite	100	107	112	158	166	173	159,267 (11,565)	97	59
Pyrophyllite	270	286	303	425	445	466	18194 (12,951)	38	20
Kyanite	8	8	9	12	13	14	102,490 (7158)	794	506

Sillimantie	29	30	32	45	47	50	63,495 (19,830)	1374	873
Vermiculite	3	3	4	5	5.4	5.6	2621 (158)	37	22
IV Export Potential Minerals									
Barytes	1161	1231	1305	1830	1917	2008	80,059 (68,220	52	30
Bentonite*	-	-	-	-	-	-	-	-	-
Fuller's Earth*	-	-	-	-	-	-	-	-	-
Mica*	4	4	5	6.6	6.9	7.2	59.89 (57.68)	Large	Large
Talc/steatite	750	795	843	1182	1225	1296	269317 (138,033)	158	99

* It has not been possible to work out the life indices in respect of bentonite and fuller's earth since the production figures are not available.

** In mica, the resources upto prospecting stage has been included.

*** For calculating the life index, resources considered are Proved (111), Probable (121122), Feasibility Resources (211), Pre-feasibility Resource (221+222), Measured Resource (331) and Indicated Resource (332).

ANNEXURE- IV

PRODUCTION , APPARENT CONSUMPTION, IMPORTS AND EXPORTS OF INDUSTRIAL MINERALS

Unit in **Thousand Tonnes** (Unless otherwise Specified)

Minerals	2000-01	2001-02	2002-03	2003-04
Fertilizer Minerals				
1. Rock Phosphate & Apatite				
Production	1362	1252	1213	1446
Import	4281	3622	3889	2312
Export	7	50	1	1
Apparent consumption	5635	4823	5101	3757
2. Potash				
Production	-	-	-	-
Import	-	-	-	-
Export	-	-	-	-
Apparent consumption	-	-	-	-
3. Sulphur and Pyrite				
Production	62	86	103	109
Import	1802	1639	1388	1003
Export	1	1	6	3
Apparent consumption	1863	1723	1484	1108
4. Asbestos				
Production	15	11	14	10
Import	61	98	99	183
Export	+	1	+	2
Apparent consumption	76	108	113	190
5. Dolomite				
Production	3032	3251	3630	4051
Import	+	1	1	1
Export	16	7	79	23
Apparent consumption	3016	3244	3552	4029
6. Fluorspar (Tonnes)				
Production	7035	20766	13023	9013
Import	59676	91459	96001	100062
Export	170	20	145	578
Apparent consumption	66541	112205	108879	108497
7. Gypsum				
Production	2667	2859	2653	2774
Import	20	25	11	18
Export	38	63	47	63
Apparent consumption	2649	2821	2617	2729
8. Wollastonite (Tonnes)				
Production	121891	136420	178298	150814
Import	-	-	22	1
Export	14697	6639	10275	7673
Apparent consumption	107194	129781	168045	143142

Minerals	2000-01	2001-02	2002-03	2003-04
CERAMICS & REFRACTORY				
9. Quartz & other silica minerals				
Production	2722	1995	2328	2900
Import	31	10	49	3
Export	171	139	77	107
Apparent consumption	2583	1866	2300	2796
10. Fireclay				
Production	487	495	514	657
Import	+	-	-	-
Export	1	1	1	2
Apparent consumption	486	494	513	655
11. China Clay and Ball Clay				
Production	1335	1449	1486	1735
Import	15	30	57	46
Export	10	12	10	63
Apparent consumption	1339	1467	1533	1717
12. Magnesite				
Production	318	287	278	324
Import	16	62	72	91
Export	5	3	5	7
Apparent consumption	379	346	345	407
13. Graphite r.o.m				
Production	125	106	106	87
Import	1	2	3	6
Export	4	+	1	3
Apparent consumption	122	107	108	90
14. Pyrophyllite				
Production	148	150	147	176
Import	-	-	-	-
Export	-	-	-	-
Apparent consumption	148	150	147	176
15. Kyanite (Tonnes)				
Production	4865	4225	5327	9057
Import	-	19	-	77
Export	18	5	9973	84
Apparent consumption	4847	4239	NE	9050
16. Sillimanite (Tonnes)				
Production	15498	14720	13290	19729
Import	-	-	-	4
Export	484	383	394	822
Apparent consumption	15014	14337	12896	18911
17. Vermiculite (Tonnes)				
Production	5003	5097	5499	4493
Import	839	397	7	137
Export	443	446	665	566
Apparent consumption	5399	5048	4841	4064
EXPORT POTENTIAL MINERALS				
18. Barytes				
Production	845	916	680	723
Import	+	+	+	+
Export	154	178	314	406
Apparent consumption	691	738	365	317
19.Bentonite (Tonnes)				

Minerals	2000-01	2001-02	2002-03	2003-04
Production	N.A.	N.A.	N.A.	N.A.
Import	2639	1716	614	587
Export	118612	124710	99958	80664
Apparent consumption	N.E.	N.E.	N.E.	N.E.
20. Fuller's Earth (Tonnes)				
Production	N.A.	N.A.	N.A.	N.A.
Import	1333	1142	530	1227
Export	19655	94736	52079	66078
Apparent consumption	N.E.	N.E.	N.E.	N.E.
21. Mica (Tonnes)				
Production	4117	6095	3574	3574
Import	422	1033	1296	2551
Export	64624	58299	34705	123271
Apparent consumption	N.E.	N.E.	N.E.	N.E.
22. Talc Steatite				
Production	596	598	688	726
Import	+	+	+	+
Export	24	21	29	29
Apparent consumption	572	577	659	697

Notes : + Less than One unit

N.E. Not Estimated

N.A. Not Available

CHAPTER - IX

HEAVY SAND MINERALS

(Ilmenite, Rutile, Leucoxene, Zircon etc.)

9.0 Introduction

The term heavy beach sand minerals refer to minerals with a specific gravity greater than that of quartz, S.G.> 2.65. Minerals in the beach sands haves special significance as they contain six important elements, namely ilmenite, rutile, zircon, monazite, leucoxene (brown ilmenite), sillimanite and garnet. Two elements namely zircon and monazite find use in nuclear power generation. Other elements have industrial applications.

Beach sand minerals are found in the coastal stretches around the country. Ilmenite is the largest constituent of the Indian deposits. The minerals other than garnet and sillimanite have been classified as “prescribed substance” under the Atomic Energy Act, 1962. In accordance with the provisions of the said Act and the Rules/Notificatio&Orders thereunder, it is mandatory to obtain licence from the designated competent authority in the Department of Atomic Energy for working of any mines and minerals from which prescribed substances can be obtained as well as for acquisition, production, possession, use, disposal, export or import of prescribed substances

The principal components of mineral sands are the titanium minerals- rutile (TiO_2) and ilmenite (FeTiO3), and zircon ($ZrSiO_4$). Rutile and ilmenite are mainly used in the production of titanium dioxide pigment, as flux for welding electrodes, with a small portion (less than 4% of total titanium mineral production), typically rutile, used in making titanium sponge metal.

Zircon is used in ceramic and refractory industries besides acting as such as basic raw material for the production of Zr metal and alloys for its use as structural materials in nuclear power reactors. Zircon is used as an opacifier for glazes on ceramic tiles, in refractories and for foundry industry.

The mineral ‘monazite’ is radio active as it contains thorium and uranium and requires special measures for production and storage for exclusive use by the Dept. of Atomic Energy (DAE). Monazite is one of the principal sources for several ‘Rare Earth’ elements.

The remaining two beach sand minerals, namely Garnet and Sillimanite also are gaining market demand due to their varied uses, interalia, as abrasives and refratories respectively. Thus, the exploitation of Heavy Minerals Sands or Beach Sand Minerals offers opportunities of investment for entrepreneurs both domestic and foreign. This Report deals with the aforesaid heavy mineral sands.

India has over 7,000 kms coast-line and many favourable stretches of the beaches on both the western and eastern shorelines have large reserves of heavy minerals whose potential is yet to be fully exploited. But the presence of two Public Undertakings under the Central and State Govt.s [namely Indian Rare Earths Ltd.(IREL) and Kerala Minerals & Metals Ltd.(KMML) respectively] for several decades indicates that the Government is committed to exploit the beach sands, the minerals falling under which, were historically categorized as Atomic Minerals’ (except garnet & Sillimanite).

From 1998 onwards, this sector has been thrown open to the Pvt. Entrepreneurs in the country as well as Foreign Direct Investment (FDI). To facilitate faster and fuller development of the concerned minerals and after due consideration of all radiological, strategic and technical aspects, the Department of Atomic Energy (DAE) in consultation with the Ministry of Mines, the concerned State Govt.s and Stake Holders, has recently decided to remove Ilmenite, Rutile, Leucoxene and Zircon from the list of 'Prescribed Substances'. These minerals, except Zircon, will also cease to be 'Atomic Minerals' under the MM(DR) Act, 1956.

9.1 The Rare Earth Elements

There are thirty rare earth elements. These are composed of two series of elements, the lanthanides and actinides. One element of the lanthanide series and most of the elements in the actinide series are synthetic or man-made. All of the rare earth metals are placed in group 3 of the periodic table, and in the 6th and 7th periods. The elements in the Actinide series are radioactive. The List of 30 Rare Earth Elements is given below:

Table 1
List Of Rare Earth Elements

No	Lanthanide Series –15 Nos	Actinide Series – 15 Nos.
1	Lanthanum	Actinium
2	Cerium	Thorium
3	Praseodymium	Protactinium
4	Neodymium	Uranium
5	Promethium	Neptunium
6	Samarium	Plutonium
7	Europium	Americium
8	Gadolinium	Curium
9	Terbium	Berkelium
10	Dysprosium	Californium
11	Holmium	Einsteinium
12	Erbium	Fermium
13	Thulium	Mendelevium
14	Ytterbium	Nobelium
15	Lutetium	Lawrencium

The lanthanides, together with scandium and yttrium are also sometimes referred to by the trivial name "rare earths although this name is deprecated by International Union of Pure and Applied Chemistry (IUPAC) JUPAC, as they are neither rare in abundance (even the least abundant, lutetium, is more abundant in the Earth's crust than gold), nor are they "earths" (an obsolete term for oxides). Only actinium, thorium and uranium occur naturally in the earth's crust. The remaining actinides were synthesized in the 20th century by techniques such as neutron bombardment. The latter half of the actinide series possesses exceedingly short half-lives. IUPAC are currently recommending the names 'Lanthanoids' and 'Actinoids', rather than lanthanide and Actinides, as the suffix " ide" generally indicates anions.

In 1945, Seaborg published his 'actinide concept' of heavy element electronic structure, predicting that the actinides would form a transition series analogous to the rare earth series of lanthanide elements. The rare earth production of the world is as follows:

Table - 2
Rare Earths: Estimated World Mine Production. By Country[1]

(Metric tons of rare earth oxide equivalent) [2]

Country[3]	2000	2001	2002	2003	2004
China	73,000	80,600	88,000	92,000	98,000
Commonwealth of Independent States[4]	NA	NA	NA	NA	NA
India	2,700	2,700	2,700	2,700	2,700
Kyrgyzstan:					
Compounds	6,800	NA	NA	NA	NA
Metals	7,736	3,800	100	NA	NA
Other	2,000	2,000	2,000	2,000	NA
Malaysia	446	351	240	360	250
United States[6]	W	W	W	--	--
Total	92,700	89,500	93,000	97,100	101,000

India's share is only 2.6% in the world production of rare earths. India's share in world output of rare earth needs to be raised. This may require suitable policy environment for sustainable mining and investment.

9.2 Mineral Beach Sand Reserves

India has large reserves of beach sand minerals in the coastal stretches around the country. Beach Sand contains the important heavy minerals such as Titanium bearing minerals including Ilmenite, Rutile and Leucoxene, as well as Zircon, Monazite, Garnet and Sillimanite. Ilmenite is the largest constituent of the Indian beach sand deposits. The minerals other than garnet and sillimanite have been classified as "prescribed substance" under the Atomic Energy Act, 1962. Out of over 7,000 kms of coastline, Of this, Atomic Minerals Directorate for Exploration and Research (AMD) has undertaken exploration of about 2546 kms and has completed detailed survey of around 1000 kms. They have established quite a few promising beach mineral deposits with a cumulative length of about 100 kms. Ilmenite is the major constituent of these heavy mineral deposits i.e. 30 to 35%. Till now country is estimated to have 461.37 Million Tonnes of Ilmenite. The estimated reserves for different sand minerals are as follows:

Table 3
Reserves of Ilmenite (in million tonnes)

State	Indicated	Inferred	Total
	(=proved)	(=probable)	(in situ)
All India	150.12	224.5	374.62
Andhra Pradesh	38.71	77.42	116.13
Bihar	0	0.73	0.73
Kerala	32.97	66.55	99.52
Maharashtra	3.04	0.64	3.68
Orissa	32.08	20.51	52.59
Tamil Nadu	43.32	56.6	99.92
West Bengal	0	2.05	2.05

Table 4
Reserves of Rutile (in million Tonnes)

State	Indicated (=proved)	Inferred (=probable)	Total (in situ)
All India	7.9	13.12	21.02
Andhra Pradesh	1.99	5.11	7.1
Bihar	0	0.01	0.01
Kerala	2.44	4.18	6.62
Orissa	1.45	0.78	2.23
Tamil Nadu	2.02	2.85	4.87
West Bengal	0	0.19	0.19

Table 5
Reserves of Leucoxene (in million tonnes)

State	Indicated (=proved)	Inferred (=probable)	Total (in situ)
All India	4.64	9.23	13.87
Andhra Pradesh	1.7	2.69	4.39
Kerala	1.28	3.11	4.39
Maharashtra	0.06	0	0.06
Orissa	0.04	0.37	0.41
Tamil Nadu	1.56	3.06	4.62

The state-wise reserves as estimated by Atomic Minerals Division (AMD) as well as reserves of the other countries of the world are shown below:

Table 6
State-wise Inventory of Heavy Minerals' Reserves (Million Tonnes)

State	Ilmenite	Rutile	Zircon	Leucoxene	Monazite	Garnet	Total
Kerala	102.59	6.82	5.99	4.87	1.37	1.13	122.77
Tamil Nadu	106.68	5.11	8.62	4.91	1.85	25.61	152.78
A.P.	139.73	8.8	10.18	5.2	3.73	52.45	220.09
Orissa	105.91	5.89	2.96	1.03	1.82	-	117.61
Maharashtra	3.68	0	0.07	0.06	0	-	3.81
Bihar	0.73	0.01	0.08	0	0.22	-	1.04
West Bengal	2.05	0.19	0.39	0	1.22	-	3.85
TOTAL	461.37	26.82	28.89	16.07	10.21	117.86	661.22

Table 7
World Reserves and production of Ilmenite Minerals (in Million Tonnes)

Country	Reserves	Production	Ratio P/R
Australia	180	1.89	0.011
Brazil	6.4	0.13	0.02
Canada	200	1.8	0.009
China	142	0.84	0.006
India	461.37	0.39	0.001
Malaysia	2	0.18	0.09
Norway	244	0.87	0.004
Sri Lanka	14.8	0.08	0.005
S.Africa	162	2.12	0.013
Usa	82.2	0.53	0.006

Geological Survey of India (GSI) has been conducting systematic surveys for seabed mapping and exploration of minerals in the territorial waters, continental shelf and within the Exclusive Economic Zone (EEZ) of India. It is reported that heavy mineral sands comprising ilmenite, rutile, zircon, sillimanite, monazite and garnet have been located off the coasts of Orissa, Andhra Pradesh, Maharashtra and Kerala. That means that the probable reserves of heavy mineral sands in the country would be higher than present estimates.

Ilmenite:

Ilmenite is a black mineral, comprised primarily of iron titanium oxide, $FeTiO3$, crystallizing in the hexagonal system. It is sometimes found as tabular hexagonal crystals, but occurs more commonly as small grains in igneous and metamorphic rocks and in sands derived from them. Ilmenite has been noted as an important constituent of lunar rocks. It is the commonest titanium mineral and is the most important source of this element and its compounds. Over 3 million tons of ilmenite are mined annually in the world. The important producers of ilmenite are the Australia, Canada, Norway, China, United States, and India

Llmenite, Zircon, Rutile and Leucoxene being found in beach sands, several industries are engaged in the mining of sands containing one or more of these suit sand minerals and in production of the first stage value added products like Titania Slag, Synthetic Rutile, zirconia etc..

Ilmenite forms as a primary mineral in mafic igneous rocks and is concentrated into layers by a process called “magmatic segregation”. It crystallizes out of a magma relatively early before most of the other minerals. As a result, the heavier crystals of ilmenite fall to the bottom of the magma chamber and collect in layers. It is these layers that constitute a rich ore body for titanium miners. Ilmenite also occurs in pegmatites and some metamorphic rocks as well as in the sedimentary rocks that are formed from the weathering and erosion of the primary rocks.

Since its discovery, the mineral ilmenite has grown greatly in its importance. It is now the most important ore of titanium. Titanium was at one time a metal that had little use and basically no one knew what to do with it. Even as late as 1946 when the metal was finally shown to be capable of being produced commercially, it was considered a “laboratory curiosity”. Since that time, titanium has been shown to be a strong aluminum-like metal; light weight, non-corrosive, able to withstand temperature extremes (especially its high melting point, 1800 degrees C) and it has good strength (as strong as steel and twice as strong as aluminum). Titanium alloys have found many applications in high tech materials used in airplanes, missiles, space vehicles and even in surgical implants.

Additionally, titanium dioxide $Ti0_2$ is a white pigment that is used more and more in paints as lead paint is discontinued due to health considerations. In fact, the largest percentage (up to 95%) of world wide use for titanium is for the production of this white pigment. The pigment has great luster, good endurance, high opacity (it hides whatever is under it, important for paint) and a pure white color. The pigment is also used to provide color for rubber, plastics, textiles, ink, cosmetics, leather, ceramics and paper. Titanium and titanium compounds have found uses in desalination plants, electrical components, glass products, artificial gemstones, jewelry and even as smoke screens. Ilmenite is mined in Australia, Brazil, Russia, Canada, Sri Lanka, Norway, China, South Africa, Thailand, India, Malaysia, Sierra Leone and the United States.

Ilmenite is not the only source of titanium. There are several common to relatively rare titanium minerals such as rutile, sphene, brookite, anatase pyrophanite, osbornite, ecandrewsite, geikielite and perovskite to name a few. There is at least a small percentage of titanium in many many silicate and oxide minerals as titanium is actually quite a common element (9th most abundant in the Earth's crust). Of all of these minerals, only rutile, with a formula of Ti0 competes with ilmenite for dominance in the titanium source department. Even though rutile is the more common mineral and has a higher percentage of titanium in its formula, it is not concentrated in igneous deposits like ilmenite and is therefore less useful as an ore.

However, in sedimentary detrital deposits known as “placers”, both minerals can be concentrated into useable ores. Placers occur when a heavy, resistant mineral is mechanically and gravitationally sorted by natural processes into a recoverable deposit. Placers occur in river bends or behind river obstacles and in ocean shoreline sand deposits where slower water currents allow the heavier minerals to settle. Placer deposits often contain both rutile and ilmenite and there are enough of these deposits around the world to supply us with titanium for decades if not centuries.

Ilmenite is a metallic to submetallic mineral that is generally iron black. At times it can form brightly lustered, intricately faceted crystals or radial clusters arranged in a rosette fashion. Platy hexagonal crystals with rhombohedral faces on the edges can appear very similar to hematite's tabular habits. However hematite has a distinctly different streak. Magnetite is also similar and easily confused with ilmenite, but ilmenite has a different crystal form and is not as strongly magnetic. It is often associated with magnetite and therefore ilmenite is a minor ore of iron as the magnetite and ilmenite are processed for their iron contents. Ilmenite by itself is not a profitable iron ore as the titanium inhibits the smelting process.

Ilmenite, hematite and corundum all have similar structures and belong to a more or less informal group called the ‘Hematite Group’ with a general formula of $A_2O_{3.}$ The structure is composed of alternating layers of cations and oxygens. The cations occupy sites in the layers between the oxygen layers and each are bonded to three oxygens in the above layer and three oxygens in the bottom layer. Not all of the sites available for these cations are occupied as only two out of three are filled. If all the sites were filled, then the formula would be AO in stead of $A_2O_{3.}$

In ilmenite and other members of the I Group, alternating layers of cations are occupied by just titanium ions and the other cation layer are occupied only by iron ions and form an ordered sequence of Ti/O/Fe/O/Ti/O/Fe This effectively lowers the symmetry of ilmenite (which is bar 3 from the other Hematite Group members (which are bar 3/2/rn) The other members are more symmetrical because their A cations are all the same and thus there is no ordering of their stacking sequence. Compare the same symmetry phenomenon that occurs between the Calcitc Group and the Dolomite Group of carbonates.

Ilmenite lends it name to a group of similar, simple, trigonal, titanium oxides called the 'Ilmenite Group' a subgroup of the Hematite Group of minerals. The general formula for the group is $ATiO_3$ where the A can be either iron, magnesium, zinc and/or manganese. The Ilmenite Group members differ from the other members of the Hematite Group in that the structure is more ordered with the titanium and A ions occupying alternating layers between the oxygen layers (see above). The oxygen layers arc hexagonally packed. Each metal ion is bonded to three oxygens in the oxygen layer above and three oxygens in the layer below. All the members, except for ilmenite, are very uncommon to rare.

Rutile and Titanium Oxide:

Titanium Oxide finds its application in Pigments, Ceramics, Chemicals, Papers & Plastics, and Pharmaceuticals. Titanium Sponge, Metals & Alloys are used in Aircraft & Aerospace industries, Chemical Industries, Iron & Steel Industries, Consumer goods, golf clubs, spectacle frame and Immersion heater tubes. Grades are represented as percent TiO_2 from rutile, ilmenite, leucoxene, percent $Zr0_2$ from zircon, and percent rare-earth oxides from monazite. Zircon is correlated with rutile, ilmenite, leucoxene, and monazite. lmenite is correlated with leucoxene and with monazite.

Rutile is titanium dioxide which is naturally occurring in Australia, Siera Leone, USA, India and South Africa. Ti02 is one of three distinct titanium dioxide polymorphs. Rutile is found as an accessory mineral in some altered igneous rocks, and in certain gneisses and schists. In groups of acicular crystals it is frequently seen penetrating quartz as in the "fléches d'amour" from Grisons, Switzerland. Small rutile needles present in gems are responsible for "star" sapphires, "star" rubies and other "star" gems, an optical phenomenon known as asterism.

Synthetic rutile can be produced from naturally occurring ilmenite which is a complex oxide with iron. Rutile is used in the manufacture of titanium dioxide pigment. Rutile (TiO2, Titanium Oxide), is an interesting, varied and important mineral. Rutile is a major ore of titanium, a metal used for high tech alloys because of its light weight, high strength and resistance to corrosion. Rutile is also unwittingly of major importance to the gemstone markets. It also forms its own interesting and beautiful mineral specimens.

Rutile and Synthetic Rutile are used for manufacturing of Welding Electrodes. Rutile has among the highest refractive indices of any known mineral and also exhibits high dispersion. Finely powdered rutile is a brilliant white pigment, and is used in paints, plastics, papers, foods, and other applications that call for a bright white. Titanium dioxide pigment is the single greatest usage of titanium worldwide, as it is not currently economical to extract titanium metal from rutile. Nanoscale particles of rutile are transparent to optical light, but remain highly reflective to UV light and hence are used in sunscreens.

Synthetic rutile was first produced in 1948 and is sold under a variety of names. Synthetic rutile can be made in a variety of colors, but not a pure transparent white, being always slightly yellow. A consequence of the high refractive index is an adamantine lustre that leads to an appearance that makes it seldom used in jewellery. It is not very hard, only about 6 on the Mohs hardness scale. The near colorless diamond substitute is sold under the name Titania.

In Australia most rutile is produced from ilmenite as it naturally occurs in accessible high concentrations and in a form which allows the ready extraction of rutile. These favourable factors have made ilmenite a competitive raw material for Australia's producers reflected in high export activity. Australia supplies about 40 per cent of the world's ilmenite and about 25 per ccnt of its rutilc. Just seven producers around the world control 93 per cent of world production. Rutile in 1999 was worth A$750 per tonne (zircon around $560 per tonne), ilmenite around $120 pcr tonne. World production of titanium dioxide is around 4.5 million tonnes.

Table 8
Titanium: World Production of Mineral Concentrates, by Country[1]

[2](Metric Tons)

Concentrate type and country	1999	2000	2001	2002	2003[e]
Ilmenite and leucoxene:[3, 4]					
Australia:					
Ilmenite	1,976,000	2,146,000	2,017,000	1,917,000	2,010,000
Leucoxene	32,000	27,000	30,000	39,000	57,000
Brazil[5]	96,000	123,000	111,113	174,382 [r]	180,000
China[e]	180,000	250,000 [r]	300,000 [r]	750,000 [r]	800,000
Egypt	130,000	125,000	125,000	125,000 [e]	125,000
India[e]	378,000	380,000	430,000	460,000	500,000
Malaysia	127,695	124,801	129,750	106,046	95,148 [6]
Norway[e]	600,000	750,000	750,000	750,000	800,000
Ukraine	536,542	576,749	650,000	670,000 [e]	670,000
United States	W	400,000 [7]	500,000 [7]	400,000 [7]	500,000 [7]
Vietnam	91,000 [e]	174,000	180,000	180,000 [e]	180,000
Total	4,150,000	5,080,000 [r, 8]	5,220,000 [r, 8]	5,570,000 [r, 8]	5,910,000 [8]
Rutile:[4]					
Australia	179,000	208,000	206,000	218,000	173,000
Brazil[5]	4,300	3,162	1,791	2,645 [r]	2,650
India[e]	16,000	17,000	19,000	18,000	18,000
South Africa[e]	100,000	100,000	90,000	100,000	120,000
Ukraine[e]	49,000	58,600	60,000	70,000	60,000
United States	W	(9)	(9)	(9)	(9)
Total	348,000	387,000	377,000	409,000 [r]	374,000
Titaniferous slag:[10]					
Canada[e]	950,000	950,000	950,000	900,000	875,000
South Africa	1,168,000	1,057,000	1,090,000	1,150,000 [e]	1,100,000
Total	2,120,000	2,010,000	2,040,000	2,050,000	1,980,000

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data; not included in "Total."
[1]Totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
[2]Table includes data available through July 15, 2004.
[3]Ilmenite is also produced in Canada and South Africa, but this output is not included here because most of it is duplicative of output reported under "Titaniferous slag," and the rest is used for purposes other than production of titanium commodities, principally steel furnace flux and heavy aggregate.
[4]Small amounts of titanium minerals were reportedly produced in various countries, including Malawi and Turkey. However, information is inadequate to make reliable estimates of output levels.
[5]Excludes production of unbeneficiated anatase ore.
[6]Reported figure.
[7]Includes rutile to avoid revealing company proprietary data. Rounded to one significant digit.
[8]Includes U.S. production, rounded to one significant digit, of ilmenite, leucoxene, and rutile to avoid disclosing company proprietary data.
[9]Included with ilmenite to avoid disclosing company proprietary data; not included in "Total."
[10]Slag is also produced in Norway, Kazakhstan, and Russia, but this output is not included under "Titaniferous slag" to avoid duplicative reporting.

Source: United States Geological Survey Mineral Resources Program

Zircon:

Zircon has formula: $ZrSiO_4$, Zirconium Silicate and is associated with minerals like albite, biotite, garnets, xenotime and monazite. Zircon is used in ceramic and refractory industries besides acting as a basic raw material for the production of Zirconium metal and alloys for its use as structural materials in nuclear power reactors.

India has demonstrated technical capability to produce energy from nuclear fuel materials. In order to augment the power generation through atomic energy route in the future, search for domestically available nuclear fuel materials is imperative. Some of them like zircon and monazite from the suit of beach sand minerals find typical uses in nuclear power generation and the rest in other industries. As stated earlier, AMD has conducted preliminary investigation along the coastal areas and estimated probable reserve for all these minerals. Besides its use for nuclear fuel cladding, Zircon finds wide industrial application in the Foundries, Refractorics, Ceramics, Glazed Tiles, and White Wares. The Zirconium Mineral production of the world is as follows:

Table 9
Zirconium Mineral Concentrates: World Production, by Country'

(Metric tons)

Country	2000	2001	2002	2003[e]	2004[e]
Australia	374,000	393,000	412,000	462,000 [4]	441,000 [4]
Brazil[5]	29,805	17,031 [r]	29,342 [r]	26,059 [r, 4]	26,000
China[e]	15,000	15,000	15,000	15,000	17,000
India[e]	19,000	19,000	19,000	20,000	20,000
Indonesia[e]	250	250	250	250	200
Malaysia	3,642	3,768	5,293	3,456 [r, 4]	3,500
Russia[e, 6]	6,500	6,500	6,500	6,500	6,500
South Africa[e, 7]	253,000 [4]	262,000	274,000	280,000 [r]	300,000
Thailand	--	100	--	--	--
Ukraine[e]	30,000	33,600	34,300	35,000	35,000
United States	W	W	W	W	W
Total[8]	731,000	750,000 [r]	796,000 [r]	848,000 [r]	849,000

[e]Estimated. [r]Revised. W Withheld to avoid disclosing company proprietary data; not included in total. -- Zero.
[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes data available through May 9, 2005.
[3]Malawi was also reported to produce zirconium concentrates but information is not sufficient to estimate output.
[4]Reported figure.
[5]Includes production of baddeleyite-caldasite.
[6]Production of baddeleyite concentrate averaging 98% ZrO_2.
[7]Includes production of byproduct zircon from titanium sands mining and, until 2002, 15,000 to 20,000 metric tons per year of baddeleyite from Palabora Mining Co. Ltd.
[8]Does not include U.S. data which have been withheld to avoid disclosing company proprietary data.

Monazite:

Monazite is a primary ore of several rare earth metals most notably thorium, cerium and lanthanum.

All these metals have various industrial uses and are considered quite valuable. The mineral 'monazite' is radio active as it contains thorium and uranium and requires special measures for production and storage for exclusive use by the Dept. of Atomic Energy (DAE). The percentage of Monazite in beach minerals varies from 0.1% to 2% with isolated patches up to 10%. Background radiation level in the areas where monazite is present is high, such as in the beach sands of Kerala. Radiological hazards increase after the separation process.

Monazite specimens are often metamict. This is a condition found in radioactive minerals and results from the destructive effects of its own radiation on its crystal lattice. The effect can destroy a crystal lattice completely while leaving the outward appearance of the crystal unchanged. Increased metamictation will increase the perfection of the specimens conchoidal fracture. The radioactivity of monazitc has been used as an aid in radioactive dating.

Monazite has the formula (Ce, La, Th, Nd, Y)P04, Cerium Lanthanum Thorium Neodymium Yttrium Phosphate Technically, Monazite consists of three different minerals but because of a lack of significant difference between them they arc referred to as one mineral, monazite. The three monazites have differences in the percentages of their chemical makeup and these differences are reflected in their respective names.

Monazite is also a primary source of Thorium which might be used as nuclear fuel material, as a replacement for uranium in India's 3rd stage (fast breeder) of Nuclear Power Generation Programme.

India is second largest country with thorium reserves of about 290,000 tonnes. The world reserves of thorium are as follows:

World thorium resources (economically extractable):

Country	Reserves (tonnes)
Australia	300 000
India	290 000
Norway	170 000
USA	160 000
Canada	100 000
South Africa	35 000
Brazil	16 000
Other countries	95 000
World total	1 200 000

Source: US Geological Survey, Mineral Commodity Summaries, January 1999

NAME:	FORMULA:
MONAZITE-(Ce)	**(Ce, La, Nd, Th, Y)PO4**
MONAZITE-(La)	**(La, Ce, Nd)PO4**
MONAZITE-(Nd)	**(Nd, La, Ce)PO4**

The differences in the formula represent the greater percentages of certain elements in the mineral. The first element listed in the parenthesis is the element with the greater percentage in the mineral; so that monazite-(La) is greatly enriched in lanthanum, etc. Monazite-(Ce) is not only enriched in cerium it is also by far the most common of the three and is probably the actual mineral when one encounters a specimen that is simply labeled monazite. The general formula represents an aggregate formula for monazite. Silica or SiO4, will often be present in monazite replacing a small percentage of the phosphate groups, but this is not typically shown in monazite's formula. Uranium is also a trace element in some specimens.

The name monazite comes from a Greek word, monazein, which means "to be alone". It is an apt name as it is an allusion to the typical crystal habit of primary origin for monazite as isolated individual crystals in phosphatic pegmatites. Solitary crystals all alone in a dissimilar crystalline matrix. The name does seem to fit.

Monazite, as already mentioned, forms in phosphatic pegmatites but is actually a standard trace constituent in many ordinary igneous, metamorphic and vein filling rocks. If not too metamict, crystals of monazite are rather durable. They can be weathered out from their host rocks and carried downstream great distances and collect in river deposits and even in ocean beach deposits. Their great density (specific gravity is 4.6 - 5.7) makes it easy for the crystals to be collected into what are called placer deposits.

Placers, as they are informally called, are deposits where heavier objects settle while lighter objects such as sand are constantly removed by the force of water. This process naturally concentrates some pretty valuable stuff Ores such as rutile and monazite, metals such as gold and platinum and gemstones such as diamonds, rubies, sapphires and spinels, to name a few, are all found in placers. Some monazite beach placers in India alone are so rich that they could supply the entire worlds need for monazite for many years to come.

Crystals of monazite are generally simple equant to prismatic crystals that show their monoclinic symmetry without any pretense. **Twinning** is common and produces crosses and angled reentrant crystals. Specimens of monazite are sought after for their unique chemistry, nice monoclinic form and some specimens are actually quite attractive. Remember, this is a radioactive mineral and should be stored away from other minerals that are subject to damage from radioactivity, and of course human exposure should be limited.

Table 10
Monazite Concentrate: Estimated World Production, By Country[1]

(Metric tons, gross weight)

Country[3]	2000	2001	2002	2003	2004
Brazil	200	200	200	200	200
India	5,000	5,000	5,000	5,000	5,000
Malaysia	818[4]	643[4]	441[r, 4]	795[r, 4]	500
Total	6,020	5,840	5,640[r]	6,000[r]	5,700

[r]Revised.

The reserve base may perhaps be more as whole area of the country covered under the beach sand is not yet fully explored. Also desert sand in the country has not yet been considered as potential source for the heavy minerals.

Garnet:

Garnet is used as Abrasives and in Water filtration, Water jet cutting, Blasting media, Anti-skid agent for road surface for road & air-strips, in preparation of Artificial Granite tiles (Garnet tiles) and Decorative Wall plaster.

Garnet, the January birthstone, derived its name from the Latin word granatus, meaning like a grain, which refers to the mode of occurrence wherein crystals resemble grains or seeds embedded in the matrix. Garnet is a family of minerals having similar physical and crystalline properties. They all have the same general chemical formula, $\mathbf{A_3B_2\ (SiO_4)_3}$ where A can be calcium, magnesium, ferrous iron, or manganese, and B can be aluminum, ferric iron, or chromium, or in rare instances, titanium.

The formulas and names of common garnet species are:

Uvarovite	:	$Ca_3Cr_2Si_3O_{12}$
Pyrope:	:	$Mg_3Al_2Si_3O_{12}$
Crossularite	:	$Ca_3Al_2Si_3O_{12}$ Cs
Almandite	:	$Fe_3Al_2Si_3O_{12}$
Andradite	:	$Ca_3Al_2Si_3O_{12}$
Spessarilte	:	$Mn_3Al_2Si_3O_{12}$

Some rare species of garnet are known that illustrate the Wide range of substitution that the garnet crystal structure can accommodate. They include:

Hydro grossular	:	$Ca_3Al_2(SiO_4)_{3-x}\,(OH)_4$
Henritermierlte	:	$Ca_3(Mn,Al)(SiO_4)_2\,(OH)_4$
Gotdmanite	:	$Ca_3V_2Si_3O_{12}$
Kimzeyite	:	$Ca_3(Zr,Ti)_2(Al,Si)_3O_{12}$
Knorringite	:	$Mg_3Cr_2Si_3O_{12}$
Majorite	:	$Mg3(Fe,Al,Si)_2Si_3O_{12}$
Schorlomite	:	$Ca_3(Fe,Ti)_2[(Si,Ti)O_4\,]_3$
Yamaloite	:	$Mn_3V_2Si_3O_{12}$

There has been massive increase in world consumption of industrial garnet (over 80%) since 1994/95 to 1999, when world production of industrial garnet was estimated to be 335,000t Demand for industrial garnet has been growing worldwide at the rate of 3-5% per year. Abrasives, blast cleaning and waterjet cutting arc the markets that show the most growth.

United States has been a leading producer in the Nineties, but in recent years Australia, China, and India too have started production of garnet. It is estimated that Australia produces at least 35,000 to 40,000 tones of industrial garnet.

At present however, world production exceeds demand. There is general oversupply, with increased producer stocks being reported in the USA. Significant stocks of industrial garnet are also thought to be held in India and Australia.

Given the present excess production capacity in the marketplace, and possible future expansions, it is envisaged that overall prices for industrial garnet will decrease at a rate of 3-5% per year until supply and demand come into balance. The key trends, issues and developments in the market are analysed in a major new report from Roskill. It provides a clear insight into all areas of the industry and an authoritative analysis of the prospects for the future.
The global markets for industrial garnet may however grow in the coming years. Specifically, world markets for garnet blasting media and waterjet cutting conceivably could more than double by the year 2010 if economic conditions permit. New production facilities are being currently planned worldwide to meet anticipated demand. India has therefore scope for investment in the area of industrial garnet production.

The state of Orissa is considered one of the major sources of gemstones in India, producing a variety of gemstones, including ruby, sapphire, aquamarine, heliodor, garnet, cat's-eye chrysoberyl, topaz, zircon, iolite, and tourmaline. Most of these gemstones range in quality, though the garnet is exceptionally flawless.

Several gemstones are mined in the state of Rajasthan, including amethyst, aquamarine, emerald, feldspar, fluorite, and garnet. Some deposits have produced good-quality stones in the past few years, especially fluorite from the Dungarpur area.

The state of Andhra Pradesh is also becoming well known for its gem deposits. Good-quality stones of alexandrite, garnet, ruby, and tourmaline, for example, have been found here.

Alexandrite has also been found in Araku, Narsipattanm, and Vishakhapatnam, but most of the gemstones lack the dramatic color change of Russian alexandrite.

Sillimanite :

The anhydrous polymorphus aluminium silicate, such as, sillimanite, andalusite and kyanite are mainly used in refractories because of their ability to form mullite phase at high temperatures.

This phase offers a high hot strength, low co-efficient of expansion and resistance to chemical and physical erosion. Sillimanite refractory bricks are extensively used in steel & glass industries and also in ceramics, cement kilns, heat treatment furnaces and petrochemical industries.

The world production of sillimanite is about half a Million Tonnes per annum and is mainly accounted by South Africa, USA, India, France, Spain & Brazil. In India, the requirement of sillimanite is met mainly from it's rock deposits, With rapid decline in this source (M/s. Bharat Refractories Ltd at Khasi district of Meghalaya and Maharashtra State Mining Corporation in Bhandara District) Sillimanite from beach sand placers is in demand.

IRE is the major producer of sillimanite from beach sand deposits. The company produces around 15,000 tons/annum from it's units at Chavara and Chatrapur. The production of Sillimanite is slated for massive increase in the coming years as the demand for this mineral is growing both in the domestic and export markets. Reported reduction in the availability of Andalusite and Kyanite will spur the demand for sillimanite if it can be produced economically, agglomerated to the required sizes and marketed in acceptable forms. The finer grain size of beach sand sillimanite is the major reason for the slow acceptability by the user refractory industries, but then the titanium dioxide impurity in beach sand sillimanite is around 0.2 to 0.5% which is much lower than the impurity in rock sillimanite.

In India, sillimanite is mainly used in the production of high alumina refractories and the refractory manufacturers generally prefer rock sillimanite as raw material but due to gradual decrease in the availability of such material, the acceptability of beach sand sillimanite is increasing.

Recently, the Central Glass and Ceramic Research Institute (CGCRI) Calcutta has developed chemically and ceramically bonded processes to utilise the beach sand sillimanite for making high performance refractories. The above patented processes have been commercialised successfully and some entrepreneurs have started producing refractories for Iron & Steel and

Cement industries. CGCRI has also developed the process for agglomeration and sintering of beach sand sillimanite and it is expected that the sintered aggregates will have better acceptability of the refractory industries.

9.3 Exploration of Beach Sand Minerals

Surveys, prospecting and exploration of uranium, thorium, rare metals and rare earths, titanium and zirconium mineral resources are done by the Atomic Minerals Directorate for Exploration and Research (AMD).The exploratory efforts of AMD have led to the opening of uranium mines at Jaduguda, Bhatin and Narwapahar in Singhbhum (East), .Jharkhand, These mines have been meeting the needs of the Indian Nuclear Power Programme. One of the major successes of the Directorate in the recent years is the discovery of Domiasiat uranium deposit in Meghalaya.

Investigations made by AMD along the coastal areas has brought up the inventory of probable reserve of all these minerals along Indian coastal areas. As per AMD), 348 million tons (MT) of ilmenite, 18 MT of rutile, 21 MT of zircon, 8 MT of monazite, 107 MT of garnet and 130 MI of illuminate are available for exploitation and likely to increase if further areas are explored.

Mining and processing of uranium ores and mineral sands are carried out by the Public Sector Undertakings, namely (a) Uranium Corporation of India Ltd. (UCIL) and (b) Indian Rare Earths Ltd. (IRE), respectively.

9.4 Exploitation of Minerals Beach Sands

Indian Rare Earths Limited (IREL), a Govt. of India Undertaking under the administrative control of DAE, Govt. of India is operating three mines and mineral separation plants in the State of Orissa, Kerala and Tamil Nadu for the past five decades and in the State of Orissa for two decades. Similarly, the only other agency authorized by DAE is Kerala Mines & Metals Ltd. (KMML), a State Govt. Undertaking for mining & mineral separation during the past several decades in Kerala State. Brief accounts of beach mineral sand industry in Kerala and Tamil Nadu, and an account of the industrial operations of IREL are given below:

Kerala:

Kerala has 570 km long coastline. The coast sand dunes of Kerala are enriched with six prescribed minerals viz. ilmenite, rutile, zircon, monazite, leucoxene (brown ilmenite), sillimanite and garnet. The most potential source of these mineral deposits is the coastline of the districts of Kollam and Alappuzha that stretches about 150 km. Mining in the Kollam coast started in 1922 and still continues. The state government has decided to lease out a 17-km stretch of state owned land from Valiyazhikkal to Thottappilly in Alappuzha district to Kerala Rare Earths and Minerals Limited (KREML), a joint sector company, a joint venture company, in which a Kochi-based private sector company holds majority stake to conduct mineral sand mining for twenty years.

The Atomic Minerals Directorate for Exploration and Research under the Department of Atomic Energy, Government of India has carried out detailed exploration in the coastal areas of Kollam and Alappuzha Districts of the State and found that the mineral sand that occurs between Neendakara and Kayamkulam Bar (Chavara barrier beach and the eastern extension) over a length of 22 KM with a width of 225 meters is one of the best of its kind in the world, because of the high Titanium Dioxide content in the mineral Ilmenite. The reserve of Total Heavy Mineral

(THM) in Chavara barrier beach is 127 million tons with Ilmenite content of 80 million tons from the total reserve of raw sand of the order of 1400 million tons. In the Northern portion beyond Kayamkulam pozhi extending up to Thottappalli in Alappuzha District, the reserve of THM estimated is of the order of 17 million tons with Ilmenite content of 9 million tons from the raw sand reserve of 242 million tons. Out of this area, the Chavara barrier beach is divided into 8 blocks and is numbered I to VIII for separating Ilmenite for Titanium Dioxide manufacturing. These blocks are apportioned between Kerala Minerals and Metals Ltd. (KMML), a State Government Undertaking and Indian Rare Earths Ltd. (IREL), a Government of India Enterprise under Department ol Atomic Energy.

<u>*Government of Kerala's policy*</u> could be briefly summarized as follows*:*

(i) Mining leases will not be granted solely for the purpose of mining only.
(ii) Mining leases will be granted only to those factories in the State in the joint sector which produce value added products.
(iii) Proposals for establishing such factories as mentioned above shall be examined first by the Kerala State Industrial Development Corporation before placing it before the Council of Ministers for consideration.
(iv) A study will be conducted by the Department of Mining and Geology and the Centre for Earth Science Studies jointly as to the quantum of mineral sand which could be mined in the area, and a report given to the Government.
(v) A notification under the relevant statute will be issued prohibiting all future uses of lands bearing the mineral sand, for other purposes.
(vi) Action will be taken to request Govt. of India for increasing the present royalty of Mineral sand.
(vii) The eight blocks in the Chavara Barrier Beach area, at present earmarked for Kerala Minerals & Metals Limited and the Indian Rare Earths will not be leased out to any other applicants.
(viii) Fresh Mining Leases for new applicants for mining mineral sands will be issued for the area from Kayamkulam pozhi to northward up to Alappuzha only.

Tamil Nadu :

The coastal districts of Kanyakumari, Tirunelveli, Thoothukkudi, Ramanathapuram and Nagapattinam are endowed with high quality heavy mineral placers such as Garnet, Ilmenite, Rutile, Leucoxene, Monazite and Zircon. They have wide use in pigment, refractory, ceramic industries and Nuclear Industry.

The Estimated reserves are about 23 million tonnes of Garnet, 98 million tonnes of Ilmenite, 5 million tonnes of Rutile, 2 million tonnes of Monazite and 8 million tonnes of Zircon. The major players are the Indian Rare Earths (IRE), a Government of India Undertaking, V.V. Minerals, Beach Mineral Company, Transworld Garnet and Indian Ocean Garnet Sand.

Tata Iron and Steel Company (TISCO) have entered into MoU with Government of Tamil Nadu in June 2002 for establishing a Titannium-di-Oxide (Ti02) plant with a project outlay of Rs. 2,000 crores. They have commenced their prospecting operations.

Indian Rare Earth Limited (IREL):

IREL has four Production Plants viz. Minerals Division at Chavara, Manavalakurichi, OSCOM and Rare Earths Division at Aluva. Major Activities of IRE Ltd are mining and separation of heavy minerals like, ilmenite, rutile, zircon, sillimanite, garnet and monazite from beach sands. It is also engaged in chemical processing of Monazite to yield Thorium compounds, Rare Earth Chlorides and Tri-Sodium Phosphate. These products find use in manufacture of white pigments, welding electrodes, foundries, ceramics, refractories, abrasives for polishing glass, TV tubes and in sand blasting etc.

(A) Chavara Mineral Division :

The plant operates on a mining area containing as high as 40% heavy minerals and extending over a length of 23 Km in the belt of Neendakara and Kayamkulam. The deposit is quite rich with respect to ilmenite, rutile and zircon and the mineral-ilmenite happens to be of weathered variety analyzing 60% Ti02. The present annual production capacity of Chayara unit engaged in dry as well as wet (dredging up-gradation) mining and mineral separation stands at l,54,000t of ilmenite, 9,000t of rutile, 14,000t of zircon and 7,000t of sillimanite. In addition, the plant has facilities for annual production of ground zircon called zirflor (-45 micron) and microzir (1-3 micron) of the order of 6,000t and 500t respectively.

(B) ManavalaKuruchi (MK) Mineral Division :

MK plant annually produces about 90,000t ilmenite of 55%. TiO_2 grade, 3,500t rutile and 10,000t zircon in addition to 3000t monazite and 10,000t garnet based primarily on beach washings supplied by fishermen of surrounding five villages. IREL has also mining lease of mineral rich areas wherein raw sand can be made available in large quantities through dredging operation. In addition to mining and minerals separation, the unit has a chemical plant to add value to zircon in the form of zircon frit and other zirconium based chemicals in limited quantities.

(C) Orissa Sands Complex (Oscom):

OSCOM is engaged to exploit the huge placer deposit across a mining are of 40 sq.km. to produce 2,20,000 ton of 50% grade ilmenite and associated minerals like rutile, zircon, sillimanite, garnet, etc. The facility was quite unique in the sense that for the first time IREL ventured into dredging and concentration operation and setting up a value addition plant at OSCOM to convert all the ilmenite to 1,00,000 ton per annum of 92% grade synthetic rutile (SR) based on Benelite technology. The process essentially consisted of reduction roasting of ilmenite in the presence of carbon to convert ferric oxide to ferrous oxide followed by leaching with 30% HCl at 130^0C to separate iron as soluble ferrous chloride. The leached mineral is calcined to yield SR and the acidic leach liquor is treated in an acid regeneration plant to recover HCl for recycle and generate iron oxide as waste. The SR plant ran for about a decade before closing down as the plant could never be operated anywhere near its name plate capacity. Leaving aside SRP, rest of OSCOM is quite efficiently engaged in recent time in dredging of the raw sand, its upgradation, drying and finally separation of individual minerals through a dry mill. Ilmenite is primarily exported to customers engaged in production of slag and sulphatable TiO_2 pigment.

(D) Rare Earths Division (RED) Aluva

This Plant, with a capacity process 1400t of monazite every year, was gradually expanded to treat about 3600t of monazite/year. Elaborate solvent extraction and ion exchange facilities were built up to produce individual R.E. oxides, like oxides of Ce, Nd, Pr and La in adequate purities. All these years, RED built up large stocks of impure thorium hydroxide upgrade associated with rare earths and unreacted materials. Henceforth, RED proposes to treat this hydroxide upgrade (rather than fresh monazite) to convert thorium into pure oxalate and rare earth as two major fractions namely Ce oxide and Ce oxide free rare earth chloride.

9.5 Policy Issues

Industrial Policy Resolution of 1956 had listed ‘Atomic Energy’ and ‘Minerals specified in the Schedule to the Atomic Energy (Control of Production & Use) Order 1953’ in the Schedule A - areas to be exclusive responsibility of the State. Industrial Policy Statement of 1991 reserved these minerals for the public sector.

Immediately after the constitution of the Atomic Energy Commission in 1958, there was a ban on export of Monazite. Also the production, distribution, use and export of minerals like ilmenite, rutile, zircon, which were notified as prescribed substances, were subjected to regulations of Atomic Energy (Control of Production & Use) Order 1953 & (Control of Export) Order 1953 issued under the Atomic Energy Act 1953. Ilmenite, Rutite, Leucoxene, Zircon, and Monazite have been notified as Prescribed Substances under the Atomiø Energy Act, 1962. Also it would require licence for production of these prescribed substances under Atomic Energy (Working of Mines, Minerals and Handling of Prescribed Substances) Rules, 1984. Proposals for grant of mining lease (ML) in respect of ‘Atomic Minerals’ listed in Part ‘B’ to the First Schedule of the Mines and Minerals (Development & Regulations) Act, 1957 are referred to the Department of Atomic Energy through Ministry of Mines for approval under Section 5(1) of the Act. Grant of mining lease is subject to clearance from DAE which is communicated through the MoM to the State Govt. ML proposals & licenses are granted after consulting AMD & Atomic Energy Regulatory Board (AERB). The List of the 12 Prescribed Substances is as follows:

1. **Uranium**, its compounds and minerals/ores/concentrates containing uranium including tailings containing uranium
2. **Thorium**, its compounds and minerals/concentrates containing thorium including monazite
3. **Zirconium**, its alloys and compounds and minerals/concentrates including zircon
4. **Beryllium,** its compounds and its minerals/concentrates including Beryl but excluding Beryllium windows used for medical x-rays machines and gamma ray machines.
5. **Lithium**, its compounds and minerals/concentrates including Lepidolite.
6. **Deuterium** and its compounds
7. **Plutonium** and its compounds
8. **Neptunium** and its compounds
9. **Columbite and Tantalite**
10. **Titanium** ores and concentrates (limenite, Rutile and Leucoxene)
11. Nuclear grade **graphite**
12. **Tritium** and its compounds

Out of the above 12 prescribed groups, Sl. Nos 1,2,3 and 10 fall under these Notes on beach sand minerals. With the policy of selective liberalisation in the area of exploitation of beach sand minerals, some Indian as well as Foreign Companies have shown interest and proposals have been received from time to time for setting up Units to produce these minerals and undertake value addition too. The facts are that (a) there are large reserves of these minerals in the country, (b) production to reserve ratio is very low, (c) there is need to get latest technology for value addition of minerals within the country, (d) and the sector is inherently capable of attracting large scale investments-both domestic and foreign. Realisation of these potentials necessitated progressive liberalisation of the beach mineral sector.

Towards this end, DAE in their Sept.1998 policy notification on the subject, categorized the activities for approval of private investment as follows:

(i) Mining and mineral separation,
(ii) Value addition per se to the products of (i) and
(iii) Integrated activities comprising both (i) and (ii).

Participation of wholly Indian owned companies was permitted in all the three categories of activities, with or without joint venture with Central or State Govt. concerned or any existing/new Central/State PSUs.

Foreign Direct Investment (FDI), particularly with more advanced/latest technology vis-ã-vis those prevailing within the country, both in pure value addition projects & integrated projects being the need of the hour, DAE permitted foreign equity participation up to 74% in both pure value addition and integrated projects, provided value addition is maximum vis-ã-vis international standards.

Further for pure value addition projects as well as integrated projects with value addition upto any intermediate stage, foreign equity participation is permitted up to 74% through JV with Central/State PSUs with 26% equity participation.

In the latest decisions on the above subject, DAE in consultation with Ministry of Mines, Concerned State Govt.s and other Stake Holders, has notified that :

(a) Ilmenite, Rutile, Leucoxene and Zircon will be removed from the list of Prescribed Substances,
(b) Ilmenite, Rutile and Leucoxene will also be shifted from the list of Atomic Minerals appearing in Part ‘B’ of the First Schedule of the MM(D&R) Act,
(c) Zircon will continue to remain as an Atomic Mineral in Part ‘B’ of the First Schedule of the MM(D&R) Act, 1957 (but will be removed from the list of Prescribed Substances),
(e) Monazite will however continue to remain both as Prescribed Substance as well as an Atomic Mineral,

Accordingly, DAE has requested Ministry of Mines to initiate action to amend the MM (D&R) Act to give effect to above decisions, and also to review the Beach Sand Mineral Policy and issue fresh notifications to regulate the development of beach minerals to bring it in conformity with the National Mineral Policy for similar minerals. The Govt. is presently addressing the related policy issues through the Hoda Committee, appointed for the purpose.

9.6 Recommendations

1. Though there are 30 ***rare earth elements*** comprising of naturally occurring 15 elements of Lanthanide Series and a couple of actinides, India’s exploitation of rare earths is confined to Monazite based Lanthanides and the actinides Thorium and Uranium. That means there is still scope for exploration for ores like Zenotime, Bastnesite etc, containing naturally occurring rare earth elements.

2. India's share in the world production of rare earth is estimated to be 2.6%. If India rare earth industry has to improve its share, policy changes for creating enabling environment is obvious. Evolving and using "doing business indicators" in rare earth area could be useful for this purpose.
3. India has a long coastline of over 7,000 kms of coastline, only part of which (2546 kms) has been covered by exploration for beach sand minerals. There is thus an urgent need to systematically take up more exploration and detailed survey work during the XI Plan period and thereafter, in the remaining beach lengths, which hold promise.
4. Policy on Exploitation of Beach Sand Minerals (Resolution of 6.10.1998) had its objectives to encourage exploitation of the minerals through a judicious mix of public and private sector participation (including foreign investment); to maximize value addition within the country; to up-grade the existing process technologies to international standards; to attract investments from within the country and overseas. The recent delisting of several atomic minerals and placing them with other major minerals, should further facilitate faster development of the beach mineral sector. For this purpose, the Ministry of Mines should speedily enact the new liberalized dispensation keeping in mind (a) dispersal of production facilities with an eye on regional balance; (b) regulating the rate of exploitation of reserves to ensure sustainability over long periods and (c) taking care of investors' techno-economic considerations.
5. A number of suggestions have been received by MOM from the Stake Holders for consideration while the new framework is firmed up. These deserve to be considered. The Hoda Committee is also addressing all vital issues to resolve existing bottlenecks. Some of the concerns are as follows :
   a) With the deletion of Ilmenite, Rutile and Leucoxene from the list of Prescribed Substances under the Atomic Energy Act, 1962, these minerals may have to be shifted from Part 'B' of the First Schedule of the Mines & Minerals (Development & Regulation) Act, 1957 [MM(DR) Act]. Its new grouping will have to be determined and responsibilities of the State Governments and control by the nodal Ministry, MoM at the Centre will have to stipulated appropriately.
   b) Monazite continues to be Atomic Mineral as well as 'Prescribed Substance' and Zircon also would continue as an Atomic Mineral. Both these being part of Indian beach mineral suits, doubts would arise as to the nodal agency (IBM and or AMD) for dealing with Mine Plans, MOM and or DAE for approval of Mining Leases etc. Multiple control by different regulatory agencies at the State and Central Govt. levels leads to confusion and delays. This has to be minimized. Unified Windows for clearances and permissions may have to be put in position.
   c) With the removal of Ilmenite, Rutile and Leucoxene from the category of Atomic Minerals, applicability of Rule 66 A of Mineral Concession Rules (MCR) 1960 needs to be reviewed, i.e. it should not be applicable to these minerals. As a consequence, any requirements to obtain a licence from Atomic Energy Regulatory Board (AERB) to deal with Ilmenite tailings should be done away with and there should be only guidelines for handling / storage / disposal (including for landfill or other similar purposes).
   d) Procedural requirement to obtain licence from DGFT for export of Ilmenite needs recosnsideration.
   e) While value addition to the extent possible has to be encouraged, and incentivised, more investor friendly approach is called for. This could be in the form of permitting phased commitments for down stream value addition within the country or apportioning total revenue generation between indigenous and overseas sales.
   f) Mandatory JVs with PSU participation, ceilings on equity holdings by foreign share holders may be revisited and liberalized. Clarity and consistency of policies are conducive of attracting Foreign Direct Investment (FDI), which are needed to modernize and induct the state of art technologies.

g) Problems of land acquisition, delays in statutory clearances and facilitation of State regulated infrastructure may also be attended to.

Appendix-I

No. I&M-3 (24)/2006
Planning Commission
(Minerals & TRP Unit)

Yojana Bhavan, Sansad Marg,
New Delhi, 6th March, 2006

ORDER

Subject: Setting of Working Group on Mineral Exploration and Development (other than coal and lignite) for Eleventh Five Year Plan (2007-2012)

It has been decided to constitute a Working Group on Mineral Exploration and Development (other than coal and lignite) for the Eleventh Five Year Plan (2007-2012).

2. The Composition and Terms of Reference of the Working Group would be as follows :

Composition

1.	Secretary, Ministry of Mines, Shastri Bhavan, New Delhi	Chairman
2.	JS & FA, Ministry of Mines, Shastri Bhavan, New Delhi	Member
3.	Joint Secretary, Ministry of Steel, Udyog Bhavan, New Delhi	Member
4.	Joint Secretary, Deptt. of Revenue, Ministry of Finance, North Block, New Delhi	Member
5.	Joint Secretary, Deptt. of Expenditure, Ministry of Finance, North Block, New Delhi	Member
6.	Joint Secretary, Ministry of Commerce, New Delhi	Member
7.	Representative of National Disaster Management Division, Ministry of Home Affairs, New Delhi	
8.	Representative of Ministry of Environment & Forests, New Delhi	Member
9.	Representative of Railway Board, Ministry of Railways, New Delhi	Member
10.	Adviser (Minerals), Planning Commission, New Delhi	Member
11.	Principal Secretary, Industry & Mines, Govt. of Chhatisgarh, Raipur	Member
12.	Secretary, Ministry of Mining & Geology, Government of Jharkhand, Ranchi	Member
13.	Secretary, Deptt. of Mining & Geology, Govt. of Rajasthan, Jaipur	Member
14.	Secretary, Ministry of Mining & Geology, Govt. of Karnataka, Bangalore	Member
15.	Secretary, Ministry of Mining & Geology , Govt. of Andhra Pradesh, Hyderabad	Member
16.	Principal Secretary, Ministry of Steel & Mines, Govt. of Orissa, Bhubaneswar	Member
17.	Director (Research), Association of Indian Universities, New Delhi	Member
18.	Director General, Geological Survey of India, Kolkata	Member
19.	Controller General, Indian Bureau of Mines, Nagpur	Member
20.	Chairman-cum-Managing Director, Mineral Exploration Corporation	Member

	Ltd., Nagpur	
21.	Director, Atomic Minerals Division, Deptt. of Atomic Energy, Mumbai	Member
22.	Representative of Defence Metallurgical Research Laboratory, New Delhi	Member
23.	Chairman-cum-Managing Director, National Mineral Development Corporation Ltd., Hyderabad	Member
24.	Representative of National Geophysical Research Institute, Hyderabad	Member
25.	Adviser, Department of Ocean Development, New Delhi	Member
26.	Director, Indian Lead-Zinc Information Centre, New Delhi	Member
27.	Chief Technical Manager, India Copper Development Centre, Kolkata	Member
28.	Secretary General, Aluminium Association of India, Bangalore	Member
29.	Secretary General, Federation of Indian Mineral Industry, New Delhi	Member
30.	Representative of Confederation of Indian Industries, New Delhi	Member
31.	Shri P.N. Shali, Management Consultant, Met Trade India Ltd., New Delhi	Member
32.	Director (Technical), Ministry of Mines, New Delhi	Member-Secretary

3. **Terms of Reference**

I. To review the present status of Indian mining industry (excluding fuel minerals) and mineral based industries in India and to assess its international competitiveness.

II. To assess the reserves and resources of all ores/minerals (excluding fuel minerals) as per UNFC guidelines.

III. To review the mineral inventory for identifying gap areas and to suggest corrective measures and to asses the balance life of mineral inventory based on current consumption level of various ores/minerals and evolving a strategy for development and conservation in perspective of 10 to 15 years.

IV. To assess demand for ores/minerals and its likely growth during 11th plan period and in perspective of 15 years accounting for the GDP growth rate of 8%. Also to workout scenario at 9%, 10% and 7% per annum GDP growth rate.

V. To assess demand of ores/minerals with respect to domestic & international markets and assessment of potential of ores/minerals in terms of export as raw material or as value added products.

VI. To draw up an exploration strategy for regional and detailed exploration of ores/minerals keeping in view the national priorities, demand (domestic & global), consumption and availability of resources.

VII. To identify technological gaps in mineral exploration and suggest measures for filling up the gaps and also to suggest measures for making it competitive globally.

VIII. To examine the present tax and tariff structure of the mining industry and to suggest internationally comparable tax regime for ores/minerals.

IX. To review the present role of various State institutions like GSI, IBM, and Sate Directorates of Geology & Mining etc. and suggest changes and modifications in their role so that these institutions can become very effective in facilitating growth of the internationally competitive mining industry in India.

X. To review the present indigenous R&D set up in mining sector and to suggest strategy for exploiting and beneficiating lean grade ores. Measures for adopting state of the art technology in production and beneficiation etc.

XI. To indentify minerals required for production of high purity materials for use in electronics and other newly emerging technologies and review the present status of mineral inventory of these minerals and suggest exploration strategy for augmenting the inventory during XI plan period in the perspective.

XII. To suggest what promotional role both the Central and State Governments should play in the present policy dispensation of mineral exploration particularly for those minerals in which the present resource base is poor and for the development of which private sector may be reluctant to invest.

XIII. To review the availability and requirement of human resource in mining sector during the XI plan period and in perspective of 10 to 15 years and to suggest measures for capacity building by training and development of infrastructure. To also suggest strategy for modernization, updating of curriculum and technology.

XIV. To assess year-wise requirement of infrastructure such as power, water, communications, roads, ports and railways both physical and financial for the mining sector during the XI plan period and in perspective of 10 to 15 years thereafter. To suggest measures to fill up the existing gaps and building up of additional infrastructure. To define the roles of the Central Government, the State Governments and the private sector in creating such infrastructure.

XV. To assess constraints and problems encountered in exploration and exploitation of mineral resources in tribal, forest areas and to suggest measures in harmonizing mineral development with environment & forest tribal policy and laws and to suggest changes, if any.

XVI. To assess and indicate investment including FDI that would be required to be made during the XI plan period and in the perspective of 10 to 15 years thereafter in exploration, opening up new mines, setting up mineral based units, deposit/mine-specific infrastructure and in related units.

XVII. To assess and indicate investment that would be required to be made by the Central and State Governments for promotional exploration, if deemed necessary to be carried out as a matter of national policy.

XVIII. To assess possibility of zonation of mineral resource bearing areas as `mineral belts' for speedy exploitation of proven & economically viable mineral deposits.

XIX. To examine the impact of the Supreme Court verdict in the T.N. Godavarman Thirumulpad case, on assessment of Net Present Value (NPV) payable for use of forest areas for non-forest purpose, including exploration and mining activities, and to suggest measures for safeguarding the interests of the small miners.

XX. To assess the magnitude of rehabilitation and reclamation needed for abandoned or closed mines before the concept of mine closure plan and financial assurance came into being and to suggest appropriate plans for reclamation & rehabilitation for such mines to give eco-friendly image to mining industry.

XXI. To examine the impact that the Samatha Judgement would have on the present mines and mineral-based industries located in the Fifth Schedule areas of the country, if the judgment is implemented and to suggest measures that need to be taken to avert the situation and at the same time safe guarding interests of the tribals in these areas of the country.

XXII. To examine and assess the socio-economic impact of mining on the life of local inhabitants and to suggest ways and means for improving their living standard.

XXIII. To examine and suggest the role of educational/research institutes in minerals development in the country.

XXIV. To make such other recommendations as may be considered appropriate.

4. The Chairman of the Working Group may co-opt other officials or non-officials as Members, if considered necessary.

5. The expenditure on TA/DA of official members in connection for attending meetings of the Working Group will be borne by the respective parent Department/Ministry to which they belong as per the rules applicable to them. Non-official members of the Group will be paid TA/DA by the Planning Commission as per SR 190(a) as admissible to Grade-I officers of the Government of India.

6. The Working Group will submit its report by the end of June, 2006.

7. The nodal officer in Planning Commission concerned with this Working Group is Shri L.P. Sonkar, Adviser (Minerals & TRP), Planning Commission (Tel: 23096547) and any further correspondence/Query in this regard may please be made with him.

(K.K. Chhabra)
Under Secretary to the Govt. of India

Copy forwarded to:

1. Chairman and all Members of the Working Group
2. PS to Deputy Chairman, Planning Commission
3. PS to MOS (Planning)
4. PS to all Members, Planning Commission
5. PS to Member-Secretary, Planning Commission
6. Prime Minister's Office, South Block, New Delhi

7. Cabinet Secretariat, Rashtrapati Bhavan, New Delhi
8. All Ministries/Departments of Govt. of India
9. Chief Secretaries of All States/UTs
10. Ministry of Finance, Plan Finance Division, New Delhi
11. Accounts I Branch, Planning Commission
12. Information Officer, Planning Commission
13. On the Planning Commission Website.

(K.K. Chhabra)
Under Secretary to the Govt. of India

Appendix-II

F.No. 11[5]2006-M.I
Government of India
Ministry of Mines

New Delhi, dated 28.7.2006

OFFICE ORDER

The Planning Commission has set up a Working Group on Mineral Exploration and Development [other than Coal and Lignite] vide Office Order No. I&M-3[24]/2006 dated 6.3.2006. In the first meeting of the Working Group held on 20.4.2006 in Planning Commission, it has been decided to set up four Sub-Groups to study and give recommendations on various aspects of the Terms of Reference of the Working Group.

2. In the above background, the following will be the composition and the Terms of Reference of the Sub-Group-II on Mineral Output Industries -

Composition

	Name	
1.	Smt. Ajita Bajpai Pandey, Joint Secretary, Ministry of Mines	Chairman
2.	Shri Ajoy Kumar, Joint Secretary, Ministry of Steel, New Delhi	Member
3.	Shri L.P. Sonkar Advisor [Minerals & TRP] Planning Commission, New Delhi	Member
4.	Dr. R. Gedam Joint Advisor [Minerals] Planning Commission, New Delhi	Member
5.	Shri Deepak Srivastava Director [Technical] Ministry of Mines, New Delhi	Member
6.	Shri K.P. Lall Advisor, TPPC, Ministry of Mines, New Delhi	Member
7.	Shri Sunil Barthwal, Director, Ministry of Mines, New Delhi	Member
8.	Director Ministry of Commerce, New Delhi	Member
9.	Chief Mineral Economist Indian Bureau of Mines, Nagpur	Member
10.	Chief Technical Manager Indian Copper Development Centre 27-B, Camac Street, Kolkata - 700 016	Member
11.	Secretary General	Member

	Aluminium Association of India, 118, Ramanashree Arcade, 18-MG Road, Bangalore - 560 001	
12.	Secretary General Cement Manufacturers'Association, Vishnu Kiran Chamber, 2142-47, Gurudwara Road, Karol Bagh, New Delhi	Member
13.	Prof. B.B. Dhar, Senior Vice President, Ritnand Balved Education Foundation, AKC House, E-27, Defence Colony, New Delhi - 110 024	Member
14.	Director, Indian Lead Zinc Information Centre Tuglekabad Institutional Area, M.B. Road, New Delhi - 110 062	Member
15.	President All India Granites and Stone Association No. 415, 5th Cross, 12th Main, Rajmahal Vilas Extension, Sadashivnagar, Bangalore - 560 080	Member
16.	Chairman and Managing Director Hindustan Copper Limited, Tamra Bhawan, 1, Ashutosh Chowdhury Avenue, Kolkata - 700 019	Member
17.	Chairman cum Managing Director National Aluminium Co. Ltd. NALCO Bhavan, P/1 Nayapalli, Bhubaneswar - 751 013, Orissa	Member
18.	Shri B. Ramesh Kumar, Chairman cum Managing Director National Mineral Development Corporation Khanij Bhavan, 10-3-311/A, Masab Tank Hyderabad - 500 028	Member
19.	Shri P.K. Kaura Managing Director, Hindustan Zinc Limited, Yashad Bhavan, Yashadgarh, Udaipur - 313 001	Member
20.	Chairman, Steel Authority of India Ltd., Ispat Bhavan, Lodhi Road, New Delhi - 110 003	Member
21.	Dr. G. Balachandran, Scientist `F', Defence Metallurgical Research Laboratory, [PO] Kanchanbagh, Hyderabad - 500 058	Member
22.	Director CSIR [RRL], Bhubaneswar	Member
23.	Representatives of various State DGMs	Members
24.	Representative, Nonferrous Materials Technology Development Centre,	Member

	PO Kanchanbagh, Hyderabad	
25.	Director, National Metallurgical Laboratory, Jamshedpur, Jharkhand - 831 001	Member
26.	Representative, Tata Iron & Steel Co. Ltd. Jamshedpur, Jharkhand - 831 001	Member
27.	Sr. Vice President [operations], Gujarat Ambuja Cements Ltd., Unit Himachal, P.O. Darlaghat, Tehsil Arki, Distt. Solan, Himachal Pradesh	Member
28.	Regional Manager, India, Phelps Dodge Exploration India [P] Ltd, Khaitan House, B-1 Defence Colony, New Delhi - 110 024	Member
29.	Shri R.K. Sharma, Secretary General FIMI, New Delhi	Member-Convenor

Terms of Reference

1. To review the present status of Indian mineral industry [excluding fuel minerals] and Indian mineral based industries and to assess its international competitiveness.

2. To assess demand for ores/minerals and its likely growth during 11th plan period and in perspective of 15 years accounting for the GDP growth rate of 10%. Also to workout scenario at 9%, 8% and 7% per annum GDP growth rate.

3. To assess demand of ores/minerals with respect to domestic & international markets and assessment of potential of ores/minerals in terms of export as raw material or as value added products.

4. To identify minerals required for production of high purity materials for use in electronics and other newly emerging technologies and review the present status of mineral inventory of these minerals and suggest exploration strategy for augmenting the inventory during XI plan period in the perspective.

5. To make such other recommendations as may be considered appropriate.

6. The Chairman of the Sub-group may co-opt members of necessary.

The Member-Convenor is requested to take urgent necessary action in the matter and submit a report of the Sub-group by the end of August, 2006.

[Deepak Srivastava]
Director [Technical]

To

All Members

Appendix-III

No.C/61(e)/06/840 & 927

Federation of Indian Mineral Industries

New Delhi, dated 9 and 28 August, 2006

CIRCULAR

(Minutes of the first and second meetings of the Sub Group-II)

The Working Group on Mineral Exploration and Development (other than Coal and Lignite) had constituted Sub-Group on Mineral Output Industries vide Office Order No.F.No.11[5]2006-M.I dated 28 July, 2006.

The minutes of the first and second meetings of Sub-Group-II on Mineral Output Industries held on 9 and 28 August, 2006 at New Delhi under the Chairmanship of Smt. Ajita Bajpai Pande, Joint Secretary, Ministry of Mines, New Delhi are circulated.

The Sub-Group-II in its first meeting held on 9 August, 2006 at New Delhi had decided to constitute the following 9 Core Groups to study and give recommendations on various mineral output industries:

1. Core Group on Copper
2. Core Group on Lead and Zinc
3. Core Group on Aluminium
4. Core Group on Cement and Limestone
5. Core Group on Diamond and Precious Stones
6. Core Group on Gold and Precious Metals
7. Core Group on Dimensional and Decorative Stones
8. Core Group on Industrial/Non-metallic Minerals
9. Core Group on Heavy Sand Minerals

1. Composition

CORE GROUP ON COPPER

(copper, cobalt, molybdenum, selenium,tellurium)

CO-CONVENOR

Mr. P.K. Sharma
General Manager(Mines & Safety)
Hindustan Copper Ltd.
Tamra Bhavan
1, Ashutosh Chowdhury Avenue
Kolkata-700 019

MEMBERS

Prof B.B. Dhar,

Chief Technical Manager,

Senior Vice President,
Ritnand Balved Education Foundation,
AKC House, E-27, Defence Colony,
New Delhi - 110 024.

India Copper Development Centre,
27-B, Camac Street,
Kolkata 700 016

A representative of
Birla Copper

A representative of
Sterlite

CORE GROUP ON LEAD AND ZINC

(lead and zinc, cadmium,silver, nickel, antimony, arsenic,bismuth,mercury,indium, tungsten and tin)

CO-CONVENOR

Mr. D.S. Sharma
General Manager - Management Services
Hindustan Zinc Ltd.
B-II/403, Kamal Apartment-I
Bani Park, Jaipur-302 006

MEMBERS

Mr. L. Pugazhenthy
Executive Director
Indian Lead Zinc Information Centre
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Dr. R. Bhardwaj
Dy. Adviser (Minerals)
Planning Commission,
Yojana Bhawan,
New Delhi 110 001

Mr. Vakil Singh,
Joint President,
Met Trade India Ltd.
138-139, Main Road,
Ghazipur, Delhi-110 096

CORE GROUP ON ALUMINIUM

(aluminium, gallium, vanadium, magnesium, titanium and silicon)

CO-CONVENOR

Prof. K.S.S. Murthy
Hon. Secretary General
Aluminium Association of India
118, Ramanashree Arcade
18-M.G. Road
Bangalore-560 001

MEMBERS

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Director,
Director of Mines & Geology,
Govt. of Andhra Pradesh,
8th Floor, B.R.K.R. Govt. Officer's Complex,
Hyderabad - 500 029 (A.P.)

A representative of HINDALCO

A representative of BALCO

A representative of MALCO

CORE GROUP ON CEMENT AND LIMESTONE

CO-CONVENOR

Dr. S.P. Ghosh
Adviser
Cement Manufacturers' Association
CMA Tower,
A-2E Sector 24,
Noida-201 301 (U.P)

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Haryana

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President(operations)
Gujarat Ambuja Cements Ltd.
Unit Himachal, P.O. Darlaghat,
Tehsil Arki, Distt. Solan,
Himachal Pradesh

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Directorate of Geology & Mining
Govt. of Assam,P.O. Kahilipara
Guwahatti-781 009, Assam

Mr. S.K. Sen,
Director,
Department of Mines & Geology,
Govt. of Meghalaya,
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Govt. of Andhra Pradesh,
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Mr. R.K. Sharma
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Directorate of Mining & Geology,
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Mrs. Nidi Chhibbar,
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A representative of Kerala Mines and Minerals Ltd.

II. **Terms of Reference**

Terms of reference of the Core Groups will be the same as circulated by Office Order No.F.No.11[5]2006-M.I dated 28 July, 2006 referred to above in so far as they are relevant to these Core Groups as stated in Appendix-I.

(R.K. SHARMA)
MEMBER CONVENOR

REPORT OF

THE WORKING GROUP ON

MINERAL EXPLORATION AND DEVELOPMENT

(other than Coal and Lignite)

FOR

THE ELEVENTH FIVE YEAR PLAN

FISCAL MEASURES, INFRASTRUCTURE DEVELOPMENT AND ENVIRONMENT

VOL - IV

GOVERNMENT OF INDIA

PLANNING COMMISSION

January, 2007

REPORT OF

THE WORKING GROUP ON MINERAL EXPLORATION AND DEVELOPMENT
(Other than Coal and Lignite)
FOR
THE 11TH FIVE YEAR PLAN

SUB-GROUP-III
FISCAL MEASURES, INFRASTRUCTURE DEVELOPMENT & ENVIRONMENT

GOVERNMENT OF INDIA
PLANNING COMMISSION
October, 2006

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PREFACE

The Planning Commission, Goverrnment of India constituted the Working Group on Mineral Exploration & Development (other than Coal & Lignite) in the context of formulation of 11th Five Year Plan (2007-2012) under the Chairmanship of Secretary, ministry of Mines, Government of India vide Office Order No.I&M-3(24)/2006 dated 6.3.2006.

The first meeting of the Working Group on Mineral exploration & Development (other than Coal & Lignite) for the 11th Five Year Plan was held under the Chairmanship of Additional Secretary, Ministry of Mines, Government of India on 20.4.2006 at Yojana Bhavan, New Delhi. In this meeting, the following four sub groups were constituted :-

1. *Sub Group I - Survey & Mineral Exploration.*
2. *Sub Group II - Mineral Output Industries*
3. *Sub Group III - Fiscal Measures, Infrastructure Development & Environment*
4. *Sub Group IV - Human Resource Development in Mineral Sector.*

Accordingly, Office Order vide file No.11((5)/2006-MI dated 28.7.2006 was issued by the Ministry of Mines. In this order the composition and terms of reference of Sub Group III on Fiscal Measures, Infrastructure Development & Environment was formulated and the Sub Group III was constituted under the chairmanship of Dr.Pradeep Kumar, Additional Secretary, Ministry of Mines, New Delhi and Shri A.K.Srivastava, Suptdg. Mining Geologist & I/c CMG Office, Indian Bureau of Mines was nominated to be its Member Secretary & Convener. The composition of this Sub Group III together with 9 terms of reference, are given under Annexure-I.

The first meeting of the Sub Group III on Fiscal Measures, Infrastructure Development & Environment was held on 8.8.2006 in the Conference Hall of the Ministry of Chemicals & Fertilizers at Shastri Bhavan, New Delhi, which was chaired by Dr. Pradeep Kumar, Additional Secretary, Ministry of Mines. It was decided to constitute 4 Core Groups *of experts to prepare the draft chapters as per the terms of reference. A copy of the minutes of the meeting is placed as Annexure-II(A).*

(ii)

In the meetings and deliberations of this sub group non participation by ministries of Environment & Forest , Steel and Power and inadequate participation by ministries like Road, Transport & Highways and associations of Mining Industry, posed a serious handicap for this sub group III. At subsequent stages, service of some of the Core Group Convenors and members could not be availed in view of their preoccupation and parallel involvement in other Sub Groups. Thus, following reorganized Core Groups were constituted which met on revised schedules later on.

LIST OF CORE GROUPS

(i) FISCAL MEASURES

1. Shri A.K.Srivastava, Suptdg. Mining Geologist I/c CMG Office, IBM, Nagpur (Convenor & Coordinator)

2. Shri Ravinder Swarup, Director (TRU), D/o Revenue, New Delhi

3. Shri R.N.Meshram, Sg. ME, IBM, IBM, Nagpur

(ii) INFRASTRUCTURE DEVELOPMENT

1. Shri K.P.Lall, Advisor, TPPC, MOM New Delhi
(Convener & Coordinator)

2. Shri Ashok Kumar, ED (Planning) M/o Railways, New Delhi.

3. Shri A.R.Rao, Devpt. Advisor (Ports), D/o Shipping, New Delhi.

4. Shri Pooran Singh, M/o Road Transport & Highways, R.No.147, Transport Bhavan, New Delhi

5. Shri Kaushal Prasad, Consultant (Infra), L3/26, DLF, Ph II, Gurgaon

(iii) ISSUES CONCERNING ENVIRONMENT AND FOREST

(A) Sub Core Group on Environment Issues :-

1. Shri A.K.Singh, Director, MOM, (Coordinator & Convener)

2. Shri Pankaj Asthana, AIG (FC), MOEF

3. Shri S.P.Agrawal, Director, MOEF

(B) Sub Core Group on Reclamation & Rehabilitation and Tribal Issues :-

1. Shri A.K.Singh, Director, MOM, New Delhi
(Coordinator & Convener)

2. Shri Pooran Singh, M/o Road Transport & Highways, R.No.147, Transport Bhavan, New Delhi

3. Shri S.Roy, DCOM & TS, IBM, Nagpur

(iii)

During the deliberations of the Expert Group, the Department of Revenue, Ministry of Finance through its participating representative conveyed the stand that fiscal measures are considered in the context of budget based on overall revenue and expenditure needs and based on national priorities as determined by the Government. Thus, this duty structure and concessions for a particular industry should not be made part of policy making by individual ministries and to be ideally left to Ministry of Finance which is entrusted with the responsibilities of making budget for the Government. Therefore, as a part of the terms of reference No.1 given to this Sub Group III, the status and scenario of fiscal / taxation measures in Indian Mining Sector are discussed and the same is compared with practices existing in other important mineral producing countries of the world.

The Core Group of Experts on infrastructure development in its meetings held on 17th & 24th August, 2006 mainly focused attention on requirement of infrastructure for the Indian mineral sector and the initiatives needed for infrastructure development – ports, roads, railway and power. The Core Group also worked out, the projected investments needed for infrastructure during 11th Plan.

Regarding harmonizing mineral development with environment and forest land, there are a number of issues involved and entrusted to the Core Group of experts under the terms of reference No.3, 4, 5, 6 & 7 such as constraints & problems encountered in exploration & exploitation of mineral resources in tribal & forest areas, impact of Hon'ble Supreme Court Verdict in the TN Godavarman-Thirumulpad case on assessment of net present value(NPV) payable for use of forest area for non forest purpose, to assess the magnitude of rehabilitation and reclamation needed for abandoned / closed mines before the concept of mine closure plan came into being, to examine the impact of Samatha judgement on present mines and mineral based industries located in the 5th schedule areas of the country and to examine and assess the socio economic impact of mining on the life of local inhabitants and suggestions and recommendations thereof.

After a series of meetings of experts and resource persons of various Core Groups and on the basis of their presentations and comments on various issues involved, the first draft was prepared by the Member Secretary & Convenor and considered in a meeting held *on 13th September, 2006 at Shastri Bhavan, New Delhi, which was chaired by the Additional Secretary, Ministry of Mines. A copy of the minutes of 2nd meeting is placed at Annexure II(B). The comments of the members were taken due note of and suitable*

modifications were made in the report to facilitate the final report to be submitted to the Secretary, Ministry of Mines and Chairman of the Working Group .

The present report deals with the fiscal measures, infrastructure development, environment, forest and tribal issues involved in the development of mineral sector in India. Indian Mineral Sector is characterized by a large number of small mines which provide critical and rare materials for wide spectrum of Indian industries. While considering the potential of minerals particularly for their export and optimal utilization in mineral based industries, there is a need to improve the infrastructure and reorganise taxation regime . The global scenario of fast upcoming technological updation and development in the Ore Dressing flow sheets have also to be kept in view which are now available for upgrading and utilizing low grade resources. There is an increased need to harmonize mineral development with environment, forests, rehabilitation and reclamation of mined out areas and related tribal issues which need to be suitably addressed in the larger interest of mineral development and also to present an attractive frame work for Foreign Direct Investment (FDI) in this sector.

Based on the present studies & experience gained from 10th Five Year Plan documentation, certain strategic recommendations have been formulated, and spelt out in this report to facilitate formulation of plan and policies of Government of India for mineral development. The deliberations, suggestions and recommendations which have gone into this report will provide an outline and direction for the various agencies to draw up programs to meet the requirements of 11th Five Year Plan mainly in Indian mineral sector. The report has individual chapters as per the terms of reference and is the outcome of combined efforts of the members of the Sub Group III.

All members of the Sub group, resource persons and members of the Core Groups deserve thanks and gratitude for their painstaking efforts to formulate suggestions and recommendations for this report within a very strict time frame.

(A.K.Srivastava)
Sg.MG/Chief Mining Geologist(Offg.)

(Dr Pradeep Kumar)
Additional Secretary,

SUGGESTIONS & RECOMMENDATIONS

0.1.0 Suggestions on Rationalization of Taxes & Tariff Structure of Mineral Sector in India

0.1.1 **Need & necessity of Government intervention through taxation** - Taxation is a form of government intervention which is required for optimal exploration, mechanization of mining operations, maintaining environmental standards and maximizing mineral rents. It is also necessary to achieve equality and international competitiveness through optimal mineral extraction policy. Even though market can take care of optimal extraction of minerals through price and depreciation mechanism, possible market failures warrant a modest amount of government intervention.

0.1.2 The Department of Revenue, ministry of Finance through its representative in Sub Group III has conveyed the following stand of the Department of Revenue.

> "Fiscal measures have to be considered in the context of budget based on overall revenue and expenditure needs and based on national priorities as determined by the Government. Thus the duty structure and concessions for a particular industry should not be made part of policy making by the individual Ministries and should ideally be left to Ministry of Finance which is entrusted with the responsibility of making budget for the Government."

In the light of above observations of the Department of Revenue of the Ministry of Finance, no specific suggestions or recommendations on duty structure and concessions as applied to mining sector in India are proposed .

0.1.3 Internationally the ad valorem royalty system is more commonly used. In India there is unanimity among the states now in the demand that royalty rates should be shifted from tonnage to ad valorem. There is a strong case for the royalty regime in India to move strongly towards the ad valorem system to augment revenues of the states**.** In the case of some minerals international prices have risen several fold over short time periods. Unless royalty is fixed on ad valorem basis, Governments do not benefit at all from the increase in prices. Therefore, it is recommended that royalty rates in India should be shifted from tonnage to ad valorem basis.

0.1.4 The following recommendations of the multi disciplinary committee on taxation constituted by the Ministry of Mines and submitted to the Ministry of Finance, (July 2000) deserve consideration :-

(a) **Rate of annual depreciation for mining plant and equipment** should be increased to 100% in order to encourage investment in mining sector as per practice existing in a large number of mineral rich countries & notably in African countries.

(b) **All expenditure incurred prior to commercial production** including the expenditure incurred on site and deposit acquisition should be eligible for amortization over the minimum mining lease period of 20 years or a lesser period at the option of the lessee.

(c) For **reclamation of mined out area**, the mining companies may be allowed to earmark a percentage of book profits each year to met rehabilitation cost in future and set it aside as a special reserve in their books.

(d) **Import-duties on mining equipments may be reduced -** For equipments used for gold & diamond mining operations. No duty should be applicable while for other mining operations the duty should be at par with imports for coal mining equipments.

(e) **Nil levy of excise duty for concentrate produced in the leaseholds and low excise duty structure for concentrates produced outside leaseholds**, may be devised. This is as per recommendation of Mineral Development Council (MDC) which has suggested that the concentrates produced within lease area may be exempted from levy of excise duty in the same manner as ores & minerals.

0.1.5 It will be useful and worth while to workout the total cost of mineral prodution in India as a percentage of total varience of revenue. It is therefore suggested that such a study may be carried out at the earliest and the data may be provided to the mineral planners.

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0.2.0 Suggestions on Infrastructure Development in Indian Mineral Sector

General Recommendations

0.2.1 Requirement of infrastructure in respective Indian Mining belts needs to be focused sharply in order to provide them critical support and address to needs of different mineral rich areas of India. In order to undertake the task of building the infrastructure in mining areas, it is recommended that Mineral Development Fund (MDF) should be set up in each State having stake in major mining activity by earmarking 15% of the annual royalty collections for the fund.

0.2.2 For planning and promoting the development of mine-related infrastructure, it would be necessary to put in place an appropriate institutional framework. In the major mining States, we already have mineral development corporations and State Industrial Development and Investment Corporations. It would be necessary to enlarge the mandate of these corporations to include planning, promotion and financing of mining infrastructure. These corporations should take up funding for the mining infrastructure projects by inter alia promoting and implementing entities in the form of JVs/SPVs.

0.2.3 Since, Government has decided to go in for privatization of infrastructure, it is recommended that financing of new ports – rail – roads infrastructure should be considered under Ministry of Commerce scheme for Balancing of Critical Infrastructure, which envisages 50% contribution by the Central Government.

0.2.4 The railway projects, the National Highways and the port projects within the existing schemes of the Government of India can be taken up as Public Private Partnership (PPP) projects and the Government of India is committed to such projects being taken up within the existing programmes.

0.2.5 The capital cost of water and power projects (to access the main grid) for the SME sector may have to be borne by the State Government through outright grants from the Mineral Development Fund. If the Rural Water Supply Scheme of the Central Government could be extended to the mining areas to meet the water supply requirement of the mine workers of small/medium size mines, it would alleviate the strain on the resources of the

MDFs. Similarly, a conscious decision could be taken by the State Government to make electricity available to the mine sites, especially for small and medium size mines.

0.2.6 Development of high quality roads connecting priority sector mines (iron ore, bauxite, dimensional stones and limestone) to loading stations are urgently required and State Governments should earmark revenue from their royalty earnings for such infrastructure development in mining sector.

0.2.7 Power supply grid system in the country needs to be strengthened particularly that located in mining belts of India.

0.2.8 New railway lines in the eastern sector as well as in Karnataka connecting mining areas to ports will have to be undertaken to support exports and for reducing cost structure of various steel plants.

0.2.9 Development of dedicated freight corridors for transport of Iron ore by railways from the mine-heads to various ports needs to be promoted along with private promoters.

0.2.10 Ports should invest in additional tipplers to augment their receiving capacities.

0.2.11 Additional stockyard capacity at ports needs to be installed.

0.2.12 Considering high cost of construction of ports, dredging, etc. alternatives such as floating terminals, which will facilitate loading of larger ships outside the port, should be examined and implemented.

0.2.13 New ports coming up at Gopalpur (located between Paradip and Vizag) and Dhamra (located south of Haldia and north of Paradip) in Orissa by a consortium of TATA Steel and L&T and another port coming up at Ennore, on east cost should be expedited. These mega ports will hopefully have sophisticated mechanized handling plants and deep draft berths to handle super cargo.

Sector Specific Recommendations

0.2.14 **Iron Ore**

0.2.14.1 As per the steel policy, the requirement of iron ore for steel production is expected to go up from 54 million tonnes in 2004-05 to 190 million tonnes in 2019-20. The movement of iron ore will continue to be mostly by rail and therefore development of railway infrastructure to handle iron ore has to be suitably augmented. The total traffic projections for the steel sector by 2019-20 include 230 million tonnes by railways and 100 million tonnes by road.

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0.2.14.2 In a globally integrated economy, minimization of the overall cost of transportation of Iron Ore becomes an important factor for maintaining the competitive edge in both the domestic and overseas markets. The Indian steel plants and Iron Ore mines therefore need to be integrated with the ongoing programmes of National Highway development and also with the proposed rural road development schemes.

0.2.15 **Bellary-Hospet Sector**

In Bellary-Hospet Sector, the existing iron ore production of about 35 million tonnes is expected to go upto more than 45 million tonnes by 2011-2012. In order to meet the infrastructure requirements for the increase in production / demand in iron ore both for domestic and export market, following infrastructure will need to be created/augmented.

0.2.16 **Railways**

As the iron ore from this sector moves to ports namely Chennai, Krishnapatnam, Goa, Karwar, Belekeri and New Mangalore, it is necessary to strengthen and improve railway carrying capacities to all these ports. This can be achieved by the increase in rake capacity, electrification of all the routes, doubling of tracks, wherever necessary and ensuring availability of wagons. Simultaneously, the wagon tippling facility also needs to be augmented. A substantial portion of iron ore is transported by road from mine-heads to the loading stations. In addition to being costlier, it also puts a lot of strain on the road network and therefore, it would be desirable to provide suitable rail linkages to some of these large mines.

0.2.17 **Ports**

0.2.17.1 A decision has already been taken to close down Chennai port for export of iron ore due to environmental reasons. It is therefore, necessary to develop alternative port /ports to handle the current exports from Chennai as well as to meet future export demands. In this connection, a new port at Ennore, north of Chennai has already been developed. It is recommended that efforts be made for speedy development of iron ore berth, mechanical ore loading facility, adequate capacity of stockpile and dredging to accommodate large cape size vessels. The ship loading facilities at Ennore should match with other iron ore loading ports of the world to make Indian iron ore competitive in the global market.

0.2.17.2 As part of hinterland of Bellary-Hospet Sector, a private sector port at Krishnapatnam in Andhra Pradesh is being developed. Iron ore loading facilities in this port should be suitably designed to handle part of the cargo, which is expected to move from Bellary-Hospet area through this port.

0.2.17.3 Iron ore handling facilities at New Mangalore port on the west coast should be gradually improved to load additional iron ore expected to move to this port from Bellary-Hospet and other regions in Karnataka. In case of new Mangalore port, conversion of metre gauge railway line would also be required.

0.2.17.4 It would also be worthwhile to make expeditious efforts to develop an all –weather port at Tadri or Belekeri with a draft of 18 meters as a long-term solution. The port should have mechanical ore handling facilities and storage space to accommodate minimum of 5 million tonnes of cargo.

0.2.17.5 The above project is critically dependent on the construction of railway line between Hubbli and Ankola – a distance of 172 kms, involving a gradient 1 to 150 metres. The construction of this railway line will reduce the lead from Bellary-Hospet by 200 kms. This line together with the development of port is expected to increase and make iron ore exports competitive in the world market. Construction of Hubli-Ankola railway line will also give the hinterland access to the Konkan railways and whole of Karnataka coastline. These railway lines and the port projects deserve to be taken up on fast track.

0.2.17.6 Efforts should be made to deepen draft at Mormugao (Goa Port) upto 16.5 m and mechanical handling facilities be installed for rail borne iron ore traffic from Bellary-Hospet sector to Goa Port.

0.2.17.7 Obulavaripalle- Krishnapatnam port Rail line project on which NMDC has already agreed for equity participation needs to be expedited.

0.2.18 **Bailadila-Vaizag Sector**

0.2.18.1 The major iron ore producer in this sector is NMDC whose current production is 18.6 million tonnes, which is expected to go upto 32.7 million tonnes by 2012 and more than 42 million tonnes by 2022. About 8 million tonnes out of this is expected to be moved by slurry pipelines and the balance by railways, both for domestic and export demand. By 2012 rail and road movement is expected to cover 22.8 million tonnes and 1.9

million tonnes respectively. Therefore, construction of a new railway line to link Bailadila Sector (Jagdalpur) to Raipur needs to be taken up on priority.

0.2.19 **Railway**

0.2.19.1 A dedicated railway line exists between Bailadila and Vaizag port, which carries the iron ore for exports, Vishakapatnam Steel Plant, and domestic consumers namely ESSAR, ISPAT Industries and Vikram Ispat. To ensure and sustain the movement of increased tonnage by railway, it is necessary to strengthen the existing railway facilities. Similarly, to meet the iron ore demand of other steel units in Chattisgarh area immediate action is recommended to establish / improve the rail / road facilities in the region.

0.2.19.2 The load carrying capacity of this means of ore transport needs to be enhanced keeping in view the movement of bauxite envisaged from Andhra Pradesh quarries. For ensuring steady power supply, the power grid system in these belts also needs to be strengthened.

0.2.19.3 Construction of new rail line to link Bailadila sectors (Jagdalpur) to Raipur & Gua-Barbil-Badajamda sector needs to be taken up on priority. This will support NMDC's mining operations.

0.2.20 **Port**

0.2.20.1 As NMDC and MMTC are the major suppliers of iron ore from Vaizag port. Therefore, it is necessary to augment the stockpile capacity of this port.

0.9.20.2 In order to remain competitive in global market, the size of ships and loading rates should be reviewed and suitably regulated to match India's competitive edge in Iron ore trade.

0.2.21 **Orissa / Jharkhand – Haldia / Para dip Sector**

About 30% of India's Iron ore resources are located in the states of Orissa and Jharkhand. The combined production from these two states was about 56 million tonnes during 2004-05, out of the total all India production of 142 million tonnes. It is, therefore, evident that infrastructure facilities in this region are of utmost importance both from the point of view of domestic trading exports. As the belt supplies to several domestic steel units, the internal movement of iron ore both by road and rail is substantial. The prospects of growth of iron ore mining in this region is expected to be high in view of several new steel plants of Posco, TATA and Mittal Steel being proposed.

0.2.22 **Railway**

0.2.23.1 From iron ore mining areas of Barajamda, Barbil, Banspani, etc., the iron ore is transported by railways to steel plants and to the ports of Haldia and Paradip. In order to increase the capacity, several new railway projects have been undertaken in this region viz. Banspani – Daitari, Haridaspur – Paradip, Angul – Sukinda Road, Jharsuguda – Sambalpur, etc. It is, therefore, recommended that these projects be expedited and completed as soon as possible. The expeditious construction of Daitari – Banspani rail line will reduce distance between iron ore mines to the port by 313 kms.

0.2.22.2 It is, therefore, recommended that Ministry of Railways should develop product- specific railway freight corridors jointly with rail users – MNCs / private companies / or / PSUs. A similar project is under consideration at an estimated cost of Rs.560 crores fi.e. Haridaspur – Paradip railway line project in which Posco is likely to contribute Rs. 27 crore initially for its 10% stake. This will provide a dedicated rail corridor connecting its steel plant with Paradip port in consortium with PSUs and private companies like Jindals, SAIL and MSPL Mining Company. This project is being developed by Special Purpose Vehicle (SPV) led by Rail Vikas Nigam Ltd. This new railway corridor will be an alternative to the Cuttack railway line which will reduce the distance and time of transportation of raw materials like iron ore and coal from Orissa's Keonjhar and Angul districts to the plant site.

0.2.23 **Road**

In the absence of adequate rail capacity in this sector, a large quantity of iron ore is moved by roads. In view of the growing demand of iron ore, it is recommended that all the road projects undertaken in the mining area should be completed as soon as possible. Some of the road routes critical to Indian mining sector in this region are:

- Rajamunda-Barbil (NH215) - 60 kms
- Barbil-Panikhole (NH215) - 189 kms
- Chandikhole – Paradip (NH5A) - 77 kms

- Jamshedpur – Haldia (NH) 33, NH6, NH41) - 200 kms
- Jaint garh – Chaibasa – Haldia(NH 75E) - 100 kms

0.2.24 **Port**

0.2.24.1 Two major ports that handled, the iron ore exports from this sector are Haldia and Para dip. During 2004-05 the quantity exported was about 5 million tonnes and 9 million tonnes from Haldia and Para dip respectively. At present Haldia can handle a ship of about 35,000 DWT while Para dip can load a vessel of about 70,000 DWT due to draft limitations.

In view of the increase in demand of iron ore loading in these ports, immediate action is required for deepening of approach channel and turning basin and construction of iron ore berth to receive bigger ships.

0.2.24.2 Several new port projects namely Dhamra and Pasco's captive port are under consideration for quite sometime. It is recommended that these projects should be implemented expeditiously to handle additional iron ore from the region in order to reduce freight costs from India to iron ore importing countries.

0.2.24.3 Jharkhand Government's proposal for development of a dedicated port in Orissa should be given priority in order to support mineral based exports from Jharkhand.

0.2.24.4 Pasco's own port proposed at Jatadhari near Para dip should be developed expeditiously

0.2.25 **Goa Sector**

0.2.25.1 Total iron ore production in 2004-05 from this region was 22 million tonnes. In addition to local production, about 2.5 – 3 million tonnes of iron ore is moved from Karnataka region through Mormugao port. In 2004-05, total quantity of iron ore handled at Mormugao was 24.72 million tonnes.

0.2.26 **Railway**

The Goan iron ore mines are located close to rivers and therefore the iron ore movement within Goa is mostly by barges to Mormugao and Panjim ports. However, about 3 million tonnes of iron ore from Bellary Hospet is moved by railways and exported through Mormugao. The iron ore is brought to river loading point of Sanverdam from where the ore is loaded into barges and transported to the port. In order to avoid double handling, a project to handle wagons directly at the port is underway and should be completed immediately. Likewise the railway capacity from Bellary-Hospet to Goa should be suitably increased to meet the growing movement of iron ore.

0.2.27 **Port**

0.2.27.1 At Mormugao port (berth no. 9), the mechanized port loading facilities with an annual capacity of 10.5 million tonnes, can handle ships from 30,000 to 275,000 DWT capacity. The ships are partly loaded upto the permissible draft and fully loaded at anchorage with the help of transhippers. The port also loads large cape size vessels directly from barges with the help of transhippers. The main infrastructure at Mormugao port is therefore barges, mechanical ore loading facility and transhippers, which should be

maintained, replaced and suitably enhanced to take care of growing export demand. The minor port of Panjim handles about 8-9 million tonnes of iron ore annually, mainly through barge loading, and therefore, availability of adequate barges should be ensured.

0.2.28 **Dimensional & Decorative Stones**

0.2.28.1 Handling facilities at major ports viz. Chennai, Tuticorin, Cochin, Mangalore, Kaswa, Kandla, Mumbai, JNPT and Vizag need to be improved for the export of dimensional stones.

0.2.28.2 Road network should also be extended to rural mining belts including decorative & dimensional stone producing centers, thereby providing linkages to highways / expressways.

0.2.28.3 It is recommended that railway stockyards at various places should be created with Inland Container Service System (ICD) in operation. The railway stockyards with potential of handling stones should be equipped with crane facilities of minimum 50 tonnes. From these points, open wagons shall move to important ports and other destinations where the stone processing units are located.

0.2.28.4 Adequate railway transport network including container facilities and railway sidings should be extended at prominent centers producing stones.

0.2.29 **Bauxite & Alumina**

The Greenfield alumina plants and bauxite mining would require strengthening of infrastructure development of road and rail network

The bauxite mining belts of Chatttisgarh and Jharkhand also need improvement in road infrastructure for the brownfield expansion of existing plants. In Andhra Pradesh bauxite deposits would require extension of railway line up to deposits.

0.2.30 **Limestone and other industrial minerals**

0.2.30.1 Bulk handling of limestone and rock phosphate both for domestic consumption, exports and imports is made by rail and road network. Road network is a serious bottleneck in northeastern states where limestone is exported through road network to neighbouring counties. Therefore, efforts should be made to strengthen the existing road and rail network connecting mines to the consuming centres.

0.3.0 Suggestions on Measures to harmonise Mineral Development with Environment & Forests, Tribal Policy & Law

0.3.1 Measures

1) A high level expert committee comprising experts from Ministry of Mines and Ministry of Environment and Forest may be constituted to work as a nodal agency to examine and approve such mining project.
2) A copy of lease application should be sent to all the scrutinizing agencies to work on parallel fronts.
3) Environmental clearance should not be required for prospecting licence as the level of indulgence in the forest and waste generation is minimal in such cases.
4) One time in principle approval should be accorded for transfer and dereservation of entire forest land involved and deforestation should be approved in phases depending upon the requirement of the user agency.
5) A C-ordination Committee may be set up to monitor the clearances of individual applications and ensure speedy clearance by different departments & agencies. There should be a cell specified for monitoring the proposals for exploration and exploitation of mineral resources at forest headquarters of each mineral rich state.
6) There should not be any need of submitting a fresh DPR in case of a renewal of a mining lease unless fresh forest land is required to be broken or the area proposed is different from stipulated earlier.
7) Mineral rich states should create land bank of non-forest areas to be mutated in favour of forest department for compensatory afforestation and onus of non-forest land available, its mutation and transfer in the name of forest

department should lie with the revenue department of the concerned state. The lessee should be responsible for depositing the required fees only.

8) The procedure involved in public hearing can be simplified. Only the representatives of the stake holders groups should be invited for public hearing. Involvement of outsiders should be avoided as far as practicable.

9) It is preferable to demarcate mineral bearing areas as ‘Mining Land’ in all the revenue records as it is being done for the ‘Forest Land’.

10) The delays occur mainly on account of enumeration of trees and cost benefit analysis carried out by the DFOs. This can be minimized by outsourcing and building a data bank regarding the number of trees in different forest areas.

11) It is suggested to modernize the present system and make provision for on-line application for mineral concessions.

12) The renewal of lease for captive mines should be expedited in order to ensure uninterrupted supply of ore for continuous operation of the plant.

0.3.2 **Suggestions on Assessment of Net Present Value (NPV)**

1. The basic concept behind charging NPV is that forest areas give intangible benefits in shape of release of oxygen, soil and water conservation resulting into lesser floods and consequently lesser national loss in river plains. Hon’ble Court may be approached to reconsider it for a very small forest area and especially for those areas which are though recorded as forest, but are devoid of forest cover. For such areas only the provision of compensatory afforestation should be there.

2. While the final decision on the liability of mining lessees for use of forest land would be taken by the Hon’ble Supreme Court, the Committee would like to make two recommendations that would lighten the burden on the lessees :

(a) The NPV should be payable in instalments proportionate to the land broken in accordance with the pre-submitted mining plan to reduce one time burden on the lessee.

(b) The lessee should not be asked to pay NPV each time a lease is renewed as the intangible benefits have already been accounted for in previously paid N.P.V. Thus duplication of payment of N.P.V. should be avoided.

3. Once the Hon’ble Court has passed orders in this regard all “forest” land must be notified in the Official Gazette so that there is no scope for subjectivity in interpretation. It is also recommended that clear & transparent guidelines may be formulated and circulated among entrepreneurs so that their confidence level is increased.

4. Compensatory Afforestation Fund Management & Planning Authority (CAMPA) should be accountable for the funds & its financial control. CAMPA should have representatives from the industry of concerned state.

5. As there is a symbiotic relationship between tribal people & forests, employment to the tribal people & their rehabilitation should be on priority basis.

0.3.3 **Status of Rehabilitation and Reclamation of abandoned mines**

Indian Bureau of Mines (IBM) has identified 297 abandoned/orphaned mines in the country. It has put up a project proposal for reclamation/rehabilitation of 106 abandoned mine sites out of the total 297 sites. Of these 36 sites belong to Public Sector Undertakings, 25 to major private companies and 45 sites to other small private companies. Of the above 106 sites, 87 are open cast mines and 19 are underground sites varying in area from 281.6 ha to less than 1 hactare. Out of these 16 may be reopened.

The impact on these sites include unused pits and shafts, altered landscape, unusable land due to loss of soil, low pit, tailings/waste dumps, ground water depletion, soil contamination,, etc.

Soil strata are inverted due to open cast mining making the area not only refractory for vegetation growth, but also very fragile and unstable due to bouldery material at the top and the finer material at the bottom of an overburden.

Suggestions on Rehabilition & Reclamation of abondoned mines

1. To overcome the soil degradation issue, it should be mandatory for all open cast mining to store and stock the top soil at a separate place and it should be replaced as soon as the mined area is back filled with. As the top soil bears the seeding and rooting materials of most of the species growing there, replacing top soil will help in establishing most of the indigenous plant species.

2. Gradient of the slope of the overburden (OB) should not be more than 25 and the soil beneath the OB should be worked before dumping for a better stability of the OB and lesser soil erosion.
3. Contouring of the OB before plantation should essentially be done for better stability of the area and least soil erosion.
4. Plantation of bamboo and other species having strong root system should be prefared.

5. Plantation of suitable bamboo species will not only establish the area with least or no soil erosion, but will also help in improving the economic status of the local people dependent on these forest areas .
6. Plantation of local species should be preferred, especially those with whom local people have sentimental attachment.
7. Reclamation of mined areas should not consider afforestation activities only, but, it should have a holistic approach for the benefit of the local people along with environmental issues, e.g., development of fisheries, water sports, big ponds for irrigating the adjoining agricultural areas, eco-tourism, etc. depending upon local needs and requirement.

0.3.4 **Suggestions on Socio Economic Impact of Mining on Local Life & Improving their Living Standard**

1. Investible surplus must be created from every mining projects in India which can be ploughed back into local economy.
2. Through effective measures adopted for environmental protection rehabilitation of migrants and implementation of mandatory obligations, the adverse impacts on local population can be minimized.
3. Essential public services made available to the staff of the mining project like education, health and infrastructure should invariably be extended to local population particularly the poor.
4. To the extent feasible and possible the local value addition to mineral produce (through setting up of mineral based industries and ancillary industries) must be promoted for the benefit of local population.

5. The local human resource should get custom tailored training for utilizing their talents in mining project.
6. Efforts should be made to remove socio economic disparities and divides created due to projects.
7. The areas presently under mining or to be brought under mining are generally forest areas and people dwelling in and around these areas depend much on these forests for their livelihood. Therefore, a mining proposal in these areas attracts much resistance against these proposals. Such a resistance should be

won over through effactive publicity compaigns highlighting benefits of the project accruing to them.
8. People of such areas may be attached sentimentally also due to presence of temples of some local deities. Their religious sentiments should be taken care of.
9. Socio-economic Impact Assessment (SIA) is either not done, or if done, by the mining company itself, which has no credibility in the eye of local people. It should be done by local administration or the NGOs working in those areas. SIA should compulsorily be done and approved by the same authority approving the proposal at the Central Level and it should be done by some reputed and credible agency.
10. Local people see forests as a perpetual source of income for their progeny also, and hence, their economic rehabilitation along with health and education should be addressed.
11. Son of the Soil psychology is increasing and it is most prevalent in these areas. By imparting better education and inculcating in their mind that their progeny may also get higher jobs in these mining organizations in the future and may not merely end as fourth grade employee their resistance can be reduced to a great extent.
12. All the stakeholder groups should be consulted during public hearing.
13. Afforestation of various species of bamboos, shrubs and trees of medicinal use and trees bearing seeds of bio-fuel e.g. jatropha, kanji and neem should be preferred depending upon their silvicultural needs and suitability.
14. A co-operative of affected people should be established to share the benefits & fruits from these rehabilitated areas.

15. Rehabilitation of mined areas should not only concentrate on afforestation, but, viability of development of fisheries, eco-tourism, water sports, etc. should also be explored for economic upliftment of the local people.

CHAPTER 1

FISCAL MEASURES
(Status of Present Taxes & Tariff Structure of Mineral Industry in India)

(Item 1 of the Terms of reference for Sub Group III)

Terms of Reference

"To examine the present tax and tariff structure of the Mining Industry and suggest internationally comparable tax regime for ores/minerals"

1.1 Preamble

In the current scenario of globalization and enhanced private and foreign participation in Indian Mineral Sector, the focus on it may be diluted and the industry may be rendered uncompetitive unless the taxation regime is rationalised.

1.2 Major Revenue collections to State Governnment

The major revenue collection by the State Governments specifically from the mining sector in India is given below :-

Revenue collection specific to Mineral Sector -

1. By way of **royalty on minerals** extracted from the mines within state - Conceptually royalty is payment made by the mining lessee to the state (owner of the mineral) as a consideration for the mineral which the lessee extracts and sells. Rates of royalty on minerals are specified in the second schedule to the MM(DR) Act. In India royalty on major minerals is charged on both unit of production basis and on ad valorem (percentage of revenue) basis. The unit of production rates are applicable to 14 minerals (excluding coal, lignite & sand for stowing) and ad valorem rates on the rest

of the major minerals. At present the unit of production rates are varying from Rs.5 to Rs.800 per tonne while the ad valorem rates vary from 0.12 to 15%. As per data furnished under Annexure IV, it is seen that percentage of taxes & leases as a component of cost of minral production in India varies from mineral to mineral. In case of manganese mines, the percentage of royalty varies from 3.29% to 8.38% of the cost of production. In case of bauxite, the percentage of royalty varies from 4.31% to 43.74% of the cost of production. In case of iron ore, it ranges from 2.15%

to 12.29% of the cost of production. In case of another bulk mineral i.e. limestone, the percentage of royalty ranges from 33.29% to 42.5% of the cost of production.

Similarly, percentage of dead rent ranges in case of manganese from 0.02% to 0.15% of the cost of production. In case of iron ore, the dead rent varies from 0.08% to 0.37% of the cost of production.

The total collection of revenue from royalty during 2002-03, 2003-04 & 2004-05 in main mineral producing states is summarized in table 1 below :-

Table 1 :- Royalty collection on minerals in states with significant Mining Activities

(Unit Rupees crores)

Sl.No.	State	Total Royalty Collection		
		2002-03	2003-04	2004-05
1.	Chhatisgarh	552.36	637.17	694.61
2.	Jharkhand	796.65	900.16	916.2
3.	Karnataka	83.89	143.62	210.94
4.	Madhya Pradesh	590.69	646.71	733.72
5.	Orissa	440.57	547.2	663.61
6.	Rajasthan	399.68	457.96	589.79
7.	Maharashtra	400.69	475.92	568.24
8.	Gujarat	172.63	217.90	238.95
9.	Kerala	1.63	10.45	12.61
10.	Goa	14.81	17.87	17.44
11.	Tamil Nadu	297.34	324.5	324.82
12.	Andhra Pradesh	769.93	766.56	864.53
13.	Uttaranchal	22.55	30.65	35.6
14.	Uttar Pradesh	262.42	254.18	291.94
15.	Haryana	118.08	76.77	92.50
16.	Assam	9.36	12.64	13.36

(Source : Hoda Committee Report 2006)

The table gives the statistics of mineral wise royalty collection in the major mineral producing states of India. The rates of royalty on important minerals in India (1997 to 2004) is summarized and furnished at Annexure-III.

Table 2 :- MINERALWISE COLLECTION OF ROYALTY IN MAJOR MINERAL PRODUCING STATES (MADHYA PRADESH, JHARKHAND, ORISSA, CHATTISGARH, RAJASTHAN & KARNATAKA)

(Rupees in crores)

Sl. No.	Mineral	Year 2002-03					
		M.P.	**Jharkhand**	**Orissa**	**Chhatisgarh**	**Rajasthan**	**Karnataka**
1.	Iron Ore	-	20.77	42.26	35.93	0.012	5.38
2.	Bauxite	1,25	6.59	27.74	3.98	-	0.15
3.	Copper	7.69	0.22	-	-	2.14	-
4.	Limestone	113.96	3.18	8.11	58.60	93.62	44.49
5.	Dolomite	1.07	1.05	6.29	3.68	0.69	0.16
6.	Manganese	2.61	-	1.52	-	0.01	0.087
7.	Chromite	-	-	18.18	-	-	0.078
8.	Diamond	3.05	-	-	-	-	
9.	Gold	-	-	-	-	0.13	0.0066
10.	Rock Phosphate	-	-	-	-	21.15	-
11.	Lead & Zinc	-	-	-	-	85.04	-
12.	Major Mineral	129.63	31.81	104.1	102.19	202.79	50.3516
13.	Coal/Lignite	450.26	732.07	310.73	434.08	2.39	-
14.	Sub Total	579.89	763.88	414.83	536.27	205.18	0.7184
15.	Other minerals	3.87	1,.77	2.52	0.55	20.318	0.7184
16.	Major minerals grand total	583.76	765.65	417.35	536.82	225.50	51.07
17.	Minor minerals	6.93	32.00	23.22	15.54	174.18	32.82
18.	Total Royalty	590.69	697.65	440.57	552.36	399.68	83.89
		Year 2003-04					
1.	Iron Ore	-	18.22	59.32	42.92	0.0219	46.29
2	Bauxite	1.19	7.06	25.42	5.28	-	0.1
3.	Copper	6.27	-	-	-	2.31	-
4.	Limestone	101.67	2.94	8.37	57.69	95.19	51.05
5.	Dolomite	0.88	1.04	5.94	4.12	0.59	1.05
6.	Manganese	2.38	-	3.10	-	-	0.42
7.	Chromite	-	-	27.25	-	-	0.35
8.	Diamond	3.77	-	-	-	-	-
9.	Gold	-	-	-	-	-	2.91
10.	Rock Phosphate	0.29	-	-	-	27.03	--
11.	Lead & Zinc	-	-	-	-	103.2	-
12.	Major Mineral	116.45	29.26	129.40	110.01	228.3919	102.17
13.	Coal/Lignite	514.11	836.37	386.03	512.43	3.42	-
14.	Sub Total	630.56	865.63	515.43	622.44	231.8119	102.17
15.	Other minerals	2.91	1.93	4.15	0.71	25.1681	1.40

16.	Major minerals grand total	633.47	867.56	519.58	623.15	256.98	103.57
17.	Minor minerals	13.24	32.60	27.64	14.02	200.98	40.05
18.	Total Royalty	646.7	900.16	547.22	637.17	457.96	143.62
		Year 2004-05					
1.	Iron Ore	-	23.52	72.85	42.33	0.15	79.75
2	Bauxite	1.26	10.54	29.05	8.18	-	0.22
3.	Copper	9.2	0.14	-	-	3.77	-
4.	Limestone	119.95	3.08	10.35	62.06	116.56	54.24
5.	Dolomite	1.03	1.05	5.030	5.54	0.49	0.4
6.	Manganese	4.17	-	11.18	-	0.0094	1.19
7.	Chromite	-	-	44.03	-	-	0.25
8.	Diamond	4.18	-	-	-	-	-
9.	Gold	-	-	-	-	-	8.32
10.	Rock Phosphate	-	-	-	-	30.84	-

11.	Lead & Zinc	-	-	-	-	151.23	-
12.	Major Mineral	139.79	38.33	172.49	118.11	303.05	144.37
13.	Coal/Lignite	533.95	835.74	441.92	555.5	2.87	-
14.	Sub Total	673.74	874.07	614.41	673.61	305.92	144.37
15.	Other minerals	8.78	1.95	4.66	0.95	34.83	2.3
16.	Major minerals grand total	682.52	876.02	619.07	674.56	340.75	146.67
17.	Minor minerals	51.2	40.14	44.54	20-.05	249.04	64.27
18.	Total Royalty	733.72	916.16	663.61	694.61	589.79	210.94

2. **Dead Rent** - Dead rent is a charge to be paid by the lessee for that area included in the mining lease from which minerals are not being extracted. The main purpose of levying dead rent is to discourage the lessee from keeping the mineral property idle. The existing rates of dead rent are based on the area of the lease and the value of minerals. Accordingly dead rent applicable is higher for higher value group of minerals. There is also a provision in the MMDR act that if there is a difference in the amount of royalty normally paid on the minerals extracted from the area and the amount of dead rent payable for that area, the mine owner will be required to pay the higher of the two amounts.

   This revenue accrues to the states from lessees who have not been operating their mines for own reasons and thus not paying any royalty. The rates of dead rent are as specified in the third schedule of the MM (DR) Act. This greatly varies on per hect per annum basis (from Rs.100 to Rs.400 per hectare per annum) in the country depending on the area of the lease and the number of years.

3. **Revenue from initial application fees payable by the concession seeker (prospecting fee and application fee for mining lease**). The prospecting fee is

applicable to prospecting licence and is payable in advance at the rates fixed by the State Governments being not less than Re.1/- and not more than Rs.10/- per hectare. The application fee for a prospecting licence is to be paid as per schedule II and is payable @ Rs.50/- for 1st square km and Rs.10/- for each additional sq.km.. The application fee for grant of mining lease together with the deposit is required to be made to meet preliminary expenses in connection with the grant. It is charged @ Rs.2500/-. In addition, a deposit of Rs.1000/- is also required.

4. **Annual fee payable by the Reconnaissance Permit (RP) /Prospecting Licence (PL) holder on the basis of area held –** This permit fee is applicable to Reconnaissance Permits (RP) and is to be paid annually at the rates fixed by the State Governments on per sq. km basis. The application for RPs is to be accompanied by a non refundable fee charged on per sq.km. basis. The Prospecting Licence fee however, is applicable to prospecting licences and is payable in advance at the rates fixed by the State Governments on per hect. basis. Application fee for prospecting licence is to be paid as per schedule II on per sq. km basis.
5. **Surface Rent** - This is payable at a rate not exceeding the land revenue as may be specified by the State Government and may vary from state to state. The rate in Kerala is Rs.100/- per hectare/acre per annum, whereas it is Rs.5/- per hectare in Madhya Pradesh. In certain states the rates vary in villages for non agricultural area used for mining or municipal area used for mining on per sq. km basis.
6. **Sales tax or Value Added Tax (VAT)**
7. **Local area tax -** Village Panchayat levies / taxes on widely varying rates are charged in different states of India. In addition, certain other taxes like **Municipal/Octroi/Toll /Entry Taxes** are also charged at rates varying even within the mineral producing state. Various other **real estate taxes** whose rate vary from state to state, taxes on change in land use (charged under surface rent), **forest produce tax** and forest passes are charged in certain states. Certain states of India enforce **compensatory afforestation tax/levies** which differ from state to state on per hect of forest land diverted for mining. These rates vary with respect to mechanized,

non mechanized and underground mining and range on per hect basis. These rates also differ on the basis of forest density .

8. **Stamp duty or transaction fee** paid on registration of mining lease for a period of 20 to100 years as charged in different states**.**
9. **Cess and surcharge on minerals** :- Some states like Orissa and West Bengal have also imposed a cess and surcharge on minerals under the understanding that they have necessary powers under entries 49 and 50 in list II of the seventh schedule.

10. **Security deposit** :- This deposit for the observance of relevant terms and conditions, is required to be made before execution of the RP/PL/ML at the rate of Rs.20/- per sq.km. for a RP, Rs.2500/- for every sq.km. or part thereof for PL and RS.10,0000/- for ML.

1.3 Direct Taxes :- The following taxes and incentives under the Income tax Act applicable to the industry in general and mineral sector in specific are mentioned for reference here. However, since these taxes are common to corporate bodies they are not brought under the preview of the present Sub Group III :-

1. **Corporate tax** - in respect of Indian & foreign companies.
2. **Withholding taxes** - in respect of dividends, interest, fee & salaries paid to foreign consultants.
3. **Taxes on capital gains –** charged on long term capital gains.
4. **Minimum Alternate taxes (MAT) –** payable by companies where the total taxable income of a company is less than 30% of its book profits
5. **Service tax –** leviable on certain taxable services hired or undertaken by the company
6. **Tax incentives and allowable deductions –**
   - (i) **Tax holidays –** Mining companies in specified backward areas are eligible for a complete tax holiday under IT Act for specified years.
   - (ii) **Depreciation allowance –** Annual depreciation eligibility on buildings, machinery & equipments, commercial vehicles, furniture & fittings, and Mining pollution control and energy saving equipments.
   - (iii) **Carry forward and settlement of all business losses** - .

(iv) **Deduction for export turn over**

(v) **Expenditure on prospecting/extraction and production of minerals**.

(vi) **Expenditure on research and development** – Deductions available to mining companies on payments made to specified Universities and Laboratories for carrying out scientific research.

1.4 **Indirect taxes** :- The following indirect taxes are levied on mineral sector in India :-

1. **Customs duty** – The basic customs duty is levied on most minerals and concentrates of metals at the rate fixed by the Government. From Table 1.4 given below, it is noticed that customs duty on ore or concentrates was levied @ 5% from year 2002-03 to 2005-06 while 2% customs duty is levied during 2006-07. However, additional customs duty @ 4% is attracted on import of ores, machinery, other equipments & R&D equipments w.e.f. 1.3.2006.

   The customs duty on import of machines and equipments has shown a declining trend from 25-30% in 2002-03 to 12.5% in 2006-07. In case of import of R&D equipments, however, no separate exemption/concession for mining sector are available.

2. **Excise duty / CEN VAT –** Excise duty is now described as Central Value Added tax (Central VAT) and charged at the rate fixed by Central Government.

3. **Service Tax -** The following services rendered in India attract service tax @ 12% + 2% education cess (total 12.24%)

   (a) Services provided to a customer by any person in relation to survey & exploration of minerals (introduced w.e.f. 10.9.2004).

   (b) Services provided for site formation, clearance excavations, earthmoving and demolition, etc**.** w.e.f. 26.6.2003.

The duty structure (Customs and Central Excise) on ores and machines/equipments for the mining sector for the last five years as furnished by the Department of Revenue, Ministry of Finance is given under table 1.4 below. These rates have been rationalised to be at par with ASEAN countries :-

Table 1.4

DUTY STRUCTURE ON ORES AND MACHINERY/ EQUIPMENTS FOR THE MINING SECTOR FOR THE LAST FIVE YEARS

	Ores / Concentrates	**Machines & other equipments**
2002-03		
Customs duty	5%	25-30%
Excise duty	Nil	16%
2002-04*		
Customs duty	5%	25%
Excise Duty	Nil	16%
2004-05*		
Customs duty	5%	20%
Excise duty	Nil	16%
2005-06*		
Customs duty	5%	15%
Excise duty	Nil	16%
**2006-07*		
Customs duty	2%	12.5%
Excise duty	Nil	16%

* Edu cess @ 2% is attracted on import of ores, machinery & other equipment, including R&D equipments w.e.f. 9.7.2004

** Additional duty of customs @4% is also attracted on import of ores, machinery and other equipment, including R&D equipments w.e.f. 1.3.2006

1.5 Comparison of taxes in India and in selected countries

1.5.1 **Comparison of international system and rates of calculating royalty** – Three systems of calculating royalty are prevalent in the world. These are (a) Quantity based or rate per tonne, (b) Ad valorem or percentage of revenue and (c) Profit based or percentage of profit.

1.5.2 Quantity based royalty also known as specific rate royalty is charged on the basis of a unit of quantity such as weight e.g. $ or Rupees per MT. This system is easy to administer, but is inefficient in fiscal terms as the collection of royalty revenue is a function of the quantity extracted and rising prices do not get reflected in the receipts. It is generally used for low value and high volume minerals. An ad valorem or value-based royalty is

calculated by applying a percentage rate to the gross sale value. This is usually 'ex-mine' or pit head value (sale realisation) less allowable expenditure. In the profit-based system royalty is a percentage of the net profit earned by the mineral producer. This system is usually project-based and profit is calculated by obtaining all project revenues and deducting from them all project costs. A pure profit based royalty is more equitable and has less effect on exploration and mining company investment decisions than the other two systems described above. However, the major disadvantages of the system are uncertainty in yield and problems in administration.

1.5.3 Nevertheless, there is a strong case for the royalty regime in India to move strongly towards the ad valorem system to augment revenues of the states. In the case of some minerals international prices have risen several fold over short time periods. Unless royalty is fixed on an ad valorem basis Governments do not benefit at all from the increase in price.

1.5.4 Regarding royalty rates in other countries and their implications for India, it has already been discussed that benefits could be derived from conversion of specific rates of royalty to ad valorem.

1.5.5 Indian Mining companies and manufacturers are living in a rapidly globalizing world and they have to compete with their foreign counterparts not only in the external markets but in the domestic markets as well. In such a situation, it would not be wise to set a royalty rate, which is out of tune with the rates in other countries. Furthermore, India has to compete with other mineral producing countries in attracting FDI in mining. One of the factors that mining companies take into account for their investment decisions is certainly the fiscal regime and the rate of royalty in particular.

1.5.6. The following table 1.5.6 gives the comparative picture of the royalty rates prevailing in India and in other countries, drawn up by the Royalty Rates Study Group in 2004, duly corrected to take into account the latest information available from Australia, which is one of the major mining countries of the world. Three of the countries with major or significant mining activity, i.e. Canada, Chile, and South Africa do not levy any royalty at all. In Australia each of the seven states have their own royalty rates. In all the states the rates are predominantly in ad valorem terms, largely in the range of 2.5 to 5%. In few cases in the major mining states of Western Australia, the rate is 7.5% for some important minerals such as iron ore lumps, manganese, bauxite, diamonds and precious stones. The state of Northern Territories as an exception has a uniform rate of royalty of 18% for all products.

Table 1.5.6.

International Comparison of royalty rates

	Australia	**China**	**Brazil**	**Indonesia**	**Uzbekistan**	**India**
Asbestos	5% of realized value	2-4% of sale value	N.A.	-	3% of sale price	Tonnage basis
China clay	5% of realized value	N.A.	N.A.	N.A.	7.9% of sale value	Tonnage basis
Copper	5% of realized value	2% of sale value	2% of net invoice value	4% of sale value	7.9% of sale price	3.2% of LME metal price
Chromite	5% of realized value	N.A.	N.A.	3.5% of sale value	N.A.	7.5% of sale value
Bauxite	7.5% of sale value	2-4% of sale value	N.A.	3.25% of sale value	N.A.	0.35% linked to LME price
Diamond	7.5% of realized value	Industrial -25 of sale value, Gem 4% of sale value	N.A.	6.5% of sale value	2-4% of sale price	10% of sale value
Gold	1.25% of realized value	4% of sale value	1% of net invoice value	3.75% of sale value	2.8% of sale price	1.5% of London Bullion Market Association price
Graphite	5% of realized value	N.A.	N.A.	N.A.	6% of sale price	Tonnage basis
Iron Ore	5% to 7.5% of realized value depending on grade	2% of sale value	N.A.	3% of sale price	3% of gross value	Tonnage basis depending on grade
Magnesite	5% of realized value	20-4% of sale value	N.A.	N.A.	N.A.	3% of sale price

1.5.7 Two Asian countries, namely, China and Indonesia have significant mining activity. In China, the royalty rates are predominantly 2%. Some of the major exceptions being gold and precious stones which are charged at the rate of 4%. In Indonesia, the rates are mostly in the range of 3-5%, except for diamond which is 6.5%. In Central Asia, Kazakhstan and Uzbekistan are two important mineral states. In Kazakhstan for most important minerals the rates are established through negotiations & contracts for each single mines depending upon the project economic. In Uzbekistan, the rates are generally very low, except for copper (7.9%), diamond (24%), tungsten concentrate (8%) and kaolin (7.9%). African countries generally have low royalties except for diamond and precious stones in which it is generally 10%.

1.5.8 A study of the royalty rates in other countries shows some other features as well. In some countries each mineral type is taxed at a different rate (such as in the application of a royalty assigned to each mineral type) or minerals are grouped and each group is uniformly taxed (typical groupings include industrial and construction materials; fertilizer minerals; precious metals, precious stones; base metals; non petroleum energy minerals; so on and so forth). To some extent, the level of discrimination may depend on whether the mineral is destined for a globally competitive market or for the local market. For example, base metals are often taxed at a lower rate than low-value bulk commodities like sand and gravel reflecting the fact that investment in base metals is highly dependent on foreign investors, who have many countries to choose from while making their investment decisions, compared to sand and gravel, where mainly domestic investors are active. Governments may also adjust their tax systems in an attempt to impart higher taxes on minerals like diamonds, which are expected to generate higher profit levels. In fact, in addition to ad valorem royalty, profit based royalty is also imposed on a diamond mine in order to get a better share of revenues from such ventures.

1.5.9 Judged from the angle of internationally competitive royalty rates there would appear to be scope for upward revision only in a few minerals such as manganese ore and iron ore. In several products the Indian royalty rates are higher than those of other countries. This does not necessarily mean that the rates should be considered for lowering, as the comparative cost of mining operations in India should also be taken into account. Only in those cases in which there is evidence that the rates are inhibiting mining operations should such a step be considered.

1.6 Fiscal reforms/rationalization required in Indian Mineral Sector

1.6.1 Taxation is a form of government intervention which is necessary for optimal exploration, mechanization of mining operations, maintaining environmental standards and maximizing mineral returns. It is also necessary to achieve equality and international competitiveness through optimal mineral extraction policy. Even though market can take care of optimal extraction of mineral through price and interest mechanism, possible market failures warrant a modest amount of government intervention.

1.6.2 The Department of Revenue, ministry of Finance through its representative in Sub Group III has conveyed the following stand taken by the Department of Revenue.

> Fiscal measures have to be considered in the context of budget based on overall revenue and expenditure needs and based on national priorities as determined by the Government. Thus the duty structure and concessions for a particular industry should not be made part of policy making by the individual Ministries and should ideally be left to Ministry of Finance which is entrusted with the responsibility of making budget for the Government.

In the light of above observations of the Department of Revenue of the Ministry of Finance, no specific suggestions or recommendations on duty structure and concessions as applied to mining sector in India are proposed.

1.6.3 Internationally the ad valorem royalty system is more commonly used. In India there is unanimity among the states now in the **demand that royalty rates should be shifted from tonnage to ad valorem**. The main problem with ad valorem royalty is the determination of price or value on which the royalty rate is to be applied. Determination of value of the metals traded on International Commodity Exchanges (e.g. London Metal Exchange) for certain metallic minerals, may not be very difficult. But for others, where no such bench mark is available the determination of value for the purpose of royalty is problematic. In India, this problem is being faced in the case of most minerals, which do not have international benchmark prices. Nevertheless, there is a strong case for the royalty regime in India to move strongly towards the ad valorem system to augment revenues of the states. In the case of some minerals international prices have risen several fold over short time periods. Unless royalty is fixed on ad valorem basis, Governments do not benefit at all from the increase in price.

1.6.4 The following recommendations of the multi disciplinary committee on taxation constituted by the Ministry of Mines and submitted to the Ministry of Finance, (July 2000) deserve consideration :-

(i) Rate of annual depreciation for mining plant and equipment should be increased to 100% in order to encourage investment in mining sector as per practice existing in a large number of mineral rich countries & notably in African countries.

(ii) All expenditure incurred prior to commercial production including the expenditure incurred on site and deposit acquisition should be eligible for amortization over the minimum mining lease period of 20 years or a lesser period at the option of the lessee.

(iii) For reclamation of mined out area, the mining companies may be allowed to earmark a percentage of book profits each year to met rehabilitation cost in future and set it aside as a special reserve in their books.

(iv) Import duties on mining equipments may be reduced. In case of equipments used for gold & diamond mining operations. No duty should be applicable, while for other mining operations the duty should be at par with imports for coal mining equipments.

(v) Nil levy of excise duty structure for concentrate produced in the leaseholds and low excise duty structure for concentrates produced outside leaseholds, may be devised. This is as per recommendation of Mineral Development Council (MDC) which has suggested that the concentrates produced within lease area may be exempted from levy of excise duty in the same manner as ores & minerals.

CHAPTER 2

INFRASTRUCTURAL DEVELOPMENT

(Item No.2 of the Terms of Reference)

Terms of Reference

"To assess year-wise requirement of infrastructure such as power, water, communication, roads, ports & railways (both fiscal and financial) in the mining sector during the 11th Five year Plan period and in the perspective of 10-15 years thereafter, suggest measures to fill up existing gaps and building up of additional infrastructure defining the role of Central, State Governments and private sector in creating such infrastructure."

2.0 Preamble & Introduction

2.1.1 Development and growth of the mineral sector is dependent on availability of adequate infrastructure viz. roads, railway lines, port facilities, power, water and communication facilities. Without these basic infrastructure facilities, the mineral resources cannot be accessed, extracted and marketed. Several Indian mines are usually located in remote areas and therefore, this poses a major constraint for sustaining the production.

2.1.2 Rural roads linking major mining projects and roads from linking national or state highways are generally constructed and maintained by large mining companies.

However, in case of small and medium enterprise (SME) mines, generally unsurfaced roads cater to mineral traffic. These results in movement of minerals to distant places rather uneconomical. At times it is cheaper to import mineral than to move it from one part to another part in the country.

2. 1.3 Road and rail links for the transportation of minerals from the mined areas to the nearest railhead or national or state highway, are the primary infrastructure requirement before a mine can be opened up. In the absence of such links the growth potential of the mining sector in the country is seriously handicapped. The infrastructure issue has to be seen in two different contexts viz. needs of the mining majors on the one hand and the needs of

the mines of Small & Medium Enterprise (SME) sector on the other. Mining majors or large stand-alone mines tend to construct their own mine-linking infrastructure. Publicly funded infrastructure is needed mainly for the SME sector mines since the scale of their operations limits their ability to build their own mine-linking infrastructure.

2.1.4 In most parts of the world, there is hardly any mining in the SME sector. In India, on the other hand, the mining operations are largely confined to the SME sector. The infrastructure requirements of the SME sector operations are different, mainly, because the economies of scale does not permit miners to put up their own infrastructure. Therefore, SME sector mines usually tend to come up where some form of public infrastructure already exists. Since existing roads and railways are already over burdened, mining needs are difficult to satisfy and have to be met at the expense of other users.

2.1.5 Short-term infrastructure needs relating to movement of iron ore, bauxite, limestone, rock phosphate and dimensional stone from mine sites to ports will have to be assessed in order to assess growing demand from the increased traffic in these segments.

2.1.6 India has an edge over many countries in terms of strategic locational advantage, large domestic market, skilled manpower in steel making, availability of cheap iron ore, etc. At the same time it has some serious disadvantages such as inadequate port and rail network, lack of power, etc.

2.1.7 In order to assess year-wise requirement of infrastructure such as railways, ports, roads, power, water and communication for the mineral sector during the XI Plan period and in the perspective of 10-15 years thereafter and to suggest measures to fill up the existing gaps and building up additional infrastructure, an attempt has been made to concentrate on some important bulk minerals like iron ore, bauxite, limestone, rock phosphate and dimensional & decorative stones from the point of view of domestic requirements and / or exports.

2.2 Status of Infrastructural Development in Indian Mining Belts.

The status of infrastructure development in important Indian mining belts has been assessed and evaluated through the classic MGS/POCS/SIS reports prepared by IBM mining geologists. The review table furnished under Annexure V gives an overview on this theme in Indian context.

2.3 Requirement of infrastructure for mineral sector

2.3.1 Iron Ore

India is endowed with vast resources of iron ore distributed close to the eastern and western coast of the country. Major Indian iron ore producing areas can be grouped under the following five zones

Zone A-	CHIRIA, NOAMUNDI, KIRIBURU, BOLANI, MEGHATABURU THAKURANI, BANSPANI, GUA, BARAIBURU, DAITARI, GANDAMARDAN, MALANGTOLI
Zone B-	BAILADILA, DALLI, RAJHARA, MAHAMAYA, ARIDONGRI, ROWGHAT, SURAJGARH
Zone C-	DONIMALAI, RAMANDURG, KUMARSWAMY, NEB RANGE, ETTINAHATTI, TUMTI, BELAGAL
Zone D-	NORTH GOA, SOUTH GOA, REDDI
Zone E-	KUDREMUKH, BABABUDAN, KODACHADRI

Out of total resources of 22,108 million tonnes of iron ore, 41% is concentrated in Karnataka followed by Orissa (17%), Jharkhand (13%) and Chattisgarh (10%), Andhra

Pradesh (8%), Goa (4%) and remaining 7% in Madhya Pradesh, Maharashtra, Tamilnadu and Rajasthan. Infrastructural needs of these regions is reviewed as below :-

2.3.1.1 **Bellary-Hospet region**

The Bellary-Hospet region is endowed with rich iron ore deposits of about 1.5 billion tonnes and this sector currently produces more than 35 million tonnes of iron ore annually. Since, there are a very few large user industries (steel mills), due to water and power shortages, most of the iron ore is exported. Around 20-25 million tonnes iron ore is exported to China, Japan and South Korea, the balance being sold to the domestic pig and sponge iron units in the region. This ore is exported through ports of Mangalore, Chennai, Goa, Vizag, Kakinada, Karwar and Belekeri. Therefore, certain improvements are urgently called

for on these ports. The quality of roads is also not good enough to meet the heavy traffic requirements of trucks transporting iron ore from mines to loading stations. Improving road conditions will reduce cost by minimizing truck breakdowns, less fuel consumption and smoother travel.

2.3.1.2 **Goa region**

Export of iron ore from Goa region is equally important. Of the 78.14 million tonnes of iron ore exported from the country during the year 2004-05, more than 40% i.e. about 31.40 million tonnes was routed through Goa. There are certain bottlenecks, which are adversely affecting the exports of iron ore through the Goa port. There is limited railway line capacity to transport iron ore from Karnataka mines to Goa which also needs augmentation.

2.3.1.3 **Eastern region**

The eastern region comprising Orissa, Jharkhand and Chattisgarh, is endowed with high-grade iron ore reserves amounting to 45% of the total reserves of the country. Export of iron ore from the above States through Haldia port has increased from 0.35 million tonnes to 4.96 million tonnes and through Paradip port from 2.73 million tonnes to 9.05 million tonnes within a period of 5 years from 2000-01 to 2004-05. Rail and road linkages to the ports of Haldia and Paradip are the main short-term infrastructure requirements in the eastern sector.

The future capacity expansion of iron ore mining is possible only with expansion of railways particularly in the eastern zone and the port facilities on the eastern and western coasts. The east coast ports of Haldia, Paradip and Vishakhapatnam have recorded significant growth in iron ore shipments during the last two years. However, additional facilities have to be created to handle the increased volume of iron ore in the coming years. So far as Haldia and Paradip ports are concerned the railway bottleneck is critical and unless removed, it can frustrate any efforts by these ports to step up ore transportation. The railway bottleneck is largely, the result of single line existing between Panskura and Haldia (for Haldia port) and between Cuttack and Paradip (for Paradip port). The Haldia port will facilitate export of iron ore from Jharkhand as well as Orissa. The existing facilities at the above port are insufficient to handle increased transportation. Paradip Port in Orissa coast will provide outlet for iron ore from Orissa. The facility at this port needs further augmentation to accommodate larger ships. **Vishakapatnam port** is the most important port

in the east coast, so far as export of iron ore from Bailadila is concerned. The space allotted for iron ore in this port is inadequate to facilitate export of increased quantum of iron ore. **Chennai port** is the main outlet for iron ore from Bellary-Hospet area. As the Chennai port is likely to be closed for iron ore exports, alternate arrangement is being made at Ennore port for export of iron ore. **New Mangalore port** in the west coast has been recently developed for export of iron ore pellets and concentrates from Kudremukh iron ore project. However, the iron ore traffic at New Mangalore has gone up with additional shipment of iron ore from other mines of Karnataka. The capacity of the port to accommodate larger ships has to be developed for exports of iron ore. **Mormugao port (Goa**), on the west coast is of prime importance. The entire output of iron ore from Goa and considerable quantity of iron ore from Bellary-Hospet is exported through this port. Deepening of the draft at this port to accommodate larger size ships and installation facilities for mechanical handling for rail borne iron ore from the above area needs urgent attention. If India has to remain competitive in the world export market of iron ore, there is no option, but to match the infrastructural facilities with other iron ore exporters in the world. Our port facilities in terms of size of vessel and loading rates are far below other exporting countries, viz. Brazil, Australia, etc. Similarly, consuming countries viz. China, South Korea, Taiwan, Japan, etc. are already having ports to handle large ships while new ports with larger capacities are being built.

Production of iron ore in India is 141 million tonnes (2004-05). Orissa is largest producer (28%) followed by Karnataka (26%), Chattisgarh (16%), Goa (15%) and Jharkhand (11%). The state-wise production of iron ore is provided in ANNEXURE –VI.

The export of iron ore has increased from 37.27 million tonnes in 2000-01 to 89.27 million tonnes in 2005-06 (provisional), i.e. a growth of more than 100% in a span of 5 years. The destination-wise exports of iron ore are furnished at ANNEXURE – VII. The export of Iron Ore handled by major Indian ports is furnished under Annexure VIII.

The year-wise production, domestic consumption and exports of Indian iron ore are furnished at ANNEXURE – IX.

NMDC and SAIL are two large producers of iron ore in India. The projected production of iron ore by NMDC and SAIL is furnished at ANNEXURE - X & XI.

2.3.1.4 **Projections of domestic consumption & exports of Iron Ore** :- As per the National Steel Policy-2005, projections for domestic consumption for iron ore are at 200 million tonnes by 2020 and for exports are at 100 million tonnes by 2020. Thus, total future demand (both domestic and exports) is projected at 300 million tonnes by 2020. The sector-wise projections (based on current level of exports) from various regions is as follows:

• Bellary-Hospet Sector	-	40 million tonnes
• Goa Sector	-	30 million tonnes
• Bailadila Sector	-	5 million tonnes
• Orissa – Jharkhand Sector	-	25 million tonnes
Total		**100 million tonnes**

2.3.2 **Bauxite**

2.3.2.1 Major Indian bauxite deposits are located in Orissa, Andhra Pradesh, Jharkhand, Madhya Pradesh, Maharashtra, Chattisgarh, Tamilnadu and Gujarat. The leading producers are Orissa (45%), Gujarat (17%), Jharkhand (14%), Maharashtra (10%), Chattisgarh (8%), Tamilnadu (3%)

2.3.2.2 In the 11th plan period, envisaging a growth of 10% by the end of plan period 2011-12, the requirement of bauxite is estimated at about 28 million tonnes. By the end of 12th plan period, the bauxite requirement is likely to reach 50 million tonnes.

2.3.2.3 NALCO is the main producer of bauxite, alumina hydrate and aluminium cast metal. The projected production of NALCO for various products (up to 2022) is furnished at ANNEXURE - XII

2.3.3 **Dimensional & Decorative Stones**

2.3.3.1 Dimensional Stones are the mainstay of the economy of Indian states like Andhra Pradesh, Tamilnadu, Karnataka and Rajasthan. India is endowed with vast natural resources of granite in several States predominantly in Southern India, Uttar Pradesh, Rajasthan, Madhya Pradesh, Gujarat and Bihar.

2.3.3.2 Majority of marble, sandstone, flaggy limestone produced in India comes from Rajasthan, which accounts for over 90% of Country's production of marble, sandstone and flaggy limestone (Kotastone).

2.3.3.3 Internationally, more than 90% of the movement of dimensional stones (marble, granite) to ports and internal destinations are by rail, which is the cheapest mode of transportation. In the absence of rail transport facilities on the scale required, Indian stone miners depend for the movement of dimensional stones entirely on high cost road transport. There is a limit up to which a truck can carry the weight. Being heavy weight cargo, transportation of granites by trucks has its peculiar problems. Single dimensional blocks of 15 to 30 tonnes, which are required for export markets as well as for large factories within the country, have to be transported by trucks. Most of the trucks in India are allowed to carry only 12 tonne load. In countries like China, South Africa and Zimbabwe the transportation of dimensional stone blocks is undertaken by Railways. Compared to facilities in those countries, Indian dimensional stone industry has practically no infrastructural support from the Railways.

2.3.3.4 The transportation of raw blocks and finished goods to and fro quarries and factories are severely hampered due to lack of proper roads and rail connectivity from major stone clusters.

2.3.3.5 This Indian dimension stone industry is totally dependent on road transport with practically no support from the railways. Most of the competing countries have vast network of rail transportation supporting their stone industry through which they are able to offer any quantity in any size at very competitive prices in International market. Thus, it is necessary for the Indian stone industry to have proper rail links nearest to the quarrying areas.

2.3.3.6 A list of destinations where stockyards and separate sidings are required is given below.

Table 2.3.3.6

Projected requirement of Stockyards and Separate Railway Sidings for Dimensional Stones

		Quantity handled (in tonnes per year)	Future projections (in tonnes per year)
1.	ANDHRA PRADESH		
	Ongola	2,50,000	5,00,000
	Khammam	2,00,000	4,00,000
	Karimnagar	2,00,000	4,00,000
	Narasipatnam	2,00,000	4,00,000
	Warrangal	1,80,000	4,00,000
	Srikakulam	1,00,000	2,00,000
	Chittoor	75,000	2,00,000
	Tandur Cuddapah Markapur	These towns are handling lakhs of tonnes of Cuddapah stones, which are exported and which are also required for internal consumption.	
2.	TAMIL NADU		
	Dharmapuri	2,00,000	4,00,000
	Salem	2,00,000	4,00,000
	Madurai	3,00,000	6,00,000
	Mettur	1;00,000	2,00,000
	Nagarkoil	1,00,000	2,00,000
3.	KARNATAKA		
	Charmarajanagar	2,00,000	4,00,000
	Kanakapura	3,00,000	6,00,000
	Tumkur	1,00,000	2,00,000

	Ilkal	4,00,000	8,00,000
	Bellary	1,00,000	2,00,000
4.	KERALA		
	Tiruananthapurarn	1,00,000	2,00,000
5.	MADHYA PRADESH		
	Katni	2,50,000	5,00,000
	Chattarpur	2,00,000	4,00,000
6.	ORISSA		
	Titlagarh	2,00,000	4,00,000
	Berharmpur	1,00,000	2,00,000

7.	MAHARASHTRA		
	Nagpur	2,00,000	4,00,000
	Ballarshah	2,00,000	4,00,000
8.	CHATTISGARH		
	Raipur	1,00,000	2,00,000
	Jagdalpur	1,00,000	2,00,000
9.	HARYANA		
	Kund	1,00,000	2,00,000
10	RAJASTHAN		
	Dholpur	2,50,000	5,00,000
	Sawai-Madhopur	1,00,000	2,00,000
	Chittorgarh	1,00,000	2,00,000
	Bundi	2,50,000	5,00,000
	Kisangarh /Makrana	2,50,000	5,00,000
	Jalore	1,00,000	2,00,000
	Udaipur / Rajsamand / Abu Road	2,50,000	5,00,000
	Alwar	50,000	1,00,000
	Banswara	50,000	1,00,000
11	UTTAR PRADESH		
	Agra	1,00,000	2,00,000
	Lalitpur	2,00,000	4,00,000

2.3.3.7 Movement from all the above clusters is approximately 6,00,000 tonnes per month. Hence mineral/rock material amounting to more than 70 lakhs tonnes per year from these centres is handled. Many quarries have been closed because of high transportation cost by trucks. Hence providing proper siding arrangements, railway stockyards with ICD arrangements is the only answer for reducing transportation cost of the mineral / rock. Also there appear bright prospects for railways to have additional earnings. Such facilities of rail movement will also facilitate transportation of additional tonnage of other natural stones like Marbles, Sandstones, Kotastone, Slate etc.

2.3.3.8 Arrangements are also required to be made at ports for stone stockyards with proper handling facilities, where wagons / racks can be unloaded and directly loaded to the vessels. It is a matter of concern that the larger Mother vessels call only at the JNPT Bombay harbour. Containers, which are loaded in India, are taken to Singapore or Colombo to catch the mother vessel, which entails holding of cargo and delays shipment. The

Government, on 2nd May 2001 has notified the seaports at Mumbai, JNPT, Kolkata, Chennai, Vizag and Cochin; airports at Delhi, Mumbai, Chennai and Kolkata and ICDs. Tughlakabad, New Delhi as the only ports eligible for import of inter alia marble and granite. The move is laudable and if these ports are upgraded to handle import of stones, the facilities could simultaneously be upgraded for exports as well, so that these ports may receive the mother vessels.

2.3.4 **Limestone and other industrial minerals**

Limestone, rock phosphate and some other industrial /bulk minerals as bulk minerals also depend largely on rail, road and port infrastructure for domestic consumption and export. India produces as many as 90 minerals and most of the mines are located in interior and tribal areas. The mining companies develop infrastructure commensurate to their requirements. However, so far the development of general infrastructure like all-weather roads, which can withstand movement of heavy vehicles, is woefully lacking in such mining belts. The general road conditions in mining belts otherwise also is extremely bad. State Governments do not spend funds for providing linking infrastructure to mining areas. It is, therefore, considered necessary that State Governments apportion a certain amount out of their royalty collection for providing roads and other basic amenities like power, telecommunications, etc. at par with industrial estates. It is, therefore, essential that adequate attention is given on infrastructure development in mining areas by Central and State Government. Government should provide special emphasis on development of roads in Northeast region looking to large potential for export of limestone.

2.4. INITIATIVES FOR INFRASTRUCTURAL DEVELOPMENT

2.4.1 Ports

2.4.1.1 Ports constitute a crucial part of the transportation infrastructure of the country. The international experience with economic development has emphasized the infrastructure development near the coast by ploughing back the "gains from trade".

2.4.1.2 India has 12 major ports and 187 minor ports along its 7,517 km long Indian coastline. Cargo handled by Major Indian Ports has increased by 9.5% p.a. over last 3 years. Major ports handle nearly 75% of the total traffic. These are Chennai, Cochin, Ennore, Jawaharlal Nehru Port (Mumbai), Kandla, Kolkata, Marmugao, Mumbai, New Mangalore, Paradip, Tuticorin and Visakhapatnam. There are 187 minor ports, with a pronounced density on the west coast. These minor ports are located in Gujarat (40), Maharashtra (53), Goa (5), Daman & Diu (2), Karnataka (9), Kerala (13), Lakshadweep (10), Tamil Nadu (14), Pondicherry (1), Andhra Pradesh (12), Orissa (2), West Bengal (1) and Andaman and Nicobar Islands (23).

2.4.1.3 Recently, Ministry of Shipping has undertaken ambitious plan for development of ports. Some of these initiatives are:

- The experience of operating berths through PPPs at some of the major ports in India has been quite successful. It has, therefore, been decided to expand the programme and allocate new berths to be constructed through PPPs;
- The Government has also decided to empower and enable the 12 major ports to attain world-class standards. Recognising that the shipping industry is moving towards large vessels, a plan for capital dredging of channels in major ports has also been formulated;
- Rail-road connectivity to major ports is being enhanced;

- The National Maritime Development Programme is expected to bring a total investment of over Rs. 50,000 crore in the port infrastructure. Such improvement in the scale and quality of Indian port infrastructure will significantly improve India's competitive advantage in an increasingly globalized world;
- The wagon tipplers in Chennai port have already been revamped and replaced as per the requirements of the iron ore exporters;
- Ennore Port plans to take up within a year the development of an iron ore berth through public-private-partnership to handle 12 MMT of iron ore;
- For receiving vessels the Mangalore port has drafts of 14 metre and is proposing to increasing it to 17 metre draft. The port is also planning for mechanical unloading and stacking;

- Vishakapatnam Port has three tipplers working and the port is planning to deepen the approach channel to receive 2.25 lakh DWT vessels during the course of the XI Plan;
- Kolkata Port has already initiated action for the preparation of a deep sea port south of Haldia Dock Complex;
- Paradip Port has already invited expression of interest for construction of an iron ore berth for handling 1.25 lakh DWT vessels and also implementing the project for deepening of approach and entrance channels and turning basin; and
- Development of Dhamra port in Orissa and Krishnapatnam port in Andhra Pradesh needs to be expedited soon.

2.4.1.4 It is recommended that the above projects be implemented most expeditiously, as they would address the immediate problems of mineral/metal exporters. This will lead to the reduction of freight costs and make Indian iron ore more competitive vis-à-vis Australian and Brazilian iron ore. The deficiencies at the ports, the long linkage from the mining area to the port through road and rail and lack of long term planning by exporters are some of the factors responsible for the current situation where the landed cost of per tonne of India's high grade Iron ore at a Chinese port comes to US$ 65 as compared to Brazil's US$ 62.90 and Australia's US$ 50.99. Although location-wise India is much closer to China than Australia or Brazil, the freight cost from Brazil is more or less same as that of India due to large size ships. As a result, India's share in China's market is less than 20%.

2.4.1.5 Some of the infrastructural bottlenecks at Indian ports are as follows:

- Inadequate receiving capacity of about 15000 tonnes per tippler per day
- Inadequate stockyard capacity in ports to ensure enough quantity of iron ore stocks for the shipping system to work continuously at the optimum capacity.
- Inadequate loading capacities
- Inadequate railway network to feed the port
- Inadequate draft to handle large vessels

Some of the above bottlenecks need to be suitably corrected during the XI Five Year Plan.

2.4.2 **Roads**

2.4.2.1 For a country of India's size, an efficient road network is necessary both for national integration as well as for socio-economic development. The National Highways (NH), with a total length of 66,590 km, serves as the arterial network across the country. The ongoing programme of four-laning the 5,846 km long Golden Quadrilateral (GQ) connecting Delhi, Mumbai, Chennai and Kolkata is almost complete. The ongoing four-laning of the 7,300 km North-South East-West (NSEW) corridor is to be completed by December 2009. An ambitious National Highway Development Programme (NHDP), involving a total investment of Rs. 2,20,000 crore upto 2015, has been established. The main elements of this programme are:

- Four-laning of the Golden Quadrilateral and NS-EW Corridors (NHDP I & II)
- Four-laning of 10,000 kms (NHDP-III)
- Two laning with paved shoulders of 20,000 km (NHDP-IV)
- Six-laning of 6,500 kms (NHDP-V)
- Development of 1000 km of expressways (NHDP-VI)
- Construction of Ring Roads, By-passes, Grade-separators, service Roads, etc (NHDP-VII)
- In addition to development of roads in North-East region, special Accelerated Road Development Programme has also been approved [SAROP-NE].

2.4.2.2 A number of National Highways and State Highways have been identified which are of critical importance to the Indian mining sector for near future.

i.	Rajamundra-Barbil (NH215)	-	269 kms
ii.	Barbil-Panikhole (NH215)		
iii.	Chandikhole – Paradip (NH5A)	-	77 kms
iv.	Jamshedpur – Haldia (NH33,NH6& NH41)	-	200 kms
v.	Jaintgarh – Chaibasa – Haldia(NH 75E)	-	100 kms

These road projects are envisaged to be completed during XI Plan as per following schedules -

- Rajamunda-Barbil & Barbil-Panikhole section - NH 215 starts at Panikhole and ends at Rajamunda, and the entire 269 kms highway falls within Orissa. Improvement of NH-215 has been included under NHDP-IIIA for entire length of 269 Kms from Panilkhole to Rajamundra. The DPR and bid document is under preparation, the target data for completion of this work is December 2009.
- Chandikhole-Paradip section - NH-5A from Chandikhole to Para dip has already been taken up for four-lining in 2004 and 34% of the work has been completed. The entire NH 5A falls in Orissa and was taken up as a port connectivity project. The project is scheduled to be completed in June 2007.
- Jamshedpur-Haldia section - As far as this section is concerned, the stretch comprises NH-33, NH6 and NH 41. A part of this route from Kharagpur to Kolaghat falls on the Golden Quadrilateral and the portion from Kolaghat to Haldia has been taken up under the port schemes for improvement. The

portion of the NH 33 and NH 6 falling in Jharkhand has not been taken up for improvement.

- Jaintgarh-Chaibasa-Haldia section On this section the portion from Jaintgarh to Chaibasa is part of NH 75E and from Chaibasa to Jamshedpur is a state highway.

2.4.2.3 Thus most of the above identified roads section are already under improvement under various National Highway projects. Among national highways the only ones not yet taken up are NH 33 and a small segment of NH 6 falling in Jharkhand as well as NH 75 E. The Sub Group III therefore recommends that these sections of the route from Jaintgarh via Chaibasa and Jamshedpur to Haldia whose improvement is not yet taken up should be taken up now under NHDP III project. It is also proposed by the Sub Group that the small portion of state highway between Chaibasa to Jamshedpur be declared as National Highway.

2.4.2.4 Several State Highways and link roads from specific mines to the NH or SH or the railhead would also need to be taken up to make it easier for the SME mine owners to transport their minerals.

2.4.3 **Railways**

2.4.3.1 Minerals, being bulk commodities, are transported over a long distance mainly by the railways, the world over. In India also, the mineral transportation from the mines to the ports or to the factories takes place preferably by rail. Following railway segments / lines identified to be of critical importance for transportation of minerals in India together with their present status and cost of completion are described below:-

Sl. No.	Name of Project	Kms	Approx. Cost (Rs. Crores)	Likely Date of Completion
1.	Banspani-Keojhar	155	800.69	October 2006
2.	Dalli Rajhara-Rowghat Jagdalpur: (New line)	235	457.0	Not fixed
3.	Haridaspur-Paradeep: (New line)	82	594.34	December 2008
4.	Mahanadi Bridge: (Doubling)	3	109.56	June 2008
5.	Angul-Sukinda Road: (New line)	90	344.0	March 2009
6.	Kottur-Harihar: (New line)	65	135.55	December 2011

7.	Hubli-Ankola: (New line)	167	997.58	October 2009
8.	Obulararipalli-Krishnapattnam: (New line)	113	426.34	October 2010
9.	Banspani-Padapahar: (Doubling)	27.21	99.55	March 2009
10.	Jharsuguda-Sambalpur: (Doubling)	48.66	127.04	March 2009
11.	Sambalpur-Titlagarh: (Doubling)	182	474.25	March 2011
12.	Guntakal-Hospet: (Doubling)	115.4	350.21	2006-07
13.	Guntakal-Renigunta: (Doubling with electrification)	151	538.26	December 2008
14.	Vizianagram-Kottavalsa: (3rd line)	34.70	167.67	December 2009
15.	Goilkera-Manoharpur: (3rd line)	40	186.92	December 2009
16.	Bhatapara-Urkura: (3rd line)	110	375.42	October 2008
17.	Bilaspur-Anuppur: (Doubling)	127	409	December 2009

2.4.3.2 In addition to the above the following railway projects are under survey, which if taken up will ultimately augment movement of minerals in India.

- Doubling of rail track from Hospet to Vasco
- Doubling of rail track from Rajagoda to Haldia
- Attiputtu-Puttur: (Construction of New Line)
- Doubling of rail track of Kirandul-Kottavalsa station
- Construction of Third line from Kharagpur to Panskura
- Doubling of rail track on Raipur-Titlagarh section

2.4.3.3 It is also noticed that the present rake capacity for iron ore movement in India is only 3500 tonnes which is far below the world standard of about 18000 tonnes. Therefore, Sub Group III recommends suitable measures to augment rake capacity of Indian railway.

2.4.4 **Power**

2.4.4.1 The power sector was among the first sectors to be opened in India for private sector investment during the early 1990s. Though the initial impetus was on investment for power generation projects, the government subsequently allowed private investment in distribution and transmission projects also.

2.4.4.2 India currently has around 120,000 MW of installed power generating capacity as on March 2006. Thermal power plants comprise almost 80 per cent of this capacity, hydroelectric plants about 16 per cent, and the remaining account for nuclear plants. While a relatively smaller percentage is contributed by the non-conventional energy sources.

2.4.4.3 A large number of private power projects in India are in the pipeline. The Central Electricity Authority (CEA) has granted techno-economic clearances (TECs) to several such power projects which total for around 30,000 MW.

2.4.4.4 Considering the targets for economic growth in India, significant power generation capacities need to be added to support mineral industry during XI Plan.

2.5. Projected investment for infrastructure related to mineral sector during XI plan

Following are the projected investment levels for the development of infrastructure to support mineral industry in India during XI Plan and beyond.

Name of Project	**Approx. Cost (Rs. Crores)**
(A) Rail :	
Construction of dedicated rail corridor between Haridaspur – Paradip for iron ore transportation	560
Completion of Dalli Rajhara-Rowghat Jagdalpur: (New railway line)	457
Completion of Haridaspur-Paradeep: (New line)	594
Mahanadi Bridge: (Doubling of Railway Track)	110
Angul-Sukinda Road: (New line)	345
Kottur-Harihar:(New line)	135
Hubli-Ankola: (New line)	1000
Obulararipalli-Krishnpattnam: (New line)	426
Banspani-Padapahar: (Doubling)	100
Jharsuguda-Sambalpur: (Doubling)	127
Sambalpur-Titlagarh: (Doubling)	474
Guntakal-Renigunta: (Doubling with electrification)	538
Vizianagram-Kottavalsa: (3rd line)	168
Goilkera-Manoharpur: (3rd line)	187
Bhatapara-Urkura: (3rd line)	375
Bilaspur-Anuppur: (Doubling)	409
Doubling from Hospet to Vasco	350

Doubling from Rajagoda to Haldia	300
Attiputtu-Puttur: (New Line)	500
Doubling of Kirandul-Kottavalsa line	300
Construction of Third line from Kharagpur to Panskura	300
Doubling of Raipur-Titlagarh line	350
Construction of railway stockyards at important places including development of container service system for movement of dimensional stones for exports in southern state & Rajasthan	500
SUB TOTAL	Rs. 8,602
(B) Road:	
The strengthening of the link roads in major mining belts including NER thus connecting to the national highways. These include following highway projects: • Rajamunda-Barbil (NH215) • Barbil-Panikhole (NH215) • Chandikhole – Paradip (NH5A) • Jamshedpur – Haldia (NH33/6/41 • Jaintgarh – Chaibasa – Haldia (NH75E)	1000
SUB TOTAL	**Rs. 1,000**

(C)Ports:	
Construction of an all weather **Port at Tadri or at Belekeri** with a draft of 18 mts for mechanized handling facilities for movement of iron ore for exports in a long-term perspective from Bellary-Hospet Sector (in collaboration with private sector such as M/s Hanjin of South Korea etc.).	1500
Deepening of the approach channel to receive 2.25 lakh DWT vessels at Vizag port	200
Deeping the draft at **Mormugao Port** up to 16.5 mts (as against present 13.5 mts) along with facilities for mechanical handling of rail borne Iron ore traffic from Bellary-Hospet sector.	200
Deepening the draft at **Mangalore port** up to 17 metre and installation of system for mechanical unloading and stacking	300
Expeditious construction and commissioning of **Dhamra port** in **Orissa** and **Krishnapatnam in Andhra Pradesh**	1000
Deepening of draft at **Paradip port** in order to handle vessels upto 65,000 DWT for off take of iron ore	100
Development of **Jatadhari port** jointly with Posco (near Para dip Port)	1000
Completion of development of **Ennore port** (under implementation)	200
Paradip port – construction of iron ore berth for handling 1.25 lakh DWT vessels and deepening of approach and international channels as well as turning basin.	500
SUB TOTAL	Rs. 5,000
Grand Total of Projected Investment	**Rs. 14,602**

	or say Rs. 14,600

2.6. RECOMMENDATIONS

General Recommendations

2.6.1 In order to undertake the task of building the infrastructure in mining areas, it is recommended that Mineral Development Fund (MDF) should be set up in each State having stake in major mining activity by earmarking 15% of the annual royalty collections for the fund.

2.6.2 For planning and promoting the development of mine-related infrastructure, it would be necessary to put in place an appropriate institutional framework. In the major mining States, we already have mineral development corporations and State Industrial Development and Investment Corporations. It would be necessary to enlarge the mandate of these corporations to include planning, promotion and financing of mining infrastructure.

These corporations should take up funding for the mining infrastructure projects by inter alia promoting and implementing entities in the form of JVs/SPVs. In appropriate cases these institutions could meet their bridge financing and / or Viability Gap Funding (VGF) from the Scheme of the Ministry of Finance or from out of the Mineral Development Fund and further tie up loans from the financial institutions as well as from the India Infrastructure Finance Company Ltd. (IIFCL). It is also recommended that consideration should be given to an alternative arrangement whereby allocations would be made to the Ministry of Mines to enable it to allocate funds directly for undertaking mining infrastructure projects. In order to facilitate such an arrangement the Ministry of Mines would have to set up a small-specialized body in the form of a corporate entity for appraising projects, routing funds and providing the requisite expertise.

2.6.3 Since, Government has decided to go in for privatization of infrastructure; it is recommended that financing of new ports – rail – roads infrastructure should be considered under Ministry of Commerce scheme for Balancing of Critical Infrastructure, which envisages 50% contribution by the Central Government

2.6.4 The railway projects, the National Highways and the port projects within the existing schemes of the Government of India can be taken up as Public Private Partnership (PPP) projects and the Government of India is committed to such projects being taken up within the existing programmes.

2.6.5 The capital cost of water and power projects (to access the main grid) for the SME sector may have to be borne by the State Government through outright grants from the Mineral Development Fund. If the Rural Water Supply Scheme of the Central Government could be extended to the mining areas to meet the water supply requirement of the small/medium size mines, it would alleviate the strain on the resources of the MDFs. Similarly, a conscious decision could be taken by the State Government to make electricity available to the mine sites, especially for small and medium size mines.

2.6.6 Development of high quality roads connecting priority sector mines (iron ore, bauxite, dimensional stones and limestone) to loading stations are urgently required and State Governments should earmark revenue from their royalty earnings for such infrastructure development in mining sector.

2.6.7 Power supply grid system in the country needs to be strengthened, particularly that located in mining belts of India.

2.6.8 New railway lines in the eastern sector as well as in Karnataka connecting mining areas to ports will have to be undertaken to support exports and for reducing cost structure of various steel plants.

2.6.9 Development of dedicated freight corridors for transport of Iron ore by railways from the mine-heads to various ports needs to be promoted along with private promoters.

2.6.10 Ports should invest in additional tipplers to augment their receiving capacities.

2.6.11 Additional stockyard capacity at ports needs to be installed.

2.6.12 Considering high cost of construction of ports, dredging, etc. alternatives such as floating terminals, which will facilitate loading of larger ships outside the port, should be examined and implemented.

2.6.13 New ports coming up at **Gopalpur** (located between Paradip and Vaizag) and **Dhamra** (located south of Haldia and north of Paradip) in Orissa by a consortium of TATA Steel and L&T and another port coming up at **Ennore,** all on east cost should be expedited. These mega ports will hopefully have sophisticated mechanized handling plants and deep draft berths to handle super cargo.

Sector Specific Recommendations

2.6.14 **Iron Ore**

As per the steel policy, the requirement of iron ore for steel production is expected to go up from 54 million tonnes in 2004-05 to 190 million tonnes in 2019-20. The movement of iron ore will continue to be mostly by rail and therefore development of railway infrastructure to handle iron ore has to be suitably augmented. The total traffic projections for the steel sector by 2019-20 include 230 million tonnes by railways and 100 million tonnes by road.

In a globally integrated economy, minimization of the overall cost of transportation becomes an important factor for maintaining the competitive edge in both the domestic and overseas markets. The Indian steel plants and Iron Ore mines, therefore, need to be integrated with the ongoing programmes of National Highway development and also with the proposed rural road development schemes.

2.6.14.1 **Bellary-Hospet Sector**

In Bellary-Hospet Sector, the existing iron ore production of about 35 million tonnes is expected to go upto more than 45 million tonnes by 2011-2012. In order to meet the infrastructure requirements for the increase in production / demand in iron ore both for domestic and export market following infrastructure will need to be created/augmented.

2.6.14.1.1 **Railways**

As the iron ore from this sector moves to ports namely Chennai, Krishnapatnam, Goa, Karwar, Belekeri and New Mangalore, it is necessary to strengthen and improve railway carrying capacities to all these ports. This can be achieved by the increase in rake capacity, electrification of all the routes, doubling of tracks, wherever necessary and ensuring availability of wagons. Simultaneously, the wagon tippling facility also needs to be augmented. A substantial portion of iron ore is transported by road from mine-heads to the loading stations. In addition to being costlier, it also puts a lot of strain on the road network and therefore, it would be desirable to provide suitable rail linkages to some of these large mines.

2.6.14.1.2 **Ports**

A decision has already been taken to close down **Chennai port** for export of iron ore due to environmental reasons. It is therefore, necessary to develop alternative port or ports to handle the current exports from Chennai as well as to meet future export demand. In this connection, a new port at **Ennore**, north of Chennai has already been developed. It is recommended that efforts be made for speedy development of iron ore berth, mechanical ore loading facility, adequate capacity of stockpile and dredging to accommodate large cape size vessels. The ship loading facilities at Ennore should match with other iron ore loading ports of the world to make Indian iron ore competitive in the global market.

As part of hinterland of Bellary-Hospet Sector, a private sector **port** at **Krishnapatnam** in Andhra Pradesh is being developed. Iron ore loading facilities in this port should be suitably designed to handle part of the cargo, which is expected to move from Bellary-Hospet area through this port.

Iron ore handling facilities at **New Mangalore port** on the west coast should be gradually improved to load additional iron ore expected to move to this port from Bellary-Hospet and other regions in Karnataka. In case of new Mangalore port, conversion of metre gauge railway line would also be required.

It would also be worthwhile to make expeditious efforts to develop an **all –weather port at Tadri or Belekeri** with a draft of 18 meters as a long-term solution. The port should have mechanical ore handling facilities and storage space to accommodate minimum of 5 million tonnes of cargo.

The above project is critically dependent on the construction of railway line between Hubbli and Ankola – a distance of 172 kms, involving a gradient 1 to 150 metres. The construction of this railway line will reduce the lead from Bellary-Hospet by 200 kms. This line together with the development of port is expected to increase and make iron ore exports competitive in the world market. Construction of Hubli-Ankola railway line will also give the hinterland access to the Konkan railways and whole of Karnataka coastline. These railway lines and the port projects deserve to be taken up on fast track basis.

Efforts should be made to deepen draft at Mormugao (Goa Port) upto 16.5 m and mechanical handling facilities be installed for rail borne iron ore traffic emerging from Bellary-Hospet sector to Goa Port.

Obulavaripalle- Krishnapatnam port Rail line project on which NMDC has already agreed for equity participation needs to be expedited

2.6.14.2 **Bailadila-Vaizag Sector**

The major iron ore producer in this sector is NMDC whose current production is 18.6 million tonnes, which is expected to go upto 32.7 million tonnes by 2012 and more than 42 million tonnes by 2022. About 8 million tonnes out of this is expected to be moved by slurry pipelines and the balance by railways, both for domestic and export demand. By 2012 rail and road movement is expected to cover 22.8 million tonnes and 1.9 million tonnes respectively. Therefore, construction of a new railway line to link Bailadila Sector (Jagdalpur) to Raipur needs to be taken up on priority.

2.6.14.2.1 **Railway**

A dedicated railway line exists between Bailadila and Vaizag port, which carries the iron ore for exports, Vishakapatnam Steel Plant, and domestic consumers namely ESSAR, ISPAT Industries and Vikram Ispat. To ensure & sustain the movement of increased tonnage by railway, it is necessary to strengthen the existing railway facilities. Similarly, to meet the iron ore demand of other steel units in Chattisgarh, area immediate action is recommended to establish / improve the rail / road facilities in the region.

The load carrying capacity of this means of ore transport needs to be enhanced keeping in view the movement of bauxite envisaged from Andhra Pradesh quarries. For steady power supply, the power grid system in these belts also needs to be strengthened.

Construction of new rail line to link Bailadila sector (Jagdalpur) & Gua-Barbil-Badajamda sector needs to be taken up on priority. This will support NMDC's mining operations.

2.6.14.2.2 **Port**

As NMDC and MMTC are the major suppliers of iron ore from Vaizag port. Therefore, it is necessary to augment the stockpile capacity of this port

In order to remain competitive in global market, the size of ships and loading rates should be reviewed and suitably regulated to match India's competitive edge in Iron ore trade.

2.6.14.3 **Orissa / Jharkhand – Haldia / Paradip Sector**

About 30% of India's Iron ore resources are located in the states of Orissa and Jharkhand. The combined production from these two states was about 56 million tonnes during 2004-05, out of the total all India production of 142 million tonnes. It is therefore evident that infrastructure facilities in this region are of utmost importance both from the point of view of domestic trading export's . As the belt supplies to several domestic steel units, the internal movement of iron ore both by road and rail is substantial. The prospects of growth of iron ore mining in this region is expected to be high in view of several new steel plants of Posco, TATA and Mittal Steel being proposed here.

2.6.14.3.1 **Railway**

From iron ore mining areas of Barajamda, Barbil, Banspani, etc., the iron ore is transported by railways to steel plants and to the ports of Haldia and Paradip. In order to increase the capacity, several new railway projects have been undertaken in this region viz.

Banspani – Daitari, Haridaspur – Paradip, Angul – Sukinda Road, Jharsuguda – Sambalpur, etc. It is therefore recommended that these projects be expedited and completed as soon as possible. The expeditious construction of Daitari – Banspani rail line will reduce distance between iron ore mines to the port by 313 kms.

It is therefore recommended that Ministry of Railways should develop product-specific railway freight corridors jointly with rail users – MNCs / private companies / or PSUs. A similar project is under consideration at an estimated cost of Rs 560 crores i.e. Haridaspur – Paradip railway line project in which Posco is likely to contribute Rs. 27 crore initially for 10% stake. This will provide a dedicated rail corridor connecting its steel plant with Paradip port in consortium with PSUs and private companies like Jindals, SAIL and MSPL Mining Company. This project is being developed by Special Purpose Vehicle (SPV) led by Rail Vikas Nigam Ltd. This new railway corridor will be an alternative to the Cuttack railway line which will reduce the distance and time of transportation of raw materials like iron ore and coal from Orissa's Keonjhar and Angul districts to the plant site.

2.6.14.3.2 **Road**

In the absence of adequate rail capacity in this sector, a large quantity of iron ore is moved by roads. In view of the growing demand of iron ore, it is recommended that all the road projects undertaken in the mining area should be completed as soon as possible. Some of the road routes critical to Indian mining sector in this region are:

- Rajamunda-Barbil (NH215) - 60 kms
- Barbil-Panikhole (NH215) - 189 kms
- Chandikhole – Paradip (NH5A) - 77 kms
- Jamshedpur – Haldia (NH 33, NH6 , NH 41)) 200 kms
- Jaint garh – Chaibasa – Haldia(NH 75E) - 100 kms

2.6.14.3.3 **Port**

Two major ports that handle, the iron ore exports from this sector are Haldia and Paradip. During 2004-05 the quantity exported was about 5 million tonnes and 9 million tonnes from Haldia and Paradip respectively. At present Haldia can handle a ship upto 35,000 DWT while Para dip can load a vessel upto 70,000 DWT due to draft limitations. In view of the increase in demand of iron ore loading in these ports, an immediate action is required for deepening of approach channel and turning basin and construction of iron ore berth to receive bigger ships.

Several new port projects namely Dhamra and Pasco’s captive port near Paradip are under consideration for quite sometime. It is, therefore, recommended that these projects should be implemented expeditiously to handle additional iron ore from the region in order to reduce freight costs from India to iron ore importing countries.

Jharkhand Government’s proposal for development of a dedicated port in Orissa should be given priority in order to support mineral based exports from Jharkhand.

A new proposed captive port at Jatadhari near Paradip (Orissa) should be developed expeditiously.

2.6.14.4 **Goa Sector**

Total iron ore production in 2004-05 from this region was 22 million tonnes. In addition to local production, about 2.5 – 3 million tonnes of iron ore is moved from Karnataka region through Marmugao port. In 2004-05, the total quantity of iron ore handled at Marmugao was 24.72 million tonnes.

2.6.14.4.1 **Railway**

The Goan iron ore mines are located close to rivers and therefore the iron ore movement within Goa is mostly by barges to Marmugao and Panjim ports. However, about 3 million tonnes of iron ore from Bellary Hospet is moved by railways and exported through Marmugao. The iron ore is brought to river loading point of Sanverdam from where the ore is loaded into barges and transported to the port. In order to avoid double handling, a project to handle wagons directly at the port is underway and should be completed immediately. Likewise the railway capacity from Bellary-Hospet to Goa should be suitably increased to meet the growing movement of iron ore.

2.6.14.4.2 **Port**

At Marmugao port (berth no. 9), the mechanized port loading facilities with an annual capacity of 10.5 million tonnes, exists which can handle ships from 30,000 to 275,000 DWT capacity. The ships are partly loaded upto the permissible draft and fully loaded at anchorage with the help of transhippers. The port also loads large cape size vessels directly from barges with the help of transhippers. The main infrastructure at Mormugao port is therefore barges, mechanical ore loading facility and transhippers, which should be maintained, replaced and their capacities suitably enhanced to take care of growing export demand.

The minor port of Panjim handles about 8-9 million tonnes of iron ore annually, mainly through barge loading. Therefore, availability of adequate barges should be ensured for Panjim port.

2.6.15 **Dimensional & Decorative Stones**

Handling facilities at major ports viz. Chennai, Tuticorin, Cochin, Mangalore, Kaswa, Kandla, Mumbai, JNPT and Vaizag need to be improved for the export of Indian dimensional stones.

Road network should also be extended to rural mining belts including decorative & dimensional stone producing centres, thereby providing linkages to highways / expressways.

It is recommended that railway stockyards at various places should be created with Inland Container Service System (ICD) in operation. The railway stockyards with potential of handling stones should be equipped with crane facilities of minimum 50 tonnes capacity. From these points, open wagons shall move to important ports and other destinations where the stone processing units are located.

Adequate railway transport network including container facilities and railway sidings should be extended at prominent centers producing stones.

2.6.16 **Bauxite & Alumina**

The Greenfield alumina plants and bauxite mining belts of India would require strengthening of infrastructure of road and rail network

The bauxite mining belts of Chatttisgarh and Jharkhand also need improvement in road infrastructure for the expansion of brownfield f existing plants. In Andhra Pradesh bauxite deposits would require extension of railway line up to deposits.

2.6.17 **Limestone and other industrial minerals**

Bulk handling of limestone and rock phosphate both for domestic consumption, exports and imports is made by rail and road network. Road network is a serious bottleneck in northeastern states where limestone is exported through road network to neighbouring counties. Therefore, efforts should be made to strengthen the existing road and rail network connecting these mines to the consuming centres.

CHAPTER 3.

PROBLEMS AND CONSTRAINTS IN EXPLORATION & EXPLOITATION OF MINERAL RESOURCES IN TRIBAL FOREST AREAS

CHAPTER 3.1

PROBLEMS & CONSTRAINTS IN EXPLORATION & EXPLOITATION OF MINERAL RESOURCES IN TRIBAL FOREST AREAS & MEASURES TO HARMONISE MINERAL DEVELOPMENT WITH ENVIRONMENT & FORESTS,TRIBAL POLICY AND LAW

(Item 3 of terms of reference of Sub Gr. III)

“To assess constraints and problems encountered in exploration and exploitation of mineral resources in tribal,forest areas and to suggest measures in harmonizing mineral development with environment & forest tribal policy and laws and suggest changes if any”

3.1.1 **Preamble –**

Environment concerns are growing globally as well as within the country. The mineral development is one among a number of competing land uses. Due to lack of planning efforts and other frameworks to balance and manage the possible land uses, there are problems and disagreements in the matter of control, use and management of such lands where mineral discoveries are noticed and exploration and exploitation of mineral resources in such areas is warranted in national interest. The constraints and problems of such areas are multiplied if the mineralized area happens to be forest area and inhabited by tribals or locals.

The local stake in control, use and management of such areas and resources needs to be ensured. The decision whether or not to explore or mine a certain area should be undertaken through a democratic decision making process and should also be based on an integrated assessment of ecological, environmental and socio economic impacts of the proposed mining on the local ecology and inhabitants. The planning process will be more effective in the presence of equitable and inclusive rules of tenure, compensation schemes for those affected and strong governance including mechanism for grievance redressal and arbitration where necessary.

Land is often used without the consent of indigenous community. Mining companies should ensure to involve all stake holders while deciding the rehabilitation schemes of the area. While taking decisions, the cultural circumstances of the local people and laws of access to common resources should be kept in view. Where resettlement takes place, mining entrepreneurs need to ascertain that living standards are not diminished, that community and social ties are preserved and that they provide proper compensation for loss of assets and economic opportunity. Responsibility for ensuring long term well being of resettled communities needs to be monitored. Environment friendly technologies of mining and other interests are to be considered along with interests of the poor and socio economically marginalized who live in these areas.

Mineral development can bring benefits to the local people. However, the relationship between mining companies and local/ tribal communities has a history of abuse, betrayal and mistrust. The situation therefore warrants establishing and maintaining effective public relations and liaison with them. The effort should concentrate on improving the capacity of local inhabitants particularly tribal communities especially in mining related activities to get maximum benefit from mining. NGOs and other civil society groups can act as mediators to enable communities to develop partnership with mining companies and governments in development. Supporting local business, preferential procurement policies towards local suppliers and distributors, employment of locals and skill training are important means of benefiting local communities and thereby getting their support for the project. A better role in community health programmes and social infrastructure like schools and hospitals are some of the other areas in which mining companies need to have pro active role.

3.1.2 Constraints and problems in exploration and exploitation of mineral resources in tribal and forest areas.

1) As per present practice, long delays often upto 24 months are noticed in getting forest or environmental clearances. There are nearly 10 agencies at the centre and state levels through which a prospecting license/ mining lease application has to be routed. This situation requires to be focused at in order to provide quick remedies.

2) At present it is witnessed that inordinate delays take place in public hearing for grant of mining lease in a forest area. In such public hearings there is involvement of out side agencies, which often creates delay and poses hindrances.
3) Large number of authorities are involved in granting the clearance. It is noticed that a high degree of inter dependency and poor co-ordination exists within various authorities approving mineral concessions. This needs to be suitably addressed.
4) Identification of equivalent non-forest land for compensatory afforestation is a major constraint. Sometime such land for compensatory afforestation is not available or the allotted land is far from the area of operation of the concession seeker. Such problems are common in rugged & fragile Himalayan terrains. Therefore, the compensatory afforestation in such cases becomes cumbersome and expensive.

5) It has been noticed that the acquisition of land particularly, in tribal areas is very difficult. This is owing to the fact that due to non settlement of these areas the land acquisition is often rendered impossible.

3.1.3 Suggested measures to harmonise mineral development with environment and forest and to win over these difficulties.

1) A high level expert committee comprising experts from Ministry of Mines and Ministry of Environment and Forest may be constituted to work as a nodal agency to examine and approve such mining project.
2) A copy of lease application should be sent to all the scrutinizing agencies to work on parallel fronts.
3) Environmental clearance should not be required for prospecting licence as the level of indulgence in the forest and waste generation is minimal in such cases.
4) One time in principle approval should be accorded for transfer and dereservation of entire forest land involved and deforestation should be approved in phases depending upon the requirement of the user agency.

5) A Co-ordination Committee may be set up to monitor the clearances of individual applications and ensure speedy clearance by different Departments & Agencies. There should be a cell-specified for monitoring the proposals for exploration and exploitation of mineral resources at forest headquarters of each mineral rich state.
6) There should not be any need of submitting a fresh DPR in case of a renewal of a mining lease unless fresh forest land is required to be broken or the area proposed is different from stipulated earlier.
7) Mineral rich states should create land bank of non-forest areas to be mutated in favour of forest department for compensatory afforestation and onus of non-forest land available, its mutation and transfer in the name of forest department should lie with the revenue department of the concerned state. The lessee should be responsible for depositing the required fees only.

8) The procedure involved in public hearing can be simplified. Only the representatives of the stake holders groups should be invited for public hearing. Involvement of outsiders should be avoided as far as practicable.

9) It is preferable to demarcate mineral bearing areas as ‘Mining Land’ in all the revenue records as it is being done for the ‘Forest Land’.

10) The delays occur mainly on account of enumeration of trees and cost benefit analysis carried out by the DFOs. This can be minimized by outsourcing and building a data bank regarding the number of trees in different forest areas.

11) It is suggested to modernize the present system and make provision for on-line application for mineral concessions.

12) The renewal of lease for captive mines should be expedited in order to ensure uninterrupted supply of ore for continuous operation of the plant.

CHAPTER 3.2

IMPACT OF SUPREME COURT VERDICT IN T N GODAVARMAN THIRUMULPAD CASE & ASSESSMENT OF N P V

(Item 4 of terms of reference of Sub Gr.III)

“To examine the impact of the Supreme Court verdict in the T N Godavarman Thirumulpad case, on assessment of net Present Value(NPV) payable for use of forest areas for non-forest purpose,including exploration and mining activities,and suggest measures for safe guarding the interests of the small miners”

Preamble, background & implications of the case

The Supreme Court in its order dated 30 October, 2002 directed that the user agency shall also pay into the Compensatory Afforestation Fund(CAF) the net present value (NPV) of the forest land diverted for non-forest purposes at the rate of RS 5.80 lacs per hectare to RS 9.20 lacs per hectare depending on the quantity and density of the forest land converted to non forest use. The order of the Hon’ble Supreme Court in WP No(C)-202 of 1995 dated 26 September,2005 has extensively dealt with the issue of calculation of NPV, but the matter is still to receive finality and the Kanchan Chopra Committee appointed by the Hon’ble Court has submitted its report. That committee has recommended that Compensatory Afforestation charges should not be payable over and above the chargeable NPV and ground rent and this recommendation is under consideration of the Hon’ble Court.

Problems due to interpretation of the Act

The Hon’ble Supreme Court in its order dated 12.12.1966 in the matter of T.N. Godavarman Thirumulpad Vs. Union of India & others extended the applicability of the FCA to “forest” in the dictionary sense. Prior to this, FCA was applicable to only such areas which were notified as “forest” under Indian Forest Act or which were recorded as “forest” in the records. The industry has represented that the dictionary meaning of “forest” leaves great scope for subjective interpretation and the custodians of forest, that is the forest officers, need to uniformly adhere to any one meaning in deciding whether a particular piece of land should be treated as “forest” in the dictionary sense or not. In such a scenario, a mining entrepreneur is unable to ascertain whether the land he wants to mine n a forest land or not. The only safe

course available to him is to actually apply for clearance in every case and let the forest officer decide whether clearance is needed.

Since all required clearances are obtained generally after the notification for grant of mineral concession by the State Government is issued, and hence, the uncertainty in obtaining the leae/licence remains as a hurdle. It is necessary to mention here that the above order of the Supreme Court was interim in nature and by the same order, the Supreme Court directed all the State Governments to constitute an Expert Committee to specifically identify such forest lands. Almost all the State Governments have submitted the reports of their Expert Committee to the Hon’ble Supreme Court and a final decision is awaited. The Kanchan Chopra Committee referred to above have also made recommendations on the definition of “forest”.

Impact of net present value (NPV) and measures to safeguard the interest of small miners

1. The basic concept behind charging NPV is that forest areas give intangible benefits in shape of release of oxygen, soil and water conservation resulting into lesser floods and consequently lesser national loss in river plains. Hon'ble Court may be approached to reconsider it for a very small forest area and especially for those areas which are though recorded as forest, but are devoid of forest cover. For such areas only the provision of compensatory afforestation should be there.
2. While the final decision on the liability of mining lessees for use of forest land would be taken by the Hon'ble Supreme Court, the Committee would like to make two recommendations that would lighten the burden on the lessees :
    a. The NPV should be payable in instalments proportionate to the land broken in accordance with the pre-submitted mining plan to reduce one time burden on the lessee.
    b. The lessee should not be asked to pay NPV each time a lease is renewed as the intangible benefits have already been accounted for in previously paid N.P.V. Thus duplication of payment of NPV should be avoided

3. Once the Hon'ble Court has passed orders in this regard all "forest" land must be notified in the Official Gazette so that there is no scope for subjectivity in interpretation. It is also recommended that clear and transparent guidelines may be formulated and circulated among entrepruners that their confidnece level is increased.

4. Compensatory Afforestation Fund Management and Planning Authority (CAMPA) should be accountable for the fund with financial controls. The Executive body of the CAMPA should have representation from the industry from the concerned state.

5. As there is symbiotic relationship between the tribal people and the forest, employment to the tribal people and their rehabilitation with the funds available under CAMPA should be on priority list.

CHAPTER 3.3

REHABILITATION & RECLAMATION NEEDED FOR ABONDONED OR CLOSED MINES & PROPOSING APPROPRIATE PLANS FOR R & R TO GIVE ECOFRIENDLY IMAGE TO MINING INDUSTRY

(Item 5 of terms of reference of Sub Gr.III)

"To assess the magnitude of rehabilitation and reclamation needed for abandoned or closed mines before the concept of mine closure plan and financial assurance come into being and to suggest appropriate plans for reclamation & rehabilitation for such mines go give eco-friendly image to mining industry"

Status of abondoned mines available for Rehabilitation and Reclamation in India

- Indian Bureau of Mines (IBM) has identified 297 abandoned/orphaned mines.

- IBM has prepared a project proposal for reclamation/rehabilitation of 106 abandoned mine sites out of the above mentioned 297.
- 36 sites belong to Public Sector Undertakings, 25 to major private companies and 45 sites to other private companies.
- IBM has informed that out of the above 106 sites, 16 may be reopened.
- Of the above 106 sites, 87 are open cast mines and 19 are underground sites varying in size from 281.6 ha to less than 1 ha.
- The impact on these sites include unused pits and shafts, altered landscape, unusable land due to loss of soil, low pit, tailings/waste dumps, ground water depletion, soil contamination, etc.
- Soil strata are inverted due to open cast mining making the area not only refractory for vegetation growth, but also very fragile and unstable due to bouldery material at the top and the finer material at the bottom of an overburden.

Suggestions on Rehabilitation & reclamation of abondoned of mines

- To overcome the soil degradation issue, it should be mandatory for all open cast mining to store and stock the top soil at a separate place and it should be replaced as soon as the mined area is back filled with. As the top soil bears the seeding and rooting materials of most of the species growing there, replacing top soil will help in establishing most of the indigenous plant species.

- Gradient of the slope of the overburden (OB) should not be more than 25 and the soil beneath the OB should be worked before dumping for a better stability of the OB and lesser soil erosion.
- Contouring of the OB before plantation should essentially be done for better stability of the area and least soil erosion.
- Plantation of bamboo and other species having strong root system should be prepared
- Plantation of suitable bamboo species will not only establish the area with least or no soil erosion, but it will also help in improving the economic status of the local people dependent on these forest areas .

- Plantation of local species should be preferred, especially those with whom local people have sentimental attachment.
- Reclamation of mined areas should not consider afforestation activities only, but, it should have a holistic approach for the benefit of the local people along with environmental issues, e.g., development of fisheries, water sports, big ponds for irrigating the adjoining agricultural areas, eco-tourism, etc. depending upon local needs and requirement.

CHAPTER 3.4

IMPACT OF SAMATHA JUDGMENT ON MINERAL SECTOR LOCATED IN 5TH SCHEDULE AREAS & SUGGESTING APPROPRIATE MEASURES

(Item 6 of terms of reference of Sub Gr.III)

"To examine the impact that the Samatha Judgment would have on the present mines and mineral-based industries located in the Fifth Schedule areas of the country, if the judgement is implemented and suggest measures that need to be taken to avert the

situation and at the same time safeguarding interests of the tribals in these areas of the country".

Preamble and case background

The Supreme Court in a majority decision dated 11-7-1997 disposed of Civil Appeal No 4601/96 filed by Samatha, a Non Government Organisation (NG)) working in the East Godavari district of Andhra Pradesh. [Reported in 1997(4) SCALE page 746 – hereinafter referred to as the Samatha judgment]. The Union of India was not a party in the Samatha case nor was any State Government other than the Government of Andhra Pradesh. However, directions have been given to the Union Government as well as other State Governments in the case (para 129, 130, 131 of the Judgment). The Supreme Court has dismissed the review petitions filed by the Government of Andhra Pradesh and the Ministry of Mines in the case. Hence, the law laid down by the Samatha Judgment is the Law of the Land.

The Samatha Judgment :

The Supreme Court analyzed and interpreted the following to arrive at its majority conclusions and directions :

(i) Article 244(19) of the Constitution provides that the provisions of the Fifth Schedule shall apply to the administration and control of the Scheduled Areas and Scheduled Tribes in any state. The Fifth Schedule of the Constitution in paragraph 5(2) provides that the Governor (of a State) may make regulations for the peace and good governance of a Scheduled Areas including regulations for transfer / allotment of land by and among Scheduled Tribes in the

Scheduled Area Concerned. Paragraph 5(3) provides that in the process, the Governor may repeal or amend any Act of Parliament or of the Legislature of the State or any existing law which is for the time being applicable to the area in question.

(ii) The Andhra Pradesh Scheduled Area Transfer Regulation, 1959 (1959 Regulation), was framed by the State Government in exercise of powers under Para 5(2) of the Fifth Schedule to the Constitution. Interalia, the 1959 Regulation (as amended) provided under Section 3.1(a) that " XXXXXX any transfer of immovable property situated in the Agency tracts by a person, whether or not such a person is a member of a Scheduled Tribe, shall be absolutely null land void, unless such transfer is made i favour of a person, who is a member of a Scheduled Tribe or a Society registered or deemed to be registered under the Andhra Pradesh Cooperative Societies Act, 1964 which is composed solely of members of the Scheduled Tribes".

(iii) Further, in exercise of the power under Para 5(3) of the Fifth Schedule to the Constitution, the State Government of Andhra Pradesh amended the Mines and Minerals (Regulation and Development) Act, 1957 (MMRD Act) vide Gazette Notification No 259 dated 14.8.1991 and inserted sub section 11(5) to the Act, as follows:

" (5) Notwithstanding anything contained in this Act no prospecting licence or mining lease shall be granted in the Scheduled Areas to any person who is not a member of the Scheduled Tribes

Provided that this sub-section shall not apply to an undertaking owned or controlled by the State or Central Government or to a Society registered or deemed to be registered under the Andhra Pradesh Co-operative Societies Act, 1964 (Act 7 of 1964) which is composed solely of members of Scheduled Tribes".

The majority decision of the Hon'ble Supreme Court in the Samatha (JJ Ramaswamy and Saghir Ahmad forming the majority and Justice Pattanaik dissenting), has concluded that in view of the provisions of the Fifth Schedule of the Constitution read with Article 244 of the Constitution, that –

(a) In the 1959 Regulation, 'person' includes the State Government and ' transfer of immovable property' includes the prospecting license and the mining lease granted by the State Government.

(b) As per the State Government Notification No 259 dated 14.8.1991 which inserted the section 11(5) to the Act, grant of mining leases/prospecting licenses to any person who was not a member of Scheduled Tribe in Scheduled Area in Andhra Pradesh was absolutely void and prohibited.

(c) All transfers of lands belonging to the State Government at any time in the past or present in " Scheduled Area of Andhra Pradesh", to non-tribals, and of mining leases/prospecting licences when so ever granted by the State Government in such areas to non tribals were absolutely void and impermissible.

(d) Mining operations in Scheduled Areas could not be carried on by reason of the provision of the Forest Conservation Act, 1980, i.e. without prior approval of the Central Government, forest land could not be used for any non forest purpose.

Further, in view of the above premises, the majority decision gave the following directions :

(i) All the mining leases or renewals situated in the reserved forest or forest land or within the Scheduled Area in the State of Andhra Pradesh were either in violation of the Fifth Scheduled of the Constitution or of the Forest Conservation Act, 1980 and Regulations framed hereunder (para 127).

a. The Chief Secretary, Andhra Pradesh should constitute a Committee comprising himself, the Secretary (Industry), Secretary (Forest) and Secretary (Tribal Welfare/Social Welfare) for examining the issue. This Committee would take orders of the Cabinet sub-committee consisting of the Chief Minister, Minister for Industries, Minister of Forests and Minister for Tribal Welfare to examine the issue whether the existing leases could be allowed to continue until they expire by efflux of time, or whether it is expedient to Prohibit further mining operations in the light of Section 11(95) of the Mines and Minerals (Regulation and Development) Act, to take appropriate action on that behalf and submit report to the Court on action taken. (para 128).

b In case where similar Acts in other States do not totally prohibit grant of mining leases of the lands in the Scheduled Area, similar Committee of Secretaries and State Cabinet sub-committees should be constituted and decision taken thereafter.(para 129).

c Before granting leases, it would be obligatory for the State Government to obtain concurrence of the Central Government which would, for this purpose, constitute a sub-Committee consisting of the Prime Minister of India, Union Minister for Welfare, Union Minister for Environment so that the State’s policy would be consistent with the policy of the nation as a whole.(para 130).

d It would be open for to the appropriate legislature, preferably after a thorough debate/conference of all the Chief Ministers, Ministers holding the concerned Ministry and the Prime Minister and the Central Ministries concerned to take a policy decision so as to bring about a suitable enactment in the light of the guidelines laid down above so that there would emerge a consistent scheme throughout the country in respect of tribal lands under which national wealth in
the form of minerals is located (para 130).

e The State Government should ensure that all concerned industrialists, be they natural or juristic persons should stop forthwith mining operations within the Scheduled Area, except where the lease has been granted to the State Undertaking. (para (132).

f The State Government should report compliance of the Order to the Registry of the court within six months from the receipt of the judgment. (para 132).

g The lessees of mining leases are directed not break fresh mines, however, in the meanwhile, they are entitled to remove the minerals already extracted and stocked in the reserved forest area within four months time. (para 132).

h Even the State Undertaking carrying the mining operations would be subject to the regulations under the Forest Conservation (FC) Act and the Environment Protection (EP) Act.

i It would be open to the State Government to organize Cooperative Societies composed solely of the Scheduled Tribes to exploit mining operations within the Scheduled Area subject to the compliance of the Forest Conservation Act, 1980 and Environment Protection Act, 1986. (para 132).

The Implications of the Samatha Judgment

The implications of the judgment are far reaching particularly in view of the fact that the word “person” occurring in para 5(2)(b) of the Fifth Schedule and Section 3(i)(a) of the Andhra Pradesh Scheduled Areas Land Transfer Regulaton,1959 has been interpreted to include the State Government. As such in Andhra Pradesh, the Government is prohibited from transferring its own land on lease to non-tribals even for the duration of the mining lease. Even though the Andhra Pradesh Scheduled Areas Land Transfer Regulation, 1959 came into effect on 4th March, 1959, and was subsequently amended in 1963 and again in 1970, all the transfers of tribal land in favour of non-tribals made earlier were made null and void retrospectively. Threfore, all the existing lessees, other than the Andhra Pradesh Mineral Development Corporation Ltd., which was a public sector undertaking, had to close the mining operations under the Court direction.

The directive of the Supreme Court that all industries, be they natural or juristic persons to stop forthwith operations within the Scheduled Areas, except where the lease has been granted to the State Undertaking, has far reaching consequences. Andhra Pradesh has the second largest deposits of bauxite in the country which lies largely in the Scheduled Areas. Similarly, large resources of limestone are also available in the Scheduled Areas. Not only all mineral based industries which draw their mineral requirements from mining leases held in tribal areas are now put to a disadvantage, but also all other industries that are located in the Scheduled Areas of Andhra Pradesh will have to be relocated. Similarly, no major industrial investment may ever take place in the Scheduled Area in future, as the State Government will not be able to transfer even its own land to any one other than tribals for setting up industries.

While it is recognized that the tribals should not be alienated from their land in any manner either by the Government or by a non tribal without their express and informed consent, at the same time it needs to be emphasized that the tribals of any State including Andhra Pradesh to which the Samatha Judgment directly pertain are economically and technically not equipped to do scientific exploration or mining. It is felt that mere provisions in Law prohibiting granting of mineral concessions to non-tribals in Scheduled Areas, without economic empowerment and technological up-gradation of the tribal population are not sufficient for their upliftment. In fact such a provision may have the unintended effect of

leaving the mineral resources unexploited, as well as depriving the tribals of developmental spin off of mining activity and setting up of mineral based industries in the Scheduled Areas.

Exploration and prospecting for minerals are very cost intensive and risky venture. Natural justice requires that the person who spends resources for exploration and prospecting should be allowed the comfort of priority in grant of mining lease, which is what the Mining and Minerals (Development and Regulation) Act, 1957 and Rules framed hereunder provide. The Central Government does not have enough resources of its own to undertake the exercise and therefore, in the process of economic liberalization, private sector initiative in this regard has been given prominence. Given the fact that the tribals are generally economically vulnerable, and the Public Sector Units (both Central and State) do not have enough resources of its own, the impact of the judgment would be that the rich mineral resources in the Scheduled Areas would remain unexploited. Besides Andhra Pradesh, Scheduled Areas have been notified in the State of Bihar, Chattisgarh, Gujarat, Himachal Pradesh, Jharkhand, Madhya Pradesh, Orissa, Rajasthan and Maharashtra. The Samatha Judgment will have similar effect on these States in the years to come. It is, therefore, felt that the law laid down by the Hon'ble Supreme Court in the Samatha Judgment will bring to halt all industrial activities including mining operations in the Scheduled Areas in Andhra Pradesh and later in other States which in turn will hamper the economic activities in the Scheduled Areas in the country. Individual tribal or group of tribals may not have and normally do not have necessary infrastructure to systematically and scientifically exploit the mineral resources and other resources for the socio-economic development of the State in general and tribals in particular. Mining Activity being temporary can never be understood to be deprivation of all rights of tribals.

Samatha Judgment is immediately applicable to all the ten States (Andhra Pradesh, Bihar, Chattisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra, Himachal Pradesh, Orissa and Rajasthan), where Scheduled areas have been declared under the Fifth Schedule of the Constitution. In particular, exploitation of the mineral resources for economic development which would be the natural advantage of the newest two States of Chattisgarh and Jharkhand may now be stymied by the Samatha judgment as no private non tribal investor would be able to invest in the Scheduled Areas.

After the Samatha Judgment, the State Government of Andhra Pradesh does not have any recourse to grant mining leases in Scheduled Areas to anybody other than a Public Sector Undertaking or to the Tribals. The Samatha Judgment further requires all States with Scheduled Areas other than Andhra Pradesh to consider whether the legal provisions pertaining to their State Should be modified on the Andhra Pradesh pattern.

CHAPTER 3.5

SOCIO ECONOMIC IMPACT OF MINING ON LOCAL LIFE & IMPROVING THEIR LIVING STANDARD

(Item 7 of terms of reference of Sub Gr.III)

“To examine and assess the socio economic impact of mining on the life of local inhabitants and to suggest ways and means for improving their living standard”

Preamble

To assess the socio economic impacts of mining in the country, it is imperative to refer to socioeconomic profile of the area and inhabitants of mining belts. The demographic profile of local community particularly scheduled castes, scheduled tribes , dwellers of forest and migratory population have to be evaluated. Unfortunately dominant tribal populace in India live on the fringe of subsistence economy. Mining often affects (positively or negatively) their livelihood, occupations, and income. Over indulgence by incoming mining community often affects their cultures, customs & traditions. Positive impacts of mining on the other hand opens up new vistas of infrastructural and community development, improves their capabilities for seeking gainful employment and often promotes new vision for their socio cultural and community growth and broadening of their traditional outlooks.

Suggestions for improving their living standard.

1. Investible surplus must be created from every mining projects in India which can be ploghed back into local economy.
2. Through effective measures adopted for environmental protection, rehabilitation of migrants and implementation of mandatory obligations, the adverse impacts on local population can be minimized.
3. Essential public services made available to the staff of the mining project like education, health and infrastructure should invariably be extended to local population particularly the poor also.
4. To the extent feasible and possible the local value addition to mineral produce (through setting up of mineral based industries and ancillary industries) must be promoted for the benefit of local population.
5. The local human resource should get custom tailored training for utilizing their talents in mining project.
6. Efforts should be made to remove socio economic disparities and divides created due to projects.

7. The areas presently under mining or to be brought under mining are generally forest areas and people dwelling in and around these forests depend much on these forests for their livelihood. Therefore, a mining proposal in these areas attracts much resistance against these proposals.
8. People of such areas may be attached sentimentally also due to presence of temples of some local deities. Their religious sentiments should be taken care of.
9. Socio-economic Impact Assessment (SIA) is either not done, or if done, by the mining company itself, which has no credibility in the eye of local people. It

should be done by local administration or the NGOs working in those areas. SIA should compulsorily be done and approved by the same authority approving the proposal at the Central Level and it should be done by some reputed and credible agency.

10. Local people see forests as a perpetual source of income for their progeny and hence, their economic rehabilitation along with health and education should be addressed.
11. Son of the Soil psychology is increasing and it is most prevalent in these areas. By imparting better education and inculcating in their mind that their progeny may also be given jobs with higher responsibilities in these mining organizations in the future and may not merely end as a fourth grade employee, their resistance can be reduced to a great extent.
12. All the stakeholder groups should be consulted during public hearing.
13. Afforestation of various species of bamboos, shrubs and trees of medicinal use and trees bearing seeds of bio-fuel e.g. jatropha, kanji and neem should be preferred depending upon their silvicultural needs and suitability.
14. A co-operative of affected people should be established to share the benefits and fruits from these rehabilitated areas after mining.
15. Rehabilitation of mined areas should not only concentrate on afforestation, but, viability of development of fisheries, eco-tourism, water sports, etc. should also be explored for economic upliftment of the local people.

ANNEXURE-I

F.No. 11(5)2006-M.I
Government of India
Ministry of Mines

New Delhi, dated 28.7.2006

KIND ATTN : Shri A K SRIVASTAVA
Suptdg. Mining Geologist
IBM, Nagpur

OFFICE ORDER

Fax No 0712-2561267

The Planning Commission has set up a Working Group on Mineral Exploration and Development (other than Coal and Lignite) vide Office Order No I&M-3(24)/2006 dated 6.3.2006. In the first meeting of the Working Group held on 20.4.2006 in Planning

Commission, it has been decided to set up four Sub-Groups to study and give recommendations on various aspects of the Terms of Reference of the Working Group.

2. In the above background, the following will be the composition and the Terms of Reference of the Sub Group III on Fiscal Measures, Infrastructure Development and Environment.

Composition

	Name	
1	Shri Pradeep Kumar, Additional Secretary, Ministry of Mines, New Delhi	Chairman
2	Shri L P Sonkar, Advisor (Minerals & TRP) Planning Commission New Delhi	Member
3	Shri C P Ambesh, Controller General Indian Bureau of Mines Nagpur	Member
4	Shri Deepak Srivastava Director(Technical) Ministry of Mines New Delhi	Member
5	Shri A K Singh Director Ministry of Mines New Delhi	Member
6	Representative Geological Survey of India 27,J L Nehru Road, Kolkata-700016	Member
7	Shri K P Lall, Adviser (TPPC) Block II, 5th floor, CGO Complex, New Delhi	Member
8	Director, Ministry of Road Transport and Highways Parivahan Bhavan, Sansad Marg New Delhi	Member
9	Director, Ministry of Railways Rail Bhavan New Delhi	Member
10	Director Ministry of Power Shram Shakti Bhavan, New Delhi	Member
11	Director, Department of Environment	Member

	Ministry of Environment and Forests, Paryavaran Bhavan,CGO complex,Lodhi Road, New Delhi	
12	Director, Department of Forests, Ministry of Environment and Forests, Paryavaran Bhavan,CGO Complex,Lodhi Road, New Delhi	Member
13	Representative of M/o Shipping & Transport, (Port Trust of India) Transport Bhavan, New Delhi	Member
14	Director General of Forests, M/o Environment and Forests Paryavaran Bhavan,CGO Complex,Lodhi Road, New Delhi-3	Member
15	Director, Ministry of Steel, Udyog Bhavan, New Delhi-1	Member
16	Secretary(Revenue) Ministry of Finance, North Block, New Delhi-1	Member
17	Shri B Ramesh Kumar, Chairman cum Managing DirectorNational Mineral Development Corporation Khanij Bhavan, 10-3-311/A, Masab Tank Hyderabad-500028	Member
18	Secretary General, Aluminium Association of India, 118,Ramanashree Arcade, 18 MG Road, Bangalore-560001	Member
19	Shri R K Sharma, Secretary General, FIMI New Delhi	Member
20	Shri P K Kaura, Managing Director, Hindustan Zinc Limited,Yashad Bhavan, Yashadgarh, Udaipur-313001	Member
21	Chairman cum Managing Director National Aluminium Co Ltd NALCO Bhavan, P/1 Nayapalli, Bhubaneshwar-751013 (Orissa)	Member
22	Director MSPL Ltd Co-operative Colony, Hospet-583203 (Karnataka)	Member
23	Manager(Business Development)	Member-

	Rio Tinto India (P) Ltd 2nd floor,DLF Center,Sansad Marg, New Delhi-1	Convener

Terms of Reference

1. To examine the present tax and tariff structure of the mining industry and suggest internationally comparable tax regime for ores/minerals.

2. To assess year-wise requirement of infrastructure such as power, water, communications, roads, ports and railways (both physical and financial) for the mining sector during the XIth Plan period and in the perspective of 10 to 15 years thereafter. Suggest measures to fill up the existing gaps and building up of additional infrastructure. Define the roles the Central Government, the State Governments and private sector in creating such infrastructure.

3. To assess constraints and problems encountered in exploration and exploitation of mineral resources in tribal, forest areas and to suggest measures in harmonizing mineral development with environment & forest tribal policy and laws and suggest changes if any.

4. To examine the impact of the Supreme Court verdict in the T N Godavarman Thirumulpad case, on assessment of net Present Value (NPV) payable for use of forest areas for non-forest purpose, including exploration and mining activities, and suggest measures for safe guarding the interests of the small miners.

5. To assess the magnitude of rehabilitation and reclamation needed for abandoned or closed mines before the concept of mine closure plan and financial assurance come into being and to suggest appropriate plans for reclamation & rehabilitation for such mines to give eco-friendly image to mining industry.

6. To examine the impact that the Samatha Judgment would have on the present mines and mineral-based industries located in the Fifth Schedule areas of the country, if the judgment is implemented and suggest measures that need to be taken to avert the situation and at the same time safeguarding interests of the tribals in these areas of the country.

7. To examine and assess the socio economic impact of mining on the life of local inhabitants and to suggest ways and means for improving their living standard.

8. To make such other recommendations as may be considered appropriate.

9. The Chairman of the Sub-group may co-opt members if necessary.

The member Convener is requested to take urgent necessary action in the matter and submit a report of the subject by the end of August,06

(Deepak Srivastava)
Director (Tech)

Copy to all members.

ANNEXURE-II(A)
BY FAX

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

No K-11012/1/2006-CMG

Suptdg. Mining Geologist I/c
Office of Chief Mining Geologist, IBM
& Member Secretary, Sub-Group-III
(Fiscal Measures, Infrastructure
Development & Environment)
Indian Bureau of Mines 'D' Block
1st Floor, Indira Bhavan, Civil Lines,
Nagpur-440001
Tel/Fax: No 0712-2561267

To
Member as per list

OFFICE MEMORANDUM

Sub: **Minutes of 1st meeting of Sub-Group-III of the Working Group on Mineral Exploration for XIth Five Year Plan held on 8.8.2006 at Shastri Bhavan, New Delhi – for necessary follow-up action**

Sir,

Please find enclosed herewith the minutes of above Sub-Group meeting duly approved by Additional Secretary to Govt. of India, Ministry of Mines, New Delhi. Your kind attention is invited to relevant paragraphs of the above minutes in which certain responsibilities have been assigned to you/representative from your Ministry/organisation as a member/coordinator & convener of specific core groups.

Accordingly you are requested to kindly make it convenient to coordinate and deliberate within your core group and send me the recommendations and supportive data on the relevant theme so as to reach me on or before 27th August,2006

It is needless to mention that this assignment is a time-bound priority programme of GOI whose report is to be submitted by 30 August, 2006. On this the Chairman and Additional Secretary of Ministry of Mines is eager to monitor the progress. Threfore further progress made on this may please be kept informed to me from time to time on phone/fax so that Chairman can be kindly apprised about it.

Thanking you,

Yours faithfully,

Encl: As above

(Sd)
(AK Srivastava)
Suptdg.Mining Geologist & offg.
Chief Mining Geologist,IBM
& Member Secretary, Sub-Group-III
(Fiscal Measures, Infrastructure Development & Environment)

Minutes of the First meeting of Sub-Group-III of the Working Group on Mineral Exploration and Development for XIth Five Year Plan held on 8.8.06 in the C&F Conference Hall, Shastri Bhavan, New Delhi

The meeting chaired by Dr Pradeep Kumar, Additional Secretary to the Government of India, Ministry of Mines, was attended by 17 members as per list of participants annexed herewith.

2. While welcoming the participants, the Chairman stressed the need to take an overview of three main issues within the purview of the Sub-Group i.e. fiscal measures, infrastructure development and environment & forests. The Chairman also stressed the need to prepare and submit the recommendations by the need of August, 2006. He also suggested that same representatives from the participating Ministries should continue in subsequent meeting to ensure continuity.

3. The Convener and Member Secretary Dr A K Srivastava, IBM reviewed the terms of reference assigned to Sub-Group-III which were already circulated to members earlier. These

terms of reference fall into three broad themes, which deserve brainstorming and detailed discussions. Discussions then ensued on the three broad themes and the major issues/decisions are as follows :

4. (i) **FISCAL MEASURES**:

1. The underlying idea is to examine the total financial burden on mining industry in India vis-à-vis in other countries and to see that the Indian industry does not become uncompetitive because of financial burden.
2. The various taxes levied by the Central Government, State Governments, local bodies etc. need to be categorized in different categories and their incidence should be worked out. State specific taxes should be separately identified.
3. Revenue Department should be approached to give details of customs duties/excise duties/service tax on import of ore, machine and equipment and R & D equipments. A letter should be issued to Dept. of Revenue indicating the points on which information is required.
4. Taxes which are common to corporate bodies like corporate tax need not come within the purview of the Group and only taxes which are specific to mining industry need to be considered.
5. Secretary General, FIMI,promised to make available the report of M/s Earnest & Young on this subject to all members of the sub-group.
6. It was decided to set up a core group on fiscal measures with the following composition;
    1. Shri R K Sharma, Secy.General,FIMI(Convener & Coordinator)
    2. Shri Ravinder Swarup,Director(TRU),D/o Revenue
    3. Shri S Sridhar, Ex-Director, Goa Mineral Ores Exporters Assocn.
    4. Shri R N Meshram,Sg. ME,IBM,MOM
    5. Shri Sidhartha Jain,Director,Rio Tinto

(ii) **INFRASTRUCTURE DEVELOPMENT** :

1. It was decided that four main sectors viz. power,roads,ports and railways will be focused upon
2. Those mineral rich areas need to be identified where mineral development is suffering for want of suitable infrastructure. An assessment should also be made regarding the likely flow of cargo/freight/traffic from these areas so that viability of infrastructure development in these areas could be worked out. Other benefits that will accrue in the form of opening of that area may also be indicated.
3. Representatives of various infrastructure Ministries mentioned that these proposals would be considered for inclusion in their respective plans in the 11th Five Year Plan.
4. The issues pertaining to infrastructural developemnt have been deliberated upon in the Hoda Committee Report, which may be taken note of.
5. It was decided to constitute a core group on the subject of infrastructure development with the following composition.
    1. Shri K P Lall,Advissor,TPPC,MOM(Convener & Coordinator)
    2. Shri Ashok Kumar,ED(Planning), M/o Railways,New Delhi
    3. Shri A R Rao, Devpt. Advisor(Ports),D/o Shipping, New Delhi
    4. Shri Pooran Singh, M/o Road Transport & Highways, R No 147, Transport Bhavan, New Delhi
    5. Representative of power Ministry
    6. Shri Kaushal Prasad,Consultant(Infra.),L3/26,DLF, Ph.II, Gurgaon (To be co-opted)

(iii) ISSUES CONCERNING ENVIRONMENT AND

FORESTS:

1 It was decided that various issues related to environment land forest as mentioned in terms of reference at S No 3,4,5,6 & 7 should be deliberated at depth and recommendations be formulated

2 It was decided to constitute one core group concerning issues pertaining to environment and forests and another group pertaining to reclamation, rehabilitation and tribal issues with the following composition

(A) **Sub-Core Group on Environment Issues** : -

1. Shri A K Singh, Director, MOM(Coordinator & Convener)
2. Shri Pankaj Asthana, AIG(FC) MOEF
3. Shri S P Agarwal,Director,MOEF
4. Shri Jiwan Mahapatra,DGM(Environment),NALCO
5. Shri Deepak Vidyarthi,NMDC
6. Shri S Sridhar,ED,GMOEA, Goa/FIMI)

(B) **Sub Core Group on Reclamation & Rehabilitation and Tribal Issues** : -

1. Shri A K Singh, Director,MOM(Coordinator & Convener)
2. Shri Pooran Singh, M/o Road Transport & Highways,R No 147, Transport Bhavan,New Delhi
3. Shri M K Prashar,RCOM,IBM,Nagpur
4. Representative from FIMI(Sukinda Chromite Belt,Orissa)
5. Representative from FIMI(Bellalry-Hospet Belt,Karnataka)

5. Some Ministries have not sent their representatives for the meeting. The attention of the concerned Secretaries should be drawn to the importance of the subject and they may be requested to depute their representatives for the meetings of the core groups as constituted as well as the meetings of the sub group.

6. All the core groups should submit their reports to the Convener of the sub group by 27.8.2006. The next meeting of the sub group would be held on 30th August, 2006.

1st MEETING OF SUB-GROUP-III OF THE WORKING GROUP ON MINERAL EXPLORATION FOR 11TH FIVE YEAR PLAN (DATED : 08.08.2006)-ATTENDANCE SHEET

Sl.No.	Name of Member/ Delegate	Designation	Postal Address with Telephone Number
1.	Dr.Pradeep Kumar	Additional Secretary, Ministry of Mines & Chairman sub group III	Shastri Bhavan,New Delhi
2.	Dr.A.K.Srivastava	Suptdg. Mining Geologist & off. Chief Mining Geologist, Indian Bureau of Mines,	Indian Bureau of Mines, Nagpur(M S)

		Member & Convener	
3.	Shri D.S.Sharma	GM(MS)	HZL,Udaipur
4.	Shri N.K.Kavdia	AGM(Expl)	HZL,Udaipur
5.	Shri B.Ramesh Kumar	CMD	NMDC, Ltd Hyderabad
6.	Shri S.Sridhar	ED	Goa Mineral Ore Explortion Associated, Goa
7.	Shri R.K.Sharma	Secretary General	FIMI, New Delhi
8.	Shri A.K.Mathur	Director LO	GSI, A-III, Pushpa Bhavan, New Delhi-110062
9	Shri A.R.Rao	Development Adviser (Ports),	Deptt. Of Shipping, New Delhi
10	Shri S.Nanda	Regional Manager	NALCO, , 303, Mercantile House, KG Marg, New Delhi
11	Shri K.P.Lall	Advisor, TPPC	MOM
12	Shri Ashok Kumar	E.D.(Planning), Ministry of Railways,	Ministry of Railways,Railway Board
13	Shri Ravinder Saroop	Director (TRU),	Department of Revenue, Ministry of Finance
14	Shri K.Prasad	Consultant (Infrastructure	Gurgaon
15	Shri Pooran Singh		Ministry of Road, Transport & Highways, R.No.147, Transport Bhavan,New Delhi
16	Shri Deepak Srivastava	Director	Ministry of Mines
17	Shri A.K.Singh	Director	Ministry of Mines

Annexure II (B)

MINUTES OF THE 2ND MEETING OF SUB GROUP III OF THE WORKING GROUP ON MINERAL EXPLORATION AND DEVELOPMENT FOR 11TH FIVE YEAR PLAN HELD ON 13.9.2006 AT CONFERENCE HALL OF SECRETARY (MINES) AT SHASTRI BHAVAN, NEW DELHI.

The meeting chaired by Dr.Pradeep Kumar, Additional Secretary to the Govt. of India, Ministry of Mines, was attended by 12 members as per list of participants annexed herewith.

1. The Chairman reviewed the Chapters on the three themes assigned to the Sub Group. The presentation on the suggestions on theme on Fiscal Measures was made by the Convenor himself. While reviewing the chapter on Fiscal Measures, the Chairman discussed and proposed that the chapter on Indirect taxes may be reviewed and the Annexure IV "Comparative summary of fiscal

measures, taxation regime of India and other important mineral producing countries" which mainly deals with corporate direct taxes could be deleted from the final report.

2. He approved suggestion of the Sub Group that the royalty should be charged in India on ad valorem basis.

3. The Chairman also suggested the Convenor and Member secretary to compile additional data highlighting the percentage of royalty and other taxes /cess which contribute to total cost of extraction in case of important minerals produced in India. The Member Secretary informed that some information/data on this aspect could be back calculated from the returns and notices submitted to IBM by the lessees and informed that compilation of such information will take some time. The Chairman advised to take 10-15 days time to compile and finalize this data.

4. Shri Ravindra Swaroop, Director, Department of revenue, informed that he has still not received a copy of the report of Ernst & Young. The Member Secretary and Convenor promised to send it within a week. The Member also informed that he has received a communication from the Convenor Sub Group III to inform the status of implementation on recommendations of the Multi Disciplinary Committee on Taxation of the Ministry of Mines which has been submitted to the Ministry of Finance in July, 2000. He admitted that he has still not been able to locate the said recommendations in his ministry, and, therefore, he cannot report/inform the follow-up action taken on these recommendations by the Ministry of Finance. However, he was informed by the Member Secretary & Convenor that a DO letter has also been sent by the then Secretary (Mines) on 25.6.2003. Therefore, the follow-up action from the Department of Revenue, on these recommendations should be informed at the earliest. The Chairman reviewed some of the recommendations particularly point No.1 and observed that these recommendations communicated to the Department of Revenue itself deserve a review.

5. The 2nd Chapter on Infrastructure development was also reviewed by the members and Chairman. The Chairman advised the Convenor of the relevant Core Group Shri K.P.Lall, Advisor, TPPC, Ministry of Mines to make the presentation particularly the salient observations and recommendations. Shri Lall, accordingly presented the salient points of his elaborate write-up highlighting the status of infrastructure development in Indian mineral sector and suggestions for improvement thereof. The recommendations were largely accepted by the Chairman and other members with minor modifications. The Chairman while reviewing the recommendations particularly point 2.6.1 suggested that Government of India need not to make major contribution to the Mineral Development Fund in each state in view of its own resource crunch.

6. Shri A.R.Rao, Development Adviser from Ministry of Shipping, promised to provide some input data on the status of infrastructural development in respect of Indian ports.

7. The Chapter on Environment, Forests and Reclamation and Rehabilitation and other related issues could not be adequately reviewed as the Convenor of the Core Group Shri A.K.Singh, Director, Ministry of Mines could not attend the meeting. However, in his absence the salient suggestions & recommendations on this relevant theme were presented by the Member Secretary and Convenor.

8. The Chairman observed that the issue pertaining to assessment of NPV should not figure in the report as this issue is still sub judicious.

   The Chairman also questioned the relevant of proposing one Committee for Forests clearance as well as Environment Appraisal instead of two committees.

9. Shri Pooran Singh representative of Ministry of Road Transport & Highways proposed that some observations and decisions already taken by his Ministry regarding ensuring participation of individual and industrially vulnerable members of the displaced community, should be incorporated in the report. Such communities should also be involved in the decision making process. He also suggested that their capacity building and ensuring socio economic justice to them should be ensured, aspect of honouring their right to livelihood should be adequately highlighted in the final document of the Sub Group III. This will help in formulating suggestions and recommendations on reclamation and rehabilitation aspects thus taking a holistic view. The Chairman advised Member Secretary and Convenor to collect input material from the member so that the same information can be incorporated in the final report.

10. The Chairman also advised few case studies to be incorporte4d on the Chapter on Socio economic Impact of Mining.

11. The Chairman advised the members to forward their inputs directly to the Member Secretary within three days and advised the Member Secretary to finalize the report on the basis of above observations at the earliest.

The meeting ended with a cordial thanks to the Chairman and participating members.

LIST OF PARTICIPANTS IN THE 2ND MEETING OF SUB GROUP III OF THE WORKING GROUP ON MINERAL EXPLORATION AND DEVELOPMENT FOR 11TH FIVE YEAR PLAN HELD ON 13.9.2006 AT CONFERENCE HALL OF SECRETARY (MINES) AT SHASTRI BHAVAN, NEW DELHI.

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Sl. No.	Name	Designation & Organization
1.	Dr.Pradeep Kumar	Additional Secretary, Ministry of Mines, New Delhi, (Chairman)
2.	Shri D.Vidyarthi	GM(Mining), NMDC, Hyderabad
3.	Shri D.S.Sharma	GM(MS), HZL, Udaipur
4.	Shri N.K.Kavdia	AGM(Exploration), HZL, Udaipur
5.	Shri Ravindar Swaroop	Director(TRU), Department of Revenue, Ministry of Finance, New Delhi

6. Shri A.R.Rao — Development Adviser (Ports), Dept. of Shipping, New Delhi
7. Shri K.P.Lall — Adviser, TPPC, Ministry of Mines, New Delhi
8. Shri Pooran Singh — Ministry of Road Transport & Highways, Transport Bhavan, New Delhi
9. Shri Deepak Srivastava — Director (Tech), Ministry of Mines
10. Shri Deepak S.Gulati — Chief Manager (Materials), NALCO
11. Shri R.S.Sarupria — HZL, Udaipur
12. Dr A.K.Srivastava — Suptdg.Mining Geologist, Offg. CMG, IBM, Nagpur (Member Secretary & Convenor)

ANNEXURE-III

RATES OF ROYALTY ON MINERALS IN INDIA FROM 1997 TO 2004(Source IBM Report ` August,2006)

S.No	Minerals	1997	2000	2004
1.	Agate	Rs.73/- per tonne	10% of the sale price on ad valorem basis	10% of the sale price on ad valorem basis
2.	Antimony	10% of the sale price on ad valorem basis		
3.	Apatite	a) For ores with more than 27% P_2O_5 – Rs.80/- per tonne. b) For ores more than 20% P_2O_5 but less than 27% P_2O_5. Rs.44/- per tonne c) For ores with less than 20% P_2O_5 –Rs.19/- per tonne For Rock Phosphate a) Above 25% P_2O_5 -11% of sale price on ad valorem basis.	i) For apatite 5% of sale price on ad valorem basis ii) For rock phosphate a) Above 25% P_2O_5 -11% of sale price on ad valorem	i) For apatite 5% of sale price on ad valorem basis ii) For rock phosphate a) Above 25% P_2O_5 -11% of sale price on ad valorem

		b) Upto 25% P_2O_5 - 5% of sale price on ad valorem basis.	basis b) Upto 25% P_2O_5 - 5% of sale price on ad valorem basis.	basis b) Upto 25% P_2O_5 - 5% of sale price on ad valorem basis.
4.	Arsenic	10% of the sale price on ad valorem basis		
5.	Asbestos	1) Superior chrysotile – Rs.726/- per tonne. 2) Amphibole – Rs.31/- per tonne	a) Superior chrysotile – Rs.726/- per tonne. b) Amphibole – Rs.35/- per tonne	a) Superior chrysotile – Rs.800/- per tonne. b) Amphibole – Rs.45/- per tonne
6.	Barytes	Barytes, all grades 5.5% of sale price on ad valorem basis.	5.5% of sale price on ad valorem basis.	5.5% of sale price on ad valorem basis.
7.	Bauxite, Laterite	Bauxite all grades – Rs.41/- per tonne	0.35% of LME Aluminium metal price chargeable on the contained aluminium metal in ore produced	0.35% of LME Aluminium metal price chargeable on the contained aluminium metal in ore produced for those dispatched for use in alumina and aluminium metal extraction. b) 20% of sale price on ad valorem basis for those dispatched for use other than alumina & aluminium metal extraction and for export.
8.	Brown Ilmenite (Leucoxene) Ilmenite, Rutile & Zircon	2% of sale price on ad valorem basis.	2% of sale price on ad valorem basis.	2% of sale price on ad valorem basis.
9.	Cadmium	Rs.82/- per unit percent of cadmium metal per tonne of ore and on pro-rata basis	10% of sale price on ad valorem basis.	10% of sale price on ad valorem basis
10.	Calcite	Rs.48/- per tonne	10% of sale price on ad valorem basis.	10% of sale price on ad valorem basis
11.	China Clay/Kaolin (including ball clay, white shale & white clay)	i) Crude Rs.18/- per tonne ii) Processed (including washed) Rs.68/- per tonne	i) Crude Rs.21/- per tonne ii) Processed (including washed) Rs.75/- per tonne	i) Crude Rs.23/- per tonne ii) Processed (including washed) Rs.85/- per tonne
Sl. No.	**Minerals**	**1997**	**2000**	**2004**
12.	Chromite	All grades – 7.5% of sale price on ad valorem basis.	All grades – 7.5% of sale price on ad valorem basis.	All grades – 7.5% of sale price on ad valorem basis.
13.	Cobalt	10% of the sale price on ad valorem basis.		
14.	Copper	Copper concentrate – 0.7% of London Metal Exchange metal price on ad valorem basis chargeable per tonne of concentrate produced.	3.2% of LME Copper metal price chargeable on the contained copper metal in ore produced.	3.2% of LME Copper metal price chargeable on the contained copper metal in ore produced
15.	Corundum	Rs.231/- per tonne	10% of the sale price on ad valorem basis.	10% of the sale price on ad valorem basis
16.	Diamond	10% of the sale price on ad valorem basis	10% of the sale price on ad valorem basis	10% of the sale price on ad valorem basis
17.	Diaspore	10% of the sale price on ad valorem basis		
18.	Dolomite	Rs.28/- per tonne	Rs.40/- per tonne	Rs.45 per tonne
19.	Felspare	Rs.17 per tonne	10% of the sale price on ad valorem basis	10% of the sale price on ad valorem basis
20.	Fireclay (including	Including plastic pipes	12% of the sale price on ad	12% of the sale price on ad

	plastic,pipel, lithomargic & natural possolanic clay)	lithomargic natural pozzolonic clay Rs.17/- per tonne	valorem basis.	valorem basis.
21.	Fluorspar(also called fluorite)	Containing more than 30% of CaF_2 – 5% of the sale price on ad valorem basis. 2.5% of sale price on ad valorem basis (hand sorted)	5% of the sale price on ad valorem basis.	5% of the sale price on ad valorem basis.
22.	Garnet a) Abrasive b) Gem	3% of sale price on ad valorem basis -	3% of sale price on ad valorem basis 10% of sale price on ad valorem basis	3% of sale price on ad valorem basis 10% of sale price on ad valorem basis
23.	Glass sand	-	-	-
24.	Gold a) Primary b)By-product gold	a) Primary 1.5% of metal sale price on ad valorem basis. b) Primary 25% of metal sale price on ad valorem basis.	a) 1.5% of London Bullion Market Association price chargeable on contained gold metal in ore produced. b) 2.5% of London Bullion Market Association price chargeable on contained gold metal in ore produced	a) 1.5% of London Bullion Market Association price chargeable on contained gold metal in ore produced. b) 2.5% of London Bullion Market Association price chargeable on contained gold metal in ore produced
25.	Graphite	a) With 80% or more fixed carbon – Rs,.205 per tonne b) With 40% but below 80% fixed carbon-Rs.110/- per tonne c) With 20% or more but less than 40% fixed carbon – Rs.45/- per tonne. d) With less than 20% fixed carbon – Rs.28/- per tonne	a) With 80% or more fixed carbon – Rs.225 per tonne b) With 40% but below 80% fixed carbon-Rs.130/- per tonne c) With 20% or more but less than 40% fixed carbon – Rs.50/- per tonne.	a) With 80% or more fixed carbon – Rs.225 per tonne b) With 40% but below 80% fixed carbon-Rs.130/- per tonne c) With 20% or more but less than 40% fixed carbon – Rs.50/- per tonne.
26.	Gypsum	Rs.22/- per tonne	20% of the sale price on ad valorem basis.	20% of the sale price on ad valorem basis.
Sl. No.	**Minerals**	**1997**	**2000**	**2004**
27.	Ilmenite	2% of sale price on ad valorem basis	-	-
28.	Iron Ore	1) Ore lumps a) 65% Fe & above – Rs.21.50 per tonne. b) 62-65% Fe-12% per tonne c) 60-62% Fe – Rs.8.50/- per tonne d) Less than 60% Fe – Rs.6/- per tonne 2) Fines A) Fines including natural fines produced incidental to mining and sizing of ore. a) 65% Fe & above – Rs.15.50/- per tonne. b) 62-65% Fe – Rs.8.50 per tonne. c) Less than 62% Fe – Rs. 6/- per tonne	1) Ore lumps a) 65% Fe & above – Rs.24.50 per tonne. b) 62-65% Fe- RS.14.50 per tonne c) 60-62% Fe – Rs.10/- per tonne d) Less than 60% Fe – Rs.6/- per tonne 2) Fines A) Fines including natural fines produced incidental to mining and sizing of ore. a) 65% Fe & above – Rs.17/- per tonne. b) 62-65% Fe – Rs.10 per tonne. c) Less than 62% Fe – Rs.	1) Ore lumps a) 65% Fe & above – Rs.21.50 per tonne. b) 62-65% Fe-Rs.16/- per tonne c)Less than 62% Fe – Rs.11/- per tonne - 2) Fines A) Fines including natural fines produced incidental to mining and sizing of ore. a) 65% Fe & above – Rs.19/- per tonne. b) 62-65% Fe – Rs.11/- per tonne. c) Less than 62% Fe – Rs.

		B) Concentrate prepared by beneficiation and/or concentrate of low grade ore, containing 40% Fe or less – Rs.2.50 per tonne.	7/- per tonne B) Concentrate prepared by beneficiation and/or concentrate of low grade ore, containing 40% Fe or less – Rs.3/- per tonne.	8/- per tonne B) Concentrate prepared by beneficiation and/or concentrate of low grade ore, containing 40% Fe or less – Rs.4/- per tonne.
29.	Kyanite	10% sale price on ad valorem basis.	10% sale price on ad valorem basis	10% sale price on ad valorem basis
30.	Lead	4% of LMEmetal price on ad valorem basis chargeable per tonne of concentrate produced	5% of LMEmetal price on ad valorem basis chargeable per tonne of concentrate produced	5% of LMEmetal price on ad valorem basis chargeable per tonne of concentrate produced
31.	Limestone (including lime kankar	a) L.D. grade (less than 1.5% silica content) – Rs.50/- per tonne. b) Others – Rs.32/- per tonne	a) L.D. grade (less than 1.5% silica content) – Rs.50/- per tonne. b) Others – Rs.40/- per tonne	a) L.D. grade (less than 1.5% silica content) – Rs.55/- per tonne. b) Others – Rs.45/- per tonne
32.	a) Lime shell (including calcareous sand & chalk) b) Lime Kankar	Rs.28/- per tonne -	Rs.40/- per tonne. Rs.40/-per tonne	Rs.45/- per tonne. Rs.45/-per tonne
33.	Magnesite	10% of sale price on ad valorem basis	3% of sale price on ad valorem basis	3% of sale price on ad valorem basis.
34.	Manganese Ore	a) MnO_2 (containing 78% or more MnO_2 & above 4% or below Fe) – Rs.112/- per tonne. b) 46% Mn & above – Rs.42/- per tonne, c) Below 46% Mn but 35% Mn or above – Rs.25/- per tonne., d) Below 35% Mn but above 25% Mn – Rs.17/- per tonne, e) 25% Mn or below – Rs.7/- per tonne, f) Concentrates – Rs.2/- per tonne.	a) Ore of all grades - 3% of sale price on ad valorem basis.. b) Concentrate 1% of sale price on ad valorem basis	a) Ore of all grades - 3% of sale price on ad valorem basis b) 1% of sale price on ad valorem basis.
Sl. No.	**Minerals**	**1997**	**2000**	**2004**
35.	Mica (crude waste & scrap)	Crude mica, waste and scrap mica – 4% of sale price on ad valorem basis.	Crude mica, waste and scrap mica – 4% of sale price on ad valorem basis.	Crude mica, waste and scrap mica – 4% of sale price on ad valorem basis.
36.	Monazite	Rs.125/- per tonne	Rs.125/- per tonne	Rs.125/- per tonne
37.	Nickel	Nickel ore: Rs.2.25/- per unit percent of contained nickel metal per tonne of ore and on pro-rata basis.	0.12% of LME nickel metal price chargeable on the contained nickel metal in ore produced.	0.12% of LME nickel metal price chargeable on the contained nickel metal in ore produced
38.	Ochre	Rs.11/- per tonne	Rs.12/- per tonne	Rs.15/- per tonne
39.	Pyrites	Rs.0.65 per unit percent of sulphur per tone of ore on pro-rate basis.	2% sale price on ad valorem basis.	2% sale price on ad valorem basis.
40.	Pyrophyllite	Rs.24/- per tonne	15% of sale price on ad valorem basis.	15% of sale price on ad valorem basis.
41.	Quartz, silica sand, moulding sand, quartzite	Quartz, silica sand and moulding sand – Rs.13/- per tonne	Quartz, silica sand, moulding sand and Quartzite– Rs.15/- per tonne	Quartz, silica sand and moulding sand and Quartzite – Rs.20/- per tonne
42.	Quartzite	-	-	-
43.	Rutile	2% of sale value on ad	-	-

		valorem basis.		
44.	Sand for stowing	Rs.3/- per tonne	Rs.3/- per tonne	Rs.3/- per tonne
45.	Selenite	Rs.50/- per tonne	10% of sale price on ad valorem basis.	10% of sale price on ad valorem basis.
46.	Sillimanite	2.5% of sale price on ad valorem basis.	2.5% of sale price on ad valorem basis.	2.5% of sale price on ad valorem basis.
47.	Silver	5% of sale price on advalorem basis.	a) By product – 5% of LME price chargeable on by product silver metal actually produced. b) Primary silver-5% of LME silver metal price chargeable on contained silver metal in ore produced.	a) By product – 5% of LME price chargeable on by product silver metal actually produced. b) Primary silver-5% of LME silver metal price chargeable on contained silver metal in ore produced.
48.	Slate	Rs.40/- per tonn	Rs.40/- per tonne	Rs.45/- per tonne
49.	Talc, steatite & soapstone	a) Insecticide grade – Rs.25/- per tonne b) Other than insecticide grade – Rs.65/- per tonne	15% of sale price on ad valorem basis.	15% of sale price on ad valorem basis.
50.	Tin	10% of sale price on ad valorem basis.	5% of LME tin metal price chargeable on the contained tin metal in ore produced	5% of LME tin metal price chargeable on the contained tin metal in ore produced
51.	Tungsten, Scheelite, Wolframe	Tungsten ore : Rs.20/- per unit percent of WO_3 per tonne of ore and on prorate basis.	Tungsten ore : Rs.20/- per unit percent of WO_3 per tonne of ore and on prorate basis.	Tungsten ore : Rs.20/- per unit percent of WO_3 per tonne of ore and on prorate basis.
52.	Uranium	Rs.5/- for dry ore with U_3O_8 content of 0.05% with prorate increase/decrease Re.1.50 per metric tonne of ore for 0.01% increase/decrease.	Rs.5/- for dry ore with U_3O_8 content of 0.05% with prorate increase/decrease Re.1.50 per metric tonne of ore for 0.01% increase/decrease.	Rs.5/- for dry ore with U_3O_8 content of 0.05% with prorate increase/decrease Re.1.50 per metric tonne of ore for 0.01% increase/decrease.
53.	Vermiculite	Rs.25/- per tonne	3% of sale price on ad valorem basis	3% of sale price on ad valorem basis
Sl. No.	**Minerals**	**1997**	**2000**	**2004**
54.	Wollastonite	10% of sale price on ad valorem basis.	10% of sale price on ad valorem basis.	10% of sale price on ad valorem basis.
55.	Zinc	Zinc concentrate: Three & half (3.5%) of LME metal price on ad valorem basis chargeable per tonne of concentrate produced.	6.6% of LME zinc metal price chargeable on the contained zinc metal in ore produced.	6.6% of LME zinc metal price chargeable on the contained zinc metal in ore produced
56.	Zircon	2% of sale price on ad valorem basis	-	-
57.	Precious & semi-precious stones	10% of sale price on ad valorem basis	-	-
58.	All other minerals (not herein before specified)	10% of sale price on ad valorem basis.	10% of sale price on ad valorem basis.	10% of sale price on ad valorem basis.

ANNEXURE-IV

COMPARATIVE TABLE SHOWING PERCENTAGE OF TAXES & CESSES FORMING COMPONENT TO COST OF MINING IN SELECTED MINES OF INDIA

(Source : Indian Bureau of Mines)

Sl.No.	Mineral/ ore	Lessee	Area	Cost of Minerals production		% of taxes & cesses as a component to cost of mine production					
				Years	Cost of mine production (in Rs.)	Royalty	Dead rent	Surface rent	Welfare rent	Entry tax	Sales tax
1.	2.	3.	4	5	6	7	8	9	10	11	12
1.	**Manganese ore**	Public Sector	Balaghat dist.	2004-05	1479.83	7.56	0.080	0.065	0.256	-	-
	-do-	-do-	-do-	2003-04	1384.37	4.37	0.093	0.077	0.284	-	-
2.	-do-	-do-	-do-	2005-06	2033.79	4.76	-	-	0.158	0.40	0.11
	-do-	-do-	-do-	2003-04	1925.73	3.29	-	-	0.195	-	0.24
3.	-do-	-do-	Nagpur dist.(Mah)	2005-06	1670.80	6.82	0.0	-	-	0.26	-
	-do-	-do-	-do-	2004-05	1693.64	7.53	0.15	-	-	0.23	-
4.	-do-	-do-	-do-	2005-06	1912.47	6.73	-	-	-	0.19	-
	-do-	-do-	-do-	2004-05	2428.28	-	-	-	-	-	0.15
5.	-do-	-do-	-do-	2004-05	2436.55	4.81	-	0.04	-	0.14	-
	-do-	-do-	-do-	2003-04	1754.80	3.97	0.03	-	-	0.26	-
6.	-do-	-do-	-do-	2004-05	1320.50	8.38	-	-	-	0.28	-
	-do-	-do-	-do-	2003-04	1040.67	7.56	-	-	-	0.40	-
7.	Bauxite	-do-(BALCO)	Kawardha dist.Chhattisgarh	2005-06	2049.64	4.31	-	-	-	-	-
	-do-	-do-	-do-	2004-05	2049.64	4.58	-	-	-	-	-
8.	-do-	-do- CMDC	Surguja dist M.P.	2005-06	141.78	43.74	-	-	-	-	2.46
	-do-	-do-	-do-	2004-05	N A	-	-	-	-	-	-
9.	-do-	BALCO	-do-	2005-06	323.81	27.31	-	-	-	-	-
	-do-	-do-	-do-	2004-05	340.47	21.36	-	-	-	-	-
10.	-do-	HINDALCO	-do-	2005-06	323.83	27.07	-	-	-	-	-
	-do-	-do-	-do-	2004-05	272.01	27.06	-	-	-	-	-
11.	-do-	-do-	-do-	2005-06	323.83	28.02	-	-	-	-	-
1.	2.	3.	4	5	6	7	8	9	10	11	12

12.	<u>Iron ore</u>	NMDC	Dist Dantewara Chhattisgarh	2004-05	139.37	12.29	0.14	-	0.32	0.18	11.3
	-do-	-do-	-do-	2003-04	199.31	8.28	0.08	-	0.18	0.078	5.98
13.	-do-	-do- SAIL BSP	Dist. Durg Chhattisgar	2003-04	372.94	2.15	0.27	-	-	-	-
	-do-	-do-	-do-	2004-05	253.50	3.33	0.37	-	-	-	-
14.	-do-	-do-	-do-	2004-05	272.58	3.29	-	-	-	-	-
	-do-	-do-	-do-	2003-04	240.76	3.55	-	-	-	-	-
15.	-do-	-do-	-do-	2003-04	178.12	4.61	-	-	-	-	-
	-do-	-do-	-do-	2003-04	178.12	4.61	-	-	-	-	-
16.	<u>Limestone</u>	Pvt Sector M/s Ambuja	Raipur Dist Chhattisgarh	2005-06	122.20	36.82	-	-	0.81	-	
	-do-	-do-	-do-	2004-05	109.01	41.65	-	-	0.98	-	-
17.	-do-	M/s ACC	Durg Dist. Chhattisgarh	2005-06	135.13	33.29	-	-	0.73	-	-
	-do-	-do-	-do-	2004-05	124.08	34.03	-	-	-	-	-
18.	-do-	Pvt Sector M/s Century Textiles	Raipur dist. (Chhattisgarh)	2005-06	122.54	36.72	-	-	0.82	-	-
	-do-	-do-	-do-	2004-05	99.84	42.50	-	-	1.00	-	-

<u>ANNEXURE V</u>

STATUS & REQUIREMENT OF INFRASTRUCTURE IN IMPORTANT MINING BELTS IN INDIA AS EVALUATED THROUGH GEOLOGICAL STUDY REPORTS OF IBM

(Source : CMG Office, IBM)

Sl. No	Name of the Mining Belt	Location			Road	Railway	Power	Ports
		Village	District	Lat./long/T.No.				
ANDHRA PRADESH								
1.	Ramgiri Gold Fields, A.P.	Ramgiri	Anantapur	14^0 18' 00'' / 70^0 30' 00'' 47F/7 & 11	Approachable by metal road	Nearest railway station Nagarmudram – 15 km.	Available	N.A
2.	Chigargunta Gold Fields, A.P.	Kothur	Chittoor	12^0 43' 30'' to 12^0 45' 30''/ 78^0 14' 30'' to 78^0 15' 30''/ 57L/2 & 6	Approachable by metal road	Nearest railway stations Gudupalli (12km.) & Kuppam (13 km.)	Available	N.A
3	Mn Ore Belt, A.P.	Peddanadipalli, Kothakarra, Garividi, Avagudem, devada, Garbham etc.	Vizianagaram Adilabad	78^0 26' 30'' to 83^0 38'/ 18^0 15' to 19^0 47' 40''/ 56I/5, 6, 10 65N/7, 11,12	All weather roads from important towns / districts	at a distance varying from 1 to 20 kms. from the mines	N.A.	N.A.
4	Telangana Mn Ore belt, A.P.	Ghotkuri, Pipalgaon & Dabakuchi	Adilabad	16^0 40' 32'' to 19^0 45' 20''/ 78^0 29' 30'' to 78^0 39' 37''	Roads upto mines available, nature needs upgradation	Adilabad 7 to 17 kms. from the area	N.A	N.A
5.	Barytes Belt, A.P.	Mangampet, Pulivendla, Vemula etc.	Cuddapah	14^0 00' to 15^0 40'/ 78^0 00' to 79^0 30'	Area lying adjacent to all weather roads	rail link at a distance varying from few meters to 40 km. from mines	N.A	N.A
6.	Limestone	Mellacheruvu,	Nalgonda,	16^0 25' to 19^0	Area lying adjacent	rail links at a distance from 3 km.to	N.A	N.A

	Belt, A.P.	Mettapalli, Kodak, Jaggaiyapet, Tandur, Macherla, Mancherial, Kazipet etc.	Krishna, Rangareddy, Guntur, Karimnagar, Adilabad	01’/ 77^0 28’ to 83^0 07’/ 56P/3,7,10,13& 14, 65D/1&2 56G/7 56N/ 5,6,8	to all weather roads	84km.		
MADHYA PRADESH								
7.	Bauxite Belt, Madhya Pradesh	Devgaon, Jurman, Naikim, Bansi etc.	Rewa, Sidhi	24^0 20’ 14’’ to 24^0 51’ 07’’/ 81^0 07’ 03’’ to 81^0 25’ 17’’/ 63H/1, 7	Partly tar road, partly unmetal road which needs to be metalled.	N.A	N.A	N.A
8.	Limestone Belt, Madhya Pradesh	Ameta, Bacholi, Badari etc .	Katni	23^0 40’ 23’’ to 24^0 02’ 05’’/ 80^0 24’ 37’’ to 80^0 35’ 30’’	approachable along Jabalpur –Maihar (N.H.No.7)	Jukhei railway station Niwar railway stn. Is 10 kms.	N.A	N.A
9.	Limestone Mining Belt, Madhya Pradesh	Jukehi, Kymore, Harraiya etc.	Katni	23^0 40’ 23’’ to 24^0 02’ 51’’/ 80^0 24’ 37’’ to 80^0 35’ 30’’/ 63D/12, 64A/5, A/6, A/9 & A/10	Approachable by NH-7. The connecting roads are in bad shape; repair is required	Nearest Rly station Jukehi (18 kms. from Katni) situated on Katni-Allahabad Broad Gauge.	N.A	N.A
10.	Jukhi-	Amheta,	Katni	$23^0$40’ 23’’ to	approachable along	Mumbai-	N.A	N.A

	Kymore-Harraiya Limestone Belt, Madhya Pradesh	Amraiya, Bacholi, Badari, bamangaon, Bistara, chandan, Mehgaon, Pipariya, Rajarwara etc.		24^0 02’ 51’’/ 80^0 24’ 37’’ to 80 ^{0}35’ 30’’	Jabalpur-Maihar-Rewa Road (NH No.7) Poorly maintained jeep able roads	Howrah Central railway from Jukehi about 22 km long 10 km. –Niwar rail etc. 10 -20 km. Rupaund railway station.		
CHHATTISGARH								
11.	Dolomite Belt, Chhattis-garh	Mohbhatta Kodwa etc.	Durg	20^0 23’ to 22^0 02’/ 80^0 46’ to 81^0 58’/ 64G/10	Well connected by road Durg-Bhilai-Dalli –Rajhara belt through dist headquarters (Durg). Durg is connected to NH-6, Mohbhatta-Kodwa area by SH-12.	Well connected by rail to all important destinations	N.A	N.A
12.	Limestone & Dolomite Belt, Chhattis-garh	Lohar, Piprahi, Khapri, Lalpur etc.	Raipur	21^0 23’ 24’’ to 21^0 45’/ 81^0 44’ 15’’ to 82^0 05’/ 64G/14 & 15, 64K/2 & 3, 64G/11, G/12, G/15 & G/16 etc.	all the mines are approachable from Raipur by all weather roads	Raipur-Howrah Broad Gauge rail line passes through the area	N.A	N.A
JHARKHAND								
13.	Rakha Copper Project, Jharkhand	Rakha	East Singhbhum	22^0 36’ to 22^0 38’/ 86^0 21’ to 86^0 24’/ 73J/6	approachable by metal road	Nearest railway station Rakha mine railway station-adjacent to the project	N.A	N.A

14.	Mosaboni Group of Copper Mines, Jharkhand	Mosaboni, Paluargova, Surda & Kendadih	East Singhbhum	22^0 30’ 45’’ to 22^0 35’ 17’’ / 86^0 25’ 19’’ to 86^0 27’ 38’’/ 73J/6 & 7	Approachable by metal road	Nearest railway station Ghatsila	N.A	N.A
15.	Bauxite Mining Belt, Jharkhand	Chirodih, Amtipani, Kujam, Harmp etc.	Gumla	23^0 18’ 19’’ to 23^0 23’ 30’’/ 84^0 12’ 40’’ to 84^0 24’ 40’’ / 73A/7, A/11	All the mines are well connected to road upto Lohardaga district and Chandwa in palamau district which are the wagon loading points	Railway Stn. Lohardaga	N.A	N.A
16.	Fireclay Mining Belt, Jharkhand	Balumath, Chandwa, ara etc.	Dhanbad, Palamau	23^0 15’ 15’’ to 23^0 51’ 57’’/ 84^0 37’ 12’’ to 84^0 57’/ 73A/9, A/13	area is approachable by all weather roads	Nearest railway station to Tori for the mines in Palamau district. The nearest railway stn. For mines in Dhanbad district is Kumardhubi	N.A	N.A
17.	Iron & China clay deposits, Jharkhand	China clay bearing belt is 25 kms.	Singhbhum West	85^0 40’ E to 86^0 00’E / 22^0 10’N to 22^0 15’ N	Approachable by all weather roads	Existing but partly dismantled light railway track from Chitra to Monocharpur needs to be renovated with broad-guage railway line	N.A	Haldia part in W.B. Paradeep port in Orissa

18.	Bauxite Mining Belt, Jharkhand	Chirodih, Amtipani, Kujam, Harup etc.	Lohardaga, Gumla	23^0 05’ 23’’ to 23^0 34’ 23’’/ 84^0 13’ 00’’ to 84^0 38’ 00’’/ 73A/3, A/6, A/7, A/10 & A/11	The area is approachable by metal and all weather roads unmetal roads from Ranchi	The area is approachable by railways. Railway stn.- Lohardaga	N.A	N.A
19.	Bauxite belt, Jharkhand	Bagru, Bhusar etc.	Lohardaga, Gumla	N.A	State Highway connects Palamau, Lohardaga, and Gumla & Ranchi distts. from the mining area.	Well connected by rail. Lohardaga 150 km. from Ranchi	N.A	N.A
20.	Limestone Mining Belt, Jharkhand	Karnarhatu, Tekrahatu, Guira, Bamesa etc.	Singhbhum West	21^0 57’ 50’’ to 23^0 09’ 15’’/ 84^0 58’ 45’’ to 86^0 18’ 50’’	Entire district is having a network of State highways	Well connected by railways. Main railway station is Chaibasa	N.A	N.A
21.	Limestone Belt, Jharkhand	Gola, Religarha, Umedandi etc.	Ranchi, Hazaribagh & Garhwa	23^0 35’ to 24^0 25’/ 83^0 30’ to 85^0 40’/ 73E/2, E/6,, E/10, E/14 & E/15, 63P/11	well connected by tar road. Approach road for most of the mines NH-3 and all weather village road	nearest railway station-Khalari	N.A	N.A
22.	Calcite deposits, Jharkhand.	Dervalia, Gandhwal, Budi etc. Kund, Bari, Panwani etc.	Khalgone Jhabua	21^0 22’ to 22^0 25’/ 74^0 23’ to 76^0 15’ 21^0 55’ to 23^0 14’ 45’’/ 74^0 02’ to 75^0 01’	Approachable by all weather tar road Well connected with state highways	Rly station-Godhra, Ratlam of Bombay-Delhi Road line of Western railways	N.A	N.A

BIHAR								
23.	Limestone Mining Belt, Bihar	Kuchwar Bhurare, Birla, Kariatari etc.	Rohtas	24^0 31’ 45’’ to 24^0 46’ 08’’/ 83^0 02’ 30’’ to 85^0 75’ 30’’/	the area is well connected by all weather road	area is connected by Dahri-Rohtas railway line	N.A	N.A
MAHARASHTRA								
24.	Limestone & Dolomite Belt, Maharashtra	Dongargaon, Wegaon, Wirkund, Maregaon etc.	Yavatmal, Chandrapur	19^0 35’ to 20^0 11’ 55’’/ 78^0 47’ 55’’ to 79^0 15’ / 56I/13, 55L/16, 56N/1, 56M/1 & 56M/2	well connected by tar roads from Nagpur, Yavatmal & Chandrapur districts.	Two broad guage railway stations viz. Rajur & Wani, nearby to the area	N.A	N.A
ORISSA								
25.	Fe/ Mn ore, Orissa	Malda, nadidih, Kolta, Mahulsuka, Khandadhar etc.	Sundergarh	21^0 44’ 52’’ to 21^0 55’ 57’’/ 85^0 08’ 48’’ to 85^0 23’ 24’’	The approach roads to Tatanagar, Rourkela, Keonjhar are in a dilapidated conditions, needs to be repaired	Approachable to Howrah – Tatanagar-Chakdhar-pur	N.A	N.a

26.	Fe- Mn Ore Belt, Orissa	Unchabali, Jampani, Porhadihi etc.	Keonjhar	20^0 48’ 26’’ to 22^0 10 00/ 85 20’ to 85^0 30’	The approach roads from the mineral belt to Tatanagar, Rourkela, Keonjhar are in a dilapidated conditions, needs to be repaired	well approachable to Howrah – Tatanagar Chakdharpur	N.A	Paradeep port is approachable by dilapidated road of 260 km. The road requires immediate repair.
27.	Graphite Belt, Orissa	Sargipalli, Saintala, Titlagarh, Madanpur, Rayagada, Tumudband, Nishikhal, Ambadola etc.	Phulbani, Kalahandi, Bargarh, Bolangir, Sambalpur, Bargar, Nuwapara, Rayagada	20^0 38’ 51’’ to 20^0 55’ 00’’/ 82^0 02’ 10’’ to 83^0 50’ 00’’/ 64L/9, 10, 13, 14 & 15 64P/1, 2 & 65M/9	Roads joining mines with state roads are in bad condition. Hence here need to construct metal roads in the area	nearest railway station- Kantabanji. Muniguda, Harishankar road	Power not available on most of the mines and hence need to supply power to the area	Visakhapatnam & Kol-kata

KARNATAKA								
28.	Chromite Belt, Karnataka	Byrapur, Thagadur, Jambur etc.	Hassan	76^{0} 20’ to 76^{0} 30’ 00’’/ 13^{0} 00’ to 13^{0} 10’ / 57C/8	Area approachable by all weather road which need to be metalled	Nearest railway station Tiptur 30 km. from area	N.A	N.A
29.	Hutti gold Field , Karnataka	Hutti	Raichur	16^{0} 11’ 00’’ /76^{0} 39’ 00’’ / 56D/12	Approach-able by metal road	Raichur, nearest rly. Stn.-80 km.	available	N.A
30.	Iron ore Belt, Bellary-Hospet sector, Karnataka	Donimalai, Ettinahatti, Devadari, Ramgad	Bellary	14^{0} 58’ 00’’ to 15^{0} 13’ 00’’/ 76^{0} 23’ 30’’ to 76^{0} 42’ 00’’/ 57A/7,11,12 & 57B/5	About 300-320 km. from Bangalore . Hospet Sandur only by road Roads are in a pathetic condition require immediate mending.	Well connected by rail from Bangalore. Ranjitpur & Bannehatti 8-15 kms. Ranjitpur=6km. Ramgad=5km.	Some leases started the generation of power by tapping the solar energy. Power requirement is likely to increase	Chennai Port. Some ore goes to Mormu-goa. Che-nnai port will not available in future. An alter-native port need to be identified/ developed

31.	Kudremukh Iron ore Belt, Karnataka	Samse Tal.- Mudigere	Chickmanga-lur	13^0 10’ 00’’ to 13^0 17’ 00’’N / $7^0$5 10’ 00’’ to 75^0 20’ 00’’ E / 47º/4, 48º/8	300 to 350 km. from Mysore and Bangalore respectively. Road is black topped and all weather-ed lease is 110 km. from dist.	Nearest railway station Mangalura (Broad guage)	N.A	Manga-lore (Panamb ur) 110 km. from mine.
32.	Limestone & Deolomite Belt, Karnataka	Bagalkot, Badami & Mudhol, Kalaldgi, likapur	Bagalkot, Bijapur	74^0 50’ to 76^0 28’/ 15^0 20’ to 17^0 28’ / 47P	Area connected with all weather roads or lying adjacent to all weather roads	Bagalkot, nearest railway station	N.A	N.A
33.	Limestone Belt, Karnataka	Kenkera, Tarekere, Kanchipura, Doddabylada of Hosadurga of Chitradurga, Agraha, Kamenahalli, Yerrakatte, of C.N. Halli distt. Tumkur.	Chitradurga Tumkur	13^0 38’ 10’’ to 13^0 51’ 00’’/ 76^0 22’ 40’’ to 76^0 35’ 00’’ / 57C/5, C/6, C/10, C/11, C/15	Approachable from nearest towns which are 140 to 200 kms. from Banga-lore roads connected to the mines, plants,natio-nal highway are in bad condition, one ropeway for transpor-tation	N.A	Non-availability of electricity, power supply is urgently required	N.A

GUJARAT								
34.	Bauxite mining Belt, Gujarat	Kalyanpur State-Gujarat Mewasa, Virpur	Jamnagar	22^0 08' 00'' to 22^0 15' 00''/ 69^0 15' 00'' to 69^0 25' 00''/ 41F/6, 41F/7 & 41F/8	Approached from Bhatia, Bhatia – 12 km. Limdi-tar road – 2km. Ranvill (Limbdi-Gurgodh) SH 29 from Ran the area about 10 km. is motorable Kutcha road which needs to be made metal	N.A	N.A	Not Available
SIKKIM								
35.	Rhotang Copper-Lead-Zinc Project, Sikkim	Rangpo	East Sikkim	27^0 10' 30'' / 88^0 32' 00''/ 78A/12	Mine located on National Highway NH 31-A	Nearest Rly station Jarpaiguri-86km.	N.A	N.A

TAMIL NADU								
36.	Limestone Belt, Tamil Nadu	Tiruchirapalli, Perambalur	Tiruchirapalli Perambalur	10^0 55’ to 11^0 25’ 78^0 50’ / 79^0 35’/ 58M/3, 4, 7, 58I/16, 58J/13	Well connected by motorable roads from Pera-mbalur & Trichy 45km.from Tiruchirapalli & 20 km from Perambalur.	Ariyalur, nearest railway station 20 to 30 kms.	Electric power is available from majority of lease areas	Nearest port is Chennai at dist. of 300 kms.
37.	Limestone, Fireclay, Talc, Gypsum, Garnet Belt, Tamil Nadu	Perali, Varagupadi, etc.	Tiruchirapalli, Perambalur	10^0 38’ 30’’ to 11^0 12’ 30’’/ 78^0 57’ 00’’ to 79^0 15’ 78’’/ 58J/13, 58M/3, 58M/7	Well connected from Trichy & Perambalur by motorable roads (all weather roads)	Ariyalur railway station -20 to 30 kms. from mines	Electric power available in most of leaseholds area	Chennai port – 300 kms. from the area. Approachable by metalled roads.
38.	Limestone Belt, Tamil Nadu	Madurai-South Arcot-Trichinapally-Ariyalur	Salem	11^0 26’ 30’’ to 11^0 31’ 00’’ / 77 ^{0}45’ 30’’ to 77^0 54’ 00’’/ 58E/14 & 15	Connected by metal roads for the major dis-tance, rest by unmetal roads	Nearest railway station- Sankari	Electric power is available sub-stn. 380 KVA	Chennai, nearest port at 350 kms.

39.	Bauxite Belt, Tamil Nadu	Puliyur, Maanjakaattai & Semmaduvu	Namakkal, Nilgiri & Salem	11^0 13’ 00’’ to 11^0 50’ 30’’/ 78^0 13’ 00’’ to 78^0 24’ 00’’/ 58I/1	area 35 km. from Salem (approachable from Salem via Yercaud 8 km. by a motorable road.	Salem railway stn. (broad gauge) 85 km. to 100 km.	N.A	N.A
40.	Iron ore Belt, Goa.	Onda, Assonora, Usgaon, Bicholim, Suctoli, Codli, Costi, etc.	North & South Goa	73^0 53’ to 74^0 15’ / 15^0 12’ to 15^0 37’/ 48I	Mining area well connected by all weather roads of the state.	Rail link at Sancordem station – 15 to 20 km from area which can be extended upto mining area to carry ore to the port.	Power available in most of the mines	Vasco-de-Gama from where ore is loaded for export. Ore is loaded at river jetty from where it is transport-ed to port

RAJASTHAN								
41.	Zawar Group of Lead & Zinc mines, Rajasthan	Zawar Chawauda, Dehalwa, Prasad	Udaipur	24^0 19’ 08’’ to 24^0 22’ 35’’/ 73^0 40’ 25’’ to 73^0 45’ 15’’	approachable by well connected metal roads	Nearest railway station Udaipur	available	N.A
42.	Khetri Copper Project, Rajasthan	Khetri	Jhunjhunu	28^0 03’ 35’’ to 28^0 04’ 45’’/ 75^0 47’ 40’’ to 75^0 48’ 45’’	approachable by metal road	Railway Station-Jhunjhunu	Available	N.A
43.	Limestone Belt, Rajasthan	Parasrampur, Machda	Jhunjhunu, Sikar, Alwar	75^0 50’ to 76^0 25’ / 28^0 10’ to 28^0 40’	All the mines are approachable by roads.	Meter guage rail link available to most of the leases, broad guage rail link available to mines lying between Sawai-Madhopur and Kota.	N.A	N.A
HIMANCHAL PRADESH								
44.	Limestone Belt, Himachal Pradesh	Sataun, Rudana, Baldhwa Pamta etc.	Sirmour	30^0 36’ 30’’ to 30^0 34’ 00’’ 77^0 40’ 00’’ to 77^0 45’ 00’’	The mines of Baldhwa-Pamta are located 18 to 25 km. from Sataun located in Shiva-Rudana are at 30 -35 km from Paonta Sahib	Rail link available	N.A	N.A

MAHARASHTRA & MADHYA PRADESH								
45.	Manganese Belt, Maharashtra & M.P	Kandri, Parseoni, Dongri, Buzurg, Mansar etc.	Nagpur, Bhandara Chindwara	21^0 20’ to 21^0 43’/ 78^0 47’ to 79^0 45’/ 55O/3, O/10 & O/14 and 55K/14 & K/15	Well connected by all weather roads to the nearest town ships.	Well connected by rail line. The nearest railway stns. Are Tumsar, Saoner and Chindwara	N.A	N.A
MAHARASHTRA & KARNATAKA								
46.	Bauxite Mining Belt, Maharashtra & Karnataka	Durgamanwadi, Kanurkhud, Kalaarde, Udagiri, Kitwad, Ramanwadi, navage, Amate, lalamanai	Kolhapur Belgaum	15^0 47’ 30’’ to 16^0 01’ 45’’/ 74^0 05’ 15’’ to 74^0 27’ 00’’/ 48I/1 & 5, 47 L/4	Roads connected to the mines to the State roads by unmetal, fair weather, which need to be made metal	Nearest railway station Kolhapur, Belgaum (within 50km) but bauxite is consumed in Alumina plant at Belgaum	N.A	N.A

ASSAM & MEGHALAYA								
47.	Limestone Belt, Assam & Megha-laya	Bokajan, Dengaon, Kathiakali etc.	Assam: Guwahati, Dispur, Nowgong etc. Meghalaya: Shillong, Cherapunji etc.	25^0 31’ 00’’ to 26^0 01’ 00’’/ 92^0 30’ 00’’ to 93^0 35’ 50’’/ 83C/14, 83F/12 & 83G/9 25^0 10’ 20’’ to 25^0 17’ 00’’ / 91^0 37’ 30’’ to 92^0 22’ 15’’ / 78O/11, O/12	Area connected to the nearest townships (Umrang-shu, Cherapunji, etc.) by all weather roads. Roads in the rural area needs to be developed.	The nearest railway station is Bokajan	N.A	N.A

ANNEXURE – VI

PRODUCTION OF IRON ORE – STATE-WISE

(Source : Advisor TPPC , MOM)

(in thousand tonnes)

State	2001-02	2002-03	2003-04	2004-05 (p)
Andhra Pradesh	374	657	1390	2776
Chattisgarh	18660	19781	22675	23113
Goa	14784	17889	20157	21565
Jharkhand	13068	13702	14484	16069
Karnataka	22595	24797	31562	36977
Madhya Pradesh	102	128	109	193
Maharashtra	33	36	35	553
Orissa	16602	22077	30179	39982
Rajasthan	8	5	10	19
Total India	**86226**	**99072**	**120601**	**141247**

ANNEXURE – VII

DESTINATION-WISE EXPORTS OF INDIAN IRON ORE

(Source : Advisor TPPC , MOM)

(Qty. in Million Tonnes)

Country	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05 (P)
China	10.00	14.10	19.22	26.27	41.99	50.17
Japan	15.07	16.77	15.62	15.75	13.10	12.13
S. Korea	2.59	2.31	3.00	2.41	2.16	2.29
Taiwan	0.50	0.90	0.43	0.58	0.88	0.83
Europe	2.55	1.48	1.81	2.04	2.47	2.50
Others	2.20	1.93	1.56	0.97	1.51	1.90
TOTAL	**32.91**	**37.49**	**41.64**	**48.02**	**62.11**	**69.82**

ANNEXURE – VIII

IRON ORE HANDLED BY MAJOR PORTS

(Source : Advisor TPPC , MOM)

Name of the Port	Iron Ore Handled (in thousand MTS)				
	2000-01	**2001-02**	**2002-03**	**2003-04**	**2004-05**
Chennai	7049	7442	7945	8360	9598
Haldia	374	1780	2694	3752	5375
Paradip	2992	3546	4679	5934	9051
Visakhapatnam	9270	9199	10433	12378	16587
New Mangalore	5112	5783	6139	5474	10275
Mormugao	15663	17966	18665	22942	24717
Total	**40460**	**45716**	**50555**	**58780**	**75603**

ANNEXURE – IX

PRODUCTION AND CONSUMPTION OF INDIAN IRON ORE

(Source : Advisor TPPC , MOM)

F.Y.	Production (MT)	Export (MT)	Domestic consumption (MT)	% Exported
2000-01	79.22	37.49	41.73	47.3
2001-02	83.00	41.64	41.36	50.2
2002-03	98.00	48.02	49.98	49.0
2003-04	120.00	62.11	57.89	51.8
2004-05	135.00 (P)	70.00 (P)	65.00 (P)	51.8

ANNEXURE – X

NMDC - PROJECTED PRODUCTION OF IRON ORE DURING

XI PLAN (2007-2012) AND UPTO 2022

(Source : Advisor TPPC , MOM)

Year	Availability of Iron Ore from NMDC (million T)		
	Bailadila Sector	Donimalai Sector	Total
2007-08	22.5	6.5	29.0
2008-09	24.1	5.5	29.6
2009-10	26.2	5.6	31.8
2010-11	29.6	6.1	35.7
2011-12	32.7	6.1	38.8
2012-13	36.6	6.3	42.9
2013-14	40.2	6.3	46.5
2014-15	41.2	6.3	47.5
2015-16	42.5	6.3	48.8

ANNEXURE - XI

PROJECTED PRODUCTION OF IRON ORE AND LIMESTONE BY SAIL DURING XI PLAN (2007-2012)

(Source : Advisor TPPC , MOM)

Year	Production in Million Tonnes	
	Iron Ore	**Limestone**
2003-04	23.9	1.30
2004-05	22.6	1.30
2005-06	23.8	1.36
2006-07	26 (p)	1.40 (p)
2011-12	38 (p)	2.00 (p)

ANNEXURE - XII

PROJECTED PRODUCTION OF NALCO UP TO 2022

(Source : Advisor TPPC , MOM)

PRODUCT/ YEAR	2006-07	2007-08	2008-09	2009-10	2010-11	2011-012	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
BAUXITE	4.8	4.8	5.14	6.21	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
ALUMINA HYDRATE	1.57	1.57	1.69	2.07	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
ALUMINIUM CAST METAL	0.34	0.34	0.38	0.45	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46

(Figures in million tonnes)

REPORT OF

THE WORKING GROUP ON

MINERAL EXPLORATION AND DEVELOPMENT

(other than Coal and Lignite)

FOR

THE ELEVENTH FIVE YEAR PLAN

RESEARCH & DEVELOPMENT
AND
HUMAN RESOURCE DEVELOPMENT

VOL - V

GOVERNMENT OF INDIA

PLANNING COMMISSION

January, 2007

THE WORKING GROUP ON
MINERAL EXPLORATION AND DEVELOPMENT
(other than Coal and Lignite)

FOR

THE ELEVENTH FIVE-YEAR PLAN

REPORT OF THE SUB GROUP - IV

ON

RESEARCH & DEVELOPMENT

AND

HUMAN RESOURCE DEVELOPMENT

सत्यमेव जयते

GOVERNMENT OF INDIA
MINISTRY OF MINES

October, 2006

THE WORKING GROUP ON MINERAL EXPLORATION & DEVELOPMENT (OTHER THAN COAL & LIGNITE) FOR THE ELEVENT FIVE-YEAR PLAN, (REPORT OF THE SUB – GROUP IV SUB-GROUP ON R&D AND HUMAN RESOURCE DEVELOPMENT IN MINERAL SECTOR)

C O N T E N T S

PREFACE

Planning Commission constituted a Working Group on Mineral Exploration and Development (other than Coal and Lignite) in the context of formulation of the Eleventh Five Year Plan (2007-12) under the Chairmanship of Secretary, Ministry of Mines, Government of India vide their Office Order No. I&M-3[24]/2006 dated 06.03.2006.

In the first meeting of the Working Group held on 20.04.2006 under the Chairmanship of Secretary (Mines), four separate Sub Groups were constituted, of which Sub-Group IV was set up for the first time exclusively on R&D and Human Resource Development in mineral sector.

The Sub Group-IV on R& D and Human Resource Development was set up under the Chairmanship of **Shri V.K. Thakral**, Joint Secretary, Ministry of Mines and **Shri K.P. Lall**, Advisor, TPPC, Ministry of Mines as the Member Convenor. The composition of the Sub Group is given at Annexure 1 along with terms of reference issued vide Office Order No. 11[5]2006-M.I dated 28.07.2006 from Director (Technical), Ministry of Mines.

The first meeting of Sub Group-IV was held on 14^{th} August, 2006, at New Delhi wherein it was decided to constitute following Core Group of Experts to prepare the draft chapters as per the terms of reference.

<u>Core Group on Human Resource Development</u>

i. Dr. Malti Goel, Advisor, Dept. of Science & Technology - **(Convenor)**
ii. Dr. Mihir Deb, Professor, Dept. of Geolgoy, Delhi University
iii. Dr. R. Krishna Murthi, Assistant Professor, IIT Roorkee
iv. Shri B. Sengupta, DDG, Geological Survey of India
v. Shri P.K. Sinha, DDG, GSI Training Institute
vi. Prof. B.B. Dhar, Former Director, CMRI (CSIR)
vii. Dr. G.S. Roonwal, Former Professor, Dept. of Geology, Delhi University

<u>Core Group on Research & Development</u>

i. Dr. K. Balasubramanian, Director, NFTDC - **(Convenor)**
ii. Prof. D.C. Panigrahi, Professor, Indian School of Mines
iii. Dr. K.R. Gupta, Convenor, Geological Society of India, North India Chapter
iv. Dr. V.P. Mishra, DDG, GSI & Director, NIRM
v. Dr. C. Sivaji, Scientist 'D', Dept. of Science & Technology
vi. Dr. R.N. Gupta, Former Director, NIRM
vii. Dr. Amalendu Sinha, Actg. Director, CMRI

After a series of meeting of experts held on 14th August, 8th September and 19th October, 2006 the final report was prepared.

We would like to express our sincere thanks and gratitude to the members of the sub group and the core groups for providing valuable suggestions in order to finalise this report

(K.P. Lall)	**(V.K. Thakral)**
Advisor, Ministry of Mines (TPPC)	Joint Secretary, Ministry of Mines
&	&
Member Convenor,	Chairman,
Sub Group IV	Sub Group IV

EXECUTIVE SUMMARY

India is endowed with vast mineral resources. Therefore, mining continues to be an important segment of Indian economy. The contribution of mineral production (mining and quarrying) to the GDP is estimated at 2.04% in 2005-06. The mining and quarrying sector has a share of 10.74% in the overall index of the industrial production (IIP). This sector registered an average growth rate of 5.5% in the first two years of the X Plan. The approach paper for XI Five Year Plan envisages a target of 9% growth in GDP and in order to achieve this level of growth, the mining sector is expected to grow @ 10% per annum during the XI Plan. Therefore, in order to ensure growth of mineral sector [except coal, lignite, petroleum (crude) and atomic minerals], we would need to ensure enhancing production of metallic minerals, which contribute presently about 12% of the total value of mineral production.

Development of mineral sector includes processes of exploration, mining, value addition, transportation, using, reusing, recycling and disposal of mineral & metal products in most efficient, competitive and environmentally responsible manner using best international practices. Therefore, in order to ensure sustainable development of mineral sector, it is necessary to strengthen infrastructure for research & development and human resource development.

In pursuance of the reforms initiated by the Government of India in July, 1991 in fiscal, industrial and trade regimes, the National Mineral Policy recognized the need for encouraging private investment including foreign direct investment and for attracting state-of-the-art technology. While developed countries have made rapid strides in the field of exploration and mining of concealed and deep-seated mineral resources, bio-leaching, mineral beneficiation and utilization of lean grade ores, India is yet to adopt state-of-the-art technology for their commercial exploitation.

Sustained efforts for mineral exploration over last few decades have enhanced reserves and resources of minerals, however, despite several discoveries, India continues to lack in several important minerals like diamond, nickel, copper, gold, platinum group of elements, tin, tungsten, molybdenum, fertilizer minerals, etc. Most of the easily accessible and near surface mineral deposits are either mined out or are presently under production. In this context, the challenges to locate so far undiscovered and/ or deep-seated and concealed mineral deposits is assuming greater significance day by day. Also, there is need to lay greater emphasis on exploration and exploitation of high tonnage low-grade ores coupled with use of improved technology for mineral processing and enriching lean grade ores. The low-grade ores, particularly, for base metals, noble metals and strategic metals/minerals deserve due consideration. Indigenous R&D efforts need to continue for technology development for commercial exploitation of lean grade ores, recovery of valuable minerals and metals as by-products / co-products from the rejects, management of wastes and effective reclamation and rehabilitation of mining areas for better environment management and increasing efficiency of existing processes/plants.

To match a target of 8.5% growth in GDP and in order to achieve this level of growth, the mining sector would need to give greater thrust on mineral exploration and exploitation of high value low volume minerals such as platinum group of elements, gold, copper, diamond, nickel, etc. There is also need to provide impetus on formulating R&D projects specifically for exploration and mining of deep-seated and concealed mineral deposits by interfacing / networking between R&D institutions, industry and academia.

Considering need for strengthening institutional mechanism for a dedicated research & development, consultancy and training, it is proposed that a national agency should be created for undertaking, facilitating, coordinating and monitoring a multi-laboratory, multi-disciplinary R&D in the field of mineral exploration, mining and mineral development, mineral processing, nonferrous metals with a view to ensure optimum utilization of available resources and a greater synergy. It is recommended that an autonomous body in the name & style of National Council of Geo-scientific & Mineral Research and Training (NCGMRT) be established as a Society under Registration of Societies Act, 1860 under the ambit of Ministry of Mines on the pattern of The Council of Scientific & Industrial Research (CSIR). The council initially may have only seven constituent Centres each specialized in different fields with a mandate to undertake projects on commercial model in India and abroad. The area of operations of NCGMRT may cover Geo-scientific Investigations, Exploration for Minerals and Energy Resources, Development of Mining Technology (deep mining, in-situ solution mining, stope leaching, borehole slurry etc.) and Rock Mechanics, Geo-environmental Studies, Mineral Beneficiation (including Bio-leaching), Aluminium, Base Metals and Precious Metals, Materials' Research and Process Development and Miners' Health, Safety & Hygiene.

In order to meet the requirement of growth envisaged, thrust areas have been identified in four broad areas, namely exploration, mining, mineral processing and metals and products development, nucleus for which is already available with R&D organizations under Ministry of Mines (NIRM, JNARDDC, NIMH), GSI, IBM and NFTDC. It is now required to put together multiple projects under each mission within the centre of excellence concept and concurrently develop the human resource. Mission mode projects would create leadership level HR as well as large number of knowledge workers.

In order to provide impetus to research in detailed exploration, a Advanced Centre for Studies in Mineral Exploration be established which may undertake advanced studies / research for deep-seated and concealed mineral deposits by holistic understanding of geology deeply and concepts of crustal evolution leading to tectonic and metallogenic modelling. This has to be followed by systematic application of state-of-the-art geophysical techniques and multi-elemental geochemical investigations in order to unravel the existence of mineralised body at depth. Similarly, in order to fillip the gap in research for underground mining technology, a Advanced Centre for Studies in Underground Mining is proposed during XI Five Year Plan in order to synchronise research & development for deep-seated deposits.

In order to undertake research and development on lean grade ores and to ensure effective techniques for utilisation of wastes, by-products and co-products, it is proposed a Advanced Centre for Studies in Mineral Processing be established in order to address various issues relating to mineral processing and mineral beneficiation. Similarly, in order to provide greater impetus to the development of materials and development of processes for downstream industry, a Advanced Centre for Interdisciplinary Research in Materials and Systems be created for undertaking interdisciplinary research in materials and systems for development of multiple materials.

Considering priorities identified for R&D, a National R&D Fund for Mineral Development is proposed during the XI Plan for which a provision of Rs. 700 crores is recommended for various initiatives recommended

A greater stress need to be laid on formulation of R&D schemes under time bound project mode. R&D institutions having strong capabilities in research and technology development should form industrial R&D alliances and develop strategies to make research as a business. Similarly, strategy to undertake contract research involving synergistic strengths of the partners needs to be adopted. This innovative approach for research may be established through international networking with reputed organisations. Further, collaborative research as a tool for R&D in order to synergise capabilities of an Indian outfit and a foreign agency could also be used. Flow of royalties on commercialisation may result significant earnings for the country. Strong capabilities with R&D institutions can be extended to impart knowledge based consultancy services both at the national as well as at the international level.

The most important asset of the mineral sector is its human resource base. The shortage of professional skills is a pressing concern for the high technology mineral and metal sector. In order to ensure the modernisation process successful, it would be necessary to ensure availability of trained manpower in line with thrust areas identified. The National Mineral Policy aims at attracting private investment both domestic and foreign direct investment along with the state-of-the-art technology for exploration and mining. The policy also envisages level playing field for public and private sector. The increasing investment will also need more skilled manpower in this sector. The new mineral policy envisages the unbundling of the currently integrating activities of exploration and mining where junior exploration companies may take up exploration work on large scale. This would not only help in attracting more FDI but also need trained manpower particularly the “Geoscientists” for their work.

Despite availability of professionally qualified and skilled manpower and a well-established network of R&D institutions in India, desired investment and efforts in keeping the knowledge and skills of our technical manpower update has not been adequate and this has adversely affected their creative abilities and realisation of the gains for the system. Thus, there is a need to re-engineer our human assets to enhance the level of performance and productivity.

The universities and R&D institutions in India are generally in position to meet the requirements of education and training. Apart from demand – supply gap that is envisaged for human resource, which is seen generally in quantitative terms, there are significant gaps such as lack of (a) interdisciplinary R&D, (b) knowledge integration for technology development, (c) inter-related R&D between mineral sector and construction and infrastructure sectors etc. Thus, there is a strong need to look at fundamental issues governing R&D and human resource development for the mineral sector ranging from revision of course curricula in line with modern developments, continuing education and training on one hand, interdisciplinary R&D in thrust areas, knowledge integration paradigms and national mission programmes on the other hand, in order to meet the ambitious growth plans for the mineral sector. It is necessary to reorient geoscience and mining curricula and to make training interdisciplinary in nature. New courses and curriculum are required to be introduced in educational institutes in order to strengthen them. Also there is an immediate need to increase interaction between University, Industry and R&D institutions. R&D projects of high value and multidisciplinary nature are required to be taken up as joint projects between university and industry.

An important area that requires urgent attention from all concerned in mineral and nonferrous metal sector is the need to institutionalize systems to create, nurture talent and skills in several knowledge domains. Creation of Centres of Excellence is to be first initiated which will require human resource at the level of leadership in R&D in specialized fields and at the same time, knowledge workers in the respective knowledge domains. The thrust areas are chosen such that knowledge integration takes place and the Centres of Excellence have to perform the role of both specialized knowledge creation as well as knowledge integration to solve practical problems.

Considering need to have trained manpower in the field of exploration, the present GSI training infrastructure should be strengthened in respect of faculty development, curriculum development and introduction of new certificate/diploma/degree courses and upgradation of infrastructure of an international standard. A world-class fully residential infrastructure needs to be created for education and training in the multidisciplinary fields like exploration, mining, mineral processing and nonferrous metals. Special training courses need to be organized catering to the requirement of PSUs, MNCs and R&D institutions in collaboration with Universities. The institute may be linked to UGC and AICTE system for providing degree / diploma.

In order to attract suitable talent and to train them in the knowledge domains required, it would be appropriate to introduce a National Mineral Fellowship Scheme through Ministry of Mines, Govt. of India. The fellowship may be given to pursue PhD or Post –Doctoral or Advanced Research at any centre of excellence and the candidate may be simultaneously registered in a university system, say IITs, BHU or ISM.

To ensure front line scientific research in earth sciences, a continuous series of training programmes by way of workshops, summer schools, advanced short courses in selected topics are required to be encouraged. Contact programmes need to be initiated particularly in institutions where infrastructural and instrumental facilities are available. Interdisciplinary teams must be motivated to prepare instructional materials for dissemination. Refresher courses in modern trends in earth sciences with basics in physics, chemistry, mathematics and computer applications, mostly of remedial nature, should be formulated and distributed to various institutions / universities largely through video-lectures and correspondence materials.

Northeast region has tremendous potential for mineral development, however, due to lack of funds, inadequate institutional mechanism and poor infrastructure support for R&D and capacity building for training & skill development, the mineral resources have so far been not harnessed optimally. It is, therefore, imperative to provide greater support to mineral development activities in NER including capacity building for training & skill development, strengthening of Directorate of Mines & Geology and technological upgradation and modernization including preparation of district resource maps, undertaking hydro-geological resource mapping, natural geological hazard zonation, establishing training and demonstration centres for local miners, creating awareness for safeguarding from natural hazards, upgrading laboratories and R&D facilities for sustaining exploration and mining activities etc. In order to ensure speedy development of northeast region, Special Fund for Capacity Building of HR and R&D needs be established exclusively for north east region and for this purpose an amount of Rs. 50 crores be earmarked during the XI Five Year Plan.

RESEARCH & DEVELOPMENT
AND
HUMAN RESOURCE DEVELOPMENT

1. INTRODUCTION

1.1 India is endowed with very rich mineral resources and skilled manpower. The country accounts for 67 major minerals and 23 minor minerals (besides a host of atomic minerals). However, the contribution of mineral production (mining & quarrying) to GDP was only 2.04% in 2005-06 as against 8% growth of Indian economy. Sustained efforts for mineral exploration over last few decades have enhanced reserves and resources of minerals, however, despite some major discoveries and noteworthy additions to the National Mineral Inventory, India continues to lack in several crucial minerals like diamond, nickel, copper, gold, platinum group of elements, tin, tungsten, molybdenum, fertilizer minerals, etc. The situation, therefore, calls for immediate attention and efforts to augment their resources.

1.2 In pursuance of the reforms initiated by the Government of India in July, 1991 in fiscal, industrial and trade regimes, the National Mineral Policy was announced in March, 1993. The National Mineral Policy recognized the need for encouraging private investment including foreign direct investment and attracting state-of-the-art technology in mineral sector. The basic mining statute, namely MMDR Act, 1957 was amended from time to time to open up the sector to private investment and to make the mineral concession regime more investor friendly by depleting process to the State Governments and limiting the role of Government of India. Now 100% FDI is permitted in mineral exploration, mining and mineral processing, which has somewhat, led to narrowing of technological gaps and exposed Indian mineral industry to the foreign technology and practices. Despite ushering in various reforms, the mineral sector in India is far from achieving the growth potential in any significant manner. While developed countries have made rapid strides in the field of exploration and mining of concealed and deep-seated mineral resources, bio-leaching, mineral beneficiation and utilization of lean grade ores, India is yet to adopt state-of-the-art technology on commercial scale in these areas of vital importance.

1.3 The role of technology, therefore, appears crucial. A greater emphasis will have to be laid on research & development for exploration and exploitation of deep-seated mineral deposits adopting concept oriented programmes and application of cost effective and environmental friendly mining technology. The growth in mining sector has not been commensurate with the growth of Indian economy. In order to sustain current momentum of 8% plus growth we need to introduce necessary reforms in the mineral /mining sector to augment investment and production which would necessitate creating a strong base for research & development and to ensure professionally qualified & trained manpower, besides world-class technology and laboratory facilities.

1.4 Qualified, experienced and skilled manpower and impressive network of R&D infrastructure are our productive assets in India. There is a large network of academic institutions providing basic education and training in geosciences, mining, mineral processing and metallurgy. These institutions ensure good availability of fresh graduates and post-graduates. However, investment and efforts in keeping the knowledge, expertise and skills of manpower update has been inadequate which has been adversely affecting their capabilities. Thus, there is need to re-engineer the national human asset in order to enhance their level of performance. This calls for corrective action by way of creating capabilities for advanced research, training of manpower in key areas, institutional strengthening, encouraging students for research in hi-tech areas for their doctoral / postdoctoral / research projects, curriculum development, training of trainers, faculty development, introduction of new & advance courses, networking with national & international agencies thereby promoting collaborative approach, evolving a long time human resource planning for R&D, professionalising management & support functions through appropriate training and induction of professionals and establishing coordination & linkages between R&D, academia and industry.

1.5 Geological Survey of India, presently, is not able to attract the best of talent, though there is no dearth of scientists willing to join GSI, as the supply side is much higher than the demand. Unlike academic institutions and industry where there is continuous influx of new and young talent due to attractive fiscal package, there has been no significant influx of new talent in the GSI for quite sometime. Now, new talent is taking up jobs with MNCs and private sector in diversified fields. The inevitable outcome is that the turnover of scientists from the GSI has been small and their average age today is unduly high for a creative knowledge based organisation. Therefore, infusion of new talent is essential for rejuvenating the knowledge base of GSI. Efforts, therefore, shall have to be made to ensure induction of young officers in GSI and ensuring an effective system for performance linked career advancement coupled with attractive remuneration package in order to attract best of talents.

1.6 GSI, IBM, State Departments of Mines & Geology, State Mining Corporations, various other Central & State PSUs, research institutions, academic institutions, private industry and joint venture exploration companies involving FDI (currently in various stages of implementation) are the key players who recruit competent and trained manpower in the mineral sector. Indian universities and R&D institutions are generally in position to meet the requirements of education and training. Apart from demand – supply gap that is envisaged for human resource, which is seen generally in quantitative terms, there are significant gaps such as lack of (a) interdisciplinary R&D, (b) knowledge integration for technology development (c) inter-related R&D between mineral sector and construction and infrastructure sectors. Thus, there is a need to look at fundamental issues governing R&D and human resource development for the mineral sector ranging from revision of course curricula in line with modern developments, continuing education and training on one hand, interdisciplinary R&D in thrust areas, knowledge integration paradigms and national mission programmes on the other hand to meet the ambitious growth plans for the mineral industry.

1.7 In order to strengthen infrastructure for R&D and human resource development in the mineral sector, It is for the first time that a separate **Sub-Group** has been constituted on **Research & Development and Human Resource Development while formulating XI Five-Year Plan document**.

2 RESEARCH & DEVELOPMENT

2.1 India is a large country with intricate geology. As a result, it has a very mineral endowment. Minerals are non-renewable assets, identification and development of mineral resources is the key for industrial development. Sustained efforts led to enhanced reserve base of many minerals but so far did not assure self-sufficiency in many critical minerals therefore our dependence on imports continues for gold, copper, nickel, diamond, tin, tungsten, rock phosphate, etc. With continued mining of easily accessible and near surface ore bodies, the reserves of such mineral deposits are fast depleting. India has reached a situation where mineral finds on the surface have become scarce. Earth scientists will have to probe deeper into earth's crust, integrating geophysical, geochemical and petrological tools to meet the mineral demands. This would require a rigorous understanding of the plate tectonics vis-à-vis ore mineralisation and heat flow regimes. Therefore, we have to lay a greater emphasis on systematic search for deep-seated minerals by conducting extensive surveys aided by state-of-the-art technology. Globally, thrust has been on exploration for low-grade and high-tonnage deposits (with the change and modernization of extraction technology). India, therefore, should lay more emphasis on exploration of lean grade ores coupled with modernization and upgradation of extraction technology and improved processing for enriching lean grade ores by application of an effective beneficiation technology.

2.2 The time lag between discovery and eventual extraction of minerals is unduly long mainly on account of lack of state-of-the-art technology and resources like capital and trained manpower. The outdated technology, small size of deposits, high cost of production etc. are, thus, the contributing factors. Intensive exploration using state-of-the-art technology and modern concepts for locating concealed and deep-seated mineral deposits needs to be pursued. The revolutionary changes in improving productivity through cost effective strategies, beneficiation of low-grade ores and recovery of co-products and by-products needs to be made. Therefore, in order to address some of the above issues and to ensure matching of its growth with the Indian economy, thrust will have to be directed on exploration and exploitation of high value and low volume minerals, such as platinum group of elements, gold, copper, diamond, nickel etc. with a view to lessen our dependence on imports.

2.3 **Present indigenous R&D institutional mechanism**

2.3.1 The R&D setup in India in the mineral and mining sector broadly consist of following institutions:

a) Laboratories under Council of Scientific and Industrial Research (CSIR) namely National Metallurgical Laboratory (Jamshedpur), Regional Research Laboratories (Bhubaneswar, Bhopal, Jorhat, Trivendrum), Central Mining Research Institute (Dhanbad, Nagpur, Roorkee) and some of the defence laboratories

b) Laboratories under Indian Bureau of Mines (IBM)

c) Laboratories under the Bhabha Atomic Research Centre (BARC)

d) Laboratories under Hindustan Copper Ltd. (HCL) and National Aluminium Company Ltd. (NALCO)

e) Laboratories under Geological Survey of India (GSI) and Mineral Exploration Corporation Ltd. (MECL)

f) Laboratories under National Mineral Development Corporation Ltd. (NMDC) and Steel Authority of India Ltd. (SAIL)

g) Laboratories under private sector such as TATA R&D Centre, Pune and Central Research & Development Laboratory (CRDL) (Udaipur), Hindustan Zinc Ltd. (HZL)

h) Laboratories under Universities and National Technological Institutes including Indian Institute of Technology (IITs), Indian School of Mines (ISM), Indian Institute Science (IISc) (National Facility for Semi Solid Forming at Bangalore) etc.

i) Laboratories / centres of excellence under Ministry of Mines namely Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC), National Institute of Rock Mechanics (NIRM), National Institute of Miners' Health (NIMH) and Nonferrous Materials Technology Development Centre (NFTDC)

j) R&D setups under State Directorates of Mining & Geology

2.3.2 Thus, there exists a large network of indigenous R&D setup in mineral / mining sector with strong technical capabilities and facilities. Various institutions have carried out research work on pilot plant scale / laboratory scale in the areas of bio-leaching beneficiation, by-product recovery, upgradation of low-grade ores, extractive metallurgy, development of alloys, waste utilisation, etc., however, it appears that the success rate towards commercialisation of the processes developed has been minimal. Most of the studies have been confined to the academic level. As far as the R&D institutional mechanism is concerned, this is the growing area in the country's R&D efforts. The R&D institutions in the country amongst themselves have a very broad spectrum of R&D expertise required for mineral / mining industry but the problem lies the fact that either due to lack of coordination between the industry, R&D institutions and the academia or due to absence of any umbrella agency in the field of mineral / mining directing the efforts of the laboratories towards the ultimate requirement, most of the pilot scale studies do not get commercialised.

2.3.3 Academic or theoretical research has been largely carried out by universities and technical institutions, while projects for application oriented research have been undertaken by industry and some of the research laboratories. Successful results achieved by HZL, BALCO, HCL, CMRI, NFTDC, Defence Metallurgical Research Laboratory (DMRL), Mishra Dhatu Nigam Limited (MIDHANI), SAIL, NIRM, Tata Iron and Steel Co. Ltd. (TISCO), Central Building Research Institute (CBRI), IBM, GSI, MECL, Central Electrochemical Research Institute (CECRI), National Metallurgical Laboratory (NML) and Regional Research Laboratory (RRL) have found application in the existing industry. Some of the R&D projects had to be abandoned without any conclusive finding. It appears, lack of co-ordination between research institutions, industry and academia has been the reason for some of the failures. Other weakness of Indian R&D system has been due to lack of networking with national and international institutions, inadequate utilisation of facilities and no initiative for commercialising processes developed. Further, had the commercial consideration and viability aspect of such projects been given due importance involving industry from the very beginning, the current state of affairs could have been avoided. There is a strong need to improve linkages between laboratories, academia and the industry, adopting collaborative approach and commercial model of R&D operations, ensuring optimum utilisation of resources and enhancing productivity, encouraging scientists & engineers for aggressive marketing and business development efforts and adopting unified national programme in order to avoid duplication of R&D projects amongst different laboratories. Also research projects are largely funded by government agencies and the contribution of private sector to R&D has been negligible. R&D projects in future would need to establish co-ordination / interface with industry being the ultimate beneficiary. It is also important to continue R&D not only for high value minerals / metals but also for industrial minerals, which are deficit and scarce. Considering the present free market economy, industry in their own interest should come forward for involvement in R&D. R&D expenses are also exempted from tax. Statutory guidelines and incorporating necessary conditions in mining lease and other clearances would enforce industry to take active interest in R&D.

2.3.4 Ministry of Mines through Standing Scientific Advisory Group (SSAG) under the chairmanship of Secretary (Mines) oversees Science and Technology (S&T) activities of the constituent PSUs and R&D organizations. S&T Projects are funded through grant-in-aid by Ministry of Mines jointly with Department of Science & Technology to the research institutions and PSUs in multidisciplinary fields. Since 1978, 161 projects have been approved by SSAG. Out of these about 132 projects have so far been completed. 29 projects are ongoing. The basic objective of SSAG has been to approve R&D programmes in the areas of geology, mineral exploration, mining and environment, beneficiation, metallurgy, bioleaching, Ground Control & Rock

Mechanics and by-product recovery. However, in spite of best efforts, there has been lack of consortium approach for research between Government-University / Laboratory-Industry. It is observed investigators mostly do not have industrial exposure. Projects are rarely completed in time and thereby, results in time & cost overrun. Therefore, all out efforts are required to be made that projects are completed within the fixed time schedule without any cost overrun. Further, it is proposed focussed research need to be taken for development of technologies to extract metal from low grade ores, development of new process technologies for extraction of valuable minerals / metals from beneficiated low grade ores, advanced technologies for exploration and exploitation of deep-seated deposits, recycling of metal scrap and mineral waste and to formulate a mechanism for review of on-going projects by SSAG.

Ministry of Mines along with DST and DRDO has provided assistance for establishing **National Facility for Semi-Solid Forming** at IISc Complex in Bangalore. The scope of this research programmes is to develop and install Electro Magnetic Stirring (EMS) System and billet casting plant, integrating the EMS with a Direct Chill casting machine to produce non-dendritic “semi-solid” billets and processing of these SSF billets by various casting routes such as die casting and squeeze casting into components, generation of vital data through extensive material characterization and testing and finally, transfer of technology to the Indian Industry. The project is functional now as a national facility continued interaction with industry is established. The facility proposes to concurrently establish facilities for material and component testing, development of newer alloys, design of components, dies and other associated design / experimental facilities for the benefit of the Indian industries.

2.4 Thrust Areas in R&D

Major thrust areas identified in R&D in mineral / mining / non-ferrous metals sector are:

- **Exploration**
- **Mining Technology**
- **Mineral Processing and Value Addition**
- **Metal Extraction, Alloys and Product Development**
- **Environment Management and Sustainable Development**

2.4.1 Exploration

a) Mineral exploration is key to the discovery, developmnet and ultimate recovery of mineral resources. India is blessed with a variety of mineral resources, ranging from iron ore to monazite. However, minerals pertaining to nonferrous sector have not seen growth that one would anticipate. Barring high-grade bauxite and Rampura-Agucha lead-zinc ores, there has not been any significant find of nonferrous metallic ore. Some of the mineral deposits discovered long back are still being exploited. Surface and near surface deposits are more or less nearing exhaustion. Further, ores available are of lean-grade. This poses a serious challenge on many fronts. Therefore, Earth Scientists will have to probe deeper into earth's crust, integrating geological, geophysical, geochemical and petrological tools together with understanding of metallogenic processes in order to look for deep-seated and concealed mineral deposits. **Intensive efforts needs to be taken for undertaking exploration** with application of modern technology for locating new concealed and deep-seated deposits involving application of modern scientific techniques and development of hi-tech equipments and technology for exploration.

b) ***Thrust areas for research in mineral exploration***

- Understanding of earth processes: Interactive research programme involving geoscientists, physicists, chemists, materials' scientists and mathematicians to study the crustal processes / conditions leading to the formation of minerals, metallogensis and distribution of mineral deposits in space and time.
- Mathematical modeling of earth science phenomena: Computer simulation of earth related processes by bringing together a variety of phenomena such as plate tectonics, rock water-interaction, heat and mass transport at sub-crustal depths, metallogeny, etc.

- Exploration and precision measurements and analytical methods: Introduction of modern analytical techniques and methodologies such as (a) stable isotope measurements, (b) fluid inclusion studies, (c) geostatistics and GIS, (d) remote sensing for targeting ground areas, (e) gravity and magnetic survey, (f) development of databases and analysis etc.
- Some of the specific projects for research identified are:

  (i) Study of greenstone belts and their associated minerals, especially Gold (Au) and Platinum Group of Elements (PGE) mineralization.

  (ii) Precambrian granites and prophyries and related hypogene mineralization e.g. Tin (Sn), Tungsten (W), Copper (Cu) etc.

  (iii) Paleoweathering sites and such other locales of mineralization, particularly for Gold (Au), Uranium (U), Nickel (Ni), etc. for which geochemical studies would form a major research component

  (iv) Study of beach and inland placers.

  (v) PGE mineralization in layered igneous complexes and other bodies.

2.4.2 Mining Technology

a) Underground Mining Imperatives

Due to continued mining of depleting mineral resources, shallower mineral deposits are getting exhausted. This is causing a shift of mining activity to deeper levels. In gold and uranium mines in India, the mining activity is already touching a depth of 1 Km from the surface. In zinc and manganese, the mining activity is around a depth of 500m. Most of the precious metals occur at deeper horizons and underground method of extraction is only viable route in such cases. In all such cases, following real time problems are being faced by the industry.

- The high rock temperature is encountered at depth due to geothermic gradient
- The mines are mechanized in order to be cost effective. Several thousand kW of electrical and diesel machines are running in the closed space underground generating heat and diesel fumes.
- In deeper horizons, water percolation is high.
- High rock temperature and heat released by machines coupled with high water percolation are creating a difficult working conditions
- Safety at work in underground mines at depth also pose a serious problem

Therefore, there is need for a nationally acceptable and internationally comparable mine safety programme.

(b) Thrust areas for Underground Mining

Thrust area for R&D in deep mining would involve (i) mine planning & design (ii) strata control & rock mechanics, (iii) Rock – water interactions, (iv) deep shaft winding and transport, (v) mining machinery optimisation and mechanized mining, (vi) studies for in-situ leaching in mines, (vii) studies for deep mine environment, (viii) development of sensors and mine safety studies and (ix) technology for deep mining etc. The emphasis in all of these studies would be directed on removal of large tonnage and the lean ores.

2.4.3 **Mineral Processing and Value Addition**

Given the scenario that higher-grade ores have been mined extensively and are getting scarce, it is imperative to develop new and innovative methods for beneficiating lean-grade ores commercially, recovery of valuable minerals and metals from rejects of the existing mines/ beneficiation plants and industry, management of wastes and effective reclamation and rehabilitation of mining areas and Increasing efficiency of existing process/plants are developed.

(a) Mineral processing for Lean-grade Ores and Oxide / Silicate Systems

In this regard, two basic approaches are possible, namely, (i) in situ leaching or heap leaching via biological processes / industrial process at a slower pace and (ii) pressure leaching, microwave assisted leaching processes to enhance kinetics of beneficiation, thereby enabling larger quantities of material handling in a given time.

(b) Processing and flow sheet development for Secondaries, By-products and Wastes

Secondaries /by products and wastes available are valuable products for the future. An integrated approach to win many materials from the same source will make more economic sense. Red mud requires a serious second look as many metals such as Titanium (Ti), Vanadium (V), Gallium (Ga) can be recovered. With metal prices for Ti, V, Ga scaling new highs, simultaneous extraction of these metals and other oxides would make sense. Similarly, a re-look at various slags and anode slimes (for PG metals) and high value trace metals is needed and specific R&D programmes should be taken up for secondaries and wastes.

(c) Direct conversion of Minerals to value-added compounds and Mineral Products

For long, R&D on minerals has been undertaken to win the metallic content and accordingly flow sheets were oriented in that direction. Of late, a wide variety of products are derived directly from the minerals or by conversion to other compounds. For example, purified zircon sand, purified moly sulphides represent such value addition from the mineral, without conversion to metallic state. Another example would be to separate ultra fine alumina from the alumina that is produced for aluminum extraction and conversion into other forms of alumina. Improving the purity of alumina gives a much higher value added products. Alumina, zirconia, magnesia are now being produced at a higher level of purity for high value ceramic structural parts. Value addition to mineral occurs, if certain specific impurities are removed from the mineral and thereafter rest of the constituents become useful. Secondly, if the size of the mineral product is reduced, higher returns are obtained. Higher purity oxides, nitrides and carbides are to be produced from the minerals, in addition to the metals, as these ceramic and inorganic materials are expanding the materials product sector.

(d) Mathematical Modelling and Computer Simulation in Mineral processing

One of the recent advances has been to understand the mineralogical locking of silicates, oxides and sulphides systems and development of specific agents that combine with a particular phase to liberate the desired constituents. Starting materials are liquid wastes i.e. raffinates. Ion exchange and solvent extraction (SX) processes need to be developed. Process simulation and mathematical modelling will go a long way in reducing experimentation.

2.4.4 **Metal Extraction, Alloy Development and Product Development**

Metal extraction is a phase separation exercise involving high expenditure and a lot of energy, reductants, with attendant production of large quantities of by products. Given that, the tenor of the ores is less than 1% in most of the cases (except Fe, monazite, sand based derivatives), more than 99% of the materials have to be removed. It is, therefore, more appropriate to initiate multi material extraction technology.

In India, we have so far not adopted suitable processes and technology for extraction of multi metals. Even for beach sands, where we have enough resources, there is no extraction plant for titanium so far. With the globalization of Indian economy and high metal price, it would be appropriate that we set up extraction plants with imported technology rather exporting beach sands. Therefore, R&D needs to be initiated on extraction of metals like Tungsten (W), Molybdenum (Mo), Niobium (Nb), Tantalum (Ta), Nickel (Ni), Cobalt (Co), Vanadium (V), Chromium (Cr), Calcium (Ca), Magnesium (Mg), etc. on one hand and value added trace metals like Gallium (Ga), Germanium (Ge), Indium (In), Cadmium (Cd), Tellurium (Te) etc. on the other hand. PGE from anode slimes and slags is also needs to be addressed.

In addition, alloys and products are also required to be developed. Therefore, end-to-end materials product development i.e starting from commercial purity metal to advanced alloys and products based on these alloys should be developed. Such facilities need to be developed for copper, zinc, lead and magnesium. In a very limited way, MIDHANI and NFTDC at Hyderabad are catering to nickel, titanium and zirconium based alloys and products.

2.4.5 Environmental Management and Sustainable Development

Thrust area for R&D in this field calls for adoption of eco-friendly techniques for land reclamation and mine rehabilitation, safe & scientific disposal of hazardous mineral waste, development of scientific methods for slope stability, etc.

2.5 Recommendations

Considering above background in view following recommendations are put forward:

1. Specific R&D projects may be formulated for exploration and mining (other than metallurgical projects).

2. Considering thrust areas recommended, it is necessary to create project execution mode: (a) streamlining the execution by the existing institutional mechanisms and (b) to create centres of excellence on a mission mode to undertake interdisciplinary research. Centres of excellence: Bench marking and best practices adoption and other metrics of performance of excellence have to be put into place; excellence should be an earned attribute for an organization or a research group and evaluation norms and

indices have to be spelt out for existing institutions. Centres of excellence have to result in knowledge creation and knowledge integration to solve practical problems ranging from exploration to metal products. Centres of Excellence need to be carved out for the emphasis and focus or created ab initio or the existing institutions should evolve excellence by achieving slated indices.

3. Considering strong need for active interface, networking and coordination between R&D institutions, industry and academia, it is recommended that all funding, henceforth, should only be extended to projects / schemes, which have established prior linkages, before considering approval of the project in order to ensure development of industry linked indigenous technology and its eventual commercial application. All R&D schemes should be formulated in the project mode. There should be a mechanism for evaluation of the project proposals by a group of experts on that subject. Project approval should be granted only after detailed appraisal of the proposal.

4. R&D laboratories / institutions with strong capabilities in research and technology should form industrial R&D alliances and develop strategies to make research as a business. For example, technology follows a growth cycle. It starts with basic research leading to laboratory scale work, development at pilot plant scale, prototyping etc. which is followed by engineering and eventually results in commercialisation.

5. Contract research needs to be undertaken involving synergistic strengths of the partners through international networking with reputed organisations.

6. Collaborative research as an important tool for R&D could be adopted where synergies of Indian outfit and a foreign agency be used effectively. Flow of royalties on commercialisation would mean significant earning for the country.

7. Rich scientific capabilities available with our R&D institutions should be extended to impart knowledge based consultancy services at the national level as well as at international level to developing countries. This may bring laurels to R&D institutions in the areas of setting up R&D setups and even management. R&D institutions in India need to undergo transformation in order to adopt market driven and performance oriented strategy. Such institutional linkages could be used to earn sizeable income to R&D institutions through expert fees, consultancy, training etc. Looking to world-class facilities with some of our laboratories, it may be cheaper and advantageous for many developing as well as developed countries to get specialised training and testing done in India. Therefore, there appears great potential in forging industrial networking for industrial R&D and for mutual benefit. Thus, strategy for internationalisation of Indian R&D for wealth creation be pursued.

8. Considering a need for nodal national agency for undertaking, facilitating, coordinating and monitoring multi-laboratory / multi-disciplinary R&D projects and with a view to ensure optimum utilization of available resources and greater synergy for research & development, technology upgradation, knowledge based consultancy services and training in the field of mineral exploration, mining and mineral development, it is proposed that an autonomous body in the name & style as **NATIONAL COUNCIL OF GEO-SCIENTIFIC & MINERAL RESEARCH AND TRAINING (NCGMRT)** be created as an autonomous Society under Registration of Societies Act, 1860, on the pattern of The Council of Scientific & Industrial Research (CSIR). The proposed council may initially have seven constituent centres of excellence specialized in various fields with a mandate to undertake projects on commercial model in India and abroad. The operations of NCGMRT may cover areas such as Geo-scientific Investigations, Exploration for Minerals and Energy Resources, Mining Technology (deep mining, in-situ solution mining, stope leaching, borehole slurry techniques etc.) and Rock Mechanics, Geo-environmental Studies, Mineral Beneficiation including Bio-leaching, Aluminium, Base Metals and Precious Metals, Materials' Research and Process Development, Miners'

Health & Hygiene. NCGMRT would ensure appropriate linkages with academia, R&D organizations, industry and Government both at national and international level. NCGMRT's seven proposed constituent centres of excellence coupled with a network of laboratories and facilities spread all over India may mobilize global alliance for collaborative and contract research, specialized testing and training etc. The focus would be primarily on technology upgradation and development for sustainable institutional infrastructure of an international standing. Following seven centres are being proposed to meet the increasing demand of geosciences in years to come so that Indian capabilities are at par with international institutions

a) ***<u>Centre for Applied Geoscientific Services (CAGS)</u>***
b) ***<u>Centre for Ore Dressing, Testing and R&D (CORD)</u>***
c) ***<u>Centre for Mining Research, Design and Development (CMRDD)</u>***
d) ***<u>Centre for Rock Mechanics and Geo-technical Engineering (CRGE)</u>***
e) ***<u>Centre for Research & Development in Aluminium and Base Metals (CRDAB)</u>***
f) ***<u>Centre for Advanced Training in Geo-scientific Management (CATGM)</u>***
g) ***<u>Centre for Research in Miners' Health and Hygiene (CRMHH)</u>***

Activities of various centres of excellence proposed above are provided in **ANNEXURE – IV**

9. In order to provide thrust to research in exploration, **ADVANCED CENTRE FOR STUDIES IN MINERAL EXPLORATION** may be created for studies in mineral exploration technology encompassing multi-disciplinary research in areas identified. The centre may undertake studies under a consortium approach jointly with other research institutes and academia. Ideal partners for such an endeavour would be NCGMRT (Centre for Applied Geoscientific Services) in consortium with IIT Roorkee and MECL.

10. In order to undertake advanced studies in the field of in Underground /deep-mining technology, an **ADVANCED CENTRE FOR STUDIES IN UNDERGROUND MINING** may be established at Indian School of Mines, Dhanbad and may undertake advanced studies in consortium with NCGMRT (National Institute of Rock Mechanics i.e. centre for rock mechanics and geotechnical engineering),Central Mining Research Institute and NFTDC (for development of sensors for mining environment and safety).

11 With a view to undertake advanced studies in the field of mineral processing, an **ADVANCED CENTRE FOR STUDIES IN MINERAL PROCESSING** is proposed to be set up at NCGMRT (JNARDDC i.e. *Centre for Research & Development in Aluminium and Base Metals)* in networking with Regional Research Laboratory, Bhopal and academic institutions address issues like (i) development of process flow sheets for lean ores / oxide + silicate beneficiation; (ii) beneficiation / upgradation of by products and realization from wastes such as red mud, anode slimes, slags via innovative processes; (iii) computer modelling and simulation of mineral processing and (iv) value addition of existing minerals via purification (impurity removal), size reduction, conversion to other ceramic compound and product development.

12. In order to provide impetus to research in multiple metals and **ADVANCED CENTRE FOR INTERDISCIPINARY RESEARCH IN MATERIALS and SYSTEMS** be set up at NFTDC, which has been undertaking interdisciplinary research in materials and systems for development of multiple materials. NFTDC may be recognised to reinforce its multidisciplinary approach to technology development for specialty metals and alloys. NFTDC along with other laboratories in partnership with industry may take up downstream processing in a consortium approach to convert the metals and alloys into semi-finished and finished products. Therefore, there is need to augment downstream process facilities (not characterization facilities) in NFTDC and other laboratories to undertake

product development enabling technology transfer to industry for diversification and forward integration.

13. In order to meet the requirement of funds for research & development in thrust areas identified for the XI Plan, a **National R&D Fund for Mineral Development** be established under the domain of Ministry of Mines for catering to requirement of following new proposals.

a. **NCGMRT – Rs. 500 crores**
b. **Advanced Centre for Studies in Mineral Exploration – Rs. 50 crores**
c. **Advanced Centre for Studies in Underground Mining – Rs. 50 crores**
d. **Advanced Centre for Studies in Mineral Processing – Rs. 50 crores**
e. **Advanced Centre for Interdisciplinary Research in Materials and Systems– Rs. 50 crores**

3. HUMAN RESOURCE DEVELOPMENT

3.1 The most important asset of mining industry is its human resource. Shortage of trained professionals is of concern for developing hi-tech minerals and metals. In order to undertake research & development in frontier areas of exploration, mining, mineral processing, metals and environment there is need for a trained manpower. The XI Plan aims at speedy development of an internationally competitive mining sector based on cost effective exploration for deep-seated and concealed deposits and developments using state-of-the-art technologies. This is proposed through promoting private investment in mineral exploration and creation of new mining capacities. The aim is to accelerate growth for sustainable mining development encouraging foreign capital and technology. Broad objective of the XI Plan is to accelerate search of minerals at deeper levels and in offshore areas, intensify mineral exploration with state-of-the-art technology for building up mineral resource base, modernisation of GSI, operationalising Heliborne geophysical surveys, marine research etc. Implementation of all these projects / schemes would entail the modernisation process successfully for which it would be necessary to ensure availability of trained manpower during XI Plan and ahead.

3.2 Human Resource in mineral / mining sector can be divided into three major categories:

(i) Professionals in geosciences, exploration, mining, mineral processing and metallurgy

(ii) Human Resource for R&D: Knowledge workers with specialization in R&D for exploration, mining, mineral processing and metallurgy and materials sciences

(iii) Mining workforce and artisan miners

3.2.1 Institutional Mechanism for creation of Professional HR

There are over 70 Universities / Institutions offering under-graduate/ post-graduate courses in geosciences, mining and allied fields. In addition, a number of Polytechnics are providing Diploma courses in mining. An indicative list of some of the important academic institutions providing education in the field of mining, geology, geophysics, mineral engineering and allied fields is at **Annexure-II**.

Banaras Hindu University was the first institution to start educational programmes in Geology, Mining and Metallurgy in 1923. Thereafter, Indian School of Mines was established in 1926.

Professional HR creation facilities are to address requirements at the entry level as well as at the advanced levels in all three areas, namely, (i) Geoscience and Exploration: This facilities has been created under applied science departments in universities like ISM, IT-BHU, IITB, IITR, IITKGP etc., (ii) Mining and Mineral Processing and Metallurgy: Such facilities have been created by engineering departments in a institutions such as IT-BHU, ISM, IITR, IITKGP, couple of NITs and some of state engineering colleges, (iii) Environment management: This requires a systems approach and involves multidisciplinary professionals in addition to mining engineers. This mandate is in the evolutionary stage as (a) courses and electives in the engineering curricula in mining and mineral processing and as continuing education and (b) industrial practice.

3.3 Status of HRD in Geosciences and Exploration

3.3.1 HR output from Academia in Geosciences

The entry-level HR requirement is generally met with BSc, MSc, M.Tech graduates in geology, applied geology, engineering geology, applied geophysics, geochemistry and mineral exploration. While a number of geoscience based graduates and postgraduates come out every year, the number of graduates taking employment in geoscientific field is only one tenth.

Advanced research training is partly met from M.Tech and PhD programmes where a specialized knowledge creation occurs and the number of PhDs, however, is dwindling. It is estimated that about 1,000 post-graduate students in Geology and Geophysics pass out every year from different parts of the country, however, only 150-200 students are well trained to face challenges in exploration. Overall there is less interest among post-graduate students in geosciences to opt for career in mineral exploration. A large number of teaching departments in colleges and universities supported by State governments lack basic resources for teaching, training/research, besides suffering from inadequacy of equipments and library facilities. However, institutions like ISM, BHU, IITB, IITR, IITKGP are well equipped. Students trained from these institutes are selected by MNCs through campus interview

In spite of a availability of institutional mechanism for education and training in the field of geology, geophysics, and other related disciplines; no special attention is being provided for employment of young PhDs / post-graduates / graduates in mining, exploration and geo-scientific profession in the country on account of following:

(a) There has been insignificant recruitment of mining engineers and geologists by the mining industry during the past several years. The salary of mining engineers and geologists, which used to be handsome at a point of time, is now not at par with other professions, thereby making the profession less lucrative. The I.T. industry absorbs scientists and engineers of any discipline including mining, which provide better options and easy life-style as compared to their core profession. Considering the hard field life and tough working conditions, professionals in the field of mining, exploration and geoscience should be encouraged by way of good salary, incentive and facilities as being provided outside India.

(b) There has been no recruitment of geologists by GSI for last several years. It is understood that a number of talented post-graduates in recent years had to seek employment elsewhere. Ministry of Mines need to ensure regular intake of geologists through UPSC exam.

(c) In general, there are lack of opportunities for employment to fresh post-graduates

3.3.2 HRD (Geosciences) in Geological Survey of India

The Geological Survey of India (GSI), a premier scientific organization in the country has been the principal employer of large number of geoscientists since its inception in 1851. Started with the modest objective of finding coal resource to plan and run the railways in India, the activities of GSI over the years have expanded to diverse fields. GSI had all along tried to assimilate new theoretical concepts developed globally and acquire the expertise required for expansion of activities. In addition to mapping for collection of geoscientific data, GSI activities now cover engineering geology, earthquake studies, airborne surveys, Antarctic research, environmental appraisal, mapping of the seabed and its resources, non-conventional energy sources, landslides, glaciers, geological health hazards etc.

Currently, GSI is passing through a phase of re-engineering of the organisation in terms of downsizing. As with many organisations that are more than a century old, GSI has to redefine its activities and human resource paradigms periodically to stay relevant and in tune with the demands of the nation in geo-exploration.

The total sanctioned S&T personnel strength of GSI as per the recommendation of The Expert Committee and after the subsequent approval of the Government stands at 3499. The present filled in strength is 1827, which is more or less works out to be 52% of the current sanctioned strength. Geology is the main scientific stream of the organization with supporting scientific and technical streams like geophysics, chemistry, geophysics (inst.), mineral physics, drilling and mechanical engineering. It is appropriate that GSI now reengineers itself to become an interdisciplinary research organisation for geo-exploration studies with a strong HR and training stream to stay relevant. It is important that it is re-engineered to have more multidisciplinary knowledge workers rather than non-executive support based organisation which will give a better reputation and image not only to attract better talent, but also to live up to the present demand on exploration.

3.3.3 HRD in Mining Engineering

Mining Engineering is well-established degree course in more than 15 institutions in the country such as ISM, IT-BHU, IITKGP etc. . The availability of BTech and MTech qualified professionals is well taken care of not only for the nonferrous sector, but also for coal and petroleum sectors by these institutions as well as by other universities and colleges. Nearly 700 graduates qualify as mining engineers every year and a part of them get absorbed in the mineral sector. The IT industry and studies in management related degrees take away bulk of these professionals. Once the job prospects and remuneration improve, there will be more takers for careers in mining sector.

It may be necessary to review mining course curriculum in the B Tech programme so as to sensitize the graduates to a more multidisciplinary future. The curriculum has to prepare the professionals for both research & development and mining technology. The need for professionals is more in R&D as the thrust in the next decade will be to augment research capabilities in the country. It will be more appropriate, if academic institutions become strong partners in mission oriented national programmes related to mining. Manufacturing will be dictated more by economics and automation, which in turn will demand more generalist engineers with mining as an extra specialization. In this regard, mining engineering courses for non-mining engineers is also relevant, as this sector will employ a very large number of mechanical and electrical engineers. The academic institutions and the mining industry can come together to institute undergraduate and post graduate mining engineering courses that would serve as (a) orienting non-mining engineers for the mining industry and (b) to encourage mining engineering diploma holders employed in industry to pursue higher education.

3.3.4 HRD in Mineral Processing

Mineral processing has always been a higher degree programme (MTech) in Indian universities. Only ISM has BTech programme in mineral engineering. Mineral processing as specialization involves understanding and exploiting separation processes to enhance the concentration of desired mineral phase(s). This discipline has attracted chemists, chemical engineers, mining and metallurgical engineers as it is a quintessential step between the ore and metal extraction. Mineral processing being an applied science in phase separation, specialists in this field of late have also diversified into many other areas such as ceramic engineering, advanced materials synthesis and purification, environmental engineering and nano materials where the basic principles governing mineral processing have been effectively cross fertilized. Herein, lays the key to adaptation to changes that are happening around. Mineral beneficiation is no longer restricted to metal winning process flow sheets, but is equally relevant to separation and purification paradigms of inorganic oxides, sulphides, silicates and recombination of these to develop new materials.

3.3.5 HRD in Metallurgical and Materials Science & Engineering

One of the interesting metamorphoses that happened in metallurgy is the gradual shift to materials science and engineering all over the world. Conventional metallurgy which dealt with metal extraction, mechanical behaviour of metals and processing of metals and alloys to shapes and products has widened to encompass all materials, viz., metals, minerals (oxides, sulphides and silicates etc), ceramics, polymers and composites containing metals, ceramics and polymers in varying proportions. The field enlarged further to take in electronic materials and nano materials into its fold. Research in materials science has become more interdisciplinary and there is room for physists, chemists, chemical engineers to enter materials science and engineering for higher degrees. With the advent of nanotechnology, it has become a sunrise field. The availability of a conventional process metallurgist has dwindled and traditional iron and steel making and nonferrous metal extraction have become backwaters.

Sponsored MTech programme in iron and steel making technology was initiated by TATAs at IITKGP to keep alive the domain knowledge as well as to feed the requirements of steel industry. Metallurgical engineers specialized in aluminium are still available across the world while copper, zinc and lead has been seeing a reduction. Extraction of majority of nonferrous metals now employs both hydrometallurgical, pyro and electrochemical routes and therefore, both chemical and metallurgical engineers are employable. Further processing of these materials is by very advanced techniques. For a long time, many metallurgical and materials processing industries have relied heavily on mechanical engineers to run plants. Of late, metallurgists have contributed significantly in all metallurgical industries. Casting, forming and powder metallurgical product production have been absorbing a large number of graduates. The requirement of materials science and engineers in R & D institutions in Department of Atomic Energy (DAE), Defence Research & Development Organisation, CSIR, Department of Science & Technology, Department of Space and MNCs has been on increase. However, many of these institutions, require higher degrees and research specialization. However, there are certain shortcomings in human resource development in metallurgical and materials' processing sector. Due to reduction in duration of B.Tech programme to 4 years, many fundamental engineering science courses have been deleted due to which the graduates are severely handicapped. A large part of the learning is, therefore, to continue as on the job training. While the requirement of doctoral candidates or B.Tech and M.Tech candidates in metallurgy and materials science with a potential to do research is very high, there is a gap between the quality of available talents and vis-à-vis employable human resource. In addition to R&D, the need for faculty in many and upcoming engineering institutions is also to be addressed.

3.3.6 Human Resource Development for R&D

The human resource requirement for R&D in mining, exploration, geoscience etc. has to be understood vis-à-vis the R&D activities. The mineral sector is varied and covers many disciplines. At one end are the earth processes, which are nature driven high temperature – high pressure processes obtained in crustal conditions that are responsible for mineralization. At the other end is the production of very high purity metals, refined extracts and material products, which constitute derivatives obtained by mimicking natural processes in reactors by human intervention. Between these two extremes, a plethora of mineral and material products are realized. Human intervention has occurred in two forms: one to understand the earth processes by both observation and experimentation and the other is to take out the natural macro products of earth crust and produce new products by separation and synthesis (combination) paradigm. It is, thus, an elaborate knowledge exercise in understanding and exploiting naturally occurring multi-component and multiphase materials for the mankind. R&D in multidisciplinary knowledge domains and knowledge integration is the essence of this exercise. The need of the hour is to create human resource in many of the knowledge domains.

As outlined above, the present educational system can only cater to the requirements of professionals in general for geosciences, mining, mineral processing and metallurgical and materials science for manufacturing and service sector. However, there are severe shortage for human resources for R&D in thrust areas. The problem is twin fold. On the one hand, even a few graduating postgraduates and doctorates in geosciences are not absorbed due to lack of mission oriented R&D thrust programmes at the national level. On the other hand, once such R&D missions are initiated, there would be severe shortage of research calibre human resource with knowledge domain skill sets. Even today, there is shortage of quality applicants for the faculty positions in ISM, IT-BHU and the IITs for geology, mining, mineral processing and metallurgical departments. Exploration, which is the first link in the chain, is also the weakest link. This sector is totally scientific and research oriented compared to mining and mineral processing which have both scientific as well as manufacturing mandates. Further, exploration science needs more interdisciplinary experts encompassing and including physists, chemists, mathematicians, computational specialists, materials scientists apart from geoscientists to undertake R&D on earth processes, mineralization and metallogenesis and exploration. *Therefore, a system would have to be evolved on the lines of programmes for atomic energy, space and defence to concurrently undertake national mission oriented R&D in thrust areas and develop human resource as part of R&D missions*.

3.4 Future Perspectives in HR

From above, it is apparent that there exist certain critical gaps in quantity and more often quality between the requirement and availability of human resource over the next decade.

3.4.1 Exploration

There are glaring gaps as far as human resource for exploration is concerned. There is a huge mismatch between the requirement and the availability. There are sufficient numbers of institutions involved in HR development in this field. However, the course curriculum needs to be periodically revised to take into account the advances in the mineral sector the world over. The foundation for the growth in mineral sector is mineral exploration and therefore, creation of high calibre HR in this area is of vital importance. Since exploration has become a interdisciplinary endeavour, the need for multidisciplinary approach has to be emphasized from the early stages of education itself. It would now be appropriate that HR for research be developed at centres of excellence dedicated to exploration sciences. The following knowledge domains and skill sets are required in HR for R&D in exploration:

- Understanding of High Pressure – High Temperature Earth processes, Mineralization and Metallogenesis, Computational Fluid Dynamics (CFD) and integrated modeling of Earth processes
- Geostatistics and 3D ore modeling

- Geophysical Exploration and Data Interpretation
- Marine Exploration
- Geo-chemical Exploration
- Modern Instrumental methods for testing and analysis
- Modern Topographic Surveying Techniques
- Application of digital image processing in all fields of geological and geophysical mapping and exploration
- Remote Sensing and Geographic Information System (GIS)
- Detailed Exploration and Drilling for minerals & energy resources
- Geo-environmental studies
- Mitigation of natural hazards etc.

3.4.2 Mining

While regular course revision and updates will take care of induction of recent advances, it is necessary to have an institutionalized mechanism to impart continuing education to those engaged in mining industry. A proactive approach on the lines of Tata Steel for iron and steel making and IITKGP needs to be replicated exclusively for upgradation of qualifications of mining personnel with non mining engineering degree qualifications and for personnel with diploma qualifications.

3.4.3 Mineral Processing and Beneficiation

The academic programmes being limited to Masters Degree in engineering in this field makes it ideally suited for orienting it for R&D. Much of R&D in this area is done in research labs and it is appropriate that joint research degree programmes between research institutions and academia are to be considered. It is necessary to set up a consortium of lab groups engaged in mineral processing to come together to create a PhD programme in association with the university system. The mineral beneficiation related problems are plenty in industry and with the need to extract from lean ores, and secondaries and wastes, HR creation for R&D like in exploration is urgent.

This is the most efficient and cost effective way of achieving high calibre HR with concurrent research output as well as to strengthen R&D academia-industry linkages.

3.4.4 Metallurgical and Materials Science and Engineering

While there are sufficient graduates and even doctoral level candidates come out of the academic system, the quality of HR for research has to be improved. Just as in the case of mineral processing, it would be more appropriate to deliberately bring together laboratories - academia – industry with PhD programmes.

3.5 Recommendations

3.5.1 Human Resource Development in the area of mineral exploration technology for locating deep-seated and concealed ore deposits is of vital importance for economic development. Hence, it would be necessary to reorient geoscience curricula and making training interdisciplinary in nature. For this purpose, there is need to set up Centres of Excellence for advance studies in the field of exploration and to introduce a strong PhD programme concurrently to develop HR with domain knowledge in various sub-sectors. There is also need to introduce continuing education / training programme / degree / diploma course for geologists in the field of mineral exploration under the training setup presently under GSI.

3.5.2 GSI Training Institute initially started with the prime objective of imparting training to orient the new recruits (Geologists). The Institute slowly spread its wings from 1979 inducting even experienced incumbents of the department for refresher and advanced training courses. Thus, as against 5 to 6 courses initially conducted annually, now has diversified its activities and now conducts nearly 45 courses encompassing different sub-disciplines of earth sciences. Considering need to have trained manpower in the field of exploration, geology, geophysics, drilling, mining, mineral processing and metallurgy, the present infrastructure GSI training institute at Hyderabad should be reorganised and strengthened in order to diversify its infrastructure for training in multidisciplinary fields, induction of well-trained trainers, development of new curriculum and introduction of new certificate/diploma/degree courses and upgradation of the present training infrastructure to an international standard. Therefore, a fully residential world-class infrastructure needs to be created for education and training in the entire field of geosciences, mining, mineral processing and metallurgy. Special training courses should also be organized catering to the requirement of PSUs, MNCs and R&D institutions in collaboration with academic institutions. GSI should conduct regular courses as well as customized programmes for various organizations and can effectively serve continuing education and orientation courses for fresh intakes. The institute should be linked to UGC and AICTE system for providing degree / diploma.

3.5.3 Presently Indian School of Mines is one of the important academic institutions dedicated to research and education in the field of Mining Engineering, Fuel & Mineral Engineering, Applied Geology, Applied Geophysics, Engineering and Mining Machinery. As a result of increasing mining activity, the shallower mineral deposits are getting exhausted. This is causing the shift of mining activity to deeper horizons of the earth. As will be discussed in detail in the section on R&D thrust areas in mining sector, in order to address issues relating to technology for deep mining, a Advanced centre for studies in underground Mining need to be established at Indian School of Mines during XI Plan. The centre may undertake in R&D in various aspects of deep mining, which will serve as input for the development of future human resources for mineral industry: The centre should have international collaboration with a country having expertise in deep mining such has South Africa and Australia

3.5.4 In order to strengthen academic institutes like IITs, ISM and other educational institutions, new courses and scholarships need to be introduced. The following measures are being suggested to strengthen HR creation and continuous education programmes in academic institutions.

- To create an awareness among educational institutes that mineral sector has ample scope to give employment to graduates; to improve chances of ultimate employment for students by giving financial support while they study and access to good projects related to mineral exploration; to identify good centers of education to conduct short- term courses and summer training to interested students in mineral exploration. GSI can take up a special summer programme every year for students enrolled in geosciences courses. Government funding for these programmes should be liberally available as this is the fountain of HR for future.

- To introduce special orientation courses to existing faculty members of colleges and universities on mineral exploration; It is important to bring in courses for already employed personnel in the mining and mineral processing industry who do not have mining engineering or exploration sciences background. Govt. of India should fund this continuing education, as this is the key to upgrading the skills of both educators as well as existing mining industry personnel.

- To modernise & update curricula and degree programmes by geoscience department in order to make courses more relevant to the growing need of industry especially relating to computer science education requirement of service companies. Similarly, some business education should be included in geoscience curricula. Also to meet the needs of the global economy, department should expand international exchanges to provide students with international experience and exposure.

3.5.5 There is a strong need for increased University-Industry Interaction. Increased University – industry interaction is more difficult to be achieved in practice, though there has been some success in the recent past in ISM and the IITs. A carrot and stick policy is required to foster this interaction.

(i) R&D projects of high value and of multidisciplinary nature to be solicited as joint projects from university and industry with personnel from both involved in the project team;

(ii) Partial funding of continuing education programme of mining industry personnel, which will per se enhance the interaction;

(iii) To establish a ranking system of industry in terms of in – house R&D and continuous education programme and inter-linkages; these metrics have to be used as guidelines as well as part of criteria for future funding.

(iv)To achieve results, qualified HRD exports need to be involved from various organizations outside the mineral industry to keep in step with other developing organizations that have shown results: bench marking and adoption of best practices.

(v) To create adjunct faculty positions for industry personnel and concurrently sabbatical chairs for academicians in industry; this can be made part of the National Mineral Fellowship Award programmes; This interface is crucial for setting up R&D programmes in industry and the faculty members on sabbatical to industry are the best nucleus for starting in – house R&D schemes in industry.

(vi) Development of softer skills – leadership qualities, which has now become a need of the hour, in which mineral industry has always been lagging behind other sectors; a management and leadership initiative programme has to be specifically designed for the mineral sector.

3.5.6 An important area that requires urgent attention from all concerned in mineral and nonferrous metal sector is the need to institutionalize systems to create, nurture talent and skills in many knowledge domains. It has to be done at all levels, as we are moving towards creation of knowledge workers. Creation of centres of excellence is to be first initiated which will require human resource at the level of leadership in R & D in specialized fields and at the same time, knowledge workers in the respective knowledge domains. The thrust areas are chosen such that knowledge integration takes place and the centres of excellence have to perform the role of both specialized knowledge creation as well as knowledge integration to solve practical problems.

3.5.7 Thrust areas identified are to be treated like national mission projects such as the space or nuclear programme. For each of the four major areas, namely exploration, mining, mineral processing and metals and products development, a nucleus is already available with R&D organizations under Ministry of Mines (NIRM, JNARDDC, NIMH), GSI, IBM, ISM, NFTDC, ITBHU, etc. For each area, R & D thrust areas have also been identified. It is now required to put together multiple projects under each mission within the centre of excellence concept and concurrently develop the human resource. Mission mode projects would create leadership level HR as well as large number of knowledge workers.

3.5.8 **National Mineral Fellowship Scheme**

In order to attract talent and train them in the knowledge domains required, it is appropriate that a **National Mineral Fellowship Scheme** be introduced by Government of India. This fellowship programme can be administered by proposed NCGMRT under the Ministry of Mines. The fellowship should be on the lines of Humboldt fellowship in Germany or Brain Pool in S Korea. The fellowship should be given to pursue PhD or Post –Doctoral or Advanced Research at any centre of excellence and the candidate shall be simultaneously registered in a university system, say IITs, BHU or ISM. **The fellowship value should be enough (i.e. at least Rs 2.5 lakhs per annum or Rs. 10 lakhs for four years) and the cost of fellowship for 500 awardees spread over in 5 years will be Rs 50 crores). At least 100 awardees be given this fellowship to kick start the programme.** Therefore, in order to ensure sustainable human resource development during the XI Five Year Plan, it is recommended an amount of Rs. 50 crores be approved under the scheme.

3.5.9 To ensure front line scientific research in earth sciences, a continuous series of training programmes by way of workshops, summer schools, advanced short courses in selected topics, are required to be encouraged. Contact programmes need to be initiated particularly in institutions where infrastructural and instrumental facilities are available. Interdisciplinary teams must be motivated to prepare instructional materials for dissemination. Refresher courses in modern trends in earth sciences with basics in physics, chemistry, mathematics and computer applications, mostly of remedial nature, should be formulated and distributed to various institutions / universities largely through video-lectures and correspondence materials.

3.5.10 **North East Region Fund for capacity building of HR and strengthening of R&D**

Northeast region has tremendous potential for mineral development. However, on account of lack of institutional mechanism and infrastructure to support R&D and capacity building for training & skill development, the mineral resources have so far not been harnessed optimally. It is, therefore, imperative to provide greater support to mineral development activities in NER including capacity building for training & skill development, strengthening and creation of Directorate of Mines & Geology and technological upgradation and modernization including preparation of district resource maps, undertaking hydro-geological resource mapping, mapping of geological hazard zonation, establishing training and demonstration centres for local miners, creating awareness for safeguarding from natural hazards, upgrading laboratories and R&D facilities for sustaining exploration activities etc. However, a major constraint has been paucity of funds, therefore, **North East Region Fund for capacity building of HR and strengthening of R&D should be established exclusively for the north east region and for this purpose an amount of Rs. 50 crores be earmarked for the XI Five Year Plan.**

ANNEXURE – I

SUB GROUP-IV ON R&D AND HRD

COMPOSITION

1.	Shri V.K. Thakral, Joint Secretary, Ministry of Mines, New Delhi	Chairman
2.	Prof. T. Kumar Director, Indian School of Mines, Dhanbad – 826004	Member
3.	Shri L.P. Sonkar Advisor (Minerals & TRP) Planning Commission, Room No. 231 Yojana Bhavan, New Delhi – 110 001	Member
4.	Dr. Mihir Deb, Professor, Department of Geology, Delhi University	Member
5.	Shri B. Sengupta Dy. Director General (IR & HR) Geological Survey of India, Kolkata	Member (Nominee of DG, GSI)
6.	Shri Prabhat Kumar Sinha Dy. Director General, Geological Survey of India, Training Institute, Hyderabad	Member (Nominee of DG, GSI)
7.	Shri Deepak Srivastava Director (Technical) Ministry of Mines, New Delhi	Member
8.	Dr. M.P. Singh Professor, Department of Geology, Lucknow University, Lucknow	Member
9.	Dr. Malti Goel Advisor, Dept. of Science & Technology Technology Bhavan, New Delhi	Member – Representing Dept. of S&T

10.	Dr. R. Krishna Murthi Department of Geology & Geophysics, IIT, Roorkee, Roorkee	Member (Nominee of IIT, Roorkee)
11.	Dr. Vidyarthi Prasad Mishra DDG, GSI & Director, National Institute of Rock & Mechanics, Bangalore	Member
12.	Dr. K. Balasubramanian Driector, Nonferrous Materials Technology Development Centre, P.O. Kanchanbagh Hyderabad – 500058 (A.P.)	Member
13.	Dr. K.R. Gupta Secretary, Geological Society of India. Delhi Chapter, New Delhi	Member
14.	Shri R.K. Sharma Secretary General FIMI, 301, Bakshi House, 40-41, Nehru Place, New Delhi – 110019	Member
15.	Shri K.P. Lall Advisor, Technical Planning & Policy Committee, Ministry of Mines, New Delhi	Member Convenor
16.	Prof. B.B. Dhar Former Director, CMRI, CSIR E-27, Defence Colony New Delhi - 110 0024	Co-opted Member
17.	Shri R.P. Tyagi, Consultant Minerals, Planning Commission, New Delhi	Co-opted Member
18.	Prof. D.C. Panigrahi, Head of Mining Department, Indian School of Mines, Dhanbad	Co-opted Member

19.	Dr. R.N. Gupta Prof. & Head Dept. of Mining Engineering Golden Valley Institute of Technology Oorgaum Kolar Gold Fields – 563 120 Karnataka	Co-opted Member
20.	Dr. G.S. Roonwal Former Professor, Dept. of Geology, Delhi University New Delhi	Co-opted Member
21.	Dr. Amalendu Sinha Actg. Director, Central Mining Research Institute (Council of Scientific & Industrial Research) Barwa Road, Dhanbad	Co-opted Member

TERMS OF REFERENCE

1. To review the present indigenous R&D setup in mining sector and suggest strategy for exploiting and beneficiating lean grade ores. Measures for adopting state of art technology in production, beneficiation, etc.

2. To review the availability and requirement and human resource in mining sector during the XIth Plan period and in perspective of 10 to 15 years and suggest measures to augment it by training and development of infrastructure. Suggest strategy for modernizing, updation of curriculum and technology.

3. To examine and suggest the role of educational / research institutes in mineral development in the country.

4. To make such other recommendations as may be considered appropriate.

ANNEXURE – II

IMPORTANT ACADEMIC INSTITUTIONS PROVIDING MINING AND GEOSCIENCE EDUCATION AT VARIOUS LEVELS

(A) THE PRINCIPAL ACADEMIC INSTITUTIONS PROVIDING COURSES OF STUDY IN MINING, GEOSCIENCE AND RELATED SUBJECTS INCLUDE –

- Indian School of Mines, Dhanbad
- Indian Institute of Technology, Roorkee
- Indian Institute of Technology, Mumbai
- Indian Institute of Technology, Kharagpur
- Jadavpur University, Kolkata
- Institute of Technology, Banaras Hindu University
- Lucknow University
- University of Delhi etc.

INDIAN SCHOOL OF MINES

- **Student input:**
  - For all Undergraduate courses: Through IIT-JEE.
  - For all Dual degree courses: Through IIT-JEE.
  - For all other courses: GATE and ISM Entrance Exam.

1. **Major departments to support Applied Geology, Mineral Exploration, Mining and Mineral Processing programmes:**

   - Mining Engineering
   - Applied Geology
   - Applied Geophysics
   - Fuel and Mineral Engineering
   - Mining Machinery Engineering
   - Centre for Mining Environment

2. Courses offered by different Departments:

2.1 Mining Engineering

Sl. No.	Programme	Duration	Sanctioned strength of students
1.	B. Tech (Mining Engineering)	4 years	78
2.	B. Tech (Mining Engineering) + M. Tech (Mining Engineering)	5 years	12
3.	B. Tech (Mining Engineering) + MBA	5 years	12
4.	M. Tech (Mining Engineering)	2 years	12
5.	M. Tech (Mine Planning & Design)	2 years	10
6.	M. Tech (Opencast Mining)	2 years	15
7.	M. Tech (Rock Excavation Engg.)	2 years	15
8.	M. Tech (U.G. Space Technology)	2 years	10
9.	M. Tech (Geomatic Engineering)	2 years	10

2.2 Fuel and Mineral Engineering

Sl. No.	Programme	Duration	Sanctioned strength of students
10.	B. Tech (Mineral Engineering)	4 years	40
11.	B. Tech (Mineral Engg.) + M. Tech (Material Technology)	5 years	12
12.	B. Tech (Mineral Engg.) + M. Tech (Mineral Resource Mgt.)	5 years	12
13.	M. Tech (Mineral Engineering)	2 years	18
14.	M. Tech (Fuel Technology)	2 years	12

2.3 Centre for Mining Environment

Sl. No.	Programme	Duration	Sanctioned strength of students
15.	B. Tech (Environmental Engg.)	4 years	40
16.	M. Tech (Environmental Engg.)	2 years	18

2.4 Applied Geology

Sl. No.	Programme	Duration	Sanctioned strength of students
17.	M. Sc. (Applied Geology)	2 years	20
18.	M. Sc. Tech (Applied Geology)	3 years	20
19.	M. Sc. Tech (Applied Geology)	5 years	20
20.	M. Tech (Mineral Exploration)	2 years	12
21.	M. Tech (Engineering Geology)	2 years	12
22.	M. Tech (Petroleum Exploration)	2 years	12

2.5 Applied Geophysics

Sl. No.	Programme	Duration	Sanctioned strength of students
23.	M. Sc. Tech (Applied Geophysics)	3 years	20
24.	M. Sc. Tech (Applied Geophysics)	5 years	20

2.6 Engineering and Mining Machinery

Sl. No.	Programme	Duration	Sanctioned strength of students
25.	B. Tech (Mining Machinery Engg.)	4 years	25
26.	M. Tech (Mining Machinery Engg.)	2 years	10
27.	M. Tech (Maintenance Engg. & Tribology)	2 years	15

IIT, ROORKEE

Courses of Study offered are:

Department of Earth Sciences

- Master of Science
  - ✓ Applied Geology
- Master of Technology
  - ✓ Applied Geology
  - ✓ Applied Geophysics
- Doctor of Philosophy

Earthquake Engineering

- Master of Technology
  - ✓ Soil Dynamics
  - ✓ Structural Dynamics

- Doctor of Philosophy

IIT, BOMBAY

Courses offered are:

- Department of Earth Sciences
  - ▪ M.Sc. (Applied Geology)
  - ▪ M.Sc. (Applied Geophysics)
  - ▪ M.Tech. (Geoexploration)
  - ▪ Doctor of Philosophy

IIT, KHARAGPUR

Courses offered are:

2 years M.Sc. in Geological sciences
No. of seats 20

2 years M.Sc. in Geophysics
No. of Seats 20

2 years M. Tech. in Earth & Environment Science
No. of Seats 16

2 years M. Tech. in Computational Geology
No. of Seats 08

JADAVPUR UNIVERSITY, KOLKATA

Courses offered are:

- M.Tech / MSc. In Applied Geolgoy
- M.Tech / MSc. In Applied Geolphysics
- Doctor of Philosophy

BANARAS HINDU UNIVERSITY INSTITUTE OF TECHNOLOGY

Courses offered are:

- **B.Tech** in Mining Engineering (intake 50)
- **M.Tech** in Mining Engineering (intake 15)
- **M.Sc in Geology**

  Two years M.Sc. Degree Course
  Selection Through all India Entrance Examination
  Eligibility: Only those candidates are eligible for entrance examination who have geology as one of the subject in their three years B.Sc. course
  No. of Seats- 28 (all full)
  About 60% placements through campus interview

- **M.Sc Tech in Geophysics**

  Three years M.Sc. Tech Degree
  Selection Through all India Entrance Examination
  Eligibility: Only those candidates are eligible for entrance examination who have geology & Math or physics and Math subjects in their B.Sc. course
  No. of Seats- 22 (all full)
  About 80% placements through campus interview

LUCKNOW UNIVERSITY

M.Sc. in Geology
2 years Course
Eligibility: B.Sc. with Geology as one of the subjects
No. of Seats- 20 (all filled)
Placement about 40%

UNIVERSITY OF DELHI

Courses offered are:

B.Sc (Hons) in Geology	(intake 30)
M.Sc in Geology	(intake 15)
M.Phil in Geology	(intake 5)
Ph.D	

(B) OTHER INSTITUTIONS AWARDING MINING ENGINEERING DEGREES

1. **Bengal Engineering College,** P.O. Botanical Garden, Howrah – 711103
2. **Birsa Institute of Technology** (Formerly known as Bihar Institute of Technology), P.O. Sindri Institute, Dhanbad -828123 (Jharkhand)
3. **College of Engineering, Anna University**, Guindy, Chennai – 600 025
4. **Government Engineering College,** Bilaspur – 495009 M.P.
5. **Government Engineering College,** GE Road, Raipur – 492002 (M.P.)
6. **MBM Engineering College,** Rathoda, Jodhpur – 402117 (Rajasthan)
7. **Rajiv Gandhi College of Engineering, Research and Technology** (Formerly known as Chandrapur Engineering College, Ballarpur Road, Babupeth, Chandrapur – 442403 (Maharashtra)
8. **SRB (Shri Ramdeobaba) Kamla Nehru Engineering College**, Ramdeo Tekdi, Katol Road, Nagpur – 440 013 (Maharashtra)
9. **Golden Valley College of Engineering, Kolar, *Karnataka***
10. **Mining Engg. Department, MP University of Agri & Tech, Udaipur**
11. **Mining Engg. Department, National Institute of Technology, Rourkela**
12. **Mining Engg. Department, National Institute of Technology, Nagpur**
13. ***Mining Engg. Department, National Institute of Technology, Suratkal***
14. ***Mining Engg. Department, Sarang, Orissa***

(C) INSTITUTIONS / POLYTECHNNICS AWARDING DIPLOMA IN MINING

1. **Asansol Polytechnic, Dist. Burdwan**, (West Bengal)
   Asansol Polytechnic, P.O. Dakshin Dhadka Asansol- 713 302, Dist. Burdwan
2. **Govt. Engineering College, Bhuj**, (Gujarat)
   Govt. Engineering College, Bhuj, Dist. Kutch, Gujarat
3. **Govt. Polytechnic Bellampalli, Adilabad Distt.**, (Andhra Pradesh)
   Govt. Polytechnic Bellampalli, Adilabad Distt.
4. **Govt. Polytechnic, Ambikapur**, (Madhya Pradesh)
   Govt. Polytechnic, Ambikapur, Distt. Surguja, M.P. - 497 001
5. **Govt. Polytechnic, Dist. Chhindwara, M.P.**, (Madhya Pradesh)
   Govt. Polytechnic, Khirsadah Post Office - Parasia, Dist. Chhindwara, M.P.- 480 441
6. **Govt. Polytechnic, Gundur**, (Andhra Pradesh)
   Govt. Polytechnic, Gundur 524102 Nellore Dist.
7. **Govt. Polytechnic, Kodhagudem, Khamman Dist.**, (Andhra Pradesh)
   Govt. Polytechnic, Rudrampur (Post), Kodhagudem 507119, Khamman Dist.
8. **Govt. Polytechnic, Mayem, Bicholim, Goa**, (Goa)
   Govt. Polytechnic, Mayem, Bicholim, Goa 403504
9. **Govt. Polytechnic, Narisipatnam**, (Andhra Pradesh)
   Govt. Polytechnic, Narisipatnam 531116
10. **Govt. Polytechnic, Ratnagiri**, (Maharashtra)
    Govt. Polytechnic, Ratnagiri-415612
11. **Govt. Polytechnic, Shahdol, M.P.**, (Madhya Pradesh)
    Govt. Polytechnic, Pandav Nagar Road, Shahdol, M.P.-484 001
12. **Institute Of Mining, Dist. Burdwan**, (West Bengal)
    Institute Of Mining, Girjapara Ranigunj, Dist. Burdwan- 713 347
13. **Orissa School Of Mining Engg., Orissa**, (Orissa)
    Orissa School Of Mining Engg., Keonjhargarh, Orissa - 758 001
14. **Sri Y.S.R. Reddy Polytechni, Pulivendala, Cuddapah District**, (Andhra Pradesh) Sri Y.S.R. Reddy Polytechni, Pulivendala, Cuddapah District 516390
15. **Vivekanand Edu. Soc's Vivekanand Poly, Dist.Bhandra**, (Maharashtra)
    Vivekanand Edu. Soc's Vivekanand Poly, Sitasaonji, Tumsar, Dist.Bhandra-441 929

ANNEXURE - III

LEADING INDIAN AGENCIES RECRUITING PROFESSIONALS IN THE FIELD OF MINERAL SECTOR

(A) Central / State Government / PSUs

- Geological Survey of India, Kolkata
- Indian Bureau of Mines, Nagpur
- State Departments of Geology and Mining
- National Mineral Development Corporation Ltd, Hyderabad
- Hindustan Copper Limited, Kolkata
- Indian Rare Earths Ltd, Mumbai
- Steel Authority of India Limited, New Delhi
- National Aluminium Co., Ltd., Bhubaneshwar
- Orissa Mining Corporation Ltd., Cuttack
- Manganese Ore India Ltd, Nagpur
- Kudremukh Iron Ore Mines Ltd, Bangalore
- Mineral Exploration Corporation Limited, Nagpur
- Atomic Minerals Directorate for Exploration & Research, Hyderabad
- Gujarat Mineral Development Corporation Ltd., Ahmedabad
- Andhra Pradesh State Mineral Development Corpn., Ltd, Hyderabad
- Rajasthan State Mines & Mineral Ltd, Jaipur
- Mysore Minerals Limited, Bangalore
- Tamil Nadu Mineral Development Corporation Ltd, Ltd. (TAMIN) Chennai
- National Institute of Rock Mechanics
- Jawahar Lal Nehru Research Development and Design Centre
- National Institute of Miners' Health

(B) Private Mining firms

- Hindustan Zinc Ltd.,
- BALCO
- HINDALCO
- Tata Iron & Steel Co., Limited, Noamundi, Bihar.
- Associated Cement Companies Ltd, Mumbai.
- Sesa Goa Limited, Panjim, Goa.
- V. M. Salgaocar Mines Limited, Panjim, Goa
- Dempo Mines Limited, Panjim, Goa.
- Chowgule and Co., Ltd., Panjim, Goa.
- India Cements Limited, Chennai.

- Larsen & Toubro Limited, Mumbai.
- Sterlite Industries Limited, Mumbai
- Utkal Alumina Limited, Kolkota.
- Gujarat Aluminium & Bauxite Limited, Ahmedabad
- MSPL Limited, Hospet
- Gujarat Ambuja Cement Ltd.
- Sterlite Industries India Ltd, Mumbai
- Larsen & Toubro Limited, Mumbai
- ACC Limited, Mumbai

(C) <u>Joint Venture exploration and mining companies (involving FDI currently in various stages of implementation)</u>

- Geomysore Pvt. Ltd.
- Rio Tinto India Pvt Ltd, New Delhi
- De Beers India Pvt Ltd, New Delhi
- The Broken-Hill Pty Co. Ltd, New Delhi
- BHP Minerals India Pvt. Ltd, New Delhi etc.

ANNEXURE – IV

NATIONAL COUNCIL OF GEO-SCIENTIFIC & MINERAL RESEARCH AND TRAINING (NCGMRT)

SEVEN CENTRES OF EXCELLENCE AND THEIR PROPOSED ACTIVITIES

1. Centre for Applied Geoscientific Services (CAGS)
(Presently Consultancy Setup of GSI)

- Geological Investigations
- Exploration for Minerals and Energy Resources
- Airborne and Ground Geophysical Investigations
- Marine Investigations
- Contractual Drilling Investigations
- Geo-Environmental Studies
- Geo-technical & Engineering Geology Investigations
- Studies relating to Natural Hazards and Mitigation Management etc.

2. Centre for Ore Dressing, Testing and R&D (CORD)
(Presently Ore Dressing Division of IBM and R& D Setup / Laboratories of GSI)

- Mineral beneficiation / ore dressing investigations
- Chemical / Petrographic analysis / mineralogical studies
- Techno-economic feasibility studies
- Testing services for minerals, rocks, metals and materials
- Quality Certification
- Technology upgradation & development related to mineral processing / flow sheet development / product development etc.

3. Centre for Mining Research, Design and Development (CMRDD)
(Presently Mining Research and Technical Consultancy Cells of IBM)

- Research in Underground mining technologies
- Mining Research and Technical Consultancy
- Mine Planning and Design (underground / opencast)
- Mine pre-feasibility studies
- Mine rehabilitation plans
- Techno-economic feasibility studies for mining projects
- Mine Surveying
- Environmental monitoring of mining areas
- Environmental Impact Assessment Studies and Environment Management Plans
- Evaluation of mining areas and mineral deposits
- Preparation of mine disaster management plans and plans relating to improvement in mines' safety etc.

4. Centre for Rock Mechanics and Geo-technical Engineering (CRGE)
(Presently National Institute of Rock Mechanics)

- Rock fracture mechanics
- Electronic instrumentation for mines
- Engineering Geophysical investigations
- Geo-technical investigations
- Numerical modeling for design of rock excavations
- Ground control for mines and tunneling projects
- Controlled blasting for underground excavations
- Tunneling technology
- Underground / Opencast Mine design
- Mining seismology
- Granite Mining and related R&D
- Slope stability investigations etc.

5. Centre for Research & Development in Aluminium and Base Metals (CRDAB)
(Presently Jawaharlal Nehru Aluminium Research Development and Design Centre)

- Characterisation & Testing of raw materials, alumina, aluminium, base metals and precious metals
- R&D for aluminum, base metals and precious metals
- Analytical and laboratory services for raw materials and metals
- Technological support for secondary aluminum and other metals
- Development of low cost composites using industrial waste
- R&D for downstream processing industry
- Technology Development
- Databank for bauxite, alumina, aluminium and base metals
- Product development for materials etc.

6. Centre for Advanced Training in Geo-scientific Management (CATGM)
(Presently Training Setup of GSI, IBM and the Research Institutions)
- Short-term and long-term courses / programmes for GSI officers
- Tailor-made courses for industry / PSUs / government agencies / R&D institutions from India and abroad
- Special post-graduate degree / diploma courses in the field of mineral exploration, marine survey, geophysical exploration, geo-technical engineering, remote sensing & GIS, mineral processing, 3D ore modeling, etc.
- Training programmes in the field of mining, ore dressing, mining technology, rock mechanics, etc.

7. <u>Centre for Research in Miners' Health and Hygiene (CRMHH)</u>

(Presently National Institute of Miner's Health)

- Assessment of health hazards in work environment of mines & allied industries for regulatory and remedial measures
- Promotion of health and prevention of diseases among mine workforce and mineral based industries
- Occupational health research
- Promoting awareness for hygiene in mining areas
- Risk Assessment for safety management
- Certification for Occupational Health and Safety etc.