FOCUS INDIA

THE INDIAN MINING INDUSTRY: Market Information for Canadian Participation in Indian Market for Mining Equipment and Services

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PREFACE

The purpose of this report is to provide Canadians with information on the Indian market for mining equipment and services. As such, it is intended to help prospective exporters and investors make informed choices about increasing their presence in India. A companion report **"Indian Mineral Exploration and Development"** provides similar information of interest to potential Canadian investors in the Indian mining industry. A further report **"Indian Mining Company/Organizational Profiles"** is under development.

These reports are an integral element of Canada's "Focus India" initiative ⊕ a cooperative program by Canadian federal, provincial and private sector groups and associations to assist Canadian companies in assessing India's new economic policies and the potential they hold for Canadian entrepreneurs.

The study has been contracted by the Canadian High Commission and prepared by Mr. P.K.V. Krishnan, Director, Sarasuba Entrepreneurs Private Limited, New Delhi. While every effort has been made to ensure accuracy, no responsibility is accepted for errors or omissions.

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1. OVERVIEW OF THE INDIAN MINING EQUIPMENT AND SERVICES INDUSTRY

Introduction

With a mining record of centuries, India has developed its capabilities and capacities to manufacture equipment/machinery and a fairly good service sector. These, however, have been designed to cater the domestic mining conditions. The Indian mining industry is characterised by:

(i) predominance of coal;
(ii) presence of small sized mines;
(iii) low levels of mining technologies;
(iv) relative shortages of financial resources;
(v) low productivity and labour intensive production methods;
(vi) relatively low levels of research and development; and
(vii) predominance of underground mining method until some 20 years ago.

These characteristics of the Industry stem from the Government of India's deliberate policy of limiting the private sector's role only to the development of minor minerals, reserving others for development by the public sector companies, in line with its philosophy of providing "commanding heights" in the infrastructural segment of the Indian economy.

Growth

Consistent with this policy, the Government of India (GOI) established new public sector companies and licensed a few others to manufacture mining equipment and machinery beginning the 60's. The establishment of the Heavy Engineering Corporation Ltd (HEC) in 1959-60, marked the beginning of the present day mining equipment/machinery industry. This was followed soon by setting up of two more public sector companies: Bharat Earth Movers Ltd (BEML) in 1964 and the Mining and Allied Machinery Corporation Ltd. (MAMC) in 1965.

Along with the public sector, several private companies have diversified their products to include mining equipment to meet the demand. Leading among these include Hindustan Motors, Larsen and Toubro, Tata Engineering & Locomotive Co. Ltd. and Tractors India Ltd.

With increasing reliance on open pit mining than underground, particularly in the coal mining segment ⊕ the largest consumer, the equipment/machinery industry diversified into open pit mining equipment. This shift has enabled several construction equipment manufacturers also to enter the field by modifying/upgrading their products such as dumpers, loaders and excavators.

Most of the available equipment/machinery were developed with foreign collaborators: the MAMC has collaborations with Polish Kopex for coal preparation plants and jigs, Netherland's Stamicarbon for cyclone processes for coal treatment, Germany, UK and former USSR for other products. Similarly BEML has collaboration with the Japanese Komatsu, the U.S. Caterpillar and Dressers of Australia and HEC with former USSR (for heavy machinery building plant), Czechoslovakia (foundry and forging plant) and former West Germany (steel plant equipment).

Size and Production Capacity

Presently, India has 17 mining equipment, 20 earth moving equipment, 12 construction equipment and 20 material handling equipment manufacturers in the organised sector In addition, several small and medium sized facilities, producing equipments and parts for the machinery, have been operating. In fact, the mining equipment/machinery is one of the poorly documented sector of the industry. Information on major parameters such as actual size of the industry, its productive capacity and actual performance is lacking. Despite this lacuna, the present study has identified most of the information. Annexure 1.1 provides an illustrative list of mining & allied machinery equipment manufactured in India. The total sales volume far exceeds the production levels indicating sales of imported items and the large volume coming from smaller units. According to available data, sale of select mining, earth moving, material handling and construction equipments amounted to Rs. 17 billion in 1992-93, shared as under:

Table 1
Total Industry Size (Ra. Billion)

Segment	Sales Values
(a) Mining machinery	0.51
(b) Earth Moving Machinery	13.13
(c) Material handling equipment	0.60
(d) Construction Machinery	2.64
Total	16.88

Mining Machinery

The installed capacity of the mining machinery alone, expressed in value terms, is Rs. one billion and its production amounted to Rs. 890 million in 1993-94. The major products include coal cutters, haulages, winders, armoured face conveyors, self-advancing powered roof support and coal washeries. The total production trend in the recent years is as follows (the performance of select companies appear at Annexure 1.2).

Table 2
Production Trend of Mining Machinery (Rs. Million)

Year	Production
1982-83	49
1983-84	50
1984-85	48
1989-90	936
1990-91	649
1991-92	850
1992-93	862
1993-94	890

Source: Handbook of Statistics, Confederation of Indian Industries, New Delhi

Earth Moving Equipment

The earth moving equipment segment of the industry has a total capacity of 1,05,000 MT of various items such as different types of loaders, bulldozers, dumpers, scrapers and trailers. While the Annexure 1.3 provides the performance of select earth moving machinery/equipment manufacturers, the total production value amounted to Rs. 1.5 billion in 1992-93, coming mainly from BEML, Larsen & Toubro, Hindustan Motors and Tatas.

Construction & Material Handling Segment

The construction and material handling equipment sector, another large industry with a wide market in the mining sector had an estimated annual production (based on the sales of major players) of Rs. 3 billion.

Trade Pattern

With such a wide production base, India has been sourcing most of its requirements from within the country. The domestic industry, in fact, is confronted with the problem of under utilisation of capacity, mainly owing to imports tied to aided-projects, particularly coal. India established joint working groups with Poland, the U.K., France, Germany, former USSR, Australia and Canada to develop coal projects on a bilateral basis. These arrangements encompassed equipment and technology imports, technical assistance, training Indian manpower and part funding of the project. In addition, World Bank aided projects called for sourcing equipments by international competitive bids.

Apart from such imports, the private sector equipment manufacturers have also been basically supplying the products imported and assembled under license from their principals (indirect imports).

India continues to import mining-related equipments, particularly large-sized, and spares parts for these. Such imports totalled about Rs. 4.7 billion in 1993-94, coming mainly from the US, Japan, Italy, Korean Republic, UK and Sweden.

Mineral Services

Along with the equipment/machinery industry, India gradually developed its service capabilities from exploration of a mineral to marketing of the final product. These again were conditioned by the local requirements, lagging behind its counterparts in European and American continents. The growth of this sector, as in case of the mining industry, was restricted by limiting private and foreign participation to the barest minimum, while paucity of funds continued to plague the industry. Moreover, projects, particularly coal, covered by bilateral assistance, obviates the need for any special services as the cooperation/assistance agreements provided for rendering of such services in crucial areas. In addition, India has requisitioned services of foreign and Indian consultants for specific projects [see section on mineral services] on a need basis.

The origin of service sector dates back to 1850's when the Geological Survey of India (GSI) was set up. Annexure 1.4 lists the GSI's exploration programs for 1992-97. In 1948, the Indian Bureau of Mines (IBM) was established as an agency of the GOI. Subsequently, several public sector organisations have set up their own planning and consultancy services in such areas as exploration, mine planning and designing, construction, project management, preparation of detailed project reports and engineering aspects, etc.

Prospects for foreign participation in mining machinery and service sector are detailed in the following pages.

2. MINING MACHINERY & EQUIPMENT

Description

Mining Machinery and Equipments are a generic term covering all equipments used in activities such as road & subway construction and irrigation projects, besides mining *per se*. The specifications and sizes, however, vary according to the needs of the end-users and determine the category of equipment.

The Indian mining machinery industry caters to the needs of coal as well as other non-fuel minerals mining, both opencast and underground. Some industrial analysts say that non-coal underground mines being very small in number, (copper, zinc, gold, manganese etc.), there is a general shortage of equipment for these. The mining methods and technologies obtained in India have largely influenced the manufacturers. Hence, equipment requirements of large-sized mines are generally met by imports.

Indian capacities for manufacturing heavy machinery are limited. Major assemblies and sub-assemblies are, even today, imported. It should be noted though, that geotechnical, geomining and environmental working conditions in India are significantly different from those countries where these equipments were developed for their use. Thus, equipments designed abroad may not bear straight application here. This fact calls for a careful modification through indigenisation of equipments, or at least, design modifications, to suit Indian working conditions.

Market Size

The present annual market for mining machinery and equipment and their parts is in the neighbourhood of Rs. 21 billion, with domestic production accounting for about 80 per cent, and the balance being met by imports.

Table 1
Estimated Market Size* in 1992-93

Source	Rs. (billion)	% Share
Domestic Supplies	16.88	82.18
Imports	3.66	17.82
Total	20.54	100

*Mining machinery/equipment industry 18 one of the poorly documented sector and hence suffers statistical disabilities.

The bulk of the market is for opencast mining machinery/equipment, accounting for some 65 per cent. The balance is shared between underground mining and material handling segments.

A broad grouping of some of the major machinery and equipment currently in use and in demand are as under:

I. Mining Machinery/Equipment:

i) Tunnelling idlers with various attachments
ii) Drilling equipment - rotary and pneumatic drills
iii) Coal preparation equipment
iv) Self-advancing roof support
v) Shovels and excavators including hydraulic (0.9 to 14.0 m^3)
vi) Electric rope shovels (up to 10 m^3)
vii) Walking dragline
viii) Trucks and dumpers (10 to 170 t capacity, mostly up to 100 t capacity)
ix) Bulldozers (up to 77 HP)
x) Backhoe (1 to 85 m^3)
xi) Loaders including wheeled (1.0 to 5.86 m^3), and
xii) Longwall mining equipment

II Material Handling

i) Conveying equipment - belt and bucket type
ii) wagon tipplers
iii) Stamping, charging, pushing machines
iv) Forklift trucks, and
v) Stackers, blenders, reclaimers and spreaders

In the adoption of mechanised opencast mining the most critical aspect has been the proper maintenance and operation of Heavy Earth Moving Machinery (HEMM). While India has acquired requisite expertise in the maintenance and operation of these machines, a major concern has primarily been the availability of spares, especially those which are to be obtained from outside the country. Large capacity workshops at the unit level and also regional workshops for a group of mines and central workshops in each coalfield have been established to ensure periodical maintenance of these equipments. Till recently, there has been some difficulties in the maintenance of hydraulic system of HEMM, but sufficient capabilities have now been developed in this area as well.

Demand

Since the mid-50s, India had followed a policy of mixed economy, but with predominance of the Government-owned, public sector companies in the entire gamut of infrastructural development, these public sector companies received heavy budgetary funding. However, the economic and industrial policy changes effected in July '91 are a radical departure from this policy. The new policy envisages:

(i) public sector will find its own resources for its entire range of operations and,

(ii) public sector companies may enter into collaboration not only with domestic private sector companies but also with foreign companies.

The GOI's VIII Five-Year Plan projected that by 1996-97 the demand for coal mining equipment alone will be in the neighborhood of Rs. 57 billion, with indigenous component at Rs. 37 billion. This by itself represented an increase of 265 per cent over the present level of market. However, with the public sector companies being directed to generate their own resources and not to depend upon the budgetary support, this demand projection merely is academic in the absence of known sources of funding. Thus, the market has now become fluid with no one ready to hazard a guess as to which particular projects may be commissioned with or without joint ventures from within or from outside.

Market Analysis

Though the industry comprises some 70 organised and scores of unorganised facilities, the bulk of the production comes from a select few. Same is true of the product range, with longwall mining equipment, load headers, hydraulic rock breakers and shovels/excavators accounting for a major share of the production.

Principal players in the market with their share in total and specific items sold in 1992-93 are as under:

Table 2
Market Share of Major Manufacturers of Mining Machinery & Equipment

Company	Item	Value (R.s Million)	Total Value
A. MINING EQUIPMENT			**50.5**
1. EIMCO ELECON	Tunnelling Machines	50.0	
2. Mining & Allied Machinery Corporation Ltd.			**36.6**
	Mining Equipment	30.2	
	Coal preparation plant equipment	6.3	
3. Jessop & Co. Ltd.			7.3
	Self advancing roof support	**7.3**	
4. Williamson Magor & Co. Ltd.			4.3
	Mining accessories & equipment	**4.3**	
B. EARTHMOVING EQUIPMENT			
1. Bharat Earth Movers Limited			**60.9**
	Earth moving equipment	41.8	
	Spares	19.1	
2. Hindustan Motors			**11.0**
	Bulldozers, dumpers	11.0	
3. Larsen & Toubro		8.3	
	Earth moving equipment		
C. MATERIALS HANDLING EQUIPMENT			
1. Elecon Engineering Co. Ltd.			**27.5**
	Conveying equipment	17.5	
	Wagon tippers	1.5	
	Specialized conveyor equipment, Blenders	8.0	
2. Tata-Robins Fraser Ltd.			**26.5**
	Material handling equipment	21.0	
	Idler rollers	2.8	
	Sectional & Mine conveyors	1.7	
3. McNally Bharat Engineering Co. Ltd.	Material handling & conveying plant/machinery	12.8	**12.8**
4. Godrej & Boyce Mfg. Co. Ltd.			**8.8**
	Fork lift trucks	8.8	
5. Voltas Ltd.			**7.0**
	Fork Lifts	7.0	

Imports, accounting for over 20 per cent of the market share, has an important role to play, and are likely to increase further following the liberalisation of mining and trade policies. Major imports and their sources in 1993-94 are under (see Annexure 2.1 for details):

Table 3
Indian Imports of Select Mining Machinery & Parts in 1993-94

Product	Value (Rs. Million)	% Share of Total
A. MACHINERY		
1. Bulldozers	77.3	6.78
2. Front-ended and other mechanical shovels/excavators and shovel loaders	95.8	8.30
3. Coal/rock cutters and tunnelling machinery - self-propelled	160.1	14.05
4. Drilling and other rigs	179.9	15.78
5. Sorting, screening and washing machinery	67.6	5.93
6. Boring and Sinking machines	94.4	8.2
7. Drilling rigs	73.0	6.41
8. Others	391.4	34.55
Total	1,139.5	100.00
B. PARTS OF		
1. Self-propelled excavators, levelling, tempering machinery	1,462.3	41.25
2. Lifting, handling and loading machinery	1,120.7	31.61
Total (incl. others)	3,545.3	100.00

Table 4
Major Supplying Countries

Product	Value (Rs. Million)	% Share of Total
A. MACHINERY		
Japan	295.7	25.95
Germany	227.6	19.97
U.S.A.	187.1	16.41
Sweden	58.5	5.14
Others	368.8	32.37
Total	1,139.5	100.00
B. PARTS		
U.S.A.	1,225.8	34.59
Italy	401.7	11.33
Japan	339.1	9.56
U.K.	262.0	7.39
Sweden	225.3	6.35
Others	1,091.4	30.78
Total	3,545.3	100.00

Mechanisation schemes in India are currently plagued with severe technological and organisational problems which lead to the lower productivity levels. Eventually, these problems may even lead to failure of entire mechanisation scheme entailing huge losses.

Prospects for Foreign Participation

The opening up of the industrial as well as mining sectors has widened the scope for not only domestic private but also for foreign participation in the development of the mining sector. Based on the present technologies of the equipment industry and the virtual withdrawal of budgetary support to the public sector companies, industry analysts foresee a larger role for foreign companies. The participation could be in the form of:

i) direct export of capital goods and technologies;
ii) joint participation in mining projects (foreign direct investment); and
iii) technology transfer tie-ups.

Specific Areas for Participation

India is likely to look for technologies to manufacture machinery such as drilling equipment for large dia. blast holes (250 - 380 mm); stemming and blast hole connecting equipments; large capacity power shovels (up to 20 m^3 buckets); large capacity dumpers (over 170t to 240t) and diesel-electric dumpers and mobile and semi-mobile in-pit crushing, screening and conveying equipments. With the future adoption of in-pit crushing and conveying system in over burden (OB) and ore benches, the drill dia. size is also expected to change. In the areas of blasting initiation systems, India has not made much progress. The use of 'non-electric' delay initiation system is still in the trial stage. The IDL Chemicals has developed and manufactured 'aydet' system in India. The expected modernisation and automation of mining operations, including movement control of dumpers and other earth moving equipment through radio signals and mine communication systems are another important area for exports of capital goods, transfer of technology to the local industry by way of joint ventures. However, the bulk of the market is in the coal sector, followed by bauxite, iron ore, lead-zinc and copper mining.

3. MINERAL TECHNOLOGY

Introduction

The prime concem, the world over, is to discover blind or concealed ore deposits, as the existing mineral resources are depleting fast. To meet this challenge, especially in the coming decades for the development of mineral sector in India, applicability of new exploration techniques and use of the older techniques in an improvised manner are essential.

It may be stated that the country is largely covered by what can be described as metallogenetically favourable Precambrian Shield and large areas within it characterised by greenstone belt geology. It should also be bome in mind, that obvious and easily recognised mineral occurrences have been explored. The search now is essentially concentrated on, with almost no indications, hope that it might lead to the discovery of hidden mineral occurrences.

Another major feature that is to be considered in the context of the present day exploration activities is the increasing importance of environmental concems, sometimes forcing intemational companies to shift exploration to less environmentally sensitive areas and even away from countries with strict environmental controls. Examples can be cited in this country of area such as covered by tropical forests in the Westem Ghats (part of Kamataka, Goa, Maharashtra), Orissa and parts of Andhra Pradesh etc.

Technology Services

Geochemical Survey

Geochemical Survey is one of the specific exploration methods available. The modem approach (especially with the availability of sophisticated instruments) is to analyse samples for several or multi-elements (twenty or more elements) to locate targets. To process this multi-element data and relate to the particular geological setting, an understanding of multivariate statistics and software to perform the necessary computations are required.

A unique electrogeochemical method for base and precious metal exploration developed in the erstwhile USSR had a limited application in this country. This technique "CHIM method (an acronym derived from three Russian words meaning ⊕ partial extraction of metals) has been successfully used in Russia in exploration for gold, lead-zinc, copper, copper-nickel and beryllium deposits under vastly different conditions of geologic environment, overburden and depth of burial. Several deposits have been detected to depths of even 400 m, which are difficult or impossible to detect using surface geochemical or geophysical methods.

It is significant to note that efforts have been made to use this electrochemical technique by designing instruments. Recently, based on further research, it has been shown that partial extraction of metals by electrolysis (PEXMEL) could be effectively used for direct detection of polymetallic sulphides. India has fabricated a low powdered, less expensive instrument. As the results obtained are encouraging, this method could prove useful in a wide variety of geological terrains viz. tropical, sub-tropical and glacial overburden. Further, application of this method in lateritic or in arid terrain may prove useful in establishing whether targets could be identified under such covers, as conventional methods are unsuitable.

A new tool available in the diamond exploration is the use of Ni thermometer to evaluate the diamond grade of the host rock- kimberlite or lamproite using proton microprobe for analysis of trace elements in garnet grains.

Geophysical Surveys

Airborne geophysical surveys have been carried over some selected blocks in the country and high altitude aeromagnetic surveys have covered the southern part of the Precambrian shield. A regional aeromagnetic survey programme (NASM - National Aeromagnetic Survey Mission) to cover the entire country (except Himalayan and Deccan Trap terrain) is in progress. The purpose is to prepare a regional magnetic (total intensity) map of the entire country to elucidate the litho-structural fabric. The surveys are conducted at barometric height of 1500 m/1800 m/2100 m along lines spaced at 4 km interval. This high level altitude survey is not very useful in mineral targeting.

Apart from the multi-sensor air-borne surveys carried out in selected parts of mineralised belts in Rajasthan, Andhra Pradesh and Bihar-West Bengal during 1967-68 (under Operation Hard Rock) and parts of Rajasthan-Gujarat-Madhya Pradesh, Karnataka and Maharashtra during 1971-72 (BRGM/CGG), **such surveys** (EM, magnetic and spectrometric) **with a Twin Otter aircraft acquired by GSI are in progress** (from 1986-87) in selected areas of Tamil Nadu, Andhra Pradesh, Maharashtra, Orissa, Haryana and Rajasthan for locating targets for mineral exploration and refining of the existing geological maps. Multi-sensor airborne surveys yield a wealth of data which could be utilised for exploration for base, precious metals and rare earth metals which are associated with radio-active minerals amenable for detection by aero-radiometric techniques.

What is now required is the use of high quality, low-level aeromagnetic surveys to aid in mineral discovery and refinement of geological maps. **Countries with mature exploration programmes (e.g. Australia and Canada) have an excellent coverage by low-level (300 m altitude) closely spaced (1 km or less) high quality aeromagnetic surveys. Such mineral oriented surveys, help to create a very good data base for exploration.**

Ground Methods

Among ground methods, time-domain EM method (e.g. SIROTEM, UTEM) are useful in areas of conductive overburden where traditional IP or EM techniques are ineffective. Geophysical methods are useful indirect methods in gold exploration in identifying host rock, geoenvironment marker beds or structures with unusual magnetisation, density, electric polarisation or conductivity. Some of the markers may be basic rocks (magnetic) BIF or bearing signatures detectable. India has gold deposit models and geophysical signatures.

Instruments such as Terraprobe to detect gold directly is also available in India.

The scope of ground probing radar systems has vastly improved and the subsurface profiling (to map near surface structures) complemented by geochemical and IP data makes it yet another useful tool in mineral investigation.

Drilling

Drilling techniques practised in mineral exploration in the country are mostly outdated. Sophisticated and latest technology is required. Use of wireline core barrels is a must and the latest available is thin walled series TK barrels.

Mining Technology Issues

The selection of technology is largely based on the mineral characteristics such as depth, character of ore, associated mineral wealth, mine size, demand pattern for the minerals and availability of needed financial resources.

The Indian mining sector (including coal) was dominated by underground mining until about two decades ago. With the technological advances abroad and the pressing need to raise coal production to fuel a number of thermal power plants to bridge the ever-widening demand/supply gap for electric power, India also shifted to opencast mining. At the same time, the role of the underground mines kept enhancing on quality considerations and availability of large deposits.

The non-coal mineral deposits in India are primarily amenable to opencast mining, with the exception of some copper, lead-zinc, manganese ore, gold and uranium. These mines are, however, small in number.

Unlike the mineral rich developed countries such as Canada, U.S.A., and the developing countries such as Chue, Zambia, South Africa, China, Malaysia, India's absorption rate of new technologies is rather low owing to financial resource constraints. Even in the projects, such as coal, bauxite and iron ore, set up with foreign participation, the technological upgradation has been slow and poor.

Coal Sector

Of the 450 mines of Coal India Limited currently in operation, 281 are underground mines, contributing only 30 per cent of the total production of 225 million tons (1993-94), the rest being the share of opencast mines. This low production rate of underground mines is a direct consequence of dated technology. Blasting and drilling continues to be the conventional type. While in the developed world significant proportion of production comes from large dia. holes (over 100 m to 300 m), Indian mines still operate below 100 m holes. Generally, drills used are also of

conventional type, though some mines have introduced hydraulic drills jumbo. In the recent years, blasting techniques have improved with the use of ammonium nitrate based explosives. The bulk of the production comes from bord and pillar mining, though mechanisation of this is of a recent origin. The mining and allied equipment used are also of smaller size. For example, load-haul dumpers (LHD) are of the size of below $5m^3$ and are mostly operated by energy-intensive diesel. Most of the mines continue with the technology introduced in mid-'70s and early '80s. In the last decade or more, little or no new technology has been imparted into the coal mining operations.

In contrast, the opencast mining technology is somewhat better, having been introduced later. Even here, the mining operations are carried out with shovels (power and hydraulic) of smaller capacity. Dumpers of over 100 ton capacity are few. Recently, however, the Piparwar mine (Bihar) has modern technology inducted with Australian assistance.

The need for increasing production to meet domestic demands at economical prices has necessitated a closer examination of the technological needs of India's mining sector.

Continuous Excavation

Continuous excavation method is being successfully deployed at Neyveli lignite mines. Efforts are also being made to select coal mines amenable to the introduction of "Bucket Wheel Excavator" (BWE) system. At Niljai mine under Indo-German collaboration, continuous mining is to excavate top on soil and 30 m sandstone layer with BWE.

Combined Mining Systems

Conventional mining equipment is being teamed with continuous transportation systems (usually a belt conveyor) to provide combined mining systems. For softer rocks, feeder breakers are used. In the coal mines, feeder breakers (manufactured by Ingersoil Rand, Bharat Westfalia, Larsen & Toubro (L&T), Eimco Elecon, etc.) are used to crush the large coal lumps followed by transportation by trucks or by conveyors.

The most modern coal mining and beneficiation complex of India at Piparwar owned by Central Coalfields Ltd. (CCL), an Indo-Australian joint venture, has been designed under collaboration with White Industries Ltd. having in-pit crushing and conveying system i.e. 'combined mining systems'. In addition to yielding higher productivity, this system will enable the mine to achieve an Output per Man Shift (OMS) of 31 t. The salient features of this 6.5 Mt ROM coal mine are presented in Table 1.

Table 1
Salient Features of Piparwar

1.	Annual ROM coal	6.5 Mt
2.	Annual clean coal capacity	5.52 Mt
3.	Mineable reserves	197.49 Mt
4.	Stripping in ratio (av.)	0.65 m/t
5.	No. of personnel	775
6.	OMS (on 268 days basis)	31 t.
7.	Sanctioned capital outlay	Rs. 542.43 Crores
8.	Scheduled date of completion	June
9.	Grade of coal (ROM)	G
10.	Clean coal F	34% ash & 8% moisture
11.	Total land requirement	1120 hectares
12.	HEMM	Electric rope shovel 20 m : 1
		Electric rope shovels : 2
		Rear dumper 85 T : 24
		Hyd. Excavator 12 m : 1
		Blasthole drills 250 mm : 5 nos.
		Track dozer 400 HP : 5
		Mobile crusher 2800 tph : 1
		Belt conveyor 2800 : 1
		Coal conveyor 2800 tph : 1

Ramagundam OC-II (Andhra Pradesh), with 172 Million DM German credit/loan planned to produce 2 MTY in 8th Plan, will also have in-pit crushing and conveying system.

Machinery

Besides increasing the size of the equipment, hydraulic shovels have been introduced in place of rope shovels to improve the operational efficiency. The selective mining capability of the hydraulic shovels have been successfully used for mining of the banded coal seams.

Tandem operation of draglines have been successfully implemented to make faster and efficient removal of overburden and helping in quick exposure of the coal seam.

Increase in the size of the opencast mines have in turn resulted into organizing large size blasts to efficiently handle the overburden. Successful introduction of Bulk Explosives, Plant Mixed Slurries, Site Mixed Slurries and Emulsions have been made to help in organising large rounds of blasting involving use of up to 200 ton of explosive in each round. This technique and development of structures in proximity to the mine working have created the problem of safety and security of these structures and the associated population. To resolve this problem, technique of controlled blasting has been developed.

The cost per ton of coal mined by opencast method has been ranging from US$ 5 to 7. The cost per cum. of excavation has been in the range of US$ 2.5 to 3.5.

Coal Mining Issues

Mechanisation of mining operations - bord & pillar and long wall, equipment designing, washery technologies, stowing methods are some of the major issues as enumerated below:

Diverse technologies

India perhaps, is a unique example where different levels of technologies obtained from different countries under aid programs are in operation simultaneously. This in itself poses problems in obtaining spares, particularly for equipment supplied by former USSR, and matching these with equipments / machinery obtained from diverse sources.

The lignite mining complex at Neyveli with its state- of-the art technology for the extraction of lignite by adopting 'continuous mining technology' has placed India as one of the leaders in lignite mining.

The major thrust areas before the coal producing companies are

(a) detailed scientific exploration, evaluation, etc. to assist in the proper design of the mine and selection of equipment.
(b) proper production planning giving due importance to HEMM maintenance, spares part planning, machinery rehabilitation, indigenous development of spare parts.
(c) energy conservation in most mining and material handling systems
(d) providing matching capacity of material handling system for coal handling and transportation.
(e) evolving a system to procure spares for most erstwhile USSR made equipment for the smooth operation of these units.
(f) introduction of new technologies such as truck despatching system, excavator performance monitoring system, in-pit crushing and conveying for coal and OB, etc.

In this context, the introduction of 'air-deck' pre-splitting techniques at Jharia Block II mines of Bharat Coking Coal Ltd. (BCCL), by Indian School of Mines (ISM) & IBP jointly is quite commendable. Currently, at Kudremukh, Optiblast of Australia is engaged in applying air-deck techniques to reduce the consumption of explosives thereby decreasing the cost of blasting. In this connection it may be noted that Indian research institutions are now well equipped to handle any aspect of blasting ⊕ from blast design to optimisation, blast monitoring and modelling through computer application.

Coal Washeries

Technologies adopted in the existing coking coal washeries can be broadly classified into the following three groups:

Group 1 - Crushing ROM coal to suitable size (80/20mm) and washing the same up to 0.5mm without beneficiation of fine coal. Apart from dewatering of fine coal to reduce process moisture to the extent possible, upgradation of fines was also done in certain washeries.

Group 2 - Same as above but before treatment of coal in washeries, pre-washing of coarse size coal to remove free dirt was adopted in certain washeries.

Group 3 - Here the floats from pre-washers were crushed for liberation of further clean coal and fine coal beneficiated in flotation cells.

However, over a period of time with the exhaustion of comparatively better quality coal the washeries are now being fed with inferior and more-difficult-to wash coals. This has resulted in:

- Increased ash content of r.o.m. feed mix to the washeries
- Increased proportion of this fines below 0.5 mm in the feed production
- Operational/load imbalance problems in circuit and washing units
- Constraints in production and availability of Coal Preparation Plants

India has 19 washeries, 15 with Coal India Ltd (CIL) and two each with Steel Authority of India Ltd (SAIL) & Tata Iron & Steel Co. (TISCO). The main cause of lower utilisation of washeries can be attributed to power interruption and raw coal shortage. Lack of preventive maintenance culture at washeries has also contributed to sub-optimal operation of the washeries.

By the introduction of modern washery circuits and advanced automation, the possibilities of washing these coals to 16 - 17% ash is possible. Though this remains the biggest challenge for any investor, it will be in the larger interest of the country. **At the same time, beneficiation technologies of the developed world cannot be applied straightaway because of peculiar characteristics of Indian coal and therefore Indian knowhow and expertise is essential in this field.**

Foreign investor and/or Indian private sector may be allowed to associate in the field of coal mining and beneficiation for the production of low ash coking coal.

Proposed flow sheet for future washeries

Low volatile coking coal reserve in India constitutes about 35 - 40% of the total coal reserves. These coals have high rank, high ash and difficult washability characteristics. The future washeries should incorporate the folio wing circuits:

(a) Raw coal be crushed to 75 mm top size and deshaled at 1.80 specific gravity to eliminate dirt.

(b) Deshaled product (-75mm) crushed to 6 mm to 3 mm and screened at 0.5 mm to take out the fines for subsequent treatment in oil agglomeration unit.

(c) The oversize (+0.5 mm) fraction be taken to heavy media cyclone washery. The cyclone under flow (middling fraction) combined with (-0.5 mm) fines be further crushed in ball mills to pass through 0.076 mm. This product should be subjected to further treatment in the oil agglomeration unit.

(d) The cleans from the cyclone combined with oil agglomerates form the total dean product. The process recovery is expected to be 55 to 58% at 17% of ash with raw coal having 28 - 32% ash.

Modification & Modernisation

In order to deal efficiently with the changed feed characteristics the existing washeries are required to be suitably modified and modernised for crushing, handling, blending, screening, etc. in raw coal, thereafter for pre-washing and washing, particularly for washing of fine coals and improving the capacity of fine coal circuits, dewatering, etc.

Emerging Technologies

The processes now under development relate to fine coal upgradation and pneumatic and centrifugal separation. They are on laboratory development stages and require further study with scaling up. Deep Cone Thickeners and Dedusters are recent additions in process equipment. High Speed Sold and Screen Bowl Centrifuges, Belt press Filters, etc. are under consideration for trials in the washeries.

Finer crushing of raw coal (to size 13/6/3 mm) will have to be resorted to, to liberate good quality coal from the overall matrix for optimisation of recovery of dean coal. Middlings may also have to be crushed to liberate coal and separate by washing. This will substantially increase the quantum of fines fraction. Thus, fine coal beneficiation will play a pivotal role in improving the quality of washed coking coal.

A modest beginning has been made in automation by process computerisation in two washeries.

Exploiting Unconditional Reserves and Coal Standing on Pillars

Over 5 billion tonnes of coal resources in India are classified as conditional resources which cannot be mined under present technological options.

Similarly, large coal reserves estimated at 2486 million tonne are standing on pillars. Of these, 1023 million tonne are amenable to quarrying, 578 million tonne are blocked by constraints like surface structure, water logged workings etc. and 885 **million tonne are available for extraction for which an efficient technology is immediately needed.**

Planning for Large Mining Operations

In India, there is at present a general trend towards large scale opencast operations, both in the coal as well as in the metalliferous sectors. By the year 2000 A.D., the open pit mining is expected to contribute as much as 60 per cent of the total projected coal output of 400 Mt. The present day

size of 10 Mt of coal (total operations being 40 Mt) with stripping ratio of 4 cu. m. per ton of coal and up to a projected depth of 300 m or so, is likely to be exceeded substantially with passage of time. Problems related to project formulation, planning, financing, implementation and management of such gigantic projects will have to be sorted out.

Search For Appropriate Technology

India is also looking for latest technologies for:

(a) A highly productive and efficient technology for underground mining of coal seams of thickness 2.0-3.5m.
(b) Underground mining of thick virgin seams (5.0-10.0 m) and multi-seams.
(c) Underground mining of thick developed seams (5.0-10.0 m)
(d) Underground mining of seams overlain by massive hard sand-stone strata susceptible to bumps.
(e) Productive and efficient system for modernising the prevalent bord and pillar system of underground mining for the extraction of 2.0 to 5.0 m thick seams.
(f) Efficient methods of opencast mining for increasing production and also search for systems reducing consumption of diesel.
(g) Adoption of technologies alternative to mining.

Mechanised Longwall Faces

Development of this technology is considered to be a necessity for mining of deeper deposits with adverse strata conditions. This technology is also expected to achieve improved safety, conservation, production and economy. Though this has proved its success world over and is being applied quite extensively, its application in a number of mines in India has not achieved results and met with several problems. It has taken a relatively long time to resolve these problems and now the technology has reached to an acceptable level when it can be adopted on a wider scale. This method, in view of high capital cost and increased cost of production. Also it can be applied to a very limited thickness range of the coal seam and in areas where the same is free from geological disturbances.

The chock/chock shield supports up to 360 ton capacity have been found to be inadequate to deal with the indian strata condition. Investigations carried out in the Chinakuri Mine (Bihar) has indicated that the capacity of the support required for the longwall mining in this colliery is not available in the manufacturing range the world over. Similarly, the indian coal seams are quite hard and tough and require high power shearer machine to cut the coal. The shearer power of less than 200 KW is considered to be inadequate. The optimal power for the shearer in indian condition should be between 300 - 450 KW depending upon the seam hardness and thickness. The country is currently producing only 1.5 million tonne of coal per year by the adoption of this method. However, in the coming years the production by this method is expected to increase.

Underground Coal Gasification

Large reserves in India have been estimated which would be ideally suitable for underground gasification.

Ripping

Ore bodies having rippable characteristics are being identified in some non-coal mines. India will be looking to introduce this technology in such identified mines.

Spare Part Management

While adopting a technology with imported equipment, a major problem is faced with regard to the spare part management. It is, therefore, necessary that adequate provisioning of spares for the entire life of the equipment should be considered at the initial stage.

Infrastructural Set-up

Adequacy of the infrastructural set up in terms of outbye transport, ventilation, coal handling and repair and maintenance capabilities is necessary for the success of any mining technology. In fact, the instances of failure are attributable to a very large extent to the inadequacy.

Technology Issues - Non-Coal Sector

Most mines only adopt conventional mining methods and the shift for large capacity units at Kudremukh (Met-Chem, Canada) has made the system capable of meeting the very high excavation level. This experience has been utilised in other large mines. In the recent years, NALCO's 2.4 MTY bauxite mine was established by incorporating a number of state-of-the art features. Some of the new features are:

(a) Vacuum suction exploratory drill for high speed drilling, sampling and analyses to assist in geo-statistical mine planning.
(b) Articulated dumpers.
(c) All excavation by hydraulic excavators & wheeled loaders.
(d) Ripping of ore/waste amenable to ripping using D-10 dozer of 700 HP class.
(e) Mechanised mixing and charging of ANFO.
(f) Computer assisted mine planning, production planning, etc.
(g) Hydraulic impactors for ground stability and haul road maintenance.
(h) Cable belt conveyors to transfer crushed bauxite to alumina plant located at 14.6 km distance, over rugged terrain having a fall of 336.5 m. The system is designed to transport bauxite at 900 t/hr at a belt speed of 2.35 m/sec and will carry 1800 t/hr by doubling the speed.
(i) Introduction of reclamation by backfilling and plantation right from the beginning of the project, etc.

The underground mines of copper, gold and lead-zinc continue to use technologies introduced in the '70s. Blasting techniques, as in coal mines, continues with ammonium nitrate explosives, while the bulk of the production comes from small dia. holes (below 60 m) drilled with pneumatic skid mounted drills.

A significant quantity of production is raised through $2m^3$ LHD and small size pneumatic loaders. This could, perhaps, be attributed to the more easy availability of spares for the equipments. The transport equipments - dumpers - are also of smaller size (13 tons operated by diesel oil).

The ground control system techniques, though relatively better, also need modernisation. The use of rock bolt / cable bolt supports are quite wide; at the same time, the risk of accidents are more as mine dressing is done practically manually with miners just standing under the rock.

The opencast mines, on the other hand, use relatively modern technology, though this has not kept pace with the advancements. The shovels / excavators and dumpers, the main equipments, are of smaller size. The exception is the bauxite mines of NALCO which, as noted, introduced modern technology.

Operations with Problems

Gold: Kolar is currently undergoing operational problems because of exhausting reserves, poor grades and workings at ultra depth. The production cost is almost twice the prevailing market price. **The operations at Kolar are in need of funding and technological support**, lest it might get closed. Intensive probing of the deposit in the area is also required.

An enormous size of placer gold deposit has been located in Kerala bearing only 0.1 8 gm per ton. **As the deposit is of lean grade, the experience of its working abroad will be of immense use to India particularly because placer gold deposit has not been worked in the country so far.**

Copper: Operational problems at Mosaboni (Bihar) are also primarily on account of depth. The copper deposit here is known to exist at deeper levels and therefore it is now imperative to invest in further exploration. Underground operations at Ambaji (Bihar) could not be started though an open pit mine operates by the side. The presence of weak walls and highly variable shape, size and grade of the deposit are the factors which are likely to make the underground mining a difficult proposition. The multimetal ore will also pose recovery problems. **Therefore, in case of such a project, support not only in equity participation, mine design but R & D is also required.**

Mining of Small Deposits

A large number of nonferrous lean grade pockety deposits exist all over the country. Such small deposits are not self supporting in general and need support in areas such as mobile crushing, custom milling and metallurgy. Since the country is deficient in nonferrous metals, fast development of such deposits is contemplated. Another factor causing interest to the GOI in this area is the immense employment potential of such mining.

Support for Seabed Mining

India has been granted the status of a pioneer investor and has been given the rights to undertake mining in an area measuring 52,000 sq. kms. in the indian Ocean. Work has been taken up in the various areas of seabed mining by the National institute of Oceanography, Goa, Central Mechanical Engineering Research institute, Durgapur, Regional Research Laboratory, Bhubaneswar, indian institute of Technology, Madras and Hindustan Zinc Ltd. As far as seabed mining is concerned, india needs support in technology, equipment, training and in R & D.

The Future

The year 2000 A.D. and beyond will witness numerous changes in the equipment size and automation. While the common equipment size in the 1970s were 4.6 m^3 shovels in conjunction with 25/35 ton dumpers, the equipment size has now increased up to 20 m^3 shovels and 170 ton dumpers. The dragline size which was 10/70 A 15/90 in the 1970s, increased to 24/32 Cum. in the bucket size and 75/96 m boom length. The maximum size of the mine which was upto 1.0 MTY has increased to 10.0 MTY. Mines with the annual capacity of 14.0 MTY are under construction. The average OB and coal ratio which was 0.6 m^3 per ton of coal in the early 70s has now been increased to approximately 2.4 m^3 per ton of coal. Mines with the stripping ratios of 4.25 m^3 per ton of coal are under production and those upto a stripping ratio of 5.5 m^3 are under implementation. The automation area will involve:

- Computers in day to day operation as well as planning & design
- On-board computers and systems for better monitoring of the systems involved in drilling, blasting, excavation, transportation, off-pit conveying, crushing, etc.
- Communication system, etc.
- It has been predicted that there will be an increase in size of all classes of equipment by about 25 - 30% of current level. Another assessment has given emphasis to the under-mentioned trends:

    * Draglines to have 170 m^3 bucket and 122 m boom length, rope shovels with 43 m^3 (dipper) and matching trucks of 155 t, blasthole drills 300 - 350 mm dia, dozers of 784 KW engine weighing 132 t and draw bar pull of 200 t.
    * Continuous mining systems with giant BWE to find extensive use in lignite mining, Surface continuous mining, etc.
    * Use of high angle conveyors.
    * Application of heavy ANFO, in-hole delays, electronic delays, 'tailored' blasting, throw blasting, etc.

Technology for the design and development of mining methods, mine planning, environmental management, blasting, optimum ventilation system, pit slope stability for open cast mines and support design for tunnels and underground excavations in hard rock mining are well developed in India.

Besides the search for technology from abroad, efforts continue to innovate the existing mining practices and modify the technologies available in the non-coal mining sectors.

Before making a large scale application of the new technology, field trials are conducted in specified conditions. During these trials, studies are undertaken to evaluate the strength and weakness of the foreign technology, the modifications and improvements needed for its successful adoption in India and the production and productivity levels expected to be achieved by the application of particular technology.

Mechanisation

Present search for technology in mineral and allied industries has aimed itself to large scale mining, particularly with reference to (a) coal, (b) non-ferrous metals : Lead, Zinc, Copper, Gold, Uranium, (c) iron and (d) limestone.

Most non-coal mines have switched over to hydraulic excavator units for handling ore and waste. This has necessitated optimum fragmentation vis-a-vis bucket size, good floor conditions, and more vigilant machine operation. India is looking for this variety of equipment.

Low productivity of sub-systems

As noted earlier, drilling and blasting, loading & transport, ground control and ventilation systems (manually operated) have resulted in low productivity of 1.3 to 2.5 tons of output per manshift, against world average of over 10 tons.

Sub-grade & low grade ores

Exploration and improving the recovery rate of metals such as copper from lean ores is a major issue confronting the indian mining industry. Though experiments of pyrometallurgical and hydrometallurgical methods are continuing, success is still eluding India.

Beneficiation technology

Technological gaps are also wide in this area with concentrators and design parameters being dated and are devoid of modern additions such as in-stream process control, automation and computerisation, resulting in lower recoveries, excess manpower and resultant higher cost.

Exploration Techniques

Since easy-to-find deposits have been discovered and mined, India's task now is to detect concealed or hidden deposits and thus, more sophisticated technology has to be applied. This will result in an increase in capital investment in mineral exploration which is an extremely high risk activity.

The greatest advance in exploration today is the use of ore deposit modelling.

Diamond exploration needs a strategy to locate new pipes. The main issue would be to identify diamondiferous kimberlites pipe from the non-diamondiferous bodies. Three methods are normally applied viz. indicator mineral sampling, micro-diamond search and airborne geophysics followed by ground magnetic/gravity surveys. In addition the new powerful tool namely trace elements, studies in garnet and chromites, will greatly aid in evaluating the diamond potential of any igneous rock.

India is aware of the **systematic coverage of Canada by aeromagnetics has produced** maps at 1:50,000 scale that are capable of pin-pointing features of 1-2 km dimensions, such as individual faults, iron formation bands, and small intrusive bodies, thus aiding specifically in locating structures and environments favourable for gold. Even the data from high level aero-magnetic surveys over ail types of geological environment may be reprocessed to produce aeromagnetic maps on enlarged scales.

Similarly, development and mining of small base metal deposits has been advocated as there is a wide gap between demand and domestic supply. Some of the small copper deposits already identified could be utilised and their development and small-scale mining operation are the only answers in augmenting the country's metal production leading to seif-reliance and self-sufficiency. Development of about 12 small deposits will contribute to an equivalent production of a large deposit.

With the inventory of copper deposits already available as well as data from the recent investigation, it is possible to draw an integrated scheme to develop a cluster of mines (on deposits located closer to each other). It is anticipated, that a moderately sized mine, producing 500 tons of ore per day and producing upto 5000 tons of copper concentrates per year, shall certainly contribute to a sizable quantity of additional copper production.

Drilling

Indian manufacturers have the capabilities to manufacture blast hole drills upto 250 mm dia, while small mines prefer 100 mm & 150 mm dia. drills. In high benches at some coal and iron ore mines, 312 mm dia. drills have been deployed.

in-pit hauling units, notably dumpers, have undergone simultaneous development to cope up with the size of the excavating equipment. While 240 t dumpers are used in other parts of the world, in India 170 t dumpers are the latest ones. India is yet to adopt diesel-electric dumpers.

Demand/Supply

Various R & D institutions, such as Coal Mines Research Station (CMRS), have been trying to upgrade the technology but the availability is poor, perhaps due to suppressed demand owing to financial constraints. As noted earlier, indian capacities are limited to meeting requirements of smaller sized mines only, with imports catering to the other requirements.

4. MINERAL SERVICES

R&D Services

Some of the important aspects of these R&D programmes in the non-coal sector are summarised below for ready reference (significant contributions have been made in optimum exploitation of coal from existing and new mines).

1. Optimisation of stoping parameters and stop design
2. Numerical modeling of rock excavations
3. Ground monitoring and control
4. Support of underground excavation and tunnels
5. Back filling
6. Blasting
7. Method of working
8. Ventilation
9. Conservation of minerals

CMRS since its inception in 1956 is involved in research in the field of:

- coal mine galleries
- stope backs and drivages,
- hydroelectric tunnels, and
- other underground excavations like power houses, cavern for different rock conditions including highly disturbed rocks in Himalayas and rock pressures including squeezing conditions.
- Presently a new area of R&D for large scale underground storage has also been taken up, under the broad area of "Underground Space Technology".

Mechanisation Problems

The problems associated with mechanisation schemes in coal and non-metaliferrous mines can be classified, as follows:

(1) Technical Problems

(a) Geo-Know-How

Problems due to lack of prior knowledge of geomining conditions and geology of the area where mechanisation scheme had to be planned.

(b) Tech-Know-How

1. In appropriate selection of machines
2. Lack of standardisation techniques
3. Lack of infra-structural planning
4. Lack of rationalisation by product work load
5. Improper maintenance policy

(2) Organisational Problems

1. In appropriate manpower planning
2. Absenteeism of workforce
3. Improper incentives for work force
4. Inadequate training facilities for personnel

Today not much seems to have been done for medium and small scale mining sectors particularly for mining minerals other than the above mentioned. The future scenario of R&D should, therefore, focus on (a) development of scientific mining for non-coal medium and small scale mining sectors, (b) environmentally viable mining technology for overall sustainable development, (c) improvement in production and productivity, (d) man-machine optimisation, (e) mineral investment policy and planning, and (f) optimum utilisation of non-conventional mineral resources used for purposes other than usual.

Support of Underground Excavations and Tunnels

Stowing and Back Filling in Mines

Till now, more than 90 projects on design/modifications of hydraulic stowing plants in the coal sector have been completed; besides, a large number of samples of materials have been investigated to find their feasibility of stowing as alternative to sand. As a result, well developed expertise has been established and recently (October 1992) a national workshop was organised to focus attention on the need of back filling/stowing in India. Some significant contributions in this area are summarised below:

- Evaluation of the performance characteristics of indian river sands under different hydraulic gradient conditions.
- Suitability of materials for example, coal ash, washery rejects, crushed overburden rocks, mill tailings and slags from steel and aluminium plants, alternative to sand for hydraulic stowing.
- Improving the operating efficiency of the existing stowing plants.
- Development/modifications in the stowing equipment for enhancing the stowing rates of low-head stowing plants.
- Development of numerical models for operation of hydraulic stowing plants.
- Studies into the wear pattern of stowing pipes.

The mineral processing industry today is facing problems in mineral processing technology as the ores and minerals mined today are of much low grade than that was treated a decade earlier. The iow grade ores and minerals are finally interlocked with the gangue minerals and the liberation size of the values is of very finer sizes, thus making the process of physical separation a highly complicated issue.

Process Development

In recent years sophisticated benefication flow sheets for upgrading lean and complex ores have been developed as a result of which efficient and versatile equipment and reagents have gone into the mineral processing stream. However, even in the most efficient mineral processing plant, considerable amount of metallic and other useful minerals are lost in middlings/tailings, which also should be recovered. Some of the important case studies undertaken at R&D institutes are mentioned below:

(i) Considerable amount of coal fines are wasted in the coking coal washery rejects. Recently Regional Research Laboratory (RRL) Bhubaneswar developed an efficient process to recover these fuel values from these rejects using column flotation technique. Washery slimes of Sudamdih (-0.5mm) having ash content of around 35% has been brought down to 18% with 75% recovery of heat value.
Already as a pilot test facility, 1 meter dia column at Sudamdih washery plant has been installed as per the design of RRL scientists. This can handle 2.5 to 3.0 tonnes per hour of coal and has instrumentation and control required for research studies.
As the column has distinct advantages like (a) better product with higher recovery (b) reduction in number of operations (c) no moving parts (d) less capital cost and less floor space required, etc. this will be very appropriate to be adopted in ail the coal washeries, particularly in view of ecology and conservation of coking coal.

(ii) The technique of column flotation has been suitably demonstrated at Rakha (Bihar) copper mines by the RRL, Bhubaneswar to recover the molybdenum from the copper concentrates in just two stages compared to the conventional cell which takes 9 stages of cleaning. The commercial plant is under installation, relatively at a much less capital cost (Rs. 5 million) as against the conventional plant which needs Rs. 12 million.

(iii) By jigging Talcher (Orissa) coals for thermal power station, a feed (80% passing through 8.5 mm) having 40% ash is improved to 25% in a single stage where useful heat value recovery is around 85%.

(iv) In some other cases it has been possible to reduce the ash content from 40 to 20% by column flotation technique at 80% recovery of the combustibles.

(v) Fertiliser minerals : India has no source of elemental sulphur. However, it is endowed with vast reserves of pyrites. Saladipara deposit of Rajasthan has 25 million tonnes of sulphur locked in pyrites, amounting to 120 million tonnes of ore reserve with about 20% sulphur. This pyrite deposit can sustain a production of 5000 t.p.d. plant for 20 years. Based on this, PPCL has proposed to set up mine, bonification plant, acid plant, phosphatic plant.

From the extensive test works on this pyrite done at NML/Lurgi, Gmbtt, it has been possible to beneficiate the ROM pyrites with 22% sulphur to a concentrate of 40% sulphur with 90% recovery, which is considered to be technically feasible for manufacture of sulphuric acid.

(vi) Wet operations, generally, employed in India for processing of iron ores result in the rejection of 15 to 25% of ore processed in the form of slimes (finer than 0.155 mm).

(vii) Extensive investigations carried out at RRL, Bhubaneswar, National Metallurgical Laboratory (NML), NMDC, etc. on the recovery of iron values lost in the tailing of washing plants of India reveal that nearly 50% of iron values lost can be recovered involving gravity and/or magnetic separation which are commercially established. Such superfines recovered can suitably be used as part feed in sinter fines. The processes recommended for commercial operations are (a) cycloning and filtration with or without the use of dispersants and (b) wet high intensity magnetic separation/high gradient magnetic separation.

(viii) in a typical experiment, it has been possible to obtain a concentrate containing 65% iron, 1.8% alumina and 1.4% silica with an iron recovery of 80% from the tailings of Barsuan iron ore plant containing 52.5% iron, 7.4% alumina and 7.8% silica through selective flocculation employing search. Use of iron values recovered from slimes in fines form as a portion of sinter feed has been found feasible up to 40% in charge with good strength of the product.

(ix) As compared to the world scenario, the low grade iron ores like banded hematite quartzite (BHQ) or banded hematite shell (BHS) having iron content below 50% have not so far been beneficiated. Only the high grade or marginal grade ores are generally treated by the following process technologies:

i) Dry screening process

ii) Washing process including wet screening and classification. Very often scrubbing step is preceded.

iii) Washing and gravity separation (Jigging)

iv) Magnetic separation and gravity separation (Spirals)

v) The ore processing schemes of some major ore mines are given below:

Table 1
Capacity and production of Iron Ore Sintering and Pelletisation plants

	Sintering/Pelletisation plant with location	Installed capacity 1989-90	Production of sint pellets (in tonnes) 1989-90
	Sintering		
1.	TISCO, Jamshedpur, 2,537,00	1,739,633	
2.	BSP, Bhilai	4,290,000	3,600,000
3.	RSP, Rourkela	1,200,000	1,129,211
4.	DSP, Durgapur	1,500,000	728,540
5.	BSL, Bokaro	6,914,000	3,709,106
6.	Kalinga Iron Works, Barbil	17,520	4,547
7.	VISL, Bhadravati	50,000	-
8.	VSP, Visakhapatnam	2,628,000	37,800
	Total	19,136,000	10,954,837
	Pelletisation		
1.	KIOCL, Mangalore	3,000,000	1,919,000
2.	Chowgule and Co. Pvt. Ltd., Pale (Goa)	550,000	closed
3.	TISCO, Noamundi, Bihar	800,000	closed
4.	Mandovi Pellets Ltd., Mandovi, Goa	1,800,000	closed
	Total	6,150,000	1,919,000

Hydraulic transport of coal/ore fines through pipe as slurry is being adopted more and more in developed countries. India is in no way behind them. Through a collaborative programme between RRL, Bhubaneswar and Engineers India limited, a unique pilot plant facing three test loops (12", 9" & 6" dias) of 1 km length have been installed in the laboratory.

Pipeline transport of iron ore concentrates from Kudremukh to Mangalore port over a stretch of 67 km is of landmark for Indian mineral industry.

Other methods adopted include:

i) Cyclone furnace with 100 kg of coal feed per hour,
ii) Accoustic Burners, having a capacity of 200 - 500 LPH operating successfully at Rourkela Steel Plant, Hindustan Copper Ltd., Ghatsila (Bihar) and TISCO, Jamshedpur
iii) Flotation column designed at RRL, Bhubaneswar suitable to float graphite, molybdenite, coal fines functioning effectively on a continuous basis and is movable conveniently from place to place in a mineral district.
iv) Another novel way of winning metal values from very lean and complex ores is in-situ bacterial/acid leaching.

RRL Bhubaneswar has done considerable work on the bacterial leaching of pb, zn, and cu complex sulphide ore, difficult of float oxidised Cu-ore of Malanjkhand and also removal of silica from the limestone and bauxites. At present field trial leaching of Cu-ore at Malanjkhand in collaboration with HCL is going on.

Training and Education

Training and education is a key element essential for a result oriented technology transfer. In respect of a new technology, training would be necessary under three categories:

(a) Training for Planning : The engineers associated with the planning of new technology should be thoroughly trained in ail the related aspect of technology. In fact, their training should be quite an indepth appreciation of the merits and demerits of the technology and should be in a position to undertake critical evaluation of its suitability in a given geo-mining condition. This training should be started immediately after selection of technology.

(b) Operational Training : Key personnel, including junior level executives, supervisory staff and operators should be provided with on the job training backed by theory classes. The training programme should be of sufficiently long duration to acquaint these personnel with the various operational details.

(c) Training for Technology Management : Training to technology managers, who would be responsible for its implementation should be provided in the management institution, planning organisations and at the actual site where the method is in practice. Their training should largely comprise of discussions with the planners, operators and managers dealing with the selected technology.

Other R&D Institutions in Mining Research

There are several other institutions also busy in R&D activities in a limited scale for mining and other rock excavations (besides the CMRS, Dhanbad) namely, Research Laboratory National Geophysical Research Institute (NGRI) and the newly formed National institute of Rock Mechanics (NIRM), Kolar; Teaching institutions : Indian School of Mines, Dhanbad, Mining Department of BHU, Varanasi and IIT, Kharagpur (West Bengal).

To be able to utilise even iow grade ores cost-effectively is thus a challenge. CSIR laboratories, particularly National Metallurgical Laboratory (NML), Jamshedpur and Regional Research Laboratory (RRL), Bhubaneswar have been pioneers in conducting studies and developing methods and techniques for agglomeration and bonification of iow grade ores to make them suitable as industrial raw materials.

NML has now taken up a project to produce tungsten from indian tungsten ores which are lean and the deposits are embedded in the hard graphite rock. Even though the extraction of tungsten from such ores may not be economic, the process to extract tungsten has to be developed for purely strategic reason and that too at lowest possible cost.

Nickel and cobalt are totally imported at present. RRL, Bhubaneswar has been entrusted by the Government of India to coordinate with other agencies a project for beneficiating chromite over-burden to recover nickel and cobalt so that an industrial plant to manufacture these could be established in the country.

Agglomeration of ore fines and concentrates has become an integral part of the iron and steel producing industry. Due to mechanised mining, huge quantity of ore fines are generated. Besides the utilisation of fines, the concentrates, produced from iow grade ores, need agglomeration. In India, out of the total production of 55 million tonnes per annum of iron ore, 43% is in the form of lumps, 46% fines and the rest 11% as concentrate.

Other Services

With increasing role of minerals in the economic activity, India, over the years, has strengthened its services sector by enlarging the scope, nature of activities and functions of premier organisations such as Geological Survey of India (GSI), indian Bureau of Mines (IBM) and research laboratories of Council for Scientific and industrial Research (CSIR). In addition, new service organisations such as Mineral Exploration Corporation ltd. (MECL) and Metallurgical and Engineering Consultants (MECON) have been set up to provide exploration and engineering consultancy services respectively to a wide range of industries, including mining.

Indian Capabilities

Consequently, India has now a fairly well developed capabilities and capacities to provide a range of services. While the profiles on "Service Organisations" details the type of services rendered by leading organisations, some of the major available services are listed below:

(i) Geological exploration ⊕ Mine plans, mineral properties, logging and sampling of bore holes, geophysical, geochemical, remote sensing, actual surveys, mineral targetting, evaluation of exploratory data, contract drilling etc.
(ii) Bonification technologies (investigations) of lean ores (copper, gold, nickel, chromite, manganese ore etc.)
(iii) Mining services ⊕ preparation of feasibility reports, mine development proposals, preparation of detailed project reports (DPRs); mining technology upgradation; mine construction etc.
(iv) Environmental Management ⊕ Environment management plan, including water air pollution control systems, afforestation, reclamation, recovery of mineral wealth and utilisation of mine waste etc.
(v) Research and Development ⊕ in mining technologies, bonification, equipment and machinery adaptation, mineral processing.
(vi) Project management, and
(vii) Consultancy service in the above areas.

The major service organisations include:

(i) Geological Survey of India
(ii) Indian Bureau of Mines
(iii) Mineral Exploration Corporation Ltd
(iv) Bharat Gold Mines Ltd
(v) Hindustan Zinc Ltd
(vi) Engineers India Ltd, New Delhi
(vii) Metallurgical and Engineering Consultants of India
(viii) Central Mines Research Station
(ix) Council for Scientific and industrial Research through its regional research laboratories at Bhubaneswar and Hyderabad.
(x) National Geophysical Research Institute, Hyderabad
(xi) National Metallurgical Laboratory, Jamshedpur and Madras
(xii) Indian School of Mines

Environmental Services

Environmental concerns in India are relatively of a recent origin, coinciding with enactment of Water (Prevention and Control of Pollution) Act in 1974. Since then, India has strengthened both its agencies preventing environmental damages and the organisation providing such services. The major environmental issue relate to maintaining ecological balance, rehabilitating of uprooted population and land, checking and controlling affluent discharge, maintaining proper air and water qualities and utilising mine waste (iron ore, chromite etc.)

India has so far not compromised on environmental issues. It had even shelved a fully mechanized 60,000 T per annum Gandhmardon (Orissa) Bauxite project. The Supreme court stayed the limestone mining on Mussorie hills on environmental considerations. The Himachal Pradesh High court banned blasting in Sirmaur area in December 1987.

All mining projects are necessarily to have a environmental management plan weaved into them, without which the projects will be rejected.

In 1993, the Ministry of Forests and Environment mandated submission of Environment Statement annually containing following information: (i) Site plan & process flow diagram; (ii) Material balance, process inputs and outputs; (iii) Wastes considered to be hazardous or for which regulations exist; (iv) Wastes for which disposal costs are high; (v) Listing of unit operations; (vi) Recording of water usage; (vii) Current levels of waste re-use/recycling; (ix) Accounting for waste water (effluent discharge point, waste water generated from each unit operation); (x) Characteristics of waste water (parameters will be taken from Consent Form); and (xi) Accounting for gaseous emissions (Actual and potential gaseous emissions associated with each unit.

The MECON, EIL and IBM are the major organisations providing the environmental management services while Regional Research Laboratories (RRL) of CSIR undertake research on issues for ultimate adoption. RRL, Bhubaneswar (Orissa) recently conducted research on utilisation of iron ore fines and chromite slimes with a view to check pollution. According to an estimate, some 30 million tonnes of hematite ore is processed (washed) annually, resulting in over 6 million MT of slimes, in the country. Besides polluting the atmosphere, these slimes also cause loss of mineral wealth if not processed further.

Moreover, with the fast depleting of high or better grade ores (Chromite, manganese, copper, lead-zinc) utilisation of subgrade ore has become a necessity to bridge demand/supply gap for these.

Canadian Experience

Canada, with a well developed mining industry and mining technologies, can help India in developing its mining sector, whose record in the past one decade has been below the GOI's expectations. This is attributed to financial constraints. Though Canadian services have been retained in the past for the development of coal, zinc and nickel projects, its present participation is not as wide as that of the Russia's and other communist countries, UK and Germany. This could, perhaps, be traced to the GOI's earlier restrictive policies. With the opening of the economy, including mining sector, Canada can now enlarge its participation in areas such as:

(i) air and water quality maintenance,
(ii) land reclamation
(iii) toxic waste storage or elimination in industries such as copper, zinc, iron and steel, aluminium
(iv) controlling sulphur and other gaseous emissions
(v) treatment and utilisation of slimes (e.g. iron ore and chromites)
(vi) designing sumps for large sized mines (coal, iron ore etc)
(vii) project management
(viii) interpretation and analysis of geological data
(ix) exploration and prospecting, with the help of modern tools
(x) utilisation/exploitation of lean ores (copper, chromite, nickel) and even low quality coal

5. IMPORT POLICY

Along with market-oriented industrial policies, the GOI liberalised its trade policies both by relaxing controls on export-import policies and by lowering import duties on imports. In addition, full convertibility of Indian rupee on trade account is designed to improve India's exports and make the imports self- financing.

Import Policy

Consistent with its liberalised polices, the GOI practically replaced the then existing quota and licensing regime by allowing free trade in all excepting a short list of items termed "negative list". (Annexure 5.1 and 5.2)

Import Duties

To give import policy changes a meaningful and realistic effect, the GOI gradually lowered the import duties. The peak rate (effective March 15, 1995) is now reduced to 50 per cent, with still a lower duty of 25 per cent on capital goods, testing and quality control instruments and project imports.

Ferrous and non-ferrous metal imports attract at 40% duty, down from 50-60 percent the previous year. Likewise non-metallic minerals attract a duty of 30 per cent.

Trade Barriers

With the scrapping of import restrictions, Indian trade policies are now relatively favourable than they were prior to July 1991. Though import duties are still high at 25 per cent for capital goods and a peak rate of 50 per cent, these are likely to come down further in the next few years.

Current Level of Trade

Apart from mining equipment and machinery, India has been a net importer of minerals and metals to meet the growing demand. India's imports and exports of major minerals appear at Annexure 5.3 and 5.4.

Table 2
Assistance to India

Area	Project	Country/Organisation/Assistance
1. Exploration	(a) Balda, Burugubanda, Tosham for tungsten and tin	BRGM (France) with MEC, GSI
	(b) Malanjkhand for Copper	Bishimetal (Japan) with MEC, GSI, HCL
2. Coal Mining	(a) Underground Mining	Australia - Mine development
	i) Piparwar	
	ii) Monidih and Sudamdih	Poland - Shaft sinking
	(b) Opencast mining	USSR - Designing, equipment, development
	i) Korba, Singareni	
	ii) Rajmahal	Metchem (Canada)
	(c) Experiments through financial and technological assistance	CdFi (Frane) - Blasting galleries
	i) East Katras, Chora, Singareni	
	ii) Baragolai	CIDA (Canada) - Hydraulic mining
	iii) Thick seam mining	France
3. Lignite	(a) Neyveli	Germany - Financial and technical assistance, equipment
	(b) Gujarat mineral Exploration Corpn.	Germany - Consultancy
4. Non-ferrous metals	(a) Stopping	Sweden, Canada - Technology, equipment
	(b) Copper	Venot-pie and Era (France) - Design
	i) Khetri Concentrator Ore sorter	RTZ
	ii) Ghatsila flash smelter	Oktokumpu Oy
	(c) Lead-zinc	Lurgi
	i) Debari roaster	
	ii) Rajpura - Dariba flowsheet	RTZ
	iii) Rampura - Agucha	RTZ - Mine consultancy, imperial smelting process
	(d) Aluminium smelters	
	i) INDAL	ALCAN (Canada)
	ii) HINDALCO	KAISAR (USA)
	iii) MALCO	MONTECATTNI (Italy)
	iv) BALCO	VAMI (erstwhile USSR) KAISAR (USA)
	v) NALCO	PECHINEY (France)
5. Ferrous Metals	(a) Mines	METCHEM (Canada) - Designing development
	i) Kudremukh	
	ii) Kirburu	NITTSU (Japan) - Designing
	(b) Steel plants	erstwhile USSR
	i) Bhilai	
	ii) Bokaro	erstwhile USSR
	iii) Durgapur	UK
	iv) Rourkela	Germany
	v) Visakhapatnam	erstwhile USSR
6. Ore Beneficiation	(a) Ore Dressing Laboratory - Pilot plant (Indian Bureau of Mines)	UNDP - funding, consultancy, training
	(b) Hydrometallurgy (Regional Research Laboratory, Bhubaneswar)	UNDP

Source: Asia Mining, 1993, India.

The New Policy

The announcement of New Mineral Policy (NMP) in March 1993, and subsequent amendment of the Mines and Minerals (Regulation and Development) Act (MMRD) a year later marked the liberalisation of the mining sector. The salient features of the amendments to the relevant Act and rules are provided in Annexure 6.2. Within a year, the response has been encouraging, though formal proposals have yet to be finalised.

Foreign Participation - Present Level

Listed below are some of the foreign interests evinced so far:

Table 3

	Country/Company	Area of interest
1.	BHP, Australia	Exploration and extraction of trace and precious metals jointly with HZL
2.	Alcoa, Australia	10,000 MT alumina plant jointly with Associated Cement Co.
3.	Ausmelt, Australia	Its Sirosmelt technology at HCL Ghatsila (Bihar) Smelter-MOUs signed with GOI
4.	CRA, Australia	Kerala mineral resources
5.	Cluff Resources, Australia	Not Available
6.	RTZ, British	Iron ore project jointly with Orissa Mining Corporation Ltd.
7.	Metchem, Canada	Mine Development
8.	Alcan, Canada	Aluminium plant jointly with Larsen and Toubro
9.	Deebeers, UK	Diamond exploration
10.	Aluminum Pechiney, France	Aluminium plant with Hindustan Aluminium Co.

In addition, India has signed MOU with Russia for production of super purity aluminium at BALCO's plant extraction of aluminium silicon alloys and powder at NALCO, beneficiation of rare metals (indium, tellirium and germanium) at HZL marketing electrolytic copper foils in India and setting up of joint ventures for exploration and exploitation of minerals. Other central Asian countries (of former USSR) such as Kazakhistan, Uzbekistan and Kyrgystan are also discussing with the GOI areas for possible participation. The Indo-Zambian Joint Commission has identified cooperation in mineral sector as priority area.

The new Indian foreign investment policy is quite transparent and is stable, responding to the needs of the investor. Investments upto 50 per cent get automatic approval from the Reserve Bank of India (RBI) within two weeks of making an application. Stakes beyond this are approved by Foreign Investment Promotion Board (FIPB), which meets every week. Other policy parameters such as taxation, hiring of technicians, royalty payments for technologies and repatriation of dividends follow:

(i) Taxation

Wide range of tax concessions are given to investors engaged in mining activities. Some of the concessions are as given below:

Tax Holiday: Mining companies in specified backward areas are eligible for a complete tax holiday for a period of five years from commencement of production and a partial tax holiday thereafter.

Incentives for New Ventures: Newly established mining companies are eligible for a deduction of 30 per cent of gross total income for 10 years subject to the satisfaction of certain conditions. Such incentive is not available in case the benefit of the tax holiday is availed.

Depreciation Allowance: The benefits of accelerated depreciation are available for tax purposes. As a result, the total amount of depreciation which is available to tax deduction does not change but the company is allowed to make such deductions earlier in the project's life.

Table 4
Depreciation Rates

Classification	Rate
Buildings	10-20 percent
Machinery	25 percent
Equipment	25 percent
Vehicles	20-25 percent
Furniture & Fittings	10 percent

Tubs, winding ropes, haulage ropes, stowing pipes and safety lamps used in mines and quarries are allowed 100 percent depreciation.

Environment protection equipment, pollution control equipment, energy saving equipment also qualify for 100 per cent depreciation.

Unabsorbed depreciation can be carried forward indefinitely.

Deduction in respect of Export Turnover: Deduction of 100 per cent of export income is granted for export of specified processed minerals and ores. To claim this deduction, the sale proceeds of exports must be brought into India in convertible foreign exchange within a specified time period.

Expenditure on Prospecting, Extraction and Production of Minerals: The expenditure incurred by an Indian company engaged in any operation relating to prospecting for or extraction or production of any mineral during the five year period ending with the year of commercial production is allowed as a deduction form the total income to the extent of one tenth of the amount of such expenditure.

No deduction is allowed on expenditure on the acquisition of site and other capital expenses on which depreciation is claimed.

Expenditure on Scientific Research: Capital and revenue expenditure incurred by the assessee who carries on scientific research is allowed as a permissible deduction. A weighted deduction of 125 per cent is allowed for payments made to specified universities and laboratories for carrying on scientific research.

Expenditure on Know-how: Any lump sum consideration paid for acquiring know-how is deductible in 6 equal instalments over 6 years.

Preliminary Expenses: Preliminary expenses incurred by an Indian company before the commencement of business are allowed as a deduction in ten equal instalments.

Expenses for Environmental Protection: Amounts paid to approved associations or institutions for programs of conserving natural resources are allowed as a deduction in the computation of taxable income.

Principal Indirect Taxes: Indirect taxes are levied in the mining industry in various forms. The important ones are excise duty, customs duty, sales tax etc. Some states also impose octroi (entry tax) on goods entering local areas whereas some other states impose estate tax based on assessed value of property.

(ii) Hiring of Foreign Technicians

Automatic approval for engagement of foreign technicians is granted, if:

i) Remuneration of fees payable to the foreign technician does not exceed US$ 1,000 per day.
ii) Total remuneration or fees payable to a company does not exceed US$ 200,000 per calendar year.
iii) Prior approval of Ministry of Home Affairs is obtained if the duration of engagement of any single foreign technician exceeds 3 months.
iv) Total duration of engagement of foreign technicians does not exceed 12 months in a calendar year.

(iii) Royalty Payment

Indian companies are free to enter into technology transfer agreements with foreign companies provided that the payment terms satisfy the following conditions prescribed by the Government subject to the condition that the lumpsum know-how fee payable does not exceed Rs.10 million and royalty payment, do not exceed 5 per cent of domestic sales and 8 per cent of exports.

The payments are subject to an overall ceiling of 8 per cent of total sales over a 10 years period from the date or agreement, or over a 7 year period from the date of commercial production. These payments may be net of Indian taxes and will have to be at market rates of exchange.

The approval process for technology purchase is automatic and applications are scrutinised by the RBI to ensure that the proposals conform to the Government-specified norms. As in the case of the policy on foreign investment, proposals which do not conform to specified norms for automatic approval, must be approved by the Government.

The objective of this policy is clearly to ensure easy access to up-to-date technology to Indian companies and to determine purchase price on commercial considerations, rather than on those imposed by the Government.

(iv) Repatriation of Dividends

Joint ventures (JVs) involving foreign equity component upto 50 percent are allowed to repatriate dividends subject to approval by the RBL Ventures with foreign equity participation in excess of 50 per cent require the approval of FIPB for repatriation of dividends.

Joint Venture Opportunities

India has a variety of mineral resources untapped, largely sub-surface and hidden due to lack of adequate exploratory efforts and intensive mineral investigation. Annexure 6.3 details of mineral rich districts and their states as well as the number of leases granted and their areas.

Presently quite a number of mining projects are at various stages of implementation. A few of them appear to befit cases for global participation by way of equity, technology, consultation, equipment, R&D, etc.

JVs with public sector have certain in-built advantages, as these entities have operating facilities, mining leases, financial and technical resources and access to data, besides having the Government support. These undertakings now function more on commercial lines following the dilution of Govt, holdings in them.

Besides, JVs with private sector, with government or with government/foreign company/private sector are now permitted. Even partnership alliances and lines with JVs are considered for licensing. The private sector companies, particularly large industrial houses with adequate resources, are now planning diversification into the mineral sector.

Existing Units Under Capacity Augmentation

In addition, the existing projects offer scope for joint ventures (JVs) particularly with funds-starved public sector companies, following withdrawal of budgetary support to them. The magnitude of the investment size can be visualized from the originally proposed investment of Rs. 28 billion (excluding coal & lignite programs of Rs. 105 billion) during the Eighth Plan period (1992-97), which now will have to be self-funded. These public sector companies have proposed expansion/new facilities to meet the ever increasing demand for minerals/metals.

Some typical examples are given below:

Table 5

	Accounting Unit	From	To
National Aluminium Co. Ltd.			
Augmentation of mine capacity	Mt	2.4	4.8
Alumina	t	800,000	1,350,000
Smelter	t	218,000	345,000
Power Plant	MW	720	960
Hindustan Copper Ltd.			
Capacity Expansion			
Khetri smelter	t	31,000	100,000
Malanjkhand mine	Mt	2	3
(Malanjkhand might eventually have an underground mine. Total capacity of underground and opencast mining may be 5 Mt.)			
Kudremukh Iron Ore Co. Ltd.			
Capacity augmentation - Mine	Mt	ROM 220	300
		Cone 7.5	10

At Kudremukh, there is a case for developing the other deposits also in the area since the remaining life of the iron ore deposit itself is hardly 14-15 years.

Possible areas for participation

Keeping away private sector from the mineral development programs (excluding minor minerals) for nearly 40 years and then suddenly opening them, has provided a large area for participation by the interested foreign/private parties. The Ministry of Mines of the GOI has recently identified the following specific prospective areas for foreign participation.

Table 6
Prospects for Collaboration at a Glance

S. No.	Sector	Resource and capability	Needs	Sector for cooperation in India
1.	Steel	Rich grade of iron ore (60-65% Fe_2O_3). Good infrastructure, steel production units and design capabilities exist	Productivity improvement, financial inputs, technology upgradation and increased production of coking coal supply	Setting-up of primary and secondary facilities at green field / brown field sites. Direct reduction technology. Sophisticated downstream facilities. High value products.
2.	Aluminium	Rich grade of ore (40% Al_2O_3), good mining infrastructure, surplus production	Cheap power for smelting, latest technology for alumina and aluminium, semi-fabrication facilities and end-use products	Bauxite mining, Beneficiation of Bauxite, Alumina Plant (export oriented), smelting facilities abroad, secondary aluminium production, Gallium recovery, Commercial products from Red Mud
3.	Copper	Unsatisfied and growing demand, trained manpower, Basic infrastructure, large market	Exploration of ores, Beneficiation, Smelting	Exploration. Hydro-metallurgy, Bioleaching down stream products
4.	Lead	70% demand satisfaction, trained manpower	Environment friendly technologies	Exploration for lead and zinc, tie up of lead concentrate through joint ventures
5.	Zinc	Near self-sufficiency, mining capabilities	Environment friendly technologies	Exploration, primary & secondary production
6.	Gold	Trained manpower, deep mining techniques	Exploration in Archaean greenstone belts and laterites. Exploitation of lean ores/tailing dumps	Technology upgradation
7.	Diamond	Expertise in cutting and polishing	Exploration, Mining	Intensive exploration & mining
8.	Tungsten, Nickel, Tin, etc.	Basic infrastructure in mining and metallurgy	Exploration, Exploitation, Beneficiation, Smelting	Turn-key plants
9.	Scrap recycling, secondary smelting, by-product recovery	Conventional technology. Ability to absorb imported technology	Advanced techniques, Environment friendly technology. Energy efficient technology	Secondary smelters
10.	Industrial & minor minerals	Large number of high and low tenor deposits. Small mines and trained manpower	Modernisation & Technological upgradation, cost reduction and environmental protection	Revamping of mines, Reduction of wastage, beneficiation, cost reduction and export marketing

Federation of Indian Mineral Industrial (FIMI) has identified:

(i) pyrite deposits at Amjore and Saladipura (U.P.) and
(ii) Phosphorites in Udaipur (Rajasthan), Mussoorie and Lalitpur (UP) and Jhabria (MP) as additional areas of minerals where such participation could be considered.

Other areas where Canada, depending upon its strength and interest, could consider for involvement include:

(i) Geology and Exploration: As is known, almost all surface deposits have been delineated in the country. However, major discovery of sub-surface or concealed deposit is yet to be made. Therefore, deployment of high-tech expertise in exploration with equipment is required. Action for exploration of minerals in which India is deficient is also warranted. Though India has emerged as the largest exporter of cut diamonds on the world, most of the requirement for the purpose is imported (India produces only 18,000 carats per year). Specific exploratory areas are: aero-magnetic surveys; seismic sensitivity surveys; airborne surveys; detail data interpretation (MECL is open for joint project with it doing the legwork); and technology transfer in analytical and interpretation methods - ICP, atomic absorption, dertograph, potable XRF;

(ii) Mining and mine development projects: large mines of over 10 million tonnes per year, technologies for drilling large diameter blast holes, computer-aided automatic explosive loadings, directional blasting technologies, automation of mining operation (all primarily in coal sector).

(iii) Beneficiation, including R&D: efforts to improve recovery rates in respect of non-ferrous metals - pyrometallurgical and hydrometallurgical methods (these are at R&D stage in India); automation, computerisation and instrumentation of beneficiation plants, in-stream process control systems at the existing facilities and upgrading the R&D and test labs by providing advanced technologies such as column flotation and leaching.

(iv) Recovery from waste material: In Kolar gold mine about 32 Mt of old mill tailings containing 0.72 g of gold per tonne of tailings are available from which metal is being recovered with heap leaching with 55% recovery. It is apprehended that the recovery figure will gradually decrease with the passage of time. There is an obvious case of improving the recovery levels.

Though mineral wastes such as red mud, fly ash and coal washery rejects have been tried for certain uses, this has been on very small scale and not on commercial basis. Improvement in scheelite recoveries at Kolar and Hutti, barytes from Rajpura - Dariba lead-zinc plant, refractory grade magnesite from Pithorgarh (U.P.), foundry grade sand from Ratnagiri beach, rock phosphate concentrates from failings of Maton, tungsten from Degana granites, etc. are some of the areas needing attention. Development and commercial application of non-conventional extraction technology such as bacterial leaching will be helpful.

(v) Scarce Metal Recovery: Over the last 15 years, recovery of Nickel from lateritic overburden in the chromite belt of Sukinda has been attempted. Though a total of 75,000 tonnes nickel has been estimated at 0.25 to 0.90 grade, the nickel content is indeed too low. Moreover, the most economic route for nickel extraction is yet to be evolved. The work carried out by the Regional Research Laboratory, Bhubaneswar could achieve 35% recovery from the lateritic ore. The overburden also contains 0.05 to 0.10 per cent cobalt. Recovery of cobalt may also be attempted.

(vi) Environmental management: especially tailing disposal systems

(vii) Mining equipment: upgrading technologies to bring these on par with international level, particularly in underground mining equipment and large open cast mining machinery.

(viii) Consultancy services: in the areas of planning and designing deeper open pit mines, developing complete software packages for a project - exploration to final product in non-coal mining sector.

(ix) Productivity improvement including maintenance management: Productivity in Indian mining does not present a healthy picture, more so when it is compared with countries such as the U.S.A., Canada and Australia even with matching working conditions and level of mechanisation. This is not to deny the improvement made in case of minerals such as limestone. Here the productivity per man year was 422 t in 1970 which rose to 1.800 t in 1991-92. A large number of factors contributing to the **poor level of productivity** in Indian mining sector include sub-standard managerial skills, gaps between consecutive shifts, poor underground communication system, un-coordinated working elements, sub-standard ventilation, inadequate maintenance, spurious spares, substantial absenteeism, etc. **Consultancy in the area of productivity improvement will be beneficial to mining industry as it will help in reducing the production cost of minerals and metals.**

(x) Large Mineral Deposits Awaiting Development: Bubabudan (Bihar) Iron ore deposit, though a large deposit, could not be developed as magnetic is not utilised in steel marking in India owing to economics and environmental considerations as it is in the proximity of a reserve forest, coffee plantation, wildlife sanctuary and human habitation.

Haemitite reserves of 200 Mt (62 per cent Fe) at Chiria deposit (Bihar) could not be developed so far commensurate with the size of the deposit. Mining continues only on small scale.

Mukunda, in Jharia coalfield (Bihar) could not be developed for want of funds. If this mine were developed at the envisaged size of 10 Mt, import of coking coal could be eliminated, saving the scarce foreign exchange.

Risk Factors

The mineral industry by nature involves risks of exploration, uncertainties of demand and prices, besides a long gestation period. Though the GOI has announced its polities, the State Governments, which are owners of the minerals, have not kept pace with the former. Moreover, political changes at State level can cause a temporary setback to a project (as in case of the US based Enron power project at Dadhol, Maharashtra). At the same time, for fear of being left behind others, every state is attempting to attract foreign investments. This is a major factor which will ultimately decide the speed with which the state governments toe the line of the Centre, in spite of political differences, because ultimately the enhancement of employment opportunities and raising the standard of living of the people in their respective states will rule the policy makers.

There are several Canadian and other companies which are active in certain areas of the mining and mineral sector. Some of them are:

Name of the Company	Area of Operation
Leader Mining International Inc., Calgary, Alberta	Feasibility study, processing of mine tailings for recovery of gold at the Kolar Gold mines.
Kilborn Engineering Pacific Ltd., Vancouver, B.C.	Joint venture to prepare coal washery project report for Coal India Ltd.
Met-Chem Canada Inc., Montreal, Que	Has done coal projects and iron ore mining consultancy. Currently engaged in feasibility studies for coal mine development as well as fire control and management programme at Jharia Coalfields of Bharat Coking Coal Ltd.
Norwest Mine Services Ltd., Calgary, Alberta	Engaged in feasibility study on preparation of environmental management plan for Jharia Coalfields of Bharat Coking Coal Ltd.
Western Garnet Co., Vancouver, B.C.	Joint venture for processing garnet for industrial use
Falconbridge Ltd., Sudbury, Ont.	Joint venture for exploration of minerals in Rajasthan
Continuous Mining Systems Ltd., Sudbury, Ont.	Supplied drilling equipment in Hindustan Zinc Ltd.
Cubex Ltd., Winnipeg, Manitoba	Supplied drilling equipment to Hindustan Copper Corporation Ltd.
White Industries Ltd., Australia	Joint venture for combined mining systems at Piparwar coal mine of Central Coalfields Ltd.
BHP, Australia	Joint venture with Hindustan Zinc Ltd for exploration and extraction of trace and precious metals
Debeers, UK	Diamond exploration
Aluminium Pechiney, France	Aluminium plant with Hindustan Aluminium Co. Ltd.

A number of other foreign companies are looking at the possibilities of their participation in the Indian mining and mineral sector.

In totality, prospects outweight the risks for a financially strong and resilient company.

ANNEXURE 1.1

Illustrative List of Mining and Allied Machinery/Equipments Manufactured in India

I. Mining Equipment

1. Light drill rigs for exploration drilling
2. Coal drills, blast hole drills
3. Self advancing powered roof support
4. Conveyors
5. Loaders
6. Blasting equipment
7. Coal cutters
8. Loaders
9. Wagon Tipplers
10. Wagon tippers
11. Crushers
12. Screens
13. Mixers
14. Excavators
15. Shearers
16. Scrapers
17. Winders
18. Coal haulers
19. Hydraulic rock breakers
20. Longwall equipment
21. Face shovels upto 20 m^3
22. Draglines upto 24 m^3
23. Rear dump trucks upto 170 tonnes
24. Jack hammer drills
25. Power shovels, including hydraulic
26. Shovels of 0.9 m^3 to 140 m^3
27. Bulldozers - 66, 90, 165, 180, 230, 320, 410, 770 HP
28. Hydraulic excavators
29. Loading shovels - 1.2, 2.2, 4.2, 6.1, 9.5 m^3
30. Backhoe - 1.0, 1.32, 2.8, 4.3, 8.5 m^3
31. Pipe layers - 40, 70 ton
32. Electric rope shovel - 10 m^3
33. Walking draglines
34. Road headers
35. Telescopic excavators - 0.5 m^3
36. Side discharge loaders
37. Wheel loaders - 1.7, 2.0, 3.1, 3.8, 5.6 m^3
38. Bottom dumpers - 37, 56 m^3
39. Wheel dozers - 130, 300 HP
40. Water sprinkler - 28,000 litres

II. Material Handling Equipment

1. Conveying equipment
2. Wagon tippler
3. Idler rollers
4. Wagon marshelling equipments
5. Stamping - charging - pushing machines
6. Fork lift trucks
7. Weigh feeders
8. Conveyors and bucket elevators
9. Reclaiming equipment
10. Stackers, blender reclaimer, spreaders
11. Electromagnetic vibratory feeders
12. Bow feeders
13. Conveyor belt troughing idlers
14. Conveyor pulleys
15. Hydraulic pneumatic ash handling plants
16. Truck mounted load luggers
17. Vehicle mounted winches
18. Feeder crushers
19. Haulage winches
20. Heavy trailer winches

III. Construction Machinery

1. Crushers, screens and feeders
2. Perforated rotary screens
3. Engraved cylindrical screens
4. Rotary screen endrigs
5. Vibrating screens
6. Granulators

ANNEXURE 1.2

Performance of Select Procedures of Mining Machinery*

	Company	Unit	Installed Capacity	Production
1.	**Eimco Elecon**	nos		
	Tunneling loaders	nos	225.00	149.00
	Drilling & roof bolting	nos	30.00	5.00
	Mining machinery spares	Rs million	10.00	1.1
2.	**Mining & Allied Machinery Corporation**	MT	5,572.00	3,057.00
3.	**Jessop****	nos		382.00
	Self advancing roof support	nos	500.00	122.00
	Hydraulic props for mines	nos	12,000.00	260.00
4.	**Williamson Magor & Co**			
	Mining accessories	nos	Not available	Not available
5.	**Burn Standard****			
	Colliery eqpt			
6.	**Mcnally Bharat****	MT	Not available	Not available
	Coal washing plant/ machinery/spares	MT	13.00	Not available
7.	**Southern Structurals****	MT	1,400.00	Nil
8.	**Simplex Engg. & Foundry**			
	Haulage winches, coal cutting machine	Rs million	20.00	Not available
9.	**International Combustion**			
	Haulages	nos	100.00	Nil
10.	**New Standard Engg.****			
	Disc filters for coal washery	nos	20.00	Nil
11.	**Tata-Robins-Fraser**			
	Winders	nos	4.00	Nil

* year ended March 91

** year ended March 92

Source: Industrial Data Book, 1994, Centre for Industrial & Economic Research, New Delhi

ANNEXURE 1.3

Performance of Select Producers of Earth Moving Machinery*

	Company	Unit	Capacity	Production
1.	**Bharat Earth Movers****	nos	Not Available	1084.00
	Earth Moving equipment	nos	Not Available	1059.00
	Heavy duty trailers	nos	Not Available	25.00
2.	**Hindustan Motors**	nos		
	Earthmoving machinery	nos	630.00	504.00
3.	**Larsen & Toubro**	nos	953.00	357.00
	Scraper, bulldozer	nos	250.00	Nil
	Road rollers tec.	nos	150.00	Nil
	Earthmoving machinery	nos	553.00	357.00
4.	**TELCO**	nos	148.00	76.19
	Excavators	nos	148.00	76.19
5.	**Escorts JCB****	nos	500.00	354.00
	Wheeled excavator loaders	nos	500.00	354.00
6.	**TIL**	nos	75.00	Not Available
	Hyderabad industries			
	Earth moving machinery	MT	100.00	20.00
7.	**Greaves Cotton**	nos	1200.00	Not Available
	Road rollers & tractors	nos		
8.	**Standford Engineering+**			
	Earthmoving machinery	nos	100.00	38.39
9.	**Escorts**	nos	400.00	111.00
10.	**Voltas**	Rs million	Not Available	16.1
	Const. & earthmoving eqpt			
11.	**Mahindra Engineering**			
	Trailers	nos	3816.00	798.00
12.	**Jessop & Co.****	nos	1320.00	78.00
	Road rollers	nos	1200.00	78.00
13.	**Southern Structurals****	MT		734.00
	Bucket wheel excavators	MT	1100.00	734.00
	Hydraulic excavators	nos	3.00	Nil

Continued

Annexure 1.3 Continued

	Company	Unit	Capacity	Production
14.	**Engineering Systems****	nos	Not Available	10.00
	Wagon loaders	nos	Not Available	5.00
	Truck loaders	nos	Not Available	5.00
15.	**Stanes Motors****			
16.	**Eimco Elecon (India)**			
	Mining machinery	nos	30.00	1.00
17.	**Tata-Robins-Fraser**	nos	20.00	2.00
	Crawler mounted side dump loaders etc	nos	10.00	2.00
18.	**Texmaco**			
	Diesel road rollers	nos	400.00	1.00
19.	**Automotive Mfrs.**			
	Trailers	nos	Not Available	Not Available
20.	**Mahindra & Mahindra**			
	Front end dozer	nos	Not Available	Not Available
21.	**Ingersoll-Rand (India)**			
	Loaders	nos	7.00	7.00

Year ended * March 91 ** March 91 + June 91
Source: Industrial Data Book 1994, Centre for Industrial & Economic Research, New Delhi

ANNEXURE 1.4

MINERAL EXPLORATION SCHEMES OF GSI FOR THE VIII PLAN PERIOD (1992-93 TO 1996-97)

A.	**Non-Coal Minerals/Metals**	
1.	Basemetal	46 projects
	Gold	40 projects
	Tin tungsten	15 projects
	Platinum Group of metals	9 projects
	Molybdenum	3 projects
	Multimetals	13 projects
	Diamond	8 projects
	Metallogenic Studies	12 projects for above minerals
2.	Fertilizer minerals, Ferrous minerals, Industrial minerals	19 projects
B.	**Coal & Lignite**	
	Coal:	
1.	Damodar Valley Coal Basin	4 projects
2.	Rajmahal-Birbhum Master Coal Basin	2 projects
3.	Mahanadi Valley Coal Basin	4 projects
4.	Son Valley Coal Basin	2 projects
5.	Wardha Valley Coal Basin	1 project
6.	Godavari Valley Coal Basin	1 project
	Lignite:	
1.	East Coast Lignite field	1 project
2.	West Coast Lignite field	1 project
3.	Basin Analysis Studies	5 projects

NB: Number of projects variable from year to year

ANNEXURE 2.1

IMPORTS OF SELECTED MINING MACHINERIES AND PARTS BY COUNTRY (PRINCIPAL SUPPLIERS) - 1993-94 (in million rupees)

Product	Country	Value (Rs Million)	Total (Rs Million)
A. Machinery items			
1. Bulldozers			77.3
	U.S.A.	21.0	
	Japan	56.3	
2. Graders & Levellers			1.8
3. Front-end Shovel Loaders			42.9
	Japan	20.6	
	Sweden	22.3	
4. Other Mechanical Shovels			52.7
Excavators and Shovel Loaders	Netherlands	29.2	
	Brazil	9.4	
	U.K.	4.8	
	U.S.A.	4.4	
5. Rock Drilling Machinery (incl. diamond			0.5
drilling)	U.K.	0.3	
	Sweden	0.2	
6. Tunnelling Machinery (Others)			46.3
	Sweden	16.3	
	Italy	20.3	
7. Other Coal Rock Cutters & Tunnelling			160.1
Machinery - self-propelled	Germany	115.7	
8. Drilling Machinery			135.5
Numerical	Germany	33.2	
	Italy	16.0	
	Japan	14.0	
	U.S.A.	53.5	
9. Pneumatic Drills		0.3	1.2
	U.K.	0.3	
	France	0.1	
	Japan		
10. Pneumatic Tools (Others)			12.3
	U.S.A.	4.3	
	Japan	2.1	
	Germany	1.4	
11. Drilling rings			5.1
	Italy	3.9	
	Japan	0.7	
12. Other rings			174.8
	Chinese Taipei	17.0	
	Germany	76.3	
	Switzerland	14.3	
	U.S.A.	18.4	
	Canada	0.8	
13. Coal Sorting			0.9
Screening & Washing Machinery	Germany	0.67	
	Australia	0.22	

Annexure 2.1 Continued

Product	Country	Value (Rs Million)	Total (Rs Million)
14. Sorting			67.6
Screening and Washing Machinery for other minerals	Australia	24.7	
	U.S.A	15.2	
	U.K.	22.3	
15. Crushing			40.0
Grinding Machinery for Stone/Minerals	Brazil	39.7	
16. Self-propelled Boring			78.0
Sinking Machines (Other than oil & gas)	U.S.A.	72.3	
17. Other Boring & Sinking Machinery			54.4
	Sweden	19.7	
	France	6.0	
	Canada	2.9	
18. Pneumatic Conveyors & Elevators			26.5
	U.S.A.	18.7	
	Denmark	4.9	
	Italy	1.7	
19. Drilling Rigs			73.0
	Japan	72.2	
20. Bucket type elevators			46.2
conveyors for goods/materials	U.S.A.	34.8	
	Switzerland	8.3	
21. Belt type elevators			33.3
conveyors for goods/materials	Australia	24.7	
	Switzerland	8.6	
		1,139.5	
B. Parts of:			
1. Lifting			1120.7
Handling and Loading Machinery	Japan	175.4	
	Italy	118.0	
	Republic of Korea	46.2	
	Germany	41.4	
	Singapore	59.8	
	U.S.A.	370.6	
	U.K.	85.9	
	Chinese Taipei	62.5	
	Canada	24.4	
2. Buckets, Shovels, Grips			143.4
	U.S.A.	49.6	
	Japan	31.4	
	France	15.4	
	Germany	12.7	
	U.K.	10.4	
	Canada	9.1	
3. Bulldozer or Angledozer Blades			281.9
	Japan	124.1	
	France	91.9	
	Sweden	83.7	
	U.K.	31.5	
	Italy	25.0	

Continued

Annexure 2.1 Continued

Product	Country	Value (Rs Million)	Total (Rs Million)
	Japan	9.1	
4. Self-propelled Excavating, Levelling, Tempering Machinery for ores/minerals			1462.3
	Germany	109.3	
	Italy	285.7	
	Sweden	110.6	
	U.K.	134.2	
	U.S.A.	611.8	
5. Other than self-propelled Excavating, Levelling, Tempering and Extracting Machinery			530.00
	U.S.A.	193.8	
	Japan	129.6	
	Sweden	31.0	
	Germany	34.3	
	Canada	4.0	
Total		3,545.3	
C. Total of A & B			4,684.8

Source: Monthly Statistics of Foreign Trade of India, Volume II - Imports, March 1994, Directorate General of Commercial Intelligence and Statistics, Calcutta.

ANNEXURE 5.1

NEGATIVE LIST OF IMPORTS

Sl No	Description of Items	Nature of Restriction
1.	Tallow, Fat and/or Oils, rendered, unrendered or otherwise, of any animal origin including the following: i) Lard stearine, oleo stearine, tallow stearine, lard oil, oleo oil and tallow oil not emulsified or mixed or prepared in any way; ii) Neat's-foot oil and fats from bone or waste; iii) Poultry fats, rendered or solvent extracted; iv) Fats and oils of fish/marine origin, whether or not refined, excluding cod liver oil, squid liver oil or a mixture thereof and Fish Lipid Oil containing Eicospentaenoic acid and De-cosa-hexaenoic acid; and v) Margarine, imitation lard and other prepared edible fats of animal origin	Not permitted to be imported
2.	Animal rennet	Not permitted to be imported
3.	Wild animals including their parts and products and ivory	Not permitted to be imported

ANNEXURE 5.2

NEGATIVE LIST OF EXPORTS

Sl No	Description of Items
1.	All forms of wild animals including their parts and products except Peacock Tail Feathers including handicrafts made thereof and Manufactured Articles and Shavings of Shed Antlers of Chital and Sambhar subject to conditions as specified in Annexure to Public Notice No. 15-ETC(PN)92-97 dated 31st March 1993 issued by the Director General or Foreign Trade and reproduced in the Handbook of Procedures (Vol. 1)
2.	Exotic birds
3.	All items of plants included in Appendix I of the Convention on International Trade in Endangered Species (CITES), wild orchid, as well as, plants as specified in Public Notice No. 47(PN)/92-97 dated 30th March 1994, issued by the Director General of Foreign Trade and reproduced in the Handbook of Procedures (Vol. 1)
4.	Beef
5.	Human skeletons
6.	Tallow, fat and/or oils of any animal origin excluding fish oil
7.	Wood and wood products in the form of logs, timber, stumps, roots, bark, chops, powder, flakes, dust, pulp and charcoal except sawn timber made exclusively out of imported teak logs/timber subject to conditions as specified in Annexure to Public Notice No. 15-ETC(PN)/92-97 dated 31st March 1993, issued by the Director General of Foreign Trade and reproduced in the Handbook of Procedures (Vol. 1)
8.	Chemicals included in Schedule 1 to the Chemical Weapons Convention of the United Nations signed in Paris on 13-15 January 1993, as specified in the Public Notice No. 16-ETC(PN)/92-97 dated 31st March 1993, issued by the Director General of Foreign Trade and reproduced in the Handbook of Procedures (Vol. 1)
9.	Sandalwood in any form, but excluding fully finished handicrafts made out of sandalwood and machine finished sandalwood products
10.	Red Sanders wood in any form, whether raw, processed or unprocessed as well as any product made thereof

ANNEXURE 5.3

India's Imports of Select Minerals 1988-89, 1990-91, 1991-92 and 1992-93

(Value in Rs. Million)

Mineral	Unit of Quantity	1988-89		1990-91		1991-92		1992-93	
		Qty	Value	Qty	Value	Qty	Value	Qty	Value
All Minerals (Value)			70815.4		115760.8		148040.0		n.a.
Alumina	Tonne	4031	53.1	5148	110.9	3744	100.4	4946	167.8
Asbestos	Tonne	101345	635.7	77885	724.6	66171	849.4	49999	910.5
Borex	Tonne	19323	89.4	31579	197.6	23072	197.6	14687	148.7
Coal	Th.T.	4488	4002.3	6046	7564.3	5276	9006.5	6492	13093.7
Coke	Th.T.	132	193.4	152	329.4	651	1357.6	247	736.0
Diamond (uncut)	-	*	31051.2	*	35996.2	*	46958.3	*	68928.6
Emerald	-	*	493.7	*	904.2	*	741.3	*	1010.4
Flurospar	Tonne	23346	40.8	41266	116.5	31839	103.4	26258	67.7
Lead Ore & Conc.	Tonne	20530	122.8	33794	254.7	19340	107.5	50704	421.1
Magnesite	Tonne	69140	342.6	79588	461.4	79461	645.5	85532	856.6
Manganese Dioxide Electrolytic	Tonne	173	3.4	120	5.6	440	14.1	372	16.4
Manganese Ore	Tonne	4860	12.1	3471	24.8	3087	31.2	2676	36.7
Mica	Tonne	38	13.8	54	28.9	53	2.8	6.3	6.6
Nickle Ore & Conc.	Tonne	3265	448.1	5408	646.6	4964	850.5	n.a.	n.a.
Previous & Semi-precious stones (uncut) (n.e.s.)	-	*	113.1	*	314.6	*	403.0	*	595.2
Rock Phosphate	Th.T.	2017	1901.7	2682	3464.4	2428	4545.7	2148	4476.6
Sulphur	Th.T.	1299	2513.0	1199	2783.4	1082	3071.4	1398	3500.0
Tungsten Ores & Conc	Tonne	468	25.9	358	23.2	406	40.0	507	54.4
Vanadium (ores & others)	Tonne	1740	109.6	2241	159.2	1653	133.3	371	42.8
Zinc Ores & Conc.	Tonne	22537	181.1	42155	411.6	15073	164.3	60170	712.1

Th.T.: Thousand Tonnes
Kg.: Kilograms
(P): Provisional
*: Quantity figures not given due to partial coverage. The value figures, however, have full coverage.
Figures for earlier years have been revised wherever necessary.
Source: Directorate General of Commercial Intelligence & Statistics, Calcutta
NOTE: Data for 1989-90 is not available.

ANNEXURE 5.4

India's Exports of Select Minerals 1988-89, 1990-91, 1991-92 and 1992-93

(Value in Rs. Million)

Mineral	Unit of Quantity	1988-89		1990-91		1991-92		1992-93	
		Qty	Value	Qty	Value	Qty	Value	Qty	Value
All Minerals (Value)			54126.3		66594.4		83426.1		n.a.
Alumina	Tonne	400362	1679.3	315157	1992.3	329398	1427.6	338680	1621.6
Barytes	Th.T.	433	153.3	304	159.8	392	249.1	38	33.8
Bauxite	Tonne	93547	39.3	187782	47.4	121618	40.1	247238	252.7
Bentonite	Tonne	68472	32.3	49011	35.2	76857	54.0	112543	73.4
Chromite	Th.T.	589	675.8	180	417.2	398	935.7	396	788.6
Diamond (mostly cut)	-	*	41054.8	*	47118.0	*	57618.3	*	77852.4
Emerald	-	*	555.8	*	1008.3	*	1536.1	*	1577.4
Felspar	Tonne	28573	12.2	38182	28.2	47894	38.2	n.a.	47.5
Felspar (uncut)	-	*	31.3	*	39.4	*	35.6	*	0.1
Ilminite	Tonne	119108	202.8	-	-	98150	179.1	41895	89.6
Iron ore	Th.T.	33041	6730.9	32492	10491.3	29513	14353.9	22167	11040.9
Manganese Dioxide electrolytic	Tonne	234	0.9	1053	16.7	900	21.5	1596	39.8
Manganese ore	Th.T.	308	148.7	318	441.9	265	375.0	210	307.9
Marble	Tonne	17878	13.2	20952	25.5	26534	137.3	41361	260.8
Mica	Tonne	47794	508.4	42591	513.1	34879	555.0	28505	239.4
Precious & semi-precious sones (n.e.s.)	-	*	386.7	*	915.0	*	1199.6	*	1203.1
Quartz (natural)	Tonne	62778	44.2	66393	57.5	69828	81.6	47084	64.6
Slate	Tonne	58269	67.7	62643	85.6	71696	150.2	31260	143.2
Steatite	Tonne	15630	21.0	14402	25.4	15308	41.2	13342	53.1
Stone (Granite)	Th.T.	696	1359.2	765	2570.6	822	3905.1	1164	3392.4

Th.T.: Thousand Tonnes, n.e.s. note elsewhere specified

*: Quantity figures not given due to partial coverage. The value figures, however have full coverage.

Figures for earlier years have been revised where necessary.

NOTE: Data for 1989-90 is not available.

Source: Directorate General of Commercial Intelligence & Statistics, Calcutta

(P): Provisional

ANNEXURE 6.1

Product Groupwise Analysis for Foreign Direct Investment from January 1992 to December 1994

(Investment in Rs. billion)

S. No.	Name of Product	1992 No	Invest-ment	1993 No	Invest-ment	1994 No	Invest-ment
1.	Others	130	3.21	163	17.03	285	23.22
2.	Electrical Machinery	154	5.03	149	6.60	191	7.10
3.	Non-electrical machinery	91	1.77	96	1.91	111	9.29
4.	Prepared Foodstuffs	62	3.30	92	9.53	109	6.97
5.	Other chemicals (Fertilizers)	71	4.29	65	3.70	84	14.49
6.	Textiles	29	0.96	41	0.79	66	9.74
7.	Basic metals and articles thereof	30	0.78	32	12.57	27	9.17
8.	Transport equipment	26	1.51	24	3.05	33	12.09
9.	Mineral fuels and petroleum refinery products	20	15.07	21	28.23	27	38.09
10.	Leather and leather products furskins footwear	12	0.28	15	0.16	30	0.26
11.	Ceramic products	18	0.19	24	0.29	17	2.10
12.	Drugs and pharmaceuticals	9	0.29	17	0.30	22	1.63
13.	Rubber, Plastics and their products	3	0.02	11	0.60	10	0.32
14.	Paper and paper products	5	0.20	5	1.13	16	2.59
15.	Beverages, Spirits and vinegar	7	0.12	11	1.72	4	0.24
16.	Optical, Surgical, photographic instruments & appa	18	0.44	8	0.19	4	0.09
17.	Cosmetics and toiletries, soaps	1	0.18	3	0.00	8	0.25
18.	Cement, asbestos products	4	0.07	2	0.27	9	3.36
19.	Glass and glassware	2	0.44	2	0.51	6	0.86
20.	Inorganic and Organic Chemicals	1	0.00	3	0.04	3	0.05
21.	Wood and wood products	0	0.00	1	0.00	0	0.00
	Total	693	38.18	785	88.62	1062	141.87

ANNEXURE 6.2

HIGHLIGHTS OF THE MINES AND MINERALS (REGULATION AND DEVELOPMENT) ACT 1957 AS AMENDED IN 1994

1. MMRD Act, 1957, has been amended in 1994 to bring it in line with National Mineral Policy announced in 1993.

2. 13 Minerals have been de-reserved for exploitation by the Private Sector, i.e., Iron Ore, Manganese Ore, Chrome Ore, Sulphur, Gold, Diamond, Copper, Lead, Zinc, Molybdenum, Tungsten Ores, Nickel and Platinum group of metals.

3. Any company registered in India, irrespective of its foreign equity holding, allowed to apply for a mining lease or a prospecting licence.

4. 50 per foreign equity automatically allowed with RBI clearance for companies mining for commercial use. Higher equity holding to be considered on case-to-case basis by Foreign Investment Promotion Board (FIPB).

5. In case of captive mines (coal for power stations, ores for processing plants) equity approved for the main plant will be allowed in respect of the captive mine under the same company.

6. 15 minerals deleted from the first schedule of the MMRD Act - apatite and phosphatic ores, barytes, dolomite, gypsum, vanadium, kyanite, magnesite, molybdenum, nickel, platinum and other precious metals, silimanite, silver, sulphur and its ores, tin, tungsten and vanadium ore. Henceforth, State Governments are not required to take prior approval from Central Government for grant of mining lease or prospecting licence for these minerals.

7. Prior approval of Central Government required for mining leases of only 11 minerals apart from atomic and fuel minerals, i.e. asbestos, bauxite, chrome ore, copper ore, gold, iron ore, lead, limestone (except when it is used in kilns for the manufacture of lime as building materials, manganese ore, precious stones and zinc.

8. Period for which prospecting licence can be granted is increased from two to three years. Licence can be renewed upto five years by the State Government.

9. All mining leases to be granted for a minimum period of 20 years and a maximum of 30 years. Lease can also be renewed for 20 years. Further renewals possible with approval of Government.

10. Period before which a mining lease can lapse, if no work is taken up, increased from one year to two years.

11. New section introduced allowing searches to be carried out to check unauthorized mining.

12. State Governments empowered to terminate leases of minor minerals without prior approval of the Central Government.

13. No appeal or revision to lie with the Central Government for orders passed by the State Government in regard to minor minerals.

14. Notifications issued by the State Governments under their Minor Mineral Concession Rules to be placed before the State Legislature. Central Government empowered to modify leases not in conformity with the Act to bring them in line with the provisions of the Act.

ANNEXURE 6.3

The following table lists the important districts in various states which have leased out mineral deposit areas.

HIGH MINERAL POTENTIAL DISTRICTS (AS ON 1.1.1994)*

S. No.	District	No of leases granted	Areas of leases (Hect)
	Andhra Pradesh		
1.	Anantapur	138	4465
2.	Cuddapah	207	6845
3.	Kurnool	164	3513
4.	Nellore	244	6724
	Bihar		
5.	Hazaribagn	102	9111
6.	Palamau	120	10350
7.	Singhbhum	167	40265
	Goa		
8.	Goa	526	41955
	Gujarat		
9.	Jamnagar	223	8189
10.	Junagadh	394	8121
11.	Kutch	220	7194
12.	Panchmahais	100	1650
13.	Surendranagar	251	1316
	Karnataka		
14.	Bellary	150	18671
15.	Uttar Kanada	109	12898
	Madhya Pradesh		
16.	Jabalpur	350	3198
17.	Satna	344	10563
	Orissa		
18.	Bolangir	130	3729
19.	Keonjhar	150	41873
20.	Sambalpur	100	10685
21.	Sundargarh	172	38292
	Rajasthan		
22.	Ajmer	219	11445
23.	Jaipur	114	13670
24.	Udaipur	295	37518
25.	Bhilwara	149	18041
	Tamil Nadu		
26.	Salem	119	3472
	Total	**4,955**	**363,865**

*Information on Maharashtra and West Bengal are not yet available.

ANNEXURE 6.3 Continued

The following table lists the various important minerals in 11 most important states.

States	Names of minerals
Andhra Pradesh	Bauxite, Copper ore, Coal, Lead, Zinc ore, Graphite, Limestone, Mica, Silver, Talc & Pyrophylite and Oil & Gas
Bihar	Coal, Copper ore, Chromite, Graphite, Iron Ore, Kaolin and Mica
Gujarat	Bauxite, Coal, Fine Clay, Dolomite, Gypsum, Limestone, Lead, Zinc Ore and Oil & Gas
Goa	Iron Ore and Manganese Ore
Karnataka	Asbestos, Chromite, Copper ore, Gold, Iron Ore, Limestone, Manganese Ore, Silver, Talc & Pyrophylite and Tungsten
Madhya Pradesh	Bauxite, Coal, Copper ore, Dolomite, Fine Clay, Gypsum, Limestone and Manganese ore
Maharashtra	Coal, Dolomite, Manganese ore, Talc & Pyrophylite and Tungsten
Onssa	Bauxite, Chromite, Coal, Dolomite, Fine Clay, Iron ore, Manganese ore, Nickel, Silimanite & Kyanite
Rajasthan	Asbestos, Barites, Copper ore, Kaolin, Limestone, Mica, Rock phosphates and Talc & Pyrophylite
Tamil Nadu	Fine Clay, Gypsum, Lignite, Magnesite, Mica, Talc & Pyrophylite and Silimanite & Kyanite
West Bengal	Coal, Dolomite, Kaolin, Lead, Zinc ore and Tungsten