IEI Centenary Publication

Prof S K Bose Memorial Lecture

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presented in

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8 Gokhale Road Kolkata 700020

Background of
Prof S K Bose Memorial Lecture

Prof S K Bose was born on October 07, 1900 in Burdwan district of West Bengal. After passing his matriculation examination in 1917, he was admitted to Presidency College, Calcutta and secured first position in his B Sc (Geology Honours) Examination in 1921. He continued his study in M Sc (Geology) for one year only. Later, he switched over to mining, joined the Sanctoria Colliery, and took apprentice training.

In 1923, Prof Bose joined the Royal School of Mines, London, under Government of India Scholarship. He passed the ARSM (Mining) examination in 1927 and was placed first in first class. During his period of study abroad, he travelled Europe and visited some large mines in Belgium, Netherlands, Germany and France. He joined as first Professor of Mining at Indian School of Mines (ISM), Dhanbad in 1927. Later, he became Head of the bifurcated Department of Metal Mining and Surveying. He devoted his entire career at ISM, Dhanbad and retired from there in 1956.

After retirement from ISM, he served NCDC in the capacity of Officer on Special Duty (Training) for one year. During his service at ISM, he visited many minefields in India as well as abroad. It is remarkable that most of his visits were undertaken at his own expenses. He visited Ceylon in 1932, South Africa in 1934, and Japan, North Korea, Mongolia and China in 1936 to observe important mines in those countries. He often used to contribute some state-of-the-art short notes to the local weekly 'The New Sketch'.

Through his publication in this weekly, he stressed the need for establishing a Government College of Mining Engineering, similar in status and model to the Royal School of Mines in England and Japan. This eventually led to a resolution being passed by Indian National Congress.

In another publication in one of the special issues of the same weekly on 'Mining and Civilization', he emphasized the importance of the part played by mining and geological education in the industrial development of the world and improvement of the social conditions of mankind. He expired on January 15, 1968.

In memory of his dedicated service, The Institution of Engineers (India) instituted an Annual Memorial Lecture in his name during the National Convention of Mining Engineers.

Prof S K Bose Memorial Lecture

presented during **National Conventions** of **Mining Engineers**

Challenges to Mining Engineers/ Profession

Padma Bhushan G L Tandon

Former Chairman, Coal India and Neyvelli Lignite Corporation

India is one of the few countries on which God has been very kind. Our country is gifted with plentiful natural resources, land, water, forests, minerals, human reserve and hospitable varying climates in different parts of the country. After gaining independence in 1947, we embarked on large scale economic development through heavy industrialisation.

Though a fairly good rail-road and communication network had been developed by our British Rulers-to suit their objectives; democracy and fairly well developed civil administration existed but there was hardly any industry in the country. The country adopted Parliamentary democracy, Secularism and Socialism as the vehicles/systems to develop our country and uplift the living standards of our people. Many other countries started much later and some had and some have even today severe handicaps of constraints on resources. Today, after 44 years of our efforts when we start comparing our progress with other IIIrd world countries in various fields and specific areas of our concern like coal, steel, transport and modern techno 1-ogy etc. we have to admit that we have slipped and something seriously wrong has gone somewhere. Statement based on London Economist Survey, placed at annexure - shows the disparities that have occurred in Nation's Basic needs at the grass root levels. We are facing the worst ever financial and Economic crisis and our currency has depreciated to rock bottom levels. Freedom and Independence therefore, becomes meaningless when we find ourselves bonded, helpless and heavily dependent at the mercy of others. We have badly slipped even in important areas of education, social and economic fields. We must therefore, peep inwards and do an honest soul searching as blaming and counter blaming, and taking shelter under alibis of delay in clearances resulting in time and cost overrun; power and raw materials inadequacy, transport constraints, indiscipline and lack of motivation etc. will not help anyone. It is no use befooling ourselves and getting solace by comparing with the worst. Forty four years mean upsurgence of two well grown adult generations and if is no small period for a nation which has survived inspite of centuries of foreign subjugation and exploitation. How is it that our young girls and boys on whom country is spending fortunes for their education and training are performing exceedingly well by contributing to the economic prosperity of other nations, but they find themselves totally helpless and frustrated in their own country. Does this not call for creation of an environment which breeds innovation, entrepreneurship, values, discipline, competence, efficiency and prosperity instead of ignorance, indiscipline, hypocrisy, redtapism, inefficiency, disparities, poverty and violence out of frustration.

Reasons extended for our inaction or poor performance are mostly alibies; are all due to manmade problems and we are ourselves responsible for their creation. If we have the will and determination, even now by making suitable adjustments and adopting proper techniques and systems etc. we can certainly remove these handicaps. For this purpose — we must always compare and compete with the best, and like for like and not get solace by relating failures and deficiencies of the worse and weaker developing nations.

As we are meeting in the steel city which has most modern plants of the SAIL family, it is appropriate that I should restrict my talk to Iron & Steel Industry specially related to the raw materials which go to make it.

Japan, South Korea, Europe and many other countries are deficient in raw materials and they are all compelled to import these from various parts of the world, shipping over thousands of kilometres after several handling and rehandlings at different points. We in India started well after our independence in 1947 with very few handicaps and we had all the advantages including vast reserves of good quality raw materials.

Crude steel production statistics of some countries given below show an interesting picture:

					Unit 000, tonnes	
Year	India	South Korea	Brazil	China	Japan	USSR
1947-48	01,254	N.A.	N.A.	N.A.	N.A.	N.A.
1960	03,148	00,050	N.A.	N.A.	022,138	065,295
1969	06,342	00,416	04,925	16,000	082,144	110,315
1975	07,991	04,377	08,387	23,903	102,313	141,325
1979	10,126	07,610	13,893	34,484	111,748	149,087
1981	10,780	10,753	13,226	35,604	101,676	148,517
1984	10,512	13,033	18,391	43,860	105,279	154,653
1986	12,197	14,555	21,233	52,208	098,275	160,537
1987	13,121	16,782	22,228	56,020	098,513	161,935
1988	14,309	19,118	24,657	59,200	105,681	163,046
1989	14,608					
1990	14,963			66,200		
1994-95	22,766\					
1999-		|Projections/Plans				
2000AD	28,030/			85,000		

Brazil and South Korea came on the world scene much later, China started both in steel and coal at par with us. Japan started with several handicaps after almost total destruction during the 2nd World War. Japan and South Korea depend almost entirely on imports. China has inferior ores though better quality coal. Inspite of several advantages to us-our coal and steel today are among the costliest in the wor1d which is mainly due to poor productivity of our mines and Blast furnaces and other units of the steel plants.

While we have remained complacement; Japan and many other countries were all the time engaged in improving their inputs, systems, technologies and techniques, with the result that they are today in a position to buy the best of raw materials from country of their choice, ship them in bulk ore carriers through large specially built ports at most economical freight rates, blend them in large stock yards at their end to ensure absolute consistency before feeding into their blast furnaces which have also been upgraded continuously to produce steel at the most competitive prices. I will quote the figures below from MMTC, which give a glaring contrast of end result in prices of raw materials supplied mainly by developing countries and steel/finished goods by industrialized developed countries.

Except for spurt in increase in mid-seventies due to oil crisis, prices of raw materials have all along remained suppressed, If depreciation in Dollar/Pound/Yen-rupee value is taken into account, it appears that raw materials are being supplied by poor nations to rich countries at a pittance. Yet there is a competition for sale of raw materials and huge investments and efforts are being made by developing countries to earn the needed foreign exchange by them. For India if we consider parity variations of 2 or 3 in the last 36 years, we find that to import same tonnages of steel/commodity from Japan or Europe etc. we have to export today 10- 15 times more iron ore or manganese ore than required to be done 36 years age. This also means we require 10-15 mines of same size or 10-15 times larger size mines of same number for buying the same equipment from these countries. This disparity is resulting, therefore in a regular flow of wealth from poor countries making them poorer to rich countries making them richer. It serves no purpose in blaming the rich countries for this despicable situation. Ultimately the solution lies in improving our own efficiency and making ourselves competitive by controlling our expenditure and costs. We can see how USSR and other socialist countries have made a complete volte-face. Laws of nature, "Survival of the fittest" "Economic and Market laws of Demand and supply", cannot be administered for long time by unrealistic theories, policies and systems.

Price indices of mineral inputs in steel (in absolute Dollars)

Year	Iron Ore	Manganese ore	Coking coal	Steel bars	Plates
1950	---	100	100	100	100
1954	100	112	100	170	116
1960	093	095	112	193	146
1970	076	059	165	231	170
1975	159	151	607	556	325
1980	139	171	623	861	505
1985	143	154	622	643	606
1986	145	151	592	861	---
Net increase 1950-86	45	51	492	761	506

Many countries have turned their problems into opportunities and their handicaps into tools of efficiency by realistic policies, sheer hardwork, dedication, sustained determination and astute global trading acumen. The net result of continuous efforts for improvements by heavy expenditure on Research and Development and other well integrated systems, team work within the Industry and joint coordination with government and other related agencies is evident from the following.

	Japan	India
1. Productivity of B.Fs t/m/day	2.3 - 2.8	0.6 - 1.0
2. Tap to Tap time in BOF/ minutes	30 - 40	70 - 100
3. Specific consumption p.t of crude steel (G.Cal/time)	4- 6	9 - 10
4. Coke rate in Kg.	400 - 500	700 - 1000

One 4000 cum Blast furnace operating in Japan, South Korea and other countries today produces more than 10,000 t of hot metal per day and is equal or more than total production of all 10 blast furnaces under SAIL at RSP (4), DSP(4) and IISCO(2).

Other areas of improvements relate to (a) About 70% of the Energy consumption in a steel plant is reported to be for iron making stage. (b) Each 100 kg coke rate reduction brings down the enery consumption by about 0.64 G.cal. (c) 1% reduction in T.I. reduces about 2.5% Lst. consumption. These countries are making persistent efforts to improve their rates of Energy Consumption, coke and flux rates and quality of end products. Some of the major handicaps faced by Indian Steel industry today are:

1. Inadequate preparation of the burden before feeding into the Blast furnaces.
2. Lack of consistency and consequential fluctuations in the quality of feed (both physical & Chemistry) to the Blast furnaces.
3. High ash in coke and its inferior coking characteristics.
4. High alumina content and adverse SiO_2/Alumina ratio in iron ores.
5. Higher upper sizes of ores and unsatisfactory ratio of upper and lower sizes
6. Too much of undersize in the feed adversely affecting the permeability of gases in the blast furnaces.
7. High total insolubles in the fluxes.
8. High alkali content in coke and fluxes.

Comparison of Indian with Japanese steel industry shows the seriousness of the above mentioned handicaps.

	Japanese	Indian
M-10 (%)	5-8	11-18
Coke Ash(%)	9-15	23-30
Sinter in BF (%)	85-100	0-65

Size & Fines

a) Sinter 5-50 mm (-5mm 3%)
b) Pellet 9-16 mm (-5mm 3%)
c) Sized Ore 10-25 mm(-3mm 3%)

Details for all the raw materials needed for steel making, present & projected for improvement are given in Annexure II & III

Alakli input to BF

Ideal -2.5kg PTHM	Kept within	TISCO = 3.7 - 4.0 Kg Bhilai/Bokaro = 4-5kg
Tolerable = 3.5Kg	2.5 kg i.e. ideal	Other SAIL plants = 6-9kg Typical Balance for
Bad + 3.5Kg		RSP SAIL is given at Annexure - IV.

We can see from these figures and those given in annexures that even the projected figures are much inferior to the present Japanese and other advanced nation's steel plants. How has this gap occurred?

Ego, complacency and misplaced optimism are our national character. History is full of examples when we have suffered, faced defeats and humiliation at the hands of foreigners due to complacency as we never kept ourselves updated and became less and less vigilant with the passage of time, leaving the results of our actions and inactions to fate and the Alimighty God. This is in vast contrast to our dealings with others. The same Japanese steel industry has made improvements by extracting better and better raw material supplied from the same India, Brazilian and other Developing Exporting countries. Huge investments have been made by India in Vizag, Madras, Murmugao, Paradeep and other ports. Kudremukh-Mangalore complex, Bailadila-Waltair, Bellary- Hospet-Madras railway road and other infrastructural systems have been developed by us starving several other important sectors to support the export effort for earning Foreign Exchange. How much investment has been made for the domestic raw material? Have the necessary steps been taken for making similar improvements in our domestic raw materials and steel industry? If Bailadila, Bellary, Hospet and Barajamda Mines can make adjustments over period to meet the changing requirements of steel plants of Japan and South Korea etc., why should not our domestic captive mines make the required adjustments for our own steel plants? As vast reserves of fluxes of high quality are also available in the country, improved quality supply of such materials to the domestic steel plants should not be an impossibility.

It is never too late to mend, Indian Steel Industry has already woken up and SAIL and TISCO have taken several steps to improve productivity and efficiency and make steel of high quality at internationally competitive prices. Huge investments have been planned for revamping and modernising of the existing steel plants. It has, however, to be understood that even the best of plant, technology and techniques will not yield optimum results, unless raw material feeds also improve. It is always cheaper to remove extraneous matter and impurities by physical and chemical methods outside the Blast Futnace than in the Blast/Arc furnaces as energy requirements are exorbitant and prohibitive in Pyrometallurgical processes.

Again unless consistency, both in sizes and chemistry and also undersize in the burden are controlled within narrow ranges, even best of the coke, iron ore and fluxes will not give the optimum results. Optimum preparation of B.F. burden is the key to its operational efficiency.

Investments In the mines and process plants upto delivery at the Blast Furnaces are, therefore, of fundamental importance. These investments are only a fraction of huge investments needed for steel plant for improvements in their production, productivity and costs. Captive Mines of Indian steel plants belong to first generation age and were developed in early sixties. Technology has undergone a major change and so are the demands on these mines. Modernisation of these mines and development of new mines by adopting modern technology, are therefore, of vital importance to produce and supply types and quality of ores suiting the needs of modern Blast Furnaces.

Creation of Raw Material Directorate in SAIL is, therefore, a major and bold step of great significance for which SAIL top Management deserves our praise and commendation. This organization when goes in its full stride can bring in far-reaching improvements, and help SAIL in its objective of becoming one of the most-efficient steel producing companies in the world. Before listing the challenges faced by Raw Material Directorate of SAIL and other Indian Steel plant raw material suppliers, functions of RMD-let us state the existing status of most of the captive mines as raw material sources of Indian Steel Industry.

1. Most of the mines started with scanty/inadequate information but over the years they have slowly but gradually equipped themselves with enough data to mine the ores in such a way that a properly blended feed can be fed into ore-dressing plants.

2. Well organised prospecting divisions are needed to have drilling, geological mapping and surveys in advance.

3. In the absence of in-house R&D labs and pilot plant, testing facilities and also matching mine planning and engineering setups, Steel Industry has total dependence on Government R&D labs and other outside agencies which are quite busy and take long time. Moreover testing is not a one time activity. A shelf of projects therefore, cannot be built thereby leaving little option to select the most economical mining project.

4. Ore Dressing Engineers are not available for operation of most of the ore processing plants, due to which lack of balancing in the ore circuits and erratic water flows cannot be easily corrected, resulting in deficiencies In operations and maintenance of such plants. Plant availability and Capacity utilisation are obviously low.

5. As steel plants ask for better and better quality ores from the mines and as mines and plants have not been updated, modified and modernised to meet these changing needs-selective mining becomes inescapable. Short term gains create long term problems. In private small manual mines, the damages to mineral conservation and resources can be very large which, with passage of time can create serious environmental and supply problems unless corrected well in time.

6. Induction of heavy Earth Moving Equipment without matching stores and workshops for repairs and maintenance, and inadequate after sales service from the suppliers have resulted in poor availability and utilization of mining equipment.

7. a) With the rapid advancement in mining, mineral and metallurgical technologies, fines of all sizes can now be used in the steel plants and all types of coal iron ore and other minerals can be beneficiated to produce high grade ores. Selective removal of $A1_2O_3$, SiO_2 and other extraneous detriments is possible today. But this can be done only by dedicated and sustained research work in R&D labs, pilot plant and demonstration facilities. Though sporadic & adhoc studies have been made in some labs, sustained work by and large has not been possible in the absence of such in-house facilities with SAIL and other large steel producers. There is also a need for closer co-ordination between the Educational and R&D Institutions with Mining and Steel Industries.

b) Similar remarks as of (7) above also apply to limestone, dolomite, manganese, refractory and other alloying minerals. Unplanned selective mining of mineral deposits to meet immediate needs can lead to faster depletion of these finite, wasting and non-renewable resources. Panic reaction and ad hoc purchases from large number of small mines can create more problems in future but hardly help in today's performance. Coal has been given massive doses of investments and is expected to do much better if performance of coking coal mines and washeries can be improved.

8. Induction of computers and modern communications in the remote mining areas have by and- large been lagging. Same is also true for other infrastructure, functional and social facilities so much necessary to attract talented, experienced and competent personnel for this industry.

9. Mines though produce basic raw materials including coal, responsible for major share in power generation, have not received the required priority for power supply. Requirement of power is small but lack of it has a multiplied adverse effect on the heavy investments in steel plants and down stream industries. Uninterrupted/captive power supply to the mines is as essential as for the steel plants, chemical and fertiliser industry.

10. Awareness for the Environment is a recent subject but it appears to have created widespread panic reaction and often misplaced priorities in our much needed economic development. Opening of new mines has received a serious set back and even existing mines are finding problems in continuing their operations optimally.

Mining and allied disciplines which include all disciplines working in the mines/plants, and related facilities therefore, face major challenges and have an uphill task in adjusting to the new environment and changed demands. I am fully confident that these challenges can be adequately met if a fraction of investments planned for modernization of Steel Plants is also reserved for the mining sector. Industrial development and modernisation is not a one time activity, but is a progressive and continuing dedication, team work and long term vision are needed to achieve the desired goals and objectives.

Indian Steel Industry and particularly SAIL and TISCO are today quite aware of these changing demands. Creation of Raw Material Directorate in SAIL will help in removing the isolation of Mining Sector. Like Japan and other industrialised countries with their captive sources spread all over the world-SAIL will continue to have its captive sources with the difference that mines will have a separate administrative set up like steel mills, Marketing, Personnel and Finance Divisions. Exposure to outside mining world will help in updating knowledge and technologies and give more freedom and flexibility of action. Pooling of resources and Central Prospecting, Research: Development and Planning activities will benefit all, give better sense of particitpation and pride of achievement to the mines in the larger SAIL family.

Before conclusion I must touch upon an important recent induction in the Steel Industry which can be easily emulated by Mining Community as they relatively more frequently come in closer contact with supervisors, crew and other workmen. SAIL has recently set in motion an important movement of Total Quality Management which has helped many companies all over the world to achieve excellence in quality of every activity. Need for its induction in mining sector cannot be over emphasized when major changes are taking place in its transformations for overall improvements of the Steel Industry. But let me caution about TQM/TQP as this needs to be handled carefully, lest it might cause more damage than do good. I will therefore, restate some essentials of TQM/TQP briefly as follows:

1. Quality Motto encompasses the entire spectrum of organizational activity in its "totality". It covers every person, every activity, every level-and all the time every time.

2. It always focusses on customers. For raw material producers, steel plants are the customers as consumers are ultimately their customers.

3. Employee involvement is a must which includes Top Management and their total commitment and involvement.

4. Mastery of process-which includes knowledge, expertise, experiences and competence. Employees' training is an essential feature of this.

5. Team work for which employees are encouraged to pool their specialised skills and work together, laterally, across job classifications and departmental boundaries.

It must be understood that TQM is not a set of problem solving technique, nor is it quality circles. It implies the reshaping of and organization through consequential changes in all related systems. It implies a change in attitude towards work, towards other employees and the ogranisation. An integrated company-wise programme of change is required. It encompasses the three joys of HONDA's concepts which are (i) Joy of production, (ii) Joy of selling and (iii) Joy of buying. It induces a real positive thinking. Due to vast resouces it has and the great potential it holds, the same London Economist has termed India as "Caged Tiger", which once set free, can be as healthy and vigorous as anyone else. They opine that India is an "Economic Miracle-Waiting to happen"- the proverbial "Sone Ki Chidya". As choice is ours, initiative also lies with us.

I am grateful to the organisers of this Convention of Mining Engineers for giving me an opportunity to share my views with you while delivering Prof. SK Bose Memorial Lecture. Prof. Bose was a highly respected teacher and known for his human touch, integrity, composure and subject perfection.

I am sure that with the calm but determined and dedicated approach followed by Prof. Bose, Mining, Geoloqists and other engineers working in the mines will face with courage the new challenges, overcome various constraints and bring in a silent beneficial transformation in the supply of Raw Materials which are the lifeline and base foundation of the Steel Industry. This will be the fittest tribute to our guru Late Prof. SK Bose.

Thanking you and Jai Hind.

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2. Paper on Steel Industry by Dr. B.N. Singh, GM, ASP at the above workshop.

3. Key note address by Shri Agarwal, CMD, MMTC at International Convention on Marketing of Minerals 14-16 February 1991.

4.PaperbyShriS.R. Ramakrishnan, Director (Commercial), SAIL presented at the International Convention on "Marketing of Minerals" -14-16th Feb, 1991.

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Annexure I

Extracts from London Economist's Survey - May 1991.

1. Industrialisation

In 1960s: Indian Industrial Output increased on average 5.5% per year and its manufacturing output by 5.2%

Pakistani growth was twice as fast at 10.8% per year

Thailand	"	11.5%	"
Taiwan	"	13.2%	"
South Korea	"	16.5%	"

In 1970s : The gaps between India and others increased as growth rates in India slipped.

In 1990s : Indian growth again picked up -

But over the past 30 years-India's development. strategy has been termed as unambiguous failure:

2. Agriculture & Green Revolution

Between 1970 and 1989, volume of farm output in India went up by 2.1% a year.

In Indonesia - increased by 3.7%

In Malyasia -	"	by 4.7%
In Philippines -	"	by 3.6%
In Thailand	"	by 4.5%

Thus while India's output went up by 40% - Malayasia and Thiland double during the same period.

Moreover India's green revolution got flawed as it was concentrated in few regions having higher education and physical insfrastructure base, thereby widening the income disparities between different regions and states.

Figures for 14 large states reveal that current spending on agriculture grew by 6% per annum in real terms during late 1970s but came down to 3% during 1980s. Capital spending increased by 2-3% in late 1970 but contracted by 2% in 1980.

3. literacy

a. Between 1960 and 1980 Literacy rose from 24% to 36% while Malayasi an rose from 23% to 60% and China rate was 77%.

Dropouts of children from schools by Sixth year in India was 66% while in China 40%

In rural India as a whole 80% women are illiterate while among the poorest in poorest states like Bihar in rural areas the figures are as high as 93%.

b. In 1970s central and state spending on education in India was less than 2.5% which has improved to 3% in 1987. Against this Thailand spent 4.2% and Malayasia 8.5%.

Within this expenditure while in Punjab it was 133% of the National average in Bihar, UP and MP it was only 60,69 and 76% respectively

4. Productivity Poverty

Further at the national level India's farm output

a. Barely kept pace with population growth which since independence is a out 2.1 %. Farm-labour productivity in India increased by less than 1% while in South Korea the increase between 1970 and 1985was 5% per annum.

b. Inspite of war on poverty India ranks seventh in progress of poverty. In 1970s, 300 million or 50% of population in India was regarded as poor-(based on income needed to sustain a healthy adult) and in early 1980s number of poor was still the same though % age fell to 40 with population increase. Decrease in poverty rate was roughly 1% a year-while in Indonesia between 1970 and 1987 the fall was 2.3% a year.

c. As per World Bank's latest available figures of 1985-420 millions in India(55%) were "poor" with monthly income less than $30, and 250 m (33%) were "extremely poor" with income less than $23. In comparison China's figures were 20% and 8%

d. 1951 (forty years ago)

Income levels in India and rest of South Asia were comparably low and all countries were as poor as India.

1991 (a) Average Income of South Korean are 10 times greater than of Average Indians.

(b) In Hongkong Average Incomes are 25 times higher than in India.

ANNEXURE-II

RAW MATERIALS QUALITY NORMS

(Average for all integrated steel plants)

	Raw Materials		Present	Projected for 2000 AD
1.0	IRONORE			
i.	Lump (BF)	-Fe%	62.0± 1.0	62.5± 0.5
		-SiO2%	2.0±0.5	1.5±0.25
		-Al2O3%	4.0±0.5	3.0±0.25
		Size	10mm to 40/50/75mm	8mm to 30 mm
ii.	Lumps-SMS and DRI	-Fe%	64.0±1.0	65.0 and above
		SiO2+Al2O3%	5% max.	4.0% max
		Size-SMS	+50 mm	+30mm
		Size-DRI	6-20 mm	6-20 mm
iii.	Fines-Sinter	-Fe%	60± 1.0	62.5± 0.5
		-SiO2%	2.5±0.5	2.0±0.25
		-Al2O3%	4.5±0.5	4.0±0.25
		-OS(+10mm)	10%max.	+8mm-10%max.
		-US (-1mm)	20% max.	40%max.
iv.	Fines-Pellets	-Fe%	65.0	65.0
		SiO2+Al2O3%	4%max.	4%max.
		Size	-10 mm	-10mm
2.0	LIMESTONE			
i.	BF grade/ sinter grade	-CaO%	42.0±1	44.0±1
		-MgO%	6.0±1	6.0±1
		-SiO2%	11.0±1	8.0 max
		-Size	-50 mm	-50 mm
ii.	SMS grade	-CaO%	49.0± 1	52.0± 1
		-SiO2%	3.0±1	1.5±0.5
		-Size	-80 to 25 mm	-80 to + 25 mm
3.	DOLOMITE			
i	BF Grade	-Ca0%	28.0± 1	29.0± 1
		MgO%	18.0±1	19.0±1
		-SiO2%	6.0±1	5.0±1
		Size	-50 mm	-50 mm
ii	SMS/RMP grade	-CaO%	29±1	+30%
		-MgO%	19±1	+20%
		-SiO2%	6% max	3% max.
4.0	MANGANESE ORE	-Mn%	24±2	25±1
		P%	0.06 max.	0.04 max.
5.0	COKING COAL			
i.	Indigenous washed	-Ash%	21±2	19.5 max.
		-VM%	24±2	24±2
		Moisture%	6±1	6±1
ii.	Imported	-Ash%	10 max.	10.0 max.
		-VM%	24±2	24±2
		-P%	0.1 max.	0.1 max.
6.0	NON-COKING COAL			
i.	DR grade	-Ash%	25-30%(unwashed)	22%(washed)
ii.	CDI grade	-Ash %	--	17%
iii.	KR grade	-Ash %	--	21% (VM 25%)
iv.	Boiler grade	-Ash %	35%	35%

ANNEXUREIII

SPECIFIC CONSUMPTION OF RAW MATERIALS

Raw Material	Unit	Present	Projected for 2000 AD
Blast Furnace			
Iron Ore Lumps	Kg/THM	925	350
Sinter	Kg/THM	815	1200
Pellets	Kg/THM	--	175
Limestone	Kg/THM	135	--
Dolomite	Kg/THM	032	--
Manganese Ore	Kg/THM	050	030
Coke	Kg/THM	830	600/670
Coal Dust injection	Kg/THM	--	50-100
Natural Gas	NM3/THM	--	080
Sinter Making			
Iron ore fines	Kg/t of sinter	810	800
Limestone	"	260	200
Dolomite	"	160	110
Coke breeze	"	110	075
Lime dust	"	Nil to 4 kg	020
Mill scale	"	018	020
Washed coal from raw coal	%	060	055
Gross coke from dry coal	%	076	076
BF coke from dry coal	%	067	067
BF coke from gross coke	%	087	087
Specific coal consumption	Kg/THM	1450	1100-1200
SMS grade	CaO%	49.0:1	52.0:1
Dolomite	SiO2%	3.0:1	1.5+0.5
	Size%	-80 to +25mm	-80 to +25mm

Annexure IV

TYPICAL ALKALI BALANCE FOR RSP, SAIL.

Material	Rate Kg/thm	Alkali %	Alkali Kg/thm
INPUT			
Coke	730	0.35	2.56
Fluxes	400	0.8	3.20
Iron Ore	1800	0.10	1.80
Mn Ore	65	0.65	0.42
Quartzite	6	0.30	0.02
		Total	8.00
OUTPUT			
Slag(B/A=0.90)	425	1.75	7.45
Fluedust	30	1.5	0.35
Misc. Losses	--	--	0.20
		Total	8.00

Mineral Development for Economic Growth and Environment Protection

Padmabhushan G L Tandon, *Fellow*

Former Chairman, Coal India Ltd., and Neyveli Lignite Corporation Ltd.,

When I was approached to deliver Professor S K BOSE Memorial Lecture, I accepted it with happiness and pride. Prof S K Bose was my Guru in Mining. He was Guru of all the "Mining Engineers who passed out of Indian School of Mines, Dhanbad, the premier Mining Institution of the country. His students were pioneers of the Indian Mining Industry and headed almost all the mining organisations of the independent India. I, therefore, deem it a great honour, being his student, to salute him in our traditional Indian manner with the sloka from our religious scriptures:

गुरु ब्रह्मा . गुरु विष्णु, गुरु देव महेश्वर
गुरु साक्षात . गुरु पार ब्रह्म तस्मै
गुरु देव नमः

Mining has been basic to all human activity and it has been the catalyst and engine of growth for progress of mankind. It is because of this that the famous Indian sage, Intellectual celebrity, Chanakya, called "Minerals - as the treasuries of the Nation – main source of the country". Mineral's direct contribution to the treasury may be very little in the form of royalty and cess, etc. but indirect contribution is to industrialization and economic growth. Mankind, from its evolution to the present modem world, has passed through thousands of years of slow but gradual progress. Minerals have played an important role in this progress either from stone age to bronze, copper and iron age to atomic and to electronic age or agriculture society to industrial society and now to electronic society. Large number of minerals which inhabit this planet make for almost all the material activity mankind performs.

One, therefore, wonders why mining is blamed and sometimes treated akin to a criminal activity forgetting the History of Mankind's development and progress over thousands of years. Who is to blame? There is a big change alround in our thinking, attitude, and activities which over a period have become highly complex and sometimes self-contradictory. Students of PROF S K BOSE have seen a different world wherein mining was respected and Mining Profession received a priority among many avocations, with young rind bright citizens of India choosing to join.

Mining today is under attack, is facing severe criticism and requires determined efforts to convince that mining is essential for the Nation's economic growth and sustained development. Some of the factors which eclipse and bring bad name to the mining are briefly:

a) Setback to underground mining

b) Electronic age and white collar jobs

c) Unbalanced growth of open cast mining by unplanned and unsystematic activities.

a) Setback to Underground Mining: In spite of huge investments, production from underground mines in our country has shown negligible growth. In fact, in some cases, e.g., gold and coal, growth has been negative. Mineral occurrence is all-pervasive. Many of them occur near the surface, called outcrop, and continue deep into the earth. While most of the important minerals are amenable to opencast mining, there are many which have to be extracted by going deep into the ground. Underground mining, though difficult, risky, and costlier becomes inescapable, Moreover, quality of minerals including coal is generally better below the earth. Out of 67% coal reserves between 0-300 m, hardly 30% or even less is available for opencast mining (Annexure .. .). As only 25-30% of coal is economically available for surface mining which is easier and cheaper to mine, we are having serious imbalance in our coal production and this is unfortunately with the passage of time.

We had in fact an advantage over China as our underground mining was much more advanced with British Technology and several British and Indian Companies were operating many underground mines some of them with very difficult mining conditions. The picture today, unfortunately, is different. China is world's largest coal producer with production of about 1200 million tonnes and large tonnage of which is from underground (Annex). In our case, increases are in open cast mining and underground production of coal in India has come down from a maximum of 65.83 mt to 56 mt per annum in spite of huge investments and borrowing up technology from many foreign countries even from those who have only a fraction of our coal production. The small increase in underground production has been mainly in Singareni Collieries Co. Ltd., The tragedy is that very few will like to work in underground coal mines, as there is no incentive for the difficult and risky profession but has all the disincentives and handicaps in the professional career (Annex.). As India's total coal reserves are over 0.8% of the World's total reserves and India's population is 16%, space only 2.5%, per capita reserves being very low should be a matter of concern for all of us. There appears to be a complacency about the vastness of our coal reserves which are also of low grade.

b) Given the option and chance, Mining Engineers will like to go for white-collar jobs. This is, therefore, resulting in lot of brain-drain to white-collar jobs as most will like to work and remain on the surface as with lesser risks, there are better promotional avenues.

c) Imbalance due to the open cast mining and Impact on Environment: As I stated above, imbalances have taken place in production of some minerals. Mining is today invariably related to all environment and ecology degradation and this is mainly because of opencast mining. There is no denying the fact that mining disturbs the ground and all that grows and stands above it. More opencast mining, therefore, means more area disturbance. Quality of coal has also deteriorated gradually with increase in open ca. mining since nationalization. As many minerals occur in thickly-forested and ecologically sensitive areas, opencast mines directly disturb and cause damage and destruction if not operated scientifically and systematically.

Environment protection is a recent subject and the following Indian laws were passed for this purpose:

1) The Water Prevention and Control of Pollution Act 1974 and Amendment Act 1978
2) The Water Prevention and Control Cess Act 1977 and Water Cess Rules 1978
3) Forest Conservation Act 1980 - operative October 1980
4) The Air (Prevention and Control of Pollution) Act 1981 and Rules
5) Environment Protection Act 1986 - Operative November 1986
6) Mines and Minerals (Regulation and Development) Act 1987 operative Feb 10, 1987.

Based on Environment Impact Assessment (EIA), Environment Management Plans (EMP) becoming an integral part of the mining plans and strict enforcement of systematic and scientific planning and implementation, mining is no more a danger to the environment. Damage to the ecology in the past has taken place due to lack of legislative guidelines and controls. In the recent past, particularly in the latter half of 20th century, damages to environment are from the pressures of population and unorganised sector and not from the organised industries as violation of laws provide penalties which are a good deterrent to the professionals and owners (Annexures). Population Trends: Population increased by only 13 millions during 20 years 1901-21,67 millions during 1921-41, 121 millions during 1941-61, 246 millions during 1961-81, and 212 millions in only 12 years upto 1993 end. While India occupies only 2.5% space of the world, it has a population of 160%. The dangers of unchecked growth in population are quite visible as all gains of development since Independence have been nullified and we are almost at the bottom in the list of countries of the world as seen from the graphs annexed.

Census Year	Total in million	Av. Annual Growth Rate %	Present
1871	209.0	including Pakistan & Bangladesh	-
1901	238.3	0.30	India only
1911	252.0	0.56	"
1921	251.2	0.03	"
1931	278.9	1.06	"
1941	318.5	1.34	"
1951	361.0	1.24	"
1961	439.1	1.98	"
1971	548.2	2.20	"
1981	685.2	2.25	"
1988	780.0		"
1993	897.4		"
Jan 1994	900.00		"

A good comparison is available from the statement (Table …) which clearly shows that deforestation has been much lesser in the mineral-bearing States like Bihar, Madhya Pradesh, Orissa, etc., Statistically speaking, the following Table will give an idea of the extent of extinction of forest cover in India. It will be revealed from the Table that the top five States including Union Territories which witnessed an alarming rate of depletion of forest area during the seven-year period were Punjab and Chandigarh (-55.4. per cent), Rajasthan (-47.1 per cent), Haryana (-47.0 per cent), Gujrat (-46.S per cent), and Delhi (-44.4per cent) where destruction of forests could hardly be attributed to mining industry.

FOREST IN INDIA - STATEWISE

(Area in Km^2)

State/Union Territories	1972-75	1980-82	Percentage change
Andhra Pradesh	40949	40433	-17.6
Assam	21055	19796	-16.0
Bihar	22687	20139	-11.2
Gujrat	9459	5057	-46.5
Haryana	757	401	-47.0
Himachal Pradesh	15075	9130	-39.4
Jammu & Kashmir	22333	14361	-35.1
Karnataka	29480	25655	-13.0
Kerala	8611	7376	-14.3
Madhya Pradesh	108568	90215	-16.9
Maharashtra	40682	30350	-25.4
Manipur	15090	13572	-10.1
Meghalaya	14390	12458	-13.4
Nagaland	8154	8095	-0.7
Tripura	6330	5138	-18.8
Orissa	48383	39425	-18.5
Punjab & Chandigarh	1120	499	-55.4
Rajasthan	11249	5972	-47.1
Tamilnadu	16676	13187	-20.9
Uttar Pradesh	25869	21022	-18.7
West Bengal	8347	6483	-22.3
Sikkim	1761	2883	63.7
Arunachal Pradesh	51438	58104	13.0
Delhi	18	10	-44.4
Goa, Daman & Diu	1221	1139	-6.7
Mizoram	13860	11971	-13.6
TOTAL	551709	462873	-16.4

As per World Resource Institute, nearly 11 million hectares of tropical forests, larger than Austria and many other countries, are lost every year. In India, roughly 83 million hectares constituting 23 per cent of the country's land, are under forest cover, but hardly half of said area is under forests having actual, "tree cover".

Approximately, 1.3 million hectares of land were losing tree-cover every year.

Out of every lost hectare of Forest cover in India every year,

0.71 % is lost by agricultural projects
0.12% claimed by river valley projects
0.04% claimed by new industries
0.02% claimed by roads and communications
0.11 % claimed by other miscellaneous purposes

Top five States including Union Territories where alarming rate of depletion of forest took place between 1972-75 and 1980-82 were:

i) Punjab and Chandigarh 55.4%

ii) Rajasthan	47.1 %
iii) Haryana	47.00%
iv) Gujarat	46:5%
v) Delhi	44.4%

In these States, destruction of forests could hardly be attributed to mining industry. Mining areas constitute less than one per cent of the total area of the country and out of this actual work covers 5-10 per cent or so.

ANNEXURE-IV

	Millions of Acres
Agriculture	
Cropland	413.0
Grassland pasture, and range	985.7
Forest land grazed	179.4
Farmsteads, farm roads	10.9
Total, agriculture	1589.0
Wildlife refuge system	88.7
National park system	77.0
Urban and built-up areas	68.7
Forest Service wilderness	25.1
Highways (1978)	21.5
Mining	5.7
Airports (1978)	4.0
Railroads (1978)	3.0
Others	388.1
Total, all uses	2270.8

Source: U.S.Bureau of Mines, 1982 - Published in Chapter 10 on 'Environmental Regulation' in the Book "AT THE CROSSROADS" THE MINERAL PROBLEMS OF THE UNITED STATES. By Eugene N.Cameron.

LAND USE CLASSIFICATION IN INDIA - 1984-85

(Figures in'000 hectares)

1.	Area under forests	67,157
2.	Net area sown	140,715
3.	Other uncultivated land (excluding fallow land)	31,057
4.	Fallow land, including current fallows	24,915
5.	Area under Barren and uncultivated land	20,068
6.	Area under non-agricultural uses	20,408
7.	Total reporting area	304,320
8.	Total geographical area	328,726

Source:- Land Use Statistics (Part I) - Land Use Classification and Irrigated Area 1983-84 to 1984-85 (Provisional), as on 1.1.1988, prepared by the Ministry of Agriculture, Department of Agriculture and Cooperation, Directorate of Economics & Statistics.

Mining Activity in most of the cases helps in upgradation of the environment in addition to winning of mineral wealth for economic growth and prosperity of the nation. There are umpteen number of examples, such as (1) Neyveli Lignite Corporation Ltd. - by utilising water available under pressure during mining, the arid district of South Arcot has turned into lush green-fields, rich in agriculture produce. NLC's areas look like thick forest if an aerial view is taken. (2) Kudremukh Iron Ore Company Ltd., in addition to the well-planned township and tree planting alround, the bare hills of Western Ghats are being turned into thick forests by planned massive tree planting by the State Forest Department. This became possible as KIOCL immensely improved this regions communications which prior to their entrance was highly inaccessible. (3) Lambidhar Limestone Mine in the Himalayas near Mussoorie is an interesting case-study. . . There are extensive occurrences of high quality limestone along Himalayas in Himachal and Uttar Pradesh. Many places around Mussoorie were spoiled by unscrupulous small mine owners and contractors by haphazard mining of limestone with hardly any check and control. Some of the places became ugly scenes and seriously threatened the ecology and environment of all mining activity except giving a few some more time. Most of the Limestone hills like Lambidhar are bare devoid of any thick or perennial vegetation. Lambidhar mine belonging to U.P. State Govemment has adopted a well-planned Environment Management Plan as an integral part of their limestone mining. After mining of the rich limestone, layer by layer, the benches are levelled, covered with fresh soil and then planted with trees, grass, and shrubs which by research have been: found to grow in such ground and climate. The result is that Lambidhar hill will have better environment due to thick planted vegetation, the rich high-quality mineral would also have been recovered for the benefit of country's industrial and economic growth.

Why can't this be done to other mineral-bearing hills of Himalayas. Instead of two extremes of reckless damage to environment by unplanned and haphazard mining and blanket ban on mining activity, NMDC and some coal projects also take special care for environment protection.

I have deliberately not touched about warnings and projected disasters due to 'Hole in the OZONE LAYER' warming of our planet due to "Green House" effect, etc., as there are theories which present entirely a new perspective on these predictions. In this book, "THE SELF ORGANIZING UNIVERSE", Erich Jantsch has stated, perhaps we are worrying too much about the distortion of equilibrium due to impact of technology. We should, 'On the other hand, worry about distortion in the non-equilibrium. However, we cannot estimate which factors in the Gaia system easily readily just themselves and which fluctuations touch sensitive points and might lead to a new auto-poietic structure-which imply a new biosphere". This statement is in total contrast to the prevailing view of environmental problems which are worrying all of us.

Gaia system is the combination of Biosphere and Atmosphere. Biosphere is the entire living creation that is on the earth, in the Ocean, and in the attached atmosphere. The atmosphere is the combination of oxygen; carbon dioxide, nitrogen, and other gasses which envelope the planet earth. According to Jantsch, most of the problems of environment including pollution, raised by the concerned scientists and activists seem to be manageable. The concern according to him is due to the massive induction into the Biosphere/Gaia system, of several kinds of technological structures by societies and civilizations over long periods of history, particularly in the last two centuries. Human-designed technology system, represent a world of equilibrium structures while all nature is a non-equilibrium system. We are therefore, introducing equilibrium structures into non-equilibrium gaia system.

All living systems, contrary to non-living man-designed structures, are couples which are characterized by self-organisation, disorder, irreversibility, nonequilibrium emergence and evolution. The problem of environment or ecology according to Eric Jantsch which should cause concern, is not what is normally understood but is the problem of introducing a non-evolving, nonliving, non-self-limiting, non-self-organising systems into a live evolving nature. Present approaches according to Jantsch, to ecology and environment have only managerial intervention effect on limiting fluctuation/damage in our present parlance. In this, we are pursuing the simplistic solutions of population control as short-term solutions. However, when we look at the chaos in all areas of human activity around the globe, the world is either self-organised critically or in the edge of chaos with a new dissipative structure emerging or at the start of series of such structures leading to a stable structure. It is possible that Gaia system may establish its harmonious existence by throwing up land masses and vegetations and regain the original level of non-equilibrium. If this happens, it may mean massive earthquakes, changes in land mass-ocean ratios, changes in earth's rotation speeds and exist deviation, Jantsch, however, lays emphasis on the Human and evolution of a "Mind" by which Human beings are more sober, less consumerist, less desire-oriented, pragmatical idealist style of life. This is what our scriptures have taught since ages and a vedic seer echoes when he sings".

"DHYATIVA PRITHIV, DHYATIVANTARIKSAM"
DHYATIVA DYAK, DHYANTIVAPO,
DHYANAITVA PARVATA"

The earth is meditating, the mid-region is meditating, the Akasa is meditating, Water is meditating, the mountains are meditating. Then adds:

"PRITHVI SANTI, VANASPATAYAH SANTI
AUSRADHVYASANTI, SANT REVA SANTI"

(May Earth be-Peace; May the Trees be Peace, May the Healing Plants Be Peace, May Peace be Peace).

Let us also meditate and sing –

Mata Prithvi - Mother Earth
Be Kind, Shake not and Shiva,
Let the prodigal may sink and suffer
May you lead us to pragmatic light'.

Minerals are wasting and non-renewable resources but treated as source of treasuries. Minerals, therefore, need to be conserved by judicious planning, scientific and systematic mining, recycling and development of substitutes, reckless usage/wastage and non-exploitation are the two extremes and, therefore, call for a balanced approach.

Mining of minerals is essential for all development activities which lead to economic growth and generation of wealth, which is again the fundamental need for all our activities. However, economical development based on unsustainable resources use cannot continue indefinitely without endangering environment and carrying capacity of the planet. Old growth patterns prior to the enforcement of legislative measures and economic disciplines, therefore, have to change to ensure integrity of the national systems that sustain the life on earth. To achieve sustainable growth i.e., growth consistent with needs and constraints of nature and without damaging the needs and requirements of future generations, it is necessary to establish links between economical and environmental policies at all levels. Government, Society Technical and all Sectors of the economy. In India this awareness came from the scriptures and became a part of our daily living and culture.

Conservation and preservation are an integral part of Life's existence and continuation. Nature is raised to the level of god and invoked to remain in place and harmony with the animate and inanimate. Vedic though "Sayyam" (Restraint) in senses, actions, and thought so that conflict never occurs. Man, Nature and animal are to be in harmony with each other.

There was no question of rehabilitation as there was a continuous state of adjustment to the disturbance that emanates from Growth. They described divinity to earth, sky, air, trees and water and worshipped them refreshing from polluting them in any manner. The ancient thoughts recognised both the complexity and inter-dependence of the Natural system. I quote from Bhagavadgita (IIrd canto 14 and 15 verses)

"Anand Bhavanti Bhutani
Parjanyad Annasambhavah
Yajnad Bhavati Parajanyo"
Yajnah Karmsanudbhuvab

which means:

'Living creatures come into being from food
Food comes into being from rain
Rain comes into being from sacrifice
Sacrifice comes out of work"

He who does not, in this world, help to turn the wheel thus set in motion, is evil in his nature, sensual in his delight, and he lives in vain"

Many sages and World Leaders have repeatedly said that "We should adopt such lifestyles that we leave the World in the same manner if not better for the posterity."

In harmonizing economic growth with environmental protection and upgradation, we have to recognise that just as economic benefits flow from healthy natural systems, there are also environmental benefits to the growth. Recognising this many environmentalists today are working creatively towards policies that serve long-term interests of both the environment and economy.

Economic growth raises expectations and creates demands for environmental improvement. On the scale of Human needs as income levels and standards of living rise, and people satisfy their basic needs for food, shelter and clothing, they then pay attention to quality of their lives and the condition of their habitat. The correlation between rising income and environmental concern holds as true among nations as it does among social groups. The developed and highly industrialised countries with stronger economics and higher average standard of living, are spending more time and resources to better their environment than lesser developed countries with comparatively weaker economies.

Our Late Prime Minister, SMT. INDIRA GANDHI observed at the World's First Top Level Conference on "Environmental at Stockholm in 1972 that "Rich countries may look upon development as a cause of environmental destruction, but to us, it is one of the primary means of improving the environment of living, for providing food, water, sanitation, shelter; of making deserts green and mountains habitable".

Several developing countries, mired in poverty, struggling to stay in step ahead of mass starvation have, therefore, little time and even less money to devote to environment protection. Economic growth by generating wealth can, therefore, mitigate these resource constraints and environmental pressures in developing nations of the third world and can help these nations in two closely related ways. Economic development helps in reducing the poverty and in stabilising the population. Population growth is highest in the developing countries.

In our country, growth and rise of wealth in almost all fields, have been nullified by unchecked growth in population. China with larger population but slower and controlled growth of population has very low poverty levels and people below the sustenance levels. Education and economic development are the secret paths to stabilising growth and also in reducing poverty. As countries grow economically supported with education, their fertility rates tend to decline and these directly help in creating demands for better living standards and environmental improvement. These are all inter-related as healthy natural systems are a since-qua-non - for all human activity, including economic activity. Ultimate aim, therefore, should be for sustainable eco nomic growth which should pay for the technologies and clean up and thus become engine for the environmental protection.

Technology, like growth, can be a mixed blessing. Development of cleaner and environmentally benign technologies is to be aimed at in the transition to sustainable pattern of economic growth. Technology has alerted us to its adverse impact on the environment. Some of the examples are:

i) Industrial and Transportation Technologies heavily dependent on fossil fuels, non-renewable minerals and other resources for raw materials contributing substantially to urban pollution and environmental disruptions

ii) Widespread use of substance like (CFCs) Chloro fluorocarbons like Ozone depletion

iii) Massive deforestation, usage of fossil fuels - increase in CO_2 levels and warming up of the plant

iv) Usage of asbestos, lead, and synthetic organic chemicals.

All of these are hazardous to human health' and environment or both.

We need a new industrial revolution in which "Green Technologies" become central to the economic growth and sharply reduce pressures on the natural environment, biotechnology, space satellites and sensors have a great role to play. Development of substitutes for CFCs, "Telecommunicating, Miniaturization, Fibre Optics, replacement of machines and Equipment by more, efficient and less polluting ones, evolution of energy by clean coal technologies, competitive and non-polluting renewable energy technologies, viz., photo-voltaic solar cells, etc.

To sum up, we must understand that poverty and population growth are major pollutants of ecology and environment. Economic growth and rise in the living standards of the people have direct beneficial impact on both reduction of poverty and population growth.

Exploitation and judicious usage of minerals are basic to economic development and industrialization. Sustained development over long periods is possible only if environmental protection is ensured. Health, environment and sustained development have, therefore, as much benefits for economic growth as economic development has for the environment protection. They are two sides of the same coin and hence are inseparable. Mining community also must understand that scientific and systematic mining is essential for judicious exploitation and usage of minerals which have a fine life, being non-renewable and wasting assets. Let us, therefore, follow a slogan "MINERAL DEVELOPMENT FOR ECONOMIC GROWTH AND ENVIRONMENT PROTECTION AND UPGRADATION".

This will be a fitting tribute to the noble soul of great- Professor S K BOSE to whom mining owes a lot.

"JAI HIND"

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Annexure - 11

India is assessed on 1.1.93 to have 194 billion tonnes of coal in seams 0.9m and above in thickness and down to a depth of 1200 m. This is a little over 1% of the global coal resources.

Of the total coal reserves of 194 billion tonnes, 85% is of non-coking variety and only 15% is of coking variety. Further, 33% of reserves fall under the "Proved" category, 44% in the "Indicated" category and 23% in the "Inferred category". Mineable meseavable are much less and still less economically.

STATEWISE & DEPTHWISE RESERVES

State	(Million Tonnes)			Total
	0-300	300-600	600-1200	
West Bengal	11999	8933	4191	25123
Bihar	40079	17626	6666	64371
Madhya Pradesh	32638	7433	14	40085*
Maharashtra	4590	1686	-	6276
Orissa	35015	11167	37	46219
Andhra Pradesh	5245	3876	1717	10838
North Eastern Region	710	155	-	865
Total	**130276**	**50876**	**12625**	**193777**
Percentage	**67**	**26**	**7**	**100**

* Includes 1062 mt of Uttar Pradesh. Coal Reserves amueable to opencast are approximately 25-30%.

REFERENCE

Coal Atlas of India - 1993

CMPDIL - Publication

Annexure - 11a

TYPEWISE COAL RESERVE

Type of coal	Depth (m)	(Million Tonnes)				Percet-age of Total
		Proved	Indicate	Inferred	Total	
Prime Coking	Upto 600	3716	323	-	4039	
	Above 600	512	749	-	1261	
	Total	4228	1072	-	5300	2
Medium Coking	Upto 300	6786	4705	459	11950	
	Above 300	3043	6737	782	10562	
	Total	9829	11442	1241	22512	12
Semi to weekly coking	Upto 300	340	111	-	451	
	Above 300	94	782	221	1097	
	Total	434	893	221	1548	1
Non-coking	Upto 300	43351	48872	21901	114124	
	Above 300	7011	22634	20648	50293	
	Total	50362	71506	42549	164417	85
Grand Total		**64853**	**84913**	**44011**	**193777**	**100**

Coal Reserves amenable to mining are approximately 25-30%.

REFERENCE

Coal Atlas of India - 1993
CMPDIL - Publication

Annexure - 11b

WORLD HARD COAL PRODUCTION[1]

(Million Tonnes)

	1973	1980	1985	1989	1990	1991*	Rank in 1991
USA	530.1	710.2	738.8	311.3	853.6	822.5	II
Ex USSR	510.6*	553.0*	726.7	740.3	703.6	629.0	–
Georgia			1.7	1.2	1.0	1.0	–
Kazakshtan			130.8	138.1	131.3	130.0	IX
Kyrgyzstan			4.0	4.0	4.0	3.5	–
Russia			395.2	410.0	395.0	353.0	III
Tajkistan			1.0	0.8	0.7	0.3	–
Ukraine			189.0	180.0	165.0	136.0	VIII
Uzbokistan			5.0	6.2	6.0	5.9	–
China	417.0	620.0	872.3	1054.0	1066.0	1056.0	I
Poland	156.5	193.1	191.6	177.4	147.5	140.7	VII
U.K.	132.0	130.1	94.0	101.1	92.9	96.1	X
Germany	104.6	94.6	90.2	78.1	76.6	72.7	XI
India	78.2	114.0	154.2	198.7	209.5	222.0	IV
S. Africa	62.4	115.1	169.8	168.8	174.5	177.4	V
Australia	55.5	72.4	117.5	147.8	159.4	168.1	VI
N. Korea	30.0	36.0	39.0	40.5	40.5	40.5	XII
Total World	**2247.2**	**2813.6**	**3396.8**	**3724.3**	**3712.8**	**3543.1**	

1. Source : Coal Information, 1992
2. Source : IEA/OECD Statistics
3. Source : Goskomstal, Moscow

* Figures relate to washed coal production.

REFERENCE

Coal Diary - 1994

Annexure - 12

WORLD COAL RESOURCES

Marvee A.K. (1976) made an excellent map showing about 2100 coal basins in the world of 30 million tonnes of which 60% occur in Asia, 27.3% in America. 7.4% in Europe, 2.7%.

Country	Economically recoverable hard coal	Economically recoverable lower ranks	Measured reserves all ranks	Total resources all ranks	Percentage of world resources
Total World	487996	410790	1963808	13609298	100
North & Central America	108990	120759	415728	4077349	30.0
United States	107183	116076	397657	3599657	26.4
Canada	1607	4299	16091	474412	3.5
Mexico	1200	384	1980	3280	0.1
South America	1359	2255	5531	50222	0.4
Brazil	189	924	1590	15807	0.1
Colombia	1010	25	2073	10063	0.1
Others	160	1306	1868	24352	0.2
EX USSR	104000	129000	276000	5926000	43.5%
Europe	100532	11803	445131	904833	6.6
Germany	23991*	60150	99000*	3153000	2.3
Poland	27000	12000	76000	184000	1.4
United Kingdom	45000	--	45000	149500	1.1
Czechoslovakia	2700	2860	12950	20090	0.1
Others	1841	42993	212181	235943	1.7
Asia	113926	5275	665744	1648918	12.1
China	99000	--	600000	1465000	10.8
India	12610	1588	22634	114034**	0.8
North Korea	300	300	2300	7200	0.1
South Korea	116	--	182	1231	0.1
Others	1900	3387	40628	61453	0.3
Africa	32754	1382	72641	217897	1.6
South Africa	25290	--	58749	92511	0.7
Zimbabve	734	965	2500	8310	0.1
Others	6730	417	11392	117076	0.8
Oceania	25435	34116	83111	784079	5.6
Australia	25400	83940	82900	779900	5.7
Newzealand	35	176	211	4179	0.1

* East Germanh figures not included ** 194 billion tonnes hard coal and 19 billion tonnes

Source : World Coal, Vol. 8 No. 6 Nov./Dec. 1982.

India occupies only World's total population and only 0.8% of Total World Coal reserves Eco, Mineable are still less.

Ref. : Coal Atlas of India - 1993.

Annexure - 13a

COAL PRODUCTION BY COAL INDIA COALNATIONAILISATIONIN1971-72

(Figures in million Tonnes)

Year	Open Cast	Underground	Total
1974-75	20.77	58.22	78.99
75-76	23.77	65.21	83.96
76-77	23.65	65.83	89.48
77-78	24.91	64.05	88.96
78-79	28.92	61.13	90.05
79-80	32.31	59.13	91.44
80-81	39.96	60.90	100.86
81-82	45.67	63.27	105.94
82-83	53.56	61.12	114.68
83-84	60.02	61.30	121.41
84-85	70.31	60.50	130.81
85-86	74.17	59.94	134.11
86-87	54.67	60.07	144.74
87-88	99.99	59.04	159.03
88-89	110.20	61.27	171.62
89-90	119.91	58.71	176.62
90-91	133.54	56.10	181.64
91-92	147.51	56.63	204.14
92-93 March	154.34	56.85	211.19

% of U/G to Total is gradually declining

REFERENCE
Coal Diary - 1994

Annexure - 13b

OPENCAST AND UNDERGROUND

The most significant analysis of the production growth is based on the type of mining viz., opencast or underground. Table gives the distribution on this basis.

TREND OF COAL PRODUCTION IN INDIA FROM OPENCAST AND UNDERGROUND

(Million Tonnes)

Year	Open Cast	Underground	Total
1973-74	19.80	58.37	78.17
74-75	24.77	63.64	88.41
75-76	28.44	72.54	101.03
76-77	28.49	72.54	101.03
77-78	30.60	70.38	100.98
78-79	33.84	68.13	101.97
79-80	39.50	64.50	104.00
80-81	40.75	73.26	114.01
81-82	47.19	77.10	124.29
82-83	55.82	74.80	130.62
83-84	62.75	75.53	138.28

There has been a phenomenal increase in the production from opencast mines in the post-nationalisation era. As a matter of fact, the entire growth in generation of thermal electric power is based on the increase of the opencast sector which has received heavy doses of investment. U/G Production in Coal India has remained stagnant and U/G% to Total has gradualy declined.

REFERENCE

Coal Mining in India - 1984.
CMPDIL - Publication

Annexure - 13c

COMPANYWISE - COALFIELDWISE - MINEWISE (O/C & U/G) COAL PRODUCTION 1992-93

(Million Tonnes)

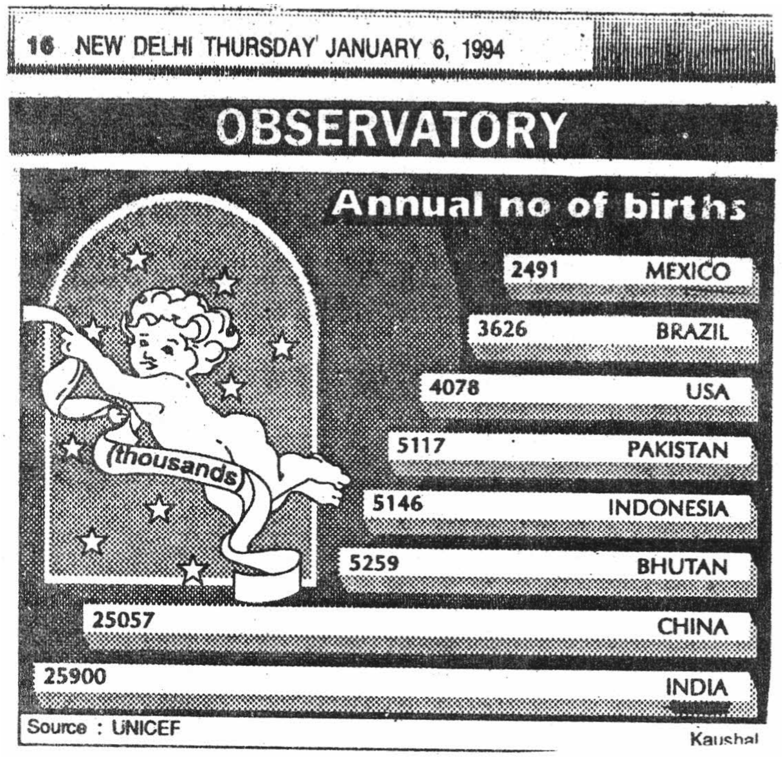
Company	Coalfield	Total No. of U/G Mines	Total No. of O/C Mines	Total No. of Mixed Mines	Total No. of Mines	Production million tonnes			
						Total from U/G Mines	Total from O/C Mines	Total from Mixed Mines	Grand Total
ECL	Raniganj	101	24	1	126	14.969	4.034	0.030	19.033
	Rajmahal	–	1	–	1	–	3.868	–	3.868
	Chuperbhite	–	1	–	1	–	0.031	–	0.031
	Saharjuri	–	1	–	1	–	1.118	–	1.118
Total		101	27	1	129	14.969	9.051	0.030	24.050
SECL	Sohagpur	28	5	–	33	5.998	3.591	–	9.589
	Johilla	4	–	–	4	1.175	–	–	1.175
	Umaria	1	–	–	1	0.155	–	–	0.155
	Chirimiri	6	5	–	11	2.466	1.486	–	3.952
	Bisrampur	5	2	–	7	1.421	1.331	–	2.752
	Sonhat	4	–	–	4	1.213	–	–	1.213
	Korba	5	6	–	11	1.754	25.360	–	27.114
	Mand-Raigarh	2	–	–	2	0.087	–	–	0.087
Total		55	18	–	73	14.269	31.768	–	46.037
WCL	Wardha Valley	9	14	–	23	2.256	13.008	–	15.264
	Kamptee	7	1	–	8	1.961	0.402	–	2.363
	Pench Kanhan	19	6	–	25	2.571	1.028	–	3.599
	Umrer	–	1	–	1	–	2.052	–	2.052
	Pathakhera	7	–	–	7	2.475	–	–	2.475
Total		42	2[illegible]	–	64	9.263	16.490	–	25.753
NECF	Makum	3	1	–	4	0.712		–	0.712
	Dilli-Jaypore	1	–	–	1		0.368		0.388
Total		4	1	–	5	0.712	0.388	–	0.388
NCL	Talcher	4	7	–	11	0.550	14.785	–	15.335
	Ib	6	5	–	11	1.361	6.448	–	7.809
Total		10	12	–	22	1.911	21.233	–	23.144
CL		–	10	–	10	–	30.703	–	30.703
Total		–	10	–	10	–	30.703	–	30.703
BCCL	Raniganj	6	1	–	7	1.292	0.202	–	1.494
	Jharia	60	12	13	85	13.309	7.753	5.502	26.564
Total		66	13	13	92	14.601	7.955	5.502	28.058
CCL	S. Karanpura	5	2	8	15	0.697	0.795	3.871	5.363
	N. Karanpura	2	4	1	7	0.477	6.304	1.221	8.002
	Daltonganj	–	1	–	1	–	0.395	–	0.395
	Hutar	1	–	–	1	0.015	–	–	0.015
	Ramgarh	–	1	–	1	–	2.821	–	2.821
	W. Bokaro	2	7	6	15	0.254	1.604	1.590	3.448
	E. Bokaro	–	6	7	13	–	6.661	5.275	11.936
	Giridih	–	1	–	1	–	0.400	–	0.400
Total		10	22	22	54	1.443	18.980	11.957	32.380
Total for CIL		288	125	36	449	57.168	136.568	17.489	211.225

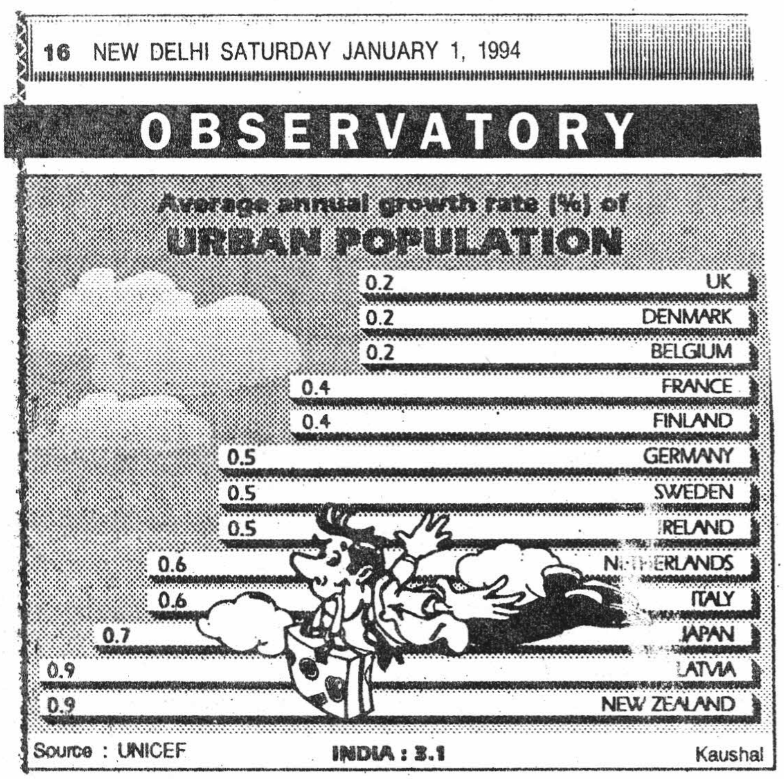
Note : O/C = Opencast, U/G = Underground

Source : (1) CIL Communication no. CIL/C-1/MISC/93/724 dated 24.8.93 of Dy. C. Manager (Stat). (2) Annual Plant (1992-93), Ministry of Coal, Government of India (3) PPD Deptt., CMPDI (4) Statistics Deptt., CCL.

REFERENCE

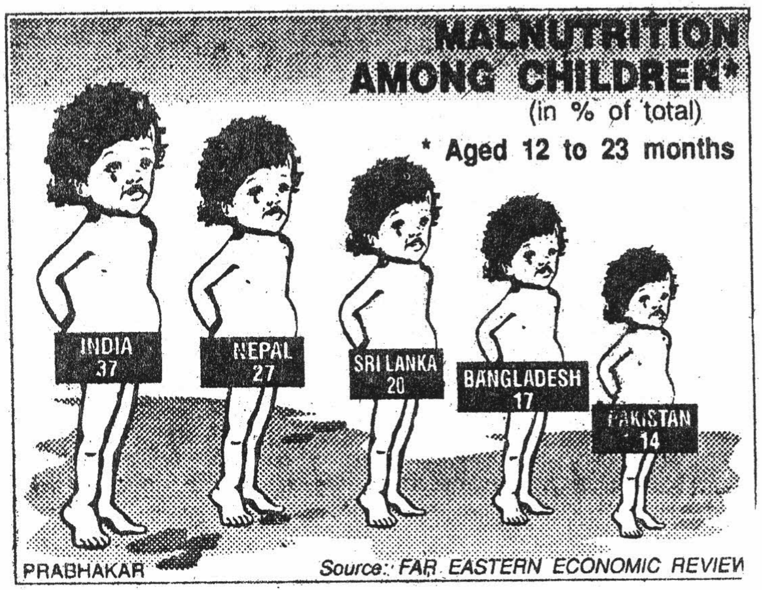
Coal Mining in India - 1993.


16 NEW DELHI THURSDAY JANUARY 6, 1994
OBSERVATORY
Annual no of births
(thousands)
2491 MEXICO
3626 BRAZIL
4078 USA
5117 PAKISTAN
5146 INDONESIA
5259 BHUTAN
25057 CHINA
25900 INDIA
Source : UNICEF
Kaushal


16 NEW DELHI SATURDAY JANUARY 1, 1994
OBSERVATORY
Average annual growth rate (%) of
URBAN POPULATION
0.2 UK
0.2 DENMARK
0.2 BELGIUM
0.4 FRANCE
0.4 FINLAND
0.5 GERMANY
0.5 SWEDEN
0.5 IRELAND
0.6 NETHERLANDS
0.6 ITALY
0.7 JAPAN
0.9 LATVIA
0.9 NEW ZEALAND
Source : UNICEF
INDIA : 3.1
Kaushal

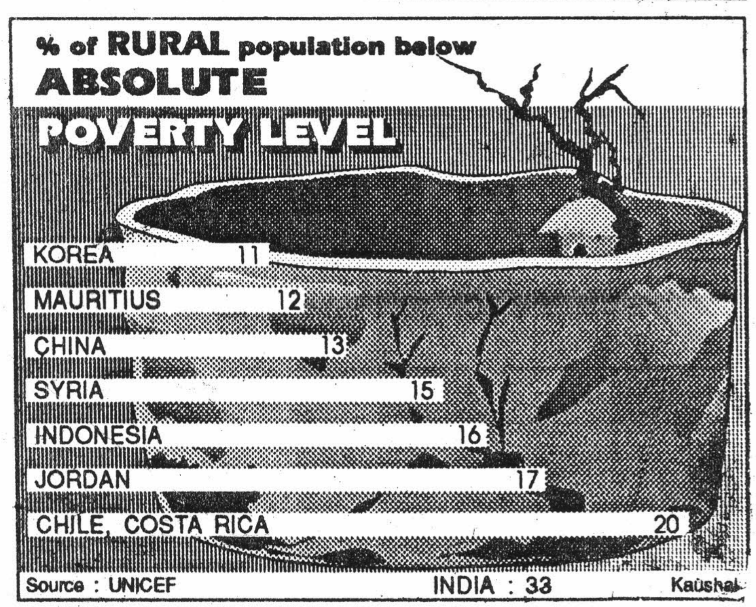
16 NEW DELHI THURSDAY JULY 1, 1993

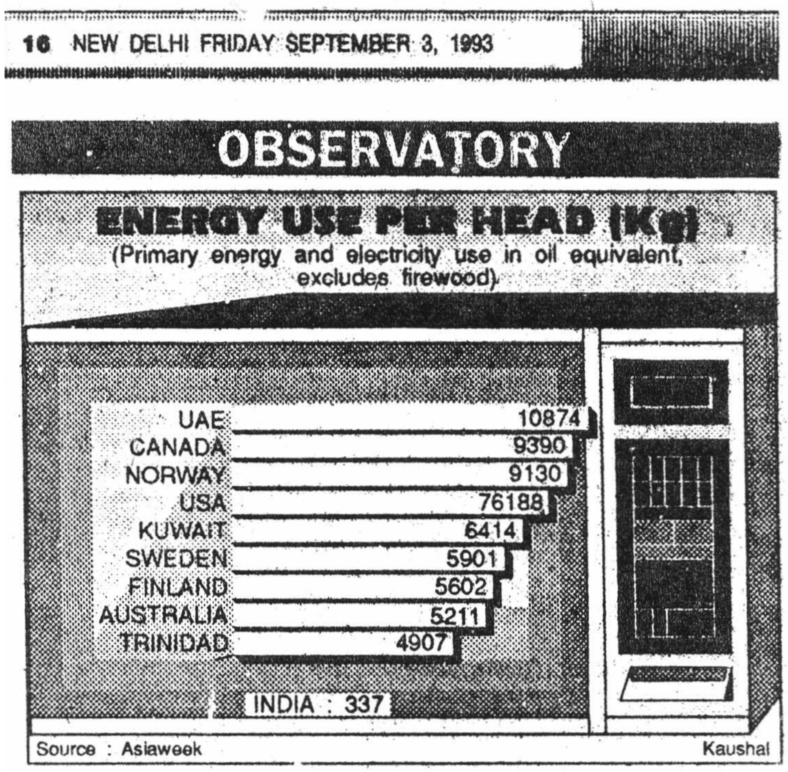
OBSERVATORY

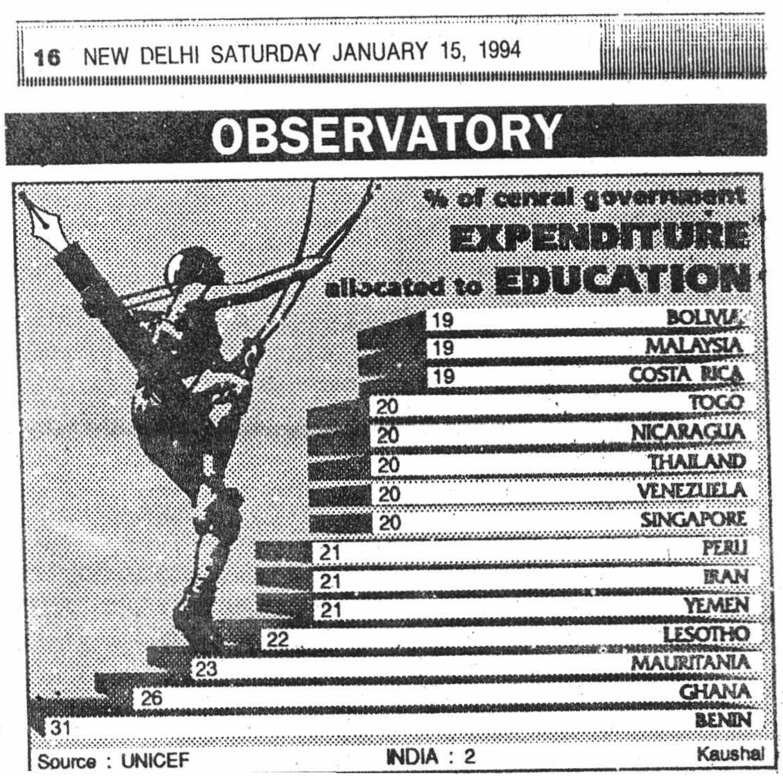


16 NEW DELHI WEDNESDAY JANUARY 19, 1994

OBSERVATORY

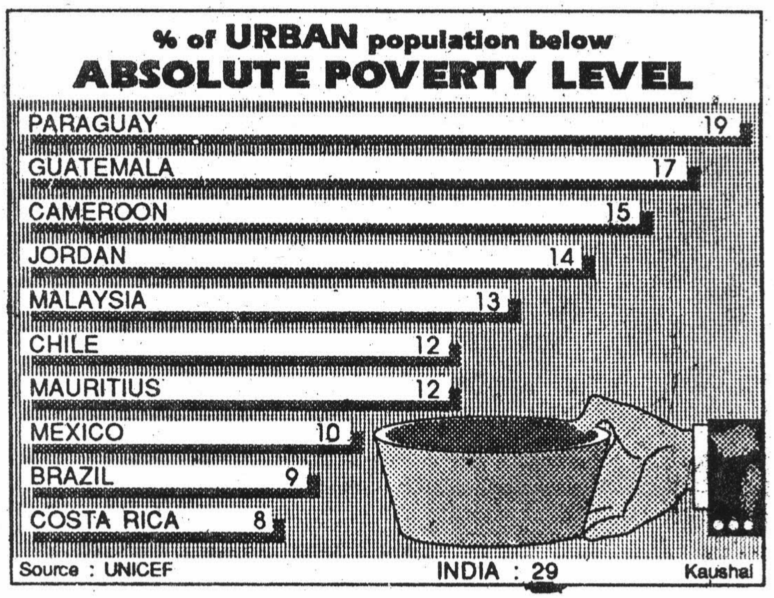



16 NEW DELHI FRIDAY SEPTEMBER 3, 1993
OBSERVATORY
ENERGY USE PER HEAD (Kg)
(Primary energy and electricity use in oil equivalent, excludes firewood)
UAE 10874
CANADA 9390
NORWAY 9130
USA 76188
KUWAIT 6414
SWEDEN 5901
FINLAND 5602
AUSTRALIA 5211
TRINIDAD 4907
INDIA : 337
Source : Asiaweek
Kaushal


16 NEW DELHI SATURDAY JANUARY 15, 1994
OBSERVATORY
% of cenral government
EXPENDITURE
allocated to EDUCATION
19 BOLIVIA
19 MALAYSIA
19 COSTA RICA
20 TOGO
20 NICARAGUA
20 THAILAND
20 VENEZUELA
20 SINGAPORE
21 PERU
21 IRAN
21 YEMEN
22 LESOTHO
23 MAURITANIA
26 GHANA
31 BENIN
Source : UNICEF
INDIA : 2
Kaushal

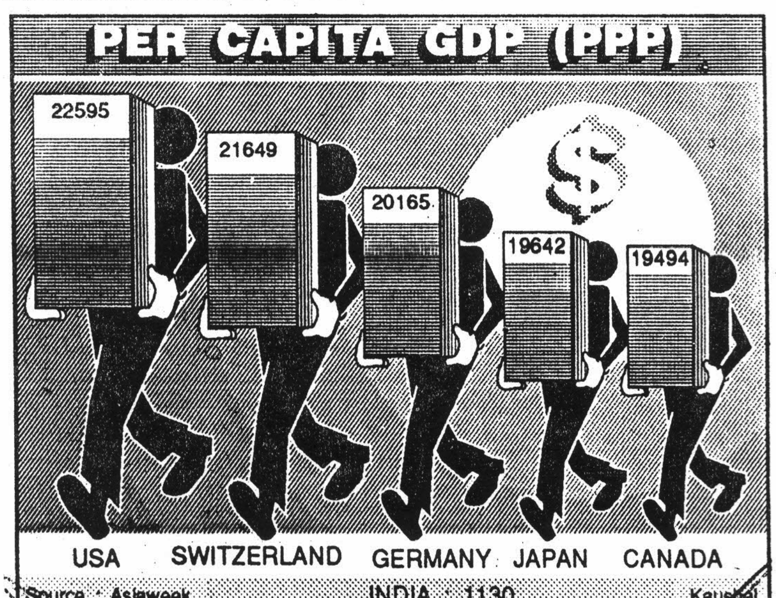
16 NEW DELHI TUESDAY JANUARY 18, 1994

OBSERVATORY



16 NEW DELHI THURSDAY DECEMBER 9, 1993

OBSERVATORY



For Mining Hall of Fame - the Unsung "GURUS"

Prof (Dr) Ajoy K Ghose, *FIE*

Former Director, Indian School of Mines, Dhanbad, India
&
Past-President, The Institution of Engineers (India)

FOR MINING HALL OF FAME — THE UNSUNG "GURUS"

Venerating "gurus" has been a tradition, if not an integral part of Indian culture. In this memorial lecture I shall not only pay my humble tributes as a student to Prof. Sudhangshu Kumar Bose, but also to two other hallowed "gurus" whose seminal contributions to mining make us, the mining community, proud. For this invidious distinction, I have chosen to single out three unique personalities, Kautilys, Henri Fayol, and of course Prof. S.K. Bose. Even if I sound somewhat uncharitable and overly critical, I must confess that the mining industry and the mining community appear to be constrained by a highly conservative mindset. Roughened by the toil and rigour of the profession, they are not only cynical but critical too of others and have never learned to lavish praises on their own kind, where it is due. By focussing the spotlight of attention on the three distinguished personalities, two of whom were mining engineers by profession, I am trying to eulogize their momentous contributions which must be recognized in the saga of mining. If ideas move the world, nay history, the ideas of Kautilya, the first mineral economist, of Fayol who was the guru of all management "gurus" and Prof. S.K. Bose, Indian mining industry's traditional guru, all have left their indelible mark in the sands of time and the mining industry and the community must recognize their insight and wisdom and reserve their places in Mining Industry's Hall of Fame.

To the western world, the credit for writing the world's first mining tome, De re Metallica, goes to Georgius Agricola (whose real name was Georg Bauer). The book was published posthumously in 1555 and is best known for its fascinating woodcuts depicting ancient and ingenious machines of pumps, hoists, stamp mills and crushers. Surprisingly, the volume also sounded the first alarm on the environmental degradation due to mining. Few in the mining community, however, are aware of the fact that Kautilya's Arthashastra (circa 330 BC), a treatise on statecraft, economics and on the art of mining and mining organisations, predates Agricola's book by some 1900 years. Kautilya, also known as Chanakya and Vishnugupta, was the man who destroyed the Nanda dynasty and installed Chandragupta Maurya as the King of Magadha around 321 BC. Even if there are controversies surrounding the authorship of Arthashastra, the book for the first time underscored the importance of mines, the mineral industry and mineral economics as the essential underpinning of the prosperity of any political economy. In fact, Kautilya was not only an administrator par excellence, but also the world's first mineral economist in his own rights. The commanding position of the mining industry in the country's economy was forcefully highlighted when Kautilya wrote that the wealth of the state has its sources in the mining and metallurgical industry; the power of the state comes out of these resources. With increased wealth and a powerful army more territory can be acquired, thereby further increasing the wealth of the state". In Arthashastra, we are given some vignettes of the mining industry; there were mines of gold, silver, diamond, gems, precious stones, and of copper, lead and tin and even of ocean mining for pearls. Kautilya described in great detail the duties of officials concerned with raising revenue from metals and precious stones. The Chief Controller of Mining and Metallurgy, for instance, had under him a number of Departments headed by the Chief Superintendent of Mines, the Chief Superintendent of Metals, the Chief Master of the Mint, the Coin Examiner and the Chief Salt Commissioner. Kautilya set out the qualifications and responsibilities of the Chief Controller of Mining and Metallurgy which included inter alia the responsibility of identifying locations for mining by "looking either for signs (such as tailings of an earlier working old crucibles, coal or ashes) of an old abandoned mine or geological evidence of mineral-bearing ores." He was also charged with the responsibility of ensuring that there was no unauthorized mining and while the state had the monopoly of mining, the Chief Controller could lease out mines which were too expensive or too difficult to exploit, on payment of either a share of the ore recovered or a fixed royalty. Kautilya's Arthashastra was indeed far ahead of its time and besides being an authoritative treatise on statecraft and the science of economics, it provided deep insight and practical knowledge of mining and mineral economics. In the Hall of Fame for mining industry, Kautilya must find his rightful place as a mineral economist par excellence.

Management is the art and science of our times and in the recent past, we have seen the emergence of management "gurus", stars who have been idolized for their prescriptions on management by objectives, quality management, strategic planning, and re-engineering and a whole host of freshly baked buzz words and concepts of core competence, learning organizations and competitive advantage which are paraded as magic potions for all the age-old dilemmas of corporate management. Such "gurus", with their hyperbole and hype, appear to have crowded the skyline hiding other great management thinkers of the past, one of whom, a mining engineer at that, Henri Fayol (1841-1925) deserves to be recognized as the guru of all management "gurus". Educated at the National School of Mines in St. Etienne, Fayol graduated as a mining engineer in 1860 and joined the French mining company Commentry-Fourchamboult-Decazeville where he rose to become the Managing Director between 1888 and 1918. He pursued a successful parallel career as a management theorist and lectured extensively on the functional principles of management. After retirement, Fayol set up a Centre of Administrative Studies and evaluated the performance of a government department and continued to lecture on management functions. Fayol was truly a management "guru" who placed management at centre stage when he stated that "Management plays a very important part in the government of undertakings; of all undertakings, large or small, industrial, commercial, political, religious or any other", a pronouncement of singular import. Equally important was his definition of the role of management: "To manage is to forecast and plan, to organize, to command, to coordinate and to control", words that have influenced and impacted on management thought in the later years. He also mooted the concept of business forecasts and talked of ten yearly forecasts revised evert five years. In his book, General and Industrial Management, published in 1916 Fayol laid down 14 principles of management that are still valid. Given that these principles were laid down nearly 80 years ago, their prescience is astounding. Fayol, unlike Frederick Taylor, recognized that espirit de corps was a vital ingredient in any organization for promoting harmony. The mining industry must acknowledge the contributions of this great mining engineer, one of the first management thinkers who focussed on the role of management and the essential skills required of managers. It is regrettable that management thinking has largely been dominated by Americans and the writings of Fayol in French did not attract the attention that it so richly deserved.

Prof. S.K. Bose was a true Indian "guru" of his genre, exemplifying simple living, high thinking and truly inspirational as a teacher. Born in 1900, Prof. Bose had a distinguished academic record, graduating with a First Class B.Sc. (Hons) degree in Geology from the Presidency College, Calcutta, and later from the Royal School of Mines, London. At the early age of 27, Prof. Bose was appointed as the first Professor of Mining at the Indian School of Mines, Dhanbad, and he retired in 1956 attar preparing nearly two generations of highly skilled mining professionals who have been at the helm of affairs of Indian mining industry. Prof. Bose was an exceptional teacher of his kind, lovable, sympathetic and yet full of erudition. His teaching method was unique, founded on encouragement for "learning to learn" through a set of questions and examples for illustrating the points he made. In a way, he was probably using the innovative approach to learning and rational enquiry first introduced by Socrates - commonly referred to as dialectic or Socratic conversation. Prof. Bose asked question; he set problems, he methodically analysed the answers, and he left it to the students to find the right answers. It was active learning-problem-based learning-that was the very antithesis of the passive, unthinking, uncritical absorption of information and ready-made answers that sometimes passes for education. His instructions during the Mine Surveying Camps were extremely profitable; he would tell you how-to undertake a measurement and then expound the errors implicit in any measurement. I vividly recall one Mine Survey Camp at Ramnagore where Prof. Bose and Prof. Roland D. Parks, a Visiting professor from M.I.T., spent a whole night with us explaining the nitty-gritty of star observations. It was a rich and memorable experience and of course unforgettable. Prof. Bose's bonhomie and rapport with the students also had an enduring influence on his students enriching the range of human experiences. I offer my deep and profound respects to Prof. Bose and his hallowed memory.

It is time now to conclude. The mining industry and the community must recognize its own people for their intrinsic worth and valued contributions and find for them positions of pride in the Hall of Fame, if only to stimulate the succeeding generations to greater levels of effort in achieving excellence.

Emerging Trends in the Mining Industry : Opportunities - Issues & Challenges with Special Reference to Iron Ore Industry

Shri B Ramesh Kumar

Chairman Cum Managing Director, NMDC Ltd, Hyderabad

At the outset I would like to thank the Organizers to have conferred upon me the great honour by viting me here to pay homage to the doyen of mining industry our revered Guru late Prof. S.K. Bose, in the form of memorial lecture in his memory.

The first professor of mining at the famous Indian School of Mines, Dhanbad, Late Prof. S.K. Bose was a visionary, an eminent Mining Engineer and an inspiring teacher besides being a simple, generous and a selfless human being.

A rich and befitting tribute to late Prof. S.K. Bose would be the traditional Indian saying -

"Gurur Brahmaa, Gurur Vishnu, Gurur Daevo Maheshwarah;
Gurur Saakshaat Parah Brahmaa, Tasmai Shree Guruvaenamah"

(I salute the preceptor who is himself the divine trinity - Brahma, Vishnu and Maheswara and who is verily Supreme Godhead.)

Ladies & Gentlemen, in the past many eminent and distinguished persons had delivered Prof. Bose memorial lecture. All were outstanding persons in their respective fields. It is thus with a sense of humility I propose to share some-of my thoughts on most significant and burning issues of the day.

"INDIAN MINING INDUSTRY - QUO VADIS ?"

In fitness of things, we should trace our roots back to the Neanderthal age when man thrived on fruits, when he had no shelter to live, no clothes to wear, no vehicles to ride, no medicines to cure, no social life and absolutely no security. His only passion was to start hunting with the dawn-chorus and retire to the terrestrial bed at dusk, under the dark celestial cover.

Gradually he stepped out of the stone age, as he learnt to light-fire, cooked his food, started building small hutments for shelter, developed a sense of security and started living in groups.

Thus began the "civilization". And it was a real struggle in its transformation into "industrialization". After industria revolution, came the age of modernization and globalization.

Today's human is a modern man endowed with all the luxuries of life, with air conditioned buildings, air conditioned cars, air conditioned buses etc. to beat the weather; and everything at his command with the press of a button.

The advent of technology has made it possible to talk to your dear and near thousands of kilometers away, with ease and clarity. The world of information is at your feet. And the latest, a station like a railway station in the space with "up" and "down" space crafts like trains;

Man has really conquered the world!

But how it was made possible??. ...a point to ponder about !!
What made the luxurious buildings and shelters possible?
What made the ornaments possible?
What made the trains and tracks possible?
What made the air crafts possible?
What made the electrification of cities and villages possible?
What made the transport possible?

How all the basic amenities were made available?

To all these and numerous of other questions, there is one and only one answer — and that is "MINING". It was only "Mining" that made all the raw materials available for modern, luxurious living. Mining has always remained an important cog in the wheel of development.

Without mining we would not have had steel to make railway tracks to cover 63,000 Kms of route carrying over 13 million passengers and 1 million tonnes of freight everyday. We could not have made buildings, would not have had cables for electric supply, would not have had cement, bricks, pottery, crockery, furniture, watches ... name anything for that matter except human beings and animals. Even for the agricultural produce that is feeding more than a billion mouths in the country, the basic ploughs and other equipment would not have seen the light of the day - without Mining.

But alas! Look at the irony of fate! Mining has not been given that much Industrial status which it deserved.

Today some sections of society who are above the poverty line, who are comfortable with modern amenities are trying to oppose the very fact that has given them all the comforts of life. They have stiff opposition to mining, without considering the future development of the country, without a concern about the new generation. They may have their vested interests in opposing.

Rarely do they realize that mining is site specific and can only be done where minerals occur, unlike plants which can be grown almost anywhere. India has a total land area of 3.28 m.sq.kms of which less than 1% is in the mining. Still there is lot of hue and cry about the degradation by mining – as the impacts are visible. .

INDIAN MINING INDUSTRY - AN OVERVIEW

Minerals constitute the backbone of economic growth of any nation. India is endowed with this gift of nature and has as many as 87 minerals under active exploitation.

Minerals are valuable natural resources, being finite and non renewable. They constitute the vital raw materials for many basic industries and are a major resource for development.

National Mineral policy of the country lays emphasis on exploitation of minerals for long term national goals, adoption of scientific methods of mining and beneficiation, keeping in view the future needs with protection of forests, environment and ecology from the adverse effects of mining.

The first recorded history of mining in India dates back to 1774 that marked the beginning of coal mines in Ranigunj, as initiated by the East India Company.

M/s. John Taylor and Sons started Gold mining in Kolar Gold Field way back in 1880. The first oil well was drilled in Digboi in 1866. Till the beginning of the current century mining activities in the country remained primitive in nature and on modest scale of operation.

The mining industry provides employment to about 1 million persons on daily average and operates 572 coal mines, about 2500 metalliferrous mines and a score of other small mines.

On account of slaughter mining and unscientific methods of mining, the control of mines from private owners was taken over by Government, with the formation of Bharat Coking Coal (BCCL) in 1971, and Coal Mines Authority Ltd (CMAL) in 1973. The mines were nationalized on 1st May 1972. Later on 1st November, 1975 CMAL and BCCL were merged and Coal India was formed bringing the entire coal mining industry under one umbrella.

After Nationalisation, the Coal Mining industry has seen phenomenal growth in production from about 70 mt in 1971-72 to 246 mt in 1993-94 and 322 mt in the year 2005-06.

Share of mining industry in gross domestic product during 1993-94 was 2.57% which has grown to 2.64% in the year 2005-06.

With the contribution of 16% in exports in terms of value, the mineral sector has become an important component of India's foreign trade.

In the field of non coal mining the production of minerals dates back to ancient times: Remnants of old workings are still available in some parts of the country like Lead and Zinc in Zawar, Copper in Khetri, Gold in Karnataka etc. Despite of an active past metal mining activities in the country remained dormant over a long period of time.

Industry's growth

The post Independent era had witnessed a massive expansion of exploration through various five year plans. This included the augmentation of mineral inventory as well as addition of a number of mineral reserves to the existing reserves and changed the scenario of the mineral map of the country. The search of minerals did not end on the land mass alone but extended to off shore areas and deep oceans.

STATUS OF MINERAL PRODUCTION

We have covered a long distance since Industrial Policy Resolution of 1956. The growth trajectory for mineral production has soared phenomenonally. The value of mineral production increased over a thousand fold from Rs.585 million in 1947-48 to over Rs.800,OOO million (80,000 crore in 2005-06). As many as 87 minerals are under active exploitation as on date while only 22 minerals were under mining before independence. India ranked amongst the top global mineral producing countries.

As on date India is self sufficient in major minerals like Iron ore, Bauxite, Limestone, Manganese ore, Chromite, Coal & Lignite and Barytes while it is deficient in the base metals, precious minerals like Gold and Diamond and depends upon imports.

Comparing to World Production,

India is :

2nd in Barytes; Chromite, Talc/Steatite and Pyrophyllite
3rd in Coal and Lignite
4th in Iron Ore and Kyanite/Silliminite/Andalusite
6th in Bauxite
7th in Manganese ore

Friends, I have been associated with iron ore mining for the last over 35 years. I witnessed various vicissitudes in the development of iron ore mining. It assumes a greater relevance to economic growth of the country, after coal, petroleum and gas. Iron ore sector earns a substantial foreign exchange for the country.

Iron ore is the principal feed material for steel, the consumption level of which determines the economic status of the country. Steel industry has made a robust growth worldwide in the last four/five years. China is in a lead position which produces about 1/3 of Global steel. Quite likely in a couple of years China may become exporter of steel after saturating its own appetite. Out of the world's Steel production of 1129 mt in 2005, China produced 349 mt i.e., 31% of the world's production.

Incidentally the China factor came as boon to the iron ore producing countries to exploit the opportunity and grab the new iron ore export destination. Earlier Japan used to be a major importer.

India and China share the same legacy of socio economic fabric. Both got independence at about the same time. But China left India far behind in scaling the economic progress. China's per capita steel consumption is about 200 kg while India is staggering at the level of 35 kg. In 1949 both; were the same level of steel production and consumption.

Question arises — Why India can not achieve what China could? There is no reason. India has all the necessary ingredients to embark on expanding Steel Industry — the backbone of growth in all sectors of economy — Heavy industries, urbanization and social infrastructure. Since the availability of iron ore is the corner stone of growth of steel sector, I thought it appropriate to discuss at this forum of the iron ore mining sector in totality.

WORLD SCENARIO

Iron ore deposits are distributed in different regions of the world. The country wise reserves, reserve base and production (in last 3 years) is given at Annexure-1:

If you look at figure of reserve base, Ukraine contains the largest reserve base of 68,000 mt, followed by Russia 56,000 mt, Brazil 62,000 mt, China 46,000 mt and Austraila 40,000 mt in that order. The grade of China's ore is very poor of 30-35% fe content. That is why its resource is converted to almost V2 of the total so that its iron ore content is equal to that on average in the rest of the world. India's reserve base is 22,000 mt.

Among the leading producers of iron ore in the world, China, Brazil, Australia and India are important from their level of production. Sweden is equally important for underground mining and its level of automation. In case of above four countries about 90% of iron ore come from open cast mining whereas in case of Sweden the entire production is from underground mining. Mass production of iron ore in these countries has resulted in technological development especially in open cast mining. The status of mining in the above countries is discussed here to know on comparison where India stands so far as technical advancement is concerned in the field of iron ore mining.

China

At the time of Independence its iron ore production was 0.6 mt. In 1995 its production soared to 225 mt and in 2006 it has achieved a production of 420 mt. China is presently producing crude steel in around 350 mt. per annum and may cross the 400 mt mark this year itself. This level of crude steel production demands about 600 mt of iron ore annually.

Iron ore production from underground mines is only 10% and 90% production is from open cast mining. Mining technology and major equipments for large open cast mines (10 mt and above) have come up to the level of developed countries in 1980 itself. Thereafter mechanization continued with foreign equipments imported from other countries. Now indigeneous companies have come up to manufacture such equipments. China has achieved a high level of mechanization in deployment of equipments and In-Pit Crushing/Conveying system for large open cast mines.

Brazil

Brazil is the largest producer (if China's converted production is taken into account). It produced 292 mt. of iron ore in 2005. At the same time it is the second largest exporter of iron ore after Australia. 90% of the Brazilian production is from 6 major mining companies — the important being CVRD, MBR and SAMARCO in order of production and export.

Carjas Mine

Carjas, the largest open cast mine in the World, has been producing iron ore since mid 80's. It lies in the Amazon jungle of Brazil in the State of Para. After many years of production the huge pit is now more than 200 meters deep. The iron ore resources at Carjas are remarkable both for their size and high quality over 66% Fe. Resource of Carjas mine is estimated at 18,000 mt of which 2400 mts are measured and 2500 mt are indicated at an average grade of over 66% Fe. Almost all the production of about 60 mt from Carjas is exported.

ITABIRA Mine

It is Located in the State of Minas Gerais. Total Reserves are 24,000 mt including Geological reserves. The entire production of over 80 mt is exported.

MBR

MBR has 7 deposits under mining operation. The collective minable reserves are 604 mt of haematite and 290 mt of Itabirite.

The production from the above mines is about 36 mt and has export outlet.

SAMARCO

SAMARCO started mining operation on 1650 mt of ore at various deposits owned by SAMITRI at Algeria

Deposit.

The Deposit has proven reserves of 160 mt and probable reserves of 210 mt.

Annual production is around 18 mt of pellet feed.

There are other smaller companies which are producing and exporting around 8 to 10 mt per annum such as Peruvian Iron Ore which contains reserves of around 1500 mt.

Australia

Western Australia is the leading iron ore producing region of the world. It started production in 1966 after discovery of Mount Tom Price Iron ore deposit. First shipment was for 52,000 tonnes only in 1966. Today Western Australia is producing over 240 mt of iron ore per annum.

There are 3 major iron ore producers i.e. BHP Billiton, Hamersley Iron ore private limited (Rio-Tinto) and Robe River Iron Associates. All these companies are mining iron ore by open cast method. Besides there is plethora of potential new developers whose projects are in rapid development schedule. All the mines in this region are integrated with excellent infrastructure - rail, port connectivity, dedicated exclusively to mining industry.

In 2005 Australia produced 261 mt out of which 240 mt was exported. The important operating mines under the control of above companies are listed below:

Haemersley Iron Pty Ltd.

Sl.No	Name of the mine	Production (in mt)	Reserve (mt)	Type of ore
1	Paraburdoo	11	430	Haematite
2	Marandaroo	13	355	Marramamba
3	Channar	10	165	Haematite
4	Brockman mine-2	8	65	Haematite
5	Mount Tom price	20	595	Haematite
6	Nammuldi	n.a	600	Marramamba
7	Yandicogina	24 plan to increase to 30	n.a	

BHP Billiton

Sl.No	Name of the mine	Production (in mt)	Reserve (mt)	Type of ore
1	Newman - Jimblebar	36	1850	Haematite & Marramamba
2	Yarrie	8	n.a	n.a
3	Yandi	30	1415	Pisolite
4	Mining Area C	15	2600	Marramamba

Robe River Iron Associate

Sl.No	Name of the mine	Production (in mt)	Reserve (mt)	Type of ore
1	Mesa J	32	2500	Pisolite
2	West Angelas	25	1000	Marramamba

Other companies are operating mines of smaller capacity and making substantial contribution to the country's production. There are many other deposits, exploitation of which is in various stages of planning & development.

Exploration expenditure for iron ore in Western Australia has reached an all time record level of US $ 136.9 million during 2004-05. It is double the expenditure what it was in 2003-04 (US $ 64.6 million).

Sweden

In all the leading countries producing iron ore through out the world, the open cast mines are the major sources. Sweden is the only country where practically the entire production comes from underground mines. There are two such mines — Kiruna mine of Northern Sweden & Malmberget near Kiruna. Workings of these underground mines continuously for more than a century have brought in the highest degree of mechanization and automation. Sweden produces about 24 mt of iron ore and exported 18 mt in 2005.

Many other countries such as Ukraine, Liberia, Russia etc., have large reserves which are being looked into by Global Mining companies for future exploitation.

INDIAN IRON ORE SCENARIO

The iron ore resource in the country has been estimated, employing U NFC norm, at 23,000 mt. About 12,000 mt is Haematite and 11,000 mt of Magnetite iron ore. Haematite deposits are mainly found in the States of Orissa, Jharkhand, Chhattisgarh, Karnataka and Goa. On the other hand Major reserves of Magnetite deposits are restricted to Karnataka State with small occurences scattered in AP, Rajasthan, Tamilnadu and Meghalaya. The following table gives the resource endowment of each State -in respect of reserves and resources.

Haematite

	Orissa	Jharkhand	Chhattisgarh	Karnataka	Goa
Reserve	1537	2367	836	677	408
Resource	2252	677	1283	471	234
Total	**3789**	**3044**	**2120**	**1148**	**642**

The above resource covers 94% of the total Haematite in the country. Since the Magnetite deposits are located mainly in environmentally fragile zone of Karnataka, and Kudremukh iron ore mine had to be closed for such reason, magnetite deposit is not being considered for exploitation for time being.

DISTRIBUTION OF IRON ORE- DEPOSITS

The entire country has been divided into five zones of iron ore occurances (Annexure-3). Zone A covers the deposits of Jharkhand and Orissa, Zone-B Chhattisgarh and Maharastra, Zone-C Karnataka, Zone-D Goa and Redi and Zone-E Kudremukh, Bababudan and Kuda Chadari of Karnataka. Let us examine the deposits zone wise.

Zone-A

Jharkhand

In Jharkhand Haematite deposits occur in a number of prominent hills in Singhbhum district. (Annexure-4). The known deposits of this district are Noamundi, Gua, Barajamda, Kiriburu, Meghahatuburu, Manoharpur and Chi ria. The Chi ria deposit is reported to be the single largest deposit in the country. All the above deposits are under exploitation at different levels of operation. The production from Jharkhand is around 18 mt.

Orissa

Ore deposits occur in the District of Keonjhar, Sundargarh, Mayurbanj, Cuttak, Koraput, Sambalpur and Dheen Kanal. Of these, deposits of Keonjhar and Sundargarh districts are worth mentioning. The important deposits containing large reserves of high grade (55% to 69% Fe) are Thakurani, Joda, Banspani, Ior uri, Malangtoli, Khandadhar pahad, Kalmang, Barsua, Bolani, and Kalta. Amongst above Malangtoli is the largest deposit containing high reserves. The Fe content varies from (55% to 63% Fe). Gandmardhan is another large deposit in terms of size and grade.

Apart from the above there are other deposits of different size and grade in Cuttack, Koraput, Iaipur, and Dheen Kanal districts where small scale mining has been going on for years. Total production from Orissa is around 50 mt.

Zone-B

Chhattisgarh

Important deposits in this zone are Bailadila, Dalli, Rajahara, Rowghat, Mahamaya etc (Annexure-5). Two important iron ore bearing areas i.e Bailadila range and Rowghat are located in Bastar Tribal region of Chhattisgarh state.

Bailadila

Bailadilla range of hills is 40 Km in length and 10 km in width. 14 deposits have been distinctly demarcated and designated from 1 to 14 (Annexure-6). The deposit was prospected by GSI (1889-90) and again during 1932-38. Itremained un-exploited till 1960. The location being too remote and devoid of access, it did not receive attention for exploitation. In early 60's IBM, GSI and NMDC further explored the deposits for planned exploitation. Since then Bailadila deposits are under active mining by Mis. NMDC at Deposit-14. Deposit 11C, Deposit 5, and Deposit 10 & 11A. (Deposit -11 consists of deposits 11 A, 11 B & 11 C). Construction work at Deposit 11B is likely to start soon.

The original reserves in explored deposits were about 972 mt. Over and above there are still 8 blocks which are not prospected but assessed at 256 mt (based on geological mapping). Thus the total available reserve from Bailadila are about 1228 mt accounting for 11% of the total Haematite of the country. The Geological setting of the region, Nature of occurance and depth persistence of ore indicated the resource base of Bailadila sector to be at about 1800 mt. Currently Bailadila produces around 20 mt iron ore of high grade.

Rowghat

Rowghat deposit is another large deposit in Bastar tribal region. Six deposits viz. A, B, C, D, E & F have been identified (Annexure-7) with total geological reserves of about 711 mt. Deposit F is the largest among others and contain a reserve of about 456 mt. with average grade of 62% Fe. Other deposits collectively gives a reserve of 241 mt.

Deposit F is further sub divided into 7 blocks from North South namely Rao Dongri block, Block-A, tarhar block, Anjrel block, Koregaon block, Kharkagaon block and Takrel block. Of the above Block A is prospected and a reserve of 254 mt have been proved. This block is expected to be exploited by SAIL for Bhilai Steel Plants.

Dalli - Rajahara

These deposits are located in Durg district of Chhattisgarh State. Deposits are of high grade and being exploited by Bhilai Steel Plant for-captive consumption. The balance reserve is 140 mt which is good enough for 15 years at the production rate of 9 mtpa.

Other Deposits in zone-B are smaller ones and located in Rajanandgaon, Gwallior and Iabalpur districts.

Zone-C

Prominent deposits are located in Bellary - Hospet sector and those are Donimalai, Ramandurg, Kumaraswami, Thimmappan gudi, NEB range, Ettinahatti and Belegal (Annexure-B). Of above Donimalai and Kumaraswamy are under exploitation by NMDC while part of Thimmappan gudi is owned by M/s.Mysore Minerals and other private miners. The total production of iron ore from this zone is around 34 mt. contributed by NMDC, Mis. Mysore Minerals, M/s.MSPL and other parties. Construction work at Kumaraswamy mine is likely to start soon.

Zone-D

Goa, Redi

Goa is the only State where large number of iron ore deposits are concentrated in such a small area. Goa covers an area of about 3700 sq.km. The production from Goa region is about 24 mt.

Zone E

This zone contains deposits located at Kudremukh, Bababudan, Kuda chadari and few others. All the deposits are Magnetite. Kudremukh and Bababudan deposits both were prospected by NMDC. Bababudan did not get clearance from Ministry of Environment & Forests Government of India for exploitation. Prior to this Kudremukh project was already developed for exploitation as export oriented unit. For over 25 years Kudremukh mine has been in operation at high level of mechanization and eco friendly mining. In December 2005 the mine faced closure order from Hon'ble Supreme Court for environmental reason.

Various studies are underway to devise methodology to exploit the Bababudan deposit of about 600 mt reserve by underground mining with due care for preservation of environment. It is, 'hop that with more technical advances in Mining operation, magnetite deposit of Karnataka may be brought under mining in future.

PRODUCTION STATUS

Indian iron ore mines are broadly divided into two categories. i.e. Manual and Mechanised. Majority of large mechanized mines are in the Public sector where as manual mines are in the private sector. Some mechanized mines in Goa, Jharkhand and Orissa are also being exploited by private sector. Overall Indian Iron ore industry has been doing extremely well in the field of production. Production increased by 9% in 2005-06 over the previous year to the total of about 155 mt. This increase is more in private sector mines than in public sector. In 2000-01 the ratio of public sector and private sector production was 55% and 45% respectively. Gradually the equation changed and now private sector mine production is credited with 58% share in country's total production. If we look at production (table below) from the year 2000-01, in the last 5 years the private sector mines increased their production from 37.27 mt to 93.5 mt while the Public Sector mines could increase from 43.50 mt to 61.5 mt only.

(in million tonnes)

Year	Public Sector	Private Sector
2000-01	43.50	37.27
2001-02	45.00	41.12
2002-03	50.00	49.37
2003-04	56.90	63.64
2004-05	57.08	85.62
2005-06	61.50 (P)	93.50 (P)

Similarly iron ore production comes from two sources-captive and non-captive mines. Captive mines are owned by SAIL's steel plants and TATA. Out of total production the non-captive mines produce 78% while the share of captive mines is only 22%.

It may be pertinent to mention that no new major mine could be developed in the last two decades. It is only through expansion and modernization of the existing mines and reworking of abandoned mines (Bellary Hospet, Jharkhand Orissa) that helped boosting the production increase year after year. The following table gives the production of iron ore rich states.

(in million tonnes)

State	2001-02	2002-03	2003-04	2004-05	2005-06
Orissa	16.6	21.52	30.12	40.6	50.01
Jharkhand	13.07	13.68	14.45	16.1	7.73
Chhattisgarh	18.66	19.36	22.67	23.1	24.97
Karnataka	22.6	24.04	31.56	37.1	34.19
Goa	14.78	17.5	20.16	22.3	23.29
Total (India)	86.00	99.00	123.00	143.00	155.17(P)

Orissa is a leading producer state with the highest production followed by Karnataka, Chhattisgarh and Goa. Jharkhand produced around 18 mt only. It is also to be noted that in the total production of 155 mt in 2005-06 the lump product is 63 mt and fine product 92 mt. It is the fine ore production which has less demand in domestic industries. R& D studies are being conducted to convert the fine product into agglomerated form to make it a usable commodity.

CONSUMPTION PATTERN OF IRON ORE

Domestic: Iron ore demand is linked to the Crude Steel production. The Steel plants of SAIL in the public sector and TATAs in private sector have their own mines for captive consumption. Another public sector steel plant VSP meets its total requirement of iron ore from NMDC mines located in Bailadila sector of Chhattisgarh state.

After 1990-91 reforms year, secondary sector started commissioning many new steel plants for which definite linkage of iron ore was being made by the Government of India. At present country's total production capacity of steel is around 42 mt. contributed by primary sector with 52% share and secondary sector with 48% share.

Government of India in order to make country a vibrant economy by the year 2019-20 has brought out a National Steel Policy document and drawn action plan to achieve the objectives contained in the policy. The Steel policy targeted 110 million tonnes and 90 million tons of steel production and consumption by 2019-20 at CAGR of 7.3% and 6.9% respectively. The iron ore requirement for 110 million tonnes of steel production would be around 180-190 mt. Although many other projections are made by the Steel manufacturers at CAGR of 10%, 12%, and 12.5%; and projected about 240 mt of steel by 2019-20. It is the double the figure what is envisaged in the policy document. However, going by the document of Government of India the availability of iron ore for the production of 110 mt steel would have to be ensured.

Export

India has long established trade link in the iron ore for the last 5 decades. Export from Goa and Karnataka was uninterrupted since late 50s. Bailadila Iron Ore Deposit was developed with the assistance of Japanese Steel Mills (JSM) in late 60's. JSM entered into long term agreement since then for supply of iron ore from Bailadila. The contract is being renewed once in every five years with yearly agreement for quantity and price.

As stated, the integrated steel plants of SAIL and TATA have their captive mines. The non-captive mines did not have domestic market and thus export was the natural outlet which earns foreign exchange also. The export quantity of iron ore has been always higher than domestic consumption for the last-25 years as shown in Annexure - 2.

Iron ore production grew gradually and so export also increased but the percentage remained almost the same. In fact export factor became instrumental for the growth of iron ore mining industry. At present export is 58% of the total production.

I may appraise the audience that the export constitutes about 16% lumps and 84% fines. Since fine ore does not have domestic demand and exporting the same country makes its presence felt in Global trade. As investments are made into beneficiation, sintering and pelletisation in the country which will use these fine ore, the growth of export is likely to decline.

NSP has estimated the exports to be around 100 mt by 2019-20, although we have already reached 90 mt of export, but without jeopardizing domestic requirement.

Thus the total demand (domestic and export) for iron ore by 2019-20 would be about 300 mt as per National Steel Policy.

NEW CAPACITY FOR IRON ORE

The country's iron ore production has been increasing annually. The incremental increase in production every year is coming from existing mines. No new mines have come up in the last several years. By 2019-20 we need to develop new capacity of about 150 mt or more.

Jharkhand, Orissa, Chhattisgarh and Karnataka are known iron ore rich states. Deposits are identified in these states for development.

Jharkhand

Many known deposits in Jharkhand are under exploitation by public sector and private sector. It has the biggest deposit of large reserves in Chiria which can be developed with a capacity of 20 mtpa. Besides, production is planned to enhance from the existing mines by technological upgradation. The production capacity of the state can be enhanced from 18 mt to 50 mt.

Orissa

In Orissa most of the production comes from large number of private mines. Malangtoli, Gandhmardhan, Mankadnacha are some of the unexploited deposits of large reserves which can be developed for the capacity of 10 mt each. State Government is putting its efforts to develop these identified deposits. Production from Orissa can be enhanced from present level of 50 mt to 100 mt.

Chhattisgarh

Chhattisgarh has large deposits such as Bailadila and Rowghat. Production from Bailadila is currently at 20 mt level. Expansion plan of Bailadila sector has projected the production of 42 mt by 2015-16 and 50 mt by 2019-20 by way of developing new mines and increasing the capacity from the existing mines.

Rowghat deposit is yet to be exploited. Efforts are being made to develop Rowghat deposit at 10 mt capacity by SAIL.

Karnataka

The existing production capacity of Karnataka is around 35-36 mt. Kumaraswamy iron ore is yet to the commissioned for full scale production and Ramandurg is still waiting for development process. At Ramandurg carrying a reserve of over 200 mt a mine of 10 mt capacity can be developed. Besides there are other deposits under private sector which have prospects for expansion in capacity. The total production from Karnataka can be increased from present level of 36 mt to 70 mt.

With the above prospects of increasing capacity in iron ore rich states the total additional capacity of iron ore production would be over 156 mt by 2019-20 and this takes care of the requirement of iron ore as projected in Steel policy.

STATUS OF IRON ORE FINES IN THE COUNTRY

Iron ore fines available in the country can be classified broadly into low grade (< 60% Fe), medium grade (60-64% Fe) and high grade (> 64% Fe) fines. High grade fines are used within the country by steel industries for sintering and some quantities are exported apart from being used for pelletising. Medium grade fines are being exported without value addition. However, huge quantities of low grade fines are lying unutilized in the country though very small quantities are getting blended with higher grade fines. These low grade fines can be utilized after beneficiation.

EXPORTS VS DOMESTIC

Steel manufacturers feel that export of iron ore from India should be curtailed or banned altogether and ore should be preserved for domestic industry for their future capacity expansion. To justify the curtailment of export various projections for increased output of steel by 2019-20 at different CAGR have been put forth. Anticipating such an enhanced Steel capacity say around 240 mt by 2019-20 the steel sector voiced apprehensions for possible short supply of iron ore to meet their projected requirement.

The subject of export is under Government's consideration. However, iron ore being a natural resource should be easily available to the domestic steel industry. Continuation of exports on a long term basis has to take into consideration the availability of iron ore in the country and the country's demand for the growing steel industry.

We shall not be able to consume the entire iron ore fines which form bulk of the export to the extent of 84% of the total export. However the subject of export is under Government scrutiny whether to continue export or discontinue.

CHALLENGES

There are some burning issues which have a direct bearing over the development of mineral sector.

(i) Access of Mineral Area

Timely grant of leases is an essence for speedy opening of mines. The processing for grant of leases takes a long time and by the time it is approved, the investors loose interest. This aspect is well taken by Hoda Committee, appointed by the Government of India to review National Mineral Policy and suggest required amendments in MMDR Act. Hoda Committee recommendations are being examined by the Government of India and it is hoped that necessary changes will be incorporated in legislation to facilitate early grant of prospecting licences and mining leases.

(ii) Forest and Environmental Clearances

Forest and Environmental clearance for exploration and mining projects are time taking processes. This is also very important aspect of mine development which needs speedy clearance from State and Central agencies.

Sometimes it is felt that arbitrarily demarcating the boundary of sanctuary zone encompass the mineral bearing areas which might be far away from the wild life zone. It is, therefore, necessary that a proper study is conducted in order to notify the mineral bearing areas in the country in consultation with concerned officials of forest, State mining and environment departments. This would enable the concerned officials to properly demarcate the respective zones after taking into consideration the mineral bearing areas. It is also necessary to demarcate mineral bearing zones on the same lines as forest land, revenue land etc.

(iii) Infrastructure

Indian mining industry has been suffering badly for want of suitable and adequate infrastructure facilities. The massive growth potential is putting a significant demand on infrastructure provision. Infrastructure is also a crucial factor in the establishment of Mining Industry. There are hardly any worthwhile roads in the mining area. The roads meant for general public are also used for movement of ore from mine to port or nearest railway station. 40% of ore traffic is handled by Railways and the balance by Road. In both the cases the connectivity is inadequate to meet the present level of production. It is good that Government has taken decision to increase spending on roads, ports and other infrastructure facilities. This will definitely be a facilitating factor for mining industry.

CONCLUSION

With the proposed higher output of domestic steel industry and if export of iron ore also continues - the iron ore reserves need augmentation through intensive prospecting. There is an urgent need to take up detailed exploration of untapped areas and where bare adequate exploration has not been done, so that additional reserves could be added.

Thank you.

JAI HIND

Annexure - 1

World Iron Ore

(in million tonnes)

Country	Reserve	Reserve base	Mine Production		
			2003	2004	2005
US	69,000	15,000	46	54	54
Australia	18,000	40,000	187	220	261
Brazil	21,000	62,000	212	220	292
Canada	1,700	3,900	31	31	28
China	21,000	46,000	261 123*	280 145*	420 197*
India	6,600	22,000	123	143	155
Iran	1,800	2,500	16	16	n.a.
Kazakhstan	8,300	19,000	17	17	17
Mauritius	700	1,500	10	10	11
Melico	700	1,500	11	12	n.a.
Russia	25,000	56,000	92	95	97
S.Africa	1,000	2,300	38	40	40
Sweden	3,500	7,800	22	22	24
Ukraine	30,000	68,000	62	66	68
Venezuela	4,000	6,000	18	18	22
Others	10,000	30,000	34	40	61
World Total	1,60,000	3,70,000	1,160	1,250	1,320

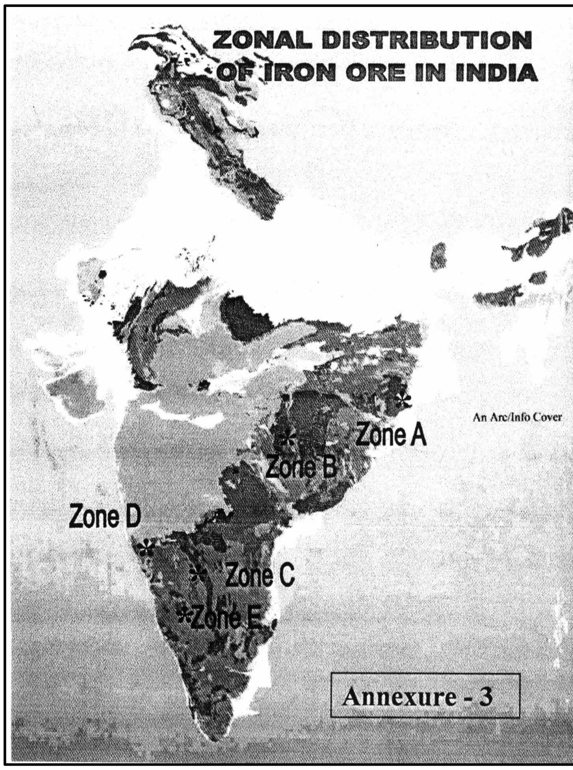
* **Production converted to half so as to match with an average Fe content in the rest of the world.**
(Source: FIMI)

Annexure- 2

Indian Iron ore production

(Million tonnes)

Year	Production	Export	Domestic consumption	Percentage of export
1980-81	42.167	22.402	13.847	53%
1981-82	41.085	23.676	15.786	57%
1982-83	42.357	21.737	15.183	51%
1983-84	39.038	22.073	15.249	56%
1984-85	43.131	25.527	15.618	59%
1985-86	44.955	30.150	16.325	67%
1986-87	52.254	28.226	17.069	54%
1987-88	50.924	29.410	17.600	57%
1988-89	49.911	33.040	19.331	66%
1989-90	55.437	35.558	19.740	64%
1990-91	54.870	31.580	23.290	57%
1991-92	57.460	31.540	25.920	55%
1992-93	58.120	28.520	29.600	49%
1993-94	58.670	31.500	27.170	54%
1994-95	64.500	28.000	36.500	43%
1995-96	66.580	31.340	35.240	47%
1996-97	66.600	31.700	34.900	47%
1997-98	75.720	35.610	40.110	47%
1998-99	70.680	31.270	39.410	44%
1999-2K	73.470	32.550	42.470	44%
2000-01	79.22	37.49	41.73	47%
2001-02	83.00	41.64	41.36	48%
2002-03	99.00	48.02	50.98	49%
2003-04	123.30	62.57	60.73	51%
2004-05	142.70	78.02	64.68	55%
2005-06	155.00 (P)	89.28	65.72	58%



Zone	Name of the Deposit
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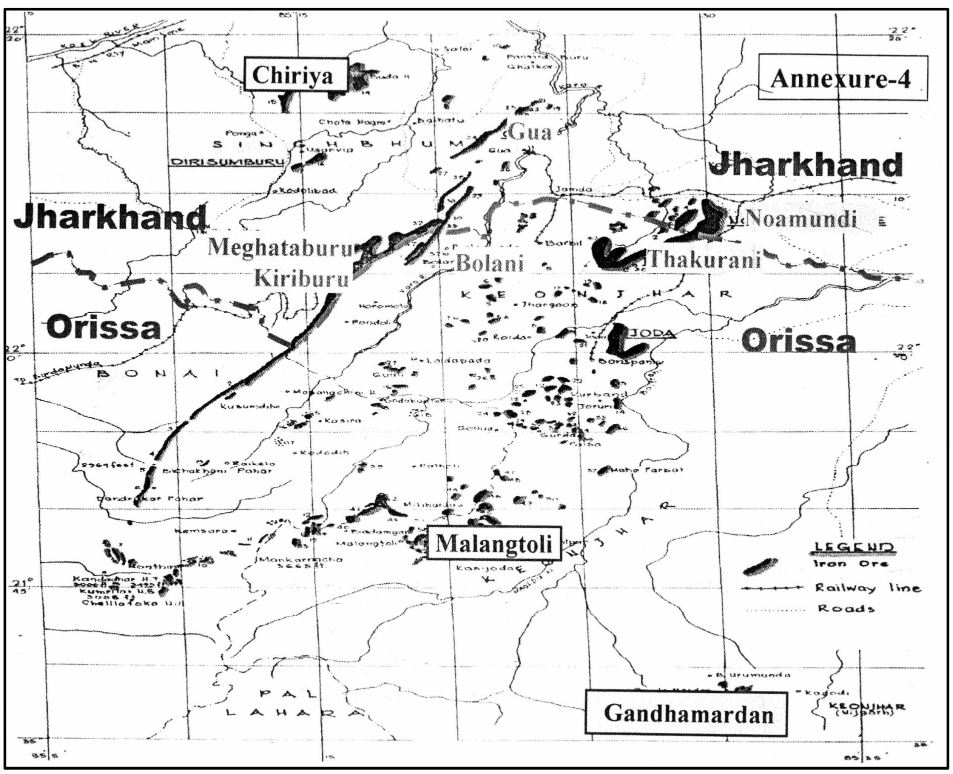
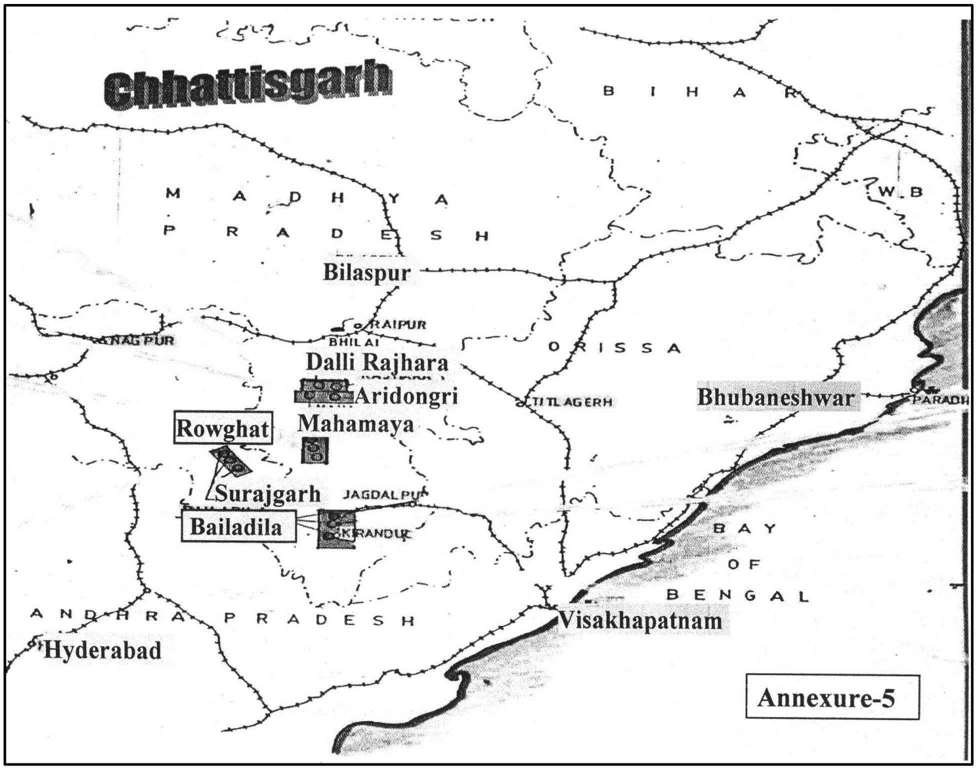
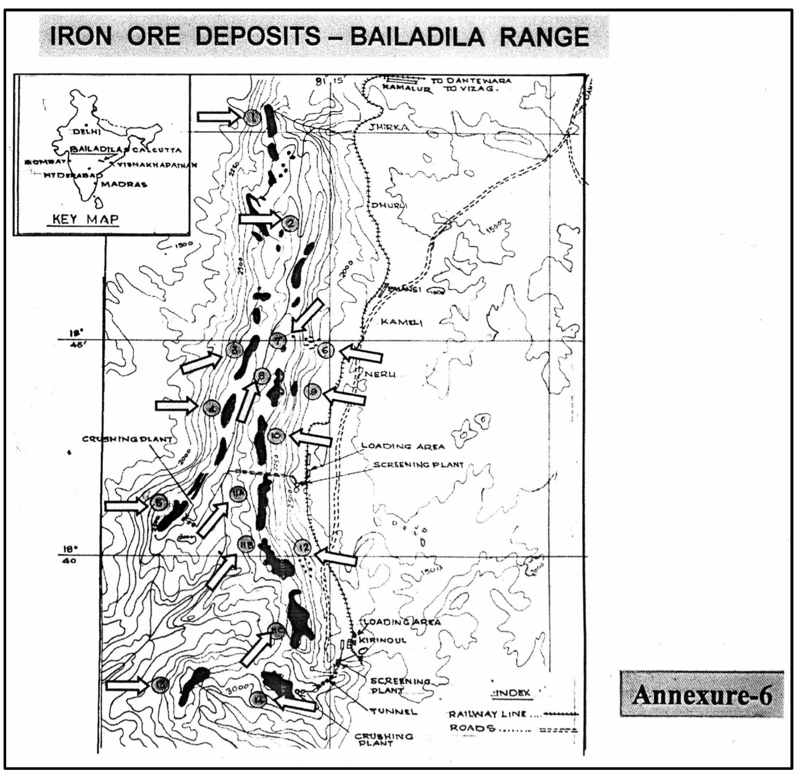
B	Bailadila, Dalli, Rajhara, Rowghat, Mahamaya, Aridongri, Surajgarh
C	Donimalai, Ramandurg, Kumaraswamy, NEB Range, Ettinahatti, Tumti, Belagal
D	N.Goa, S.Goa, Redi
E	Kudremukh, Bababudan, Kudachadri





Annexure-5



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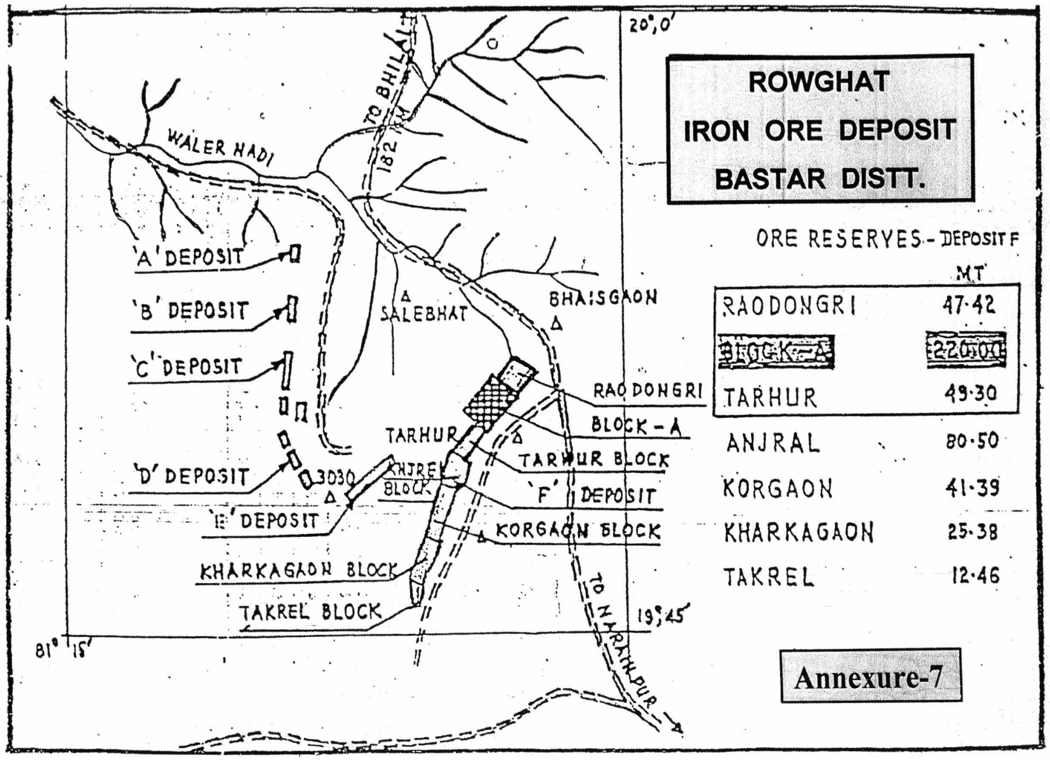

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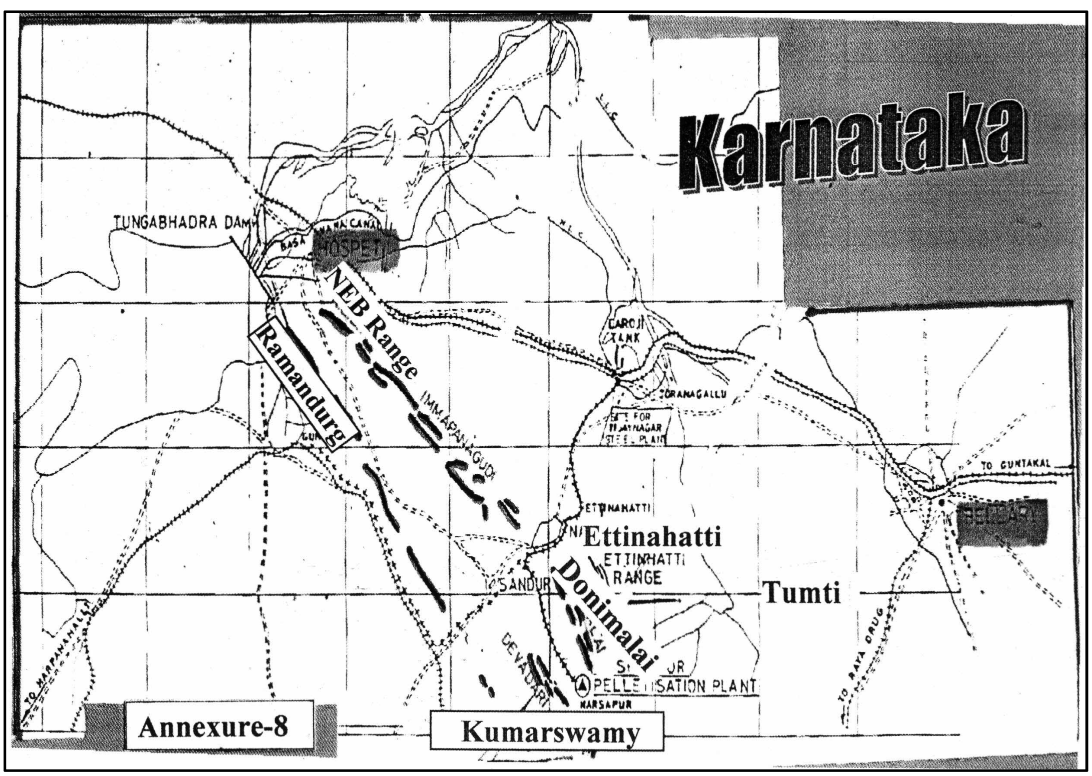

Annexure-8

Kumarswamy

Professor S K Bose Memorial Lecture

Mr A N Bose

Former Controller General, Indian Bureau of Mines, Govt. of India
E-mail: anbose@hotmail.com

I feel highly honoured to be invited to deliver the Professor S. K. Bose Memorial Lecture at this 19th National Convention of Mining Engineers and National Seminar on Disaster in Mines being held at the Indian School of Mines University, Dhanbad under the aegis of the Institution of Engineers (India), Dhanbad Local Centre.

BRIEF LIFE SKETCH OF PROF S.K. BOSE

Professor Sudhangshu Kumur Bose was born on October 7, 1900 in the Burdwan District of West Bengal. He graduated from the Presidency College, Calcutta with Honours in Geology in 1921 securing the first position in the University. He joined the Royal School of Mines, London, in 1923 under a Government of India Scholarship. He joined the Indian School of Mines in 1927 as the first Indian Professor at the age of 28 in the formative stage of the School in 1927. He continued as the Professor and Head of the Department of Metalliferous Mining &Mine Surveying. He was the Acting Principal from April, 1954 till his retirement in May 1956. After his retirement, Prof. Bose was appointed as OSD (Training) in the NCDC for a year during which he organized four Mining Training Institutes. For the next five years, he was associated with Bengal Engg. College, Presidency College and Jadavpur University as a visiting Professor.

He had prepared nearly two generations of mining professionals who have been at the helm of affairs in the Indian Mining Industry. In him, his students and colleagues found a deep source of inspiration full of lofty human qualities.

Now, I propose to make a presentation on the theme of the National Seminar i.e., Disaster in Mines, as a part of the lecture which will include some information on the Indian Mineral Sector and disasters in the non-coal mines.

MINE DISASTERS

In India, a mine disaster is defined as an accident where ten or more fatalities have taken place. Fifty one disasters took place in our coal mines during the last century (1901 to 1999). Notable among them being collieries Chinakuri, Chasnala, Dhori, Bhatdee to name a few. Courts of inquiry were setup to investigate into the causes of these disasters and necessary follow up action was taken to implement their recommendations. An analysis revealed that while the fatalities due to explosions were rather high in the first three quarters varying from 65% to 76%, it came down to 11% in the last quarter of the century. During the same period, however, the accidents due to inundation were as high as 75% which in the first three quarters varied from 6 to 20 percent.

The Scenario in non-coal Mines is radically different. Very few accidents in metalliferous mines could be classified as mine disasters mainly because underground mines in this sector are very few compared to the coal sector. Out of2400 working mines in the mineral sector, only around 80 are worked by underground methods. Out of this figure again, large mechanized mining is limited to base metals, gold only. Other minerals worked both by opencast and underground methods include leadzine, copper, chromite, barytes, ochre, soapstone etc. The accidents in open cast mines could take place due to inadequate stability of the pit slopes and dumps, drilling and blasting, loading and transportation. However, dumpers/trucks constitute a major cause of fatal accidents (about 70%) both in coal and non-coal mines.

Two major accidents took place at Rajpura Dariba mine of Hindus tan Zinc Ltd. While one such accident killed six persons in a major fire in a diesel storage tank on the surface, the other occurred during shaft deepening in which 13 persons were killed. The latter 'could be termed as a disaster. Others were sporadic accidents involving a fad persons only.

The Kolar Gold Mines are not being worked at present. It is well known that they are amongst the deepest in the world. Rock bursts were common in these mines which led to some accidents. An inhouse unit was monitoring incidents and frequency of these bursts. Two other Gold Mines at Hutti and Uti are also in Karnataka besides one in Jharkhand. No major accidents have been reported from these mines.

Mica is yet another mineral which has been worked by underground methods since long even though many of them might have been started initially as opencast workings. They can be classified as small mines developed by inclines and pits with level drives following the mica bearing pegmatites. Sporadic accidents have been reported from such mines.

TECHNOLOGY SCENARIO IN NON-COAL MINES

The mineral sector in India is fully opened up to private initiatives both domestic and foreign through the unveiling of the National Mineral Policy, 1993. With this end in view, the mining statute has also been suitably amended. Foreign equity holding up to cent percent is allowed on the automatic route for both exploration and mining of practically all the minerals.

The above policy initiatives paved the way for entry of multinationals for prospecting of high value minerals like gold, diamond, base metals etc.

The entire production of bauxite , limestone, dolomite and major share of copper, chromite etc. is obtained by surface mining 87 percent of the operations could be classified as smale scale. Technological upgradation began with some of the iron ore mines followed by those of limestone, bauxite, etc. In the recent years, there is a growing emphasis on mechanization. With the passage of time, dumper capacity has increased to 120 tonnes, diameter of blast hole drills to 310 mm, those of shovels to 4.6m^3 and 10.7m^3. Use of35 and 50 tonner dumpers have become fairly common. Hydraulic shovels have mostly replaced the mechanical ones because of their lower initial investment, better maneuverability and operational control and digging power. In some of the limestone mines, Surface Miners have been introduced.

While in manganese and chromite mines, conventional cut and fill method is being practised, in base metals and gold mines. Vertical Crater Retreat (VCR) and large diameter blasthole method of stoping is replacing the conventional methods. ANFO Mixture with pneumatic loading in large diameter holes and slurry explosives with better detonation technique with sequential blasting resulted in large production.

TREND OF MINE ACCIDENTS IN THE RECENT PAST

Mining in India is primarily labour intensive. Therefore, accident, death and injury rates are generally expressed in terms of units per 1000 persons employed on yearly average basis. The rate remained almost constant for non-coal mines during 1941-50 and thereafter in the decade 1971-80, a sight rise was observed presumably because mechanization was resorted to in the later decade. It was observed further that while in the case of coal mines roof falls, rope haulage and dumpers/trucks accounted for a major share of fatal accidents, side falls and transport equipment were responsible for such fatalities in non coal mines.

A Comparative statement showing causewise analysis of accidents in metalliferons mines for the period 1994-2001 and in 2004 is given below: -

Table 1 : - Comparative statement on causewise analysis of accidents in non-coal mines.

Sl. No.	Cause	Average 1994-2001	2004
1	Roof fall	3	4
2	Side fall	15	13
3	Fall of Objects	6	14
4	Fall of Persons	14	15
5	Explosives	8	4
6	Dumpers/ Trucks / Tankers	27	31
7	Other Machinery	12	15
8	Other Causes	15	4
	Total	100	100

From the above figures, it may be concluded that they are more or less comparable except that fatalities due to explosives and those due to other causes were substantially lower in the year 2004.

LEGISLATION & POLICY INITIATIVES

The first Mines Act was enacted in 1901 which was superceded by the one in 1923. After independence, welfare and health of mine workers are the concern of the Central Government under Article 246 of the Constitution. Accordingly, legislation has been enacted in conformity with this constitutional obligation.

The present Mines Act was enacted in 1952. Major changes were incorporated in this Act in 1959 and 1983. Under this Parent Act, Coal Mines Regulations, 1957 and Metalliferous Mines Regulations 1961 were framed which are administered by the Ministry of Labour through the Directorate General of Mines Safety.

The next stage of evolution of safety legislation came after nationalization of coal mines in 1975 when significant amendments were made. A conference held in 1976 mooted the idea of workers' participation in safety management. Under the International Programme of the ILO, a multidisciplinary team of experts visited Indian mines during 1978-79, whose recommendations provided the basis for the 5^{th} Conference on Safety in Mines held in 1980. It was a milestone so far as the mines safety in this country was concerned. The concept of self regulation was strengthened in safety conferences held subsequently.

Thereafter, the sixth and seventh safety conferences recommended formulation of a support plan for support of roof, side, back, hangwall etc. The eighth conference endorsed the recommendations of an expert Group for classification of strata using Rock Mass Rating (RMR). The 7th and the 8th conferences made several recommendations on safety in openeast mining for regulating the movement of Heavy Earthmoving Machinery (HEMM). The ninth conference on safety in Mines held in February, 2000, recommended introduction of 'Risk Assessment' and 'Safety Management Plans' Every mining Company should undertake risk assessment aimed at reducing the likelihood of impact of all mishaps in mines. It was also recommended that the 'Risk Management Plans' shall be prepared on this basis in selected mines and implemented. It was recommended further that safety performance appraisals should form an agenda item for all board meetings of a mining company.

Meanwhile the National Mineral Policy pronounced in 1993, for non fuel and non-atomic minerals, interalia, stressed the need for development and adoption of mining methods which would increase the safety of workers and reduce the accidents Towards this end, participation and cooperation of mine workers shall be secured. Steps will also be taken to minimize the adverse impact of mining on the health of workers and surrounding population (para 7-14).

CONTROL OF ACCIDENTS

The existing practice is to enforce the safety statute by periodic inspections of mines by the officers to the DGMS and through implementation of safety measures. Large companies have separate organizational setups with senior officers heading the same to ensure that adequate attention is being paid to all such aspects. Safety audits are also conducted by professionals to assist the managements in this regard. Besides Mines Safety weeks are organized by the DGMS annually in all important mining areas to bring about an awareness and a sense of competition amongst mine owners as prizes are awarded based on their performance judged by the inspection teams during the safety weeks.

SMALL SCALE MINING SECTOR

There is no universally accepted definition of Small scale mining and may vary from country to country. As mentioned earlier 87% of our mines can be termed as small scale. Small and isolated Deposits lend themselves to economic exploitation through small scale mining. Efforts will be made to promote small scale mining in scientific and efficient manner while safeguarding vital environmental and ecological imperatives. (para 7.12 of NMP, 1993).

In India, some thirty minerals are produced exclusively from medium/small scale mining. A majority of these mines have been labour intensive and have been operated with little or no mechanization. There are a number of problems facing the small scale mining sector which include lack of adequate knowledge about the deposits under exploitation which is often superficial, lack of infrastructure, finance, ore treatment, marketing facilities and trained technical personnel.

In order to systematize mining operations, including those in small mines the Government of India brought in radical reforms in the mineral legislation between 1986 and 1988 which, interalia, required the submission of a mining plan implementation of which was monitored by the Indian Bureau of mines. A simplified format was devised for small opencast mines without any beneficiation facilities as most of the small mines fall in this category. There are some challenges ahead for making small scale mining more systematic and better organized with adequate safeguards for protection of health and safety of workers.

R&D FOR SAFETY IN MINES

Considerable work related to safety in coal mining has been done in the Central Institute of Mining & Fuel Research under CSIR which include strata control investigations, longwall mining, mechanized depillaring, etc. In the non coal sector, organizations like National Institute of Rock Mechanics (NIRM) KGF under the Ministry of Mines has done considerable work on slope stability, blasting, rockbursts, etc. The Mining Research cell of the IBM has undertaken several investigations for slope stability for optimum slope design, design of waste dump slopes, etc. on request from mine owners. Besides, there is a National Institute of Miners' Health (NIMH) at Nagpur for Occupational health related problems of mine workers

CONCLUDING REMARKS

The existing Mines Safety Legislation, as amended from time to time, has been in place for over fifty years. It has been evolved based on experience and practice. It is prescriptive and permissions/approvals/relaxations are mandatory. In the coming years, Indian Mining Industry is likely to face complex safety problems due to increase mechanization and difficult geo-mining conditions which may result in increased number of accidents. Identification and assessment of dangers ahead followed by precautionary measures and implementation thereof will be important in future.

The National Mineral Policy (NMP) 1993, has opened up the mineral sector for private initiatives and investment. The existing policy is currently under review and a new NMP is on the anvil. Thus, the mineral sector is on the threshold of structural reforms technologically. Therefore, approach has to be suitably altered to take care of the emerging scenario in this country.

Considerable stress has to be laid on occupational health and environmental in the days to come. Therefore, these aspects will need greater attention so that the pollution level is kept under check and the mines are worked in an environmentally sustainable manner.

The level of computerization in small scale mining sector is rather insignificant and some efforts are being made. Through PC based systems are very popular and easily affordable, there is a fear regarding its usage in the mining environment. The concept of computerization at the mine site can be achieved by providing basic education and training to mine owners/ operators regarding the possible applications of computers.

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Development of Coal Resources — Technological and Environmental Issues

Mr Nirmal Chandra Jha

Former Chairman, Coal India Ltd.

It is indeed an honour to be invited to deliver Prof S K Bose memorial lecture in front of this august gathering. Prof Sudhansu Kumar Bose, the first Indian Professor at Indian School of Mines Dhanbad, had many accomplishments to his credit in the fields of geology, metal mining and mine surveying. Brief details that I got to know about Prof Bose speak a lot about his engineering capabilities. Based on my experiences in the coal sector, having served this industry for 37 years, I must admit that multifaceted accomplishments of Prof Bose are worth emulating.

The topic for my address today is "Development of Coal Resources-Technological and Environmental Issues" and I would be dwelling upon my experiences in dealing with these issues during my tenure at Coal India in various capacities. Coai will continue to provide a major portion of energy requirements in India for at least the next three decades, and it is imperative that we extract our coal resource efficiently, safely, and in an environmentally responsible manner. To begin with, let us know the role of coal sector in fulfilling the energy needs of the country and the widening gap between the mounting demand of thermal coal mainly on account of capacity addition for electricity generation and the domestic availability.

1. Overview of Coal sector and Emerging demand

1.1 India's coal consumption has been growing at 7% (CAGR) over the last five years and the projections of the XII Plan predict a growth rate of 8.6% (CAGR) till 2016-17. The trend signals a consistent growth at a pace of 8-9% for the foreseeable future. Electricity is desperately needed and commensurate supply of thermal coal will be required to support economic and social development of our country. As of now, coal, as the cheapest source of energy, seems to continue to enjoy the status of being the predominant fuel for electricity generation for next three decades.

1.2 Depleting non-renewable sources of energy are driving developing countries to utilize nuclear and other non-conventional sources for meeting the surging energy demands to maintain socioeconomic development. With energy consumption expected to escalate in the future, concerns are rising about the ability of existing resources to address this mounting energy demands. Overdependence on coal as a means of primary energy supplier has led to relative shortage of other energy sources, resulting in a serious energy security issues. Due to domestic coal shortage, many power projects are operating at sub-optimal capacity and are required to depend upon costly coal imports.

1.3 Coal deficit in India is likely to grow from 114 Mill tonnes by 2011-12 to 265 Mill tonnes by 2016-17 and may further rise to 473 Mill tonnes by 2021-22 i.e. the terminal year of XIIIth plan period. The demand for coat is projected to rise @ 6.4% (CAGR) from 696 million tonnes in 20 11-12 to 980 million tonnes by 2016-17 and is likely to continue rising @ 7.3% (CAGR) to a level of 1373 million tonnes in the xnr' plan period. As against the projected demand, domestic supply of coal is likely to grow from 559 million tonnes in 2011-12 to 1100 million tonnes by 2021-22, thereby leaving a shortfall of nearly 273 million tonnes, which in all probability has to be met through imports. CIL's contribution to all India production is projected to reach to 556 million tonnes by 2016-17 from the anticipated level of 440 million tonnes in 2011-12. In order to satisfy the rapid growth in coal demand, the Indian coal industry, therefore, needs more investment and active participation of private players to raise the production level. Our experiences, so far, on the contrary are not very encouraging on this front.

2. Enhancement of production through Captive blocks

2.1 By the terminal year of XII Plan, i.e. 2016-17, Coal India projects an increase in coal production from an anticipated level of 440 million tonnes (2011-12) to 556 million tonnes on Business as usual and may improve it to 615 million tonnes on optimistic basis subject to obtaining requisite clearances within the specified time schedule. However, even this increase in production is not likely to meet the projected demand of thermal coal for power sector.

2.2 In view of the widening demand-supply gap scenario, Government of India had put in place a system for allocation of coal blocks to various Govt Companies, private companies and Ultra Mega Power Projects (UMPP). As of 31.03.2011, about 216 coal blocks (including some blocks which had subsequently been de-allocated) with an aggregate geological resource of about 50 Billion tonnes of coal have been allocated to attract investments in the coal sector and increase production. Out of the 216 coal blocks allocated, only 28 coal blocks had commenced production by 2010-11, contributing a meager quantity of 34.60 million tonnes, representing a dismal 6% of all India coal production (533.07 Mt). The major factors responsible for delays in commencement of coal production are on account of delays in land acquisition, forestry clearance, Environmental clearance and other R&R issues. There were also instances that some of the coal blocks which had been allocated were not fully explored leading to delays in their development.

3. Coal sector - Policy Reforms

3.1 The new National Mineral Policy 2008 seeks to develop a sustainable framework for optimum utilization of the Country's natural resources for the industrial growth in the country. It also envisages action areas for improving the life of people living in the mining areas, which are generally located in the backward and tribal regions of the country. The policy also enunciates that special care will be taken to protect the interest of host and indigenous populations through developing models on best practices. Project affected persons will be protected through comprehensive relief and rehabilitation packages in line with the National Rehabilitation and Resettlement Policy.

3.2 Further, the Mines and Minerals Development and Regulation (MMDR) Bill 2011 provides that for all exploration activities, suitable compensation shall be payable to the person or family holding occupation or traditional rights on the area of exploration. All mining lease holders will be required to pay annually into District Mineral Foundation, a sum equivalent to royalty in case of major minerals (other than coal) and a sum equivalent to 26% of profit in case of coal. Mining companies are required to allot at-least one share at par to each person of the family affected by mining so as to give a sense of ownership in the enterprise, provide employment or other compensation as stipulated under the R&R policy etc. After mining is complete, mining companies need to pay for damages, if any, to affected persons as part of the mine closure and restoration process.

3.3 A new Land Acquisition and Rehabilitation & Resettlement (LARR) bill has recently been introduced in the Parliament which also has provisions for increased compensation to land losers and one job per affected family.

3.4 Clarity on the above policy reforms (viz. Who will administer it, how & when, who will ensure that an investor will not face trouble once compensation is paid to villagers etc) which have far reaching effects on the Indian energy sector must be addressed on priority, particularly on Environmental and Forestry issues, which has blocked development of new planned projects and stalled the expansion of ongoing projects leading to almost stagnant growth in coal production. This in turn has forced increased volume of coal import. Addressing the production hindrances is the dying need of the hour or else the high GDP growth achieved in recent past will be severely affected, especially when the global economic environment looks bleak.

4. Coal Resource Exploration

4.1 The total coal inventory of India estimated by GSi, stands at 285.86 billion tonnes (as on 01.04.2011) including 'Proved' reserves of nearly 114.0 billion tonnes, about 137.5 billion tonnes of 'Indicated' and 34.4 billion tonnes of 'Inferred' categories. This indicates that about 60% of total resources remain to be explored in detail for converting them to 'Proved' category for project planning and mining. In view of the increased requirement of coal, there is an urgent need to get such resources proved through faster detailed exploration.

4.2 We still have massive development potential in India and the time has come for the coal sector to employ advanced exploratory techniques in the fields of geological surface survey and mapping, drilling exploration, geophysical explorations and other surveys to determine the geological structure, coal reserves and coal quality. Accurate and comprehensive estimates of coal reserves are essential for a detailed strategy and infrastructure planning to develop potential coal bearing areas.

4.3 Another area requiring immediate attention is that of increased investment in research and development to ensure that the 'nation's coal resource is used efficiently, safely, and in an environmentally responsible manner. Investment in coal-related research and development (R&D) is a critical requirement for continued advances in efficiency, safety, and productivity with reduction of environmental impacts. Overwhelmingly, the environmental impacts of coal use, especially carbon dioxide emissions associated with global climate change, pose the greatest potential constraint on future coal utilization.

5. Technical and Environmental Challenges

5.1 The coal mines of the future will encounter a range of more difficult mining and processing challenges as more easily accessed coal seams are getting depleted and the coal mining turns to less accessible deep seated reserves. Increasingly difficult mining conditions will require improved methods to protect the health and safety of mine workers, careful environmental management of mined lands and waste products, and improved recovery to optimize the use of coal resources. Owing to technology innovation and up-gradation in HEMM for use in opencast mines (OC), operations in OC projects are becoming more productive with reduced cost, thereby improving profitability of operations. It is imperative for the coal sector to devise cost effective methods for use in underground mines as well.

5.2 The underground coalmines in India still rely predominantly on drill and blast cycle. It is imperative that mechanization is introduced in a large scale to ensure that delays in the interdependent processes of drill & blast cycle are minimized to maximize utilization of the loading machines to improve the overall mining cost. Underground development has to move towards increased production rates, use of instrumented drill rigs extensive adoption of coal winning by cutting machines and adherence to safety and environmental considerations to ensure realization of optimal cost control. Indigenous technology development is critical to Indian coal Industry for improved performance suited to our geo-mining conditions. This will require extensive R&D works to evolve indigenous technologies.

5.3 Any new technology that is developed today should take into account the environmental consideration and should provide benefits, which are sustainable. As mining activities extract coal from deeper and operationally more difficult seams, a range of existing environmental issues and concerns will be exacerbated and new concerns are likely to arise, particularly related to greater disturbance of hydroiogic systems, ground subsidence, and waste management at mines and processing plants. Research activities should focus on developing techniques to mitigate the alteration and collapse of rock layers overlying mined areas, to model the hydrological impacts of coal mining, to improve mine mapping and void detection, to increase stability of OB heaps on steep slopes, and to improve the construction and monitoring of haul roads in opencast mines. Research work may also have to be undertaken to mitigate the effects of past mining practices, land reclamation work and return of mined out land to the erstwhile land owners for their livelihood and income generation.

5.4 The quality of Indian coal, basically being inferior, coal beneficiation essentially will come to play a bigger role in near future. Even smaller percentage increases in coal recovery from coal washeries have the potential to significantly expand economically recoverable coal reserves, and advanced technologies will be needed as coal reserve quality decreases over time.

5.5 Growth in the use of coal depends on having sufficient capacity to deliver increasing amounts of coal or electricity derived from coal reliably and at reasonable prices to an end user. The requisite infrastructure for the coal sector needs to be built and aggressively funded by Government of India in association with Public-Private Partnerships (PPP). The capacity, 'reliability, and price of rail transportation-the dominant mode of coal transport-must come up to the planned level to cater to the consumer needs. Reliable and sufficient waterborne transportation, as an alternative method of coal transport should also be explored and developed. Adequate infrastructure in respect of port capacity also requires due attention.

5.6 As coal is to continue as a major component of the nation's future energy supply in a carbon constrained world, large-scale demonstrations of carbon capture and sequestration (CCS) to reduce CO2 emissions from coal- based power plants will be required. Detailed assessments are needed to identify potential clean fuel technologies like Coal, Bed Methane (CBM), Underground Coal gasification (UCG) and Coal Mine Methane (CMM) etc that are capable of sequestering large quantities of CO_2.

Conclusion

To conclude, I must emphasize that the key to development of coal resources depends not only on the indigenous availability, but on many other factors like improving policy guidelines, development of environmentally acceptable technologies and exploitation of the available energy resources with adequate attention towards commercial viability. We should explore different feasible alternatives, optimize the consumption of natural resources and bring out innovative ideas with active involvement of people in and around our workplace for the betterment of this industry and the society as a whole.

Risk Assessment: An Emerging Trend to Address Mine Safety Issues

Prof Ashis Bhattacherjee

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Introduction

Accidents and injuries related to work are a major occupational health problem in most of the industrialized countries. Around 317 million work related injuries and 2.34 million work related fatalities, which are caused from work-related accidents and various types of diseases, occur each year in the world from a total population of 3 billion workforce (Staermose, 2013). Accident and ill-health record of the mining sector compares poorly to that of other economic sectors such as manufacturing, construction and railway (Hermanus, 2007). For example, the industries in the United States with the highest death rates per 100,000 workers were mining (30.3), agriculture/forestry/fishing (20.1), and construction (15.2) based on the fatality information during the 16-year period (1980 - 1995) (Kisner, 2000). Moreover, the fatal and non-fatal injury rate in the USA mining industry for the year 2004 revealed that coal mining had the highest fatal and non-fatal injury rate compared to the other mining sectors. A NIOSH analysis revealed that by the age of 51 years, about 90% of the coal miners and 49% of metal/non-metal miners had a hearing impairment (Esterhuizen and Gurtunca, 2006). Due to the importance of mining to employment and in the economy in South Africa, there is significant value in the South African mining industry in addressing health and safety issues systematically. Over the years the safety performance of South African mines has improved, but not at the same rate as in other major mining countries such as Australia, Canada and the USA (Herman us, 2007). Comparison of Australian and South African rates suggests that miners are 4-5 times more likely to lose their lives in mine accidents in South Africa than in Australia (Hermanus, 2007)

The 20th century has experienced a considerable amount of success in mines safety in India. However, the fatal injury rates in coal mines in India revealed that these figures are almost constant during the recent 10-year period 2003-2012 (Safety Conference, 2013). The serious injury rates during the same period show a downward trend. Figure 1 presents the fatal and serious injury rates during the period 2003-2012. In Indian coal mines, the numbers of fatal and serious injuries for the year 2011 were 67 and 508 respectively and for the year 2012 these values were 99 and 495 respectively. The fatality and serious injury rates for the years 2011 and 2012 revealed that the fatality rates per thousand persons employed were 0.18 and 0.27 respectively; whereas, for the serious injury rates these values were 1.38 and 1.34 respectively (Safety Conference, 2013). The analysis of fatal accidents in Indian coal mines during 1998-2010 revealed that the leading causes are fall of roof and sides (31%), dumper and truck transport (23%), non-transportation machinery (10%), fall of person and object (9%), and electricity (5%) (Singh, 2011). An analysis of the serious injuries during 2006 revealed that the major causes are: slip and fall of persons (26.4%), rope haulage (22.4%), fall of object (16.8%) and fall of roof (3.7%) (DGMS, 2007). Injuries due to slip and fall of persons are major safety problems in Indian coal mines; a proper attention is necessary in this area.

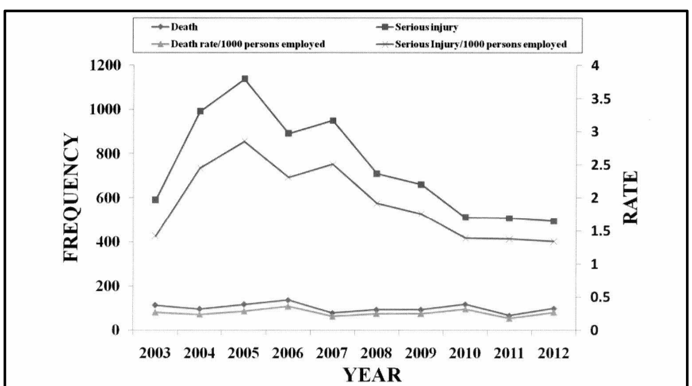

Fig. 1: Trend of death and serious injury rates in coal mines during 10-year period

The mining industry has undergone a huge technological development during the recent years. The shift of technology during the last decade, from the conventional underground mining to both the mechanized opencast and underground mining and reduction in manpower through mechanization, has reduced the injuries. However, safety at work is still a serious problem. It is important to recognize that much remains to be accomplished to achieve the goal of a totally safe mine.

Background

For the mining industry to be successful it should meet not only the production requirements, but also maintain the highest safety standards for all concerned. Everyday the miners are exposed to several job related hazards such as heat, humidity, noise, dust, improper ventilation, and slippery floor which certainly impose additional stresses upon the workers. The underground miners are especially exposed to a wide range of environmental/working conditions-related hazards and geological/strata control-related hazards in addition to a number of hand tool-related hazards, handling material-related hazards, and machine-related hazards (Chau et al, 2007). It is well known from literature that these hazards are high risk factors for occupational injuries (Chau et al, 2007).

Consequences of injuries include increased absenteeism and use of medical care services, reduced productivity, and loss of working time and disabilities. A number of job-related hazards as well as socioeconomic factors, lifestyle factors and health-related factors have been reported to be associated with the risk of being injured, especially in the mining, railway and construction industries (Gauchard et al, 2007; Ioannis et al, 2007; Chau et al, 2007). Health researchers found that the lifestyle risk factors namely smoking habit, regular alcohol consumption, sleep disorders and sedentary lifestyle were common in affecting health status (Northy, 2003; Ioannis et al, 2007). Hazards at the workplaces arise from unsafe conditions which include inappropriate materials (for example, unguarded machinery and defective or broken tools), poor working environment (slippery floor, poor workplace keeping, etc.), and unsafe acts. They are a part of the mining process and offer challenges to the mining community to research and evaluate new strategies.

Traditional approaches to managing workplace safety in mines have mainly focused on job redesign and the technical aspects of engineering systems. Moreover, it is being realized that compliance to rules and regulations of mines is a prerequisite; however, it is not sufficient to achieve further reduction in accident and injury rates in mines. Proactive approaches are necessary to further improve the safety standards in mines. Moreover, several research studies revealed that a majority of workplace accidents and injuries are attributed to the unsafe work practices of the employees rather than unsafe working conditions (Mullen, 2004, Ghosh et al, 2004). Hence, unsafe conditions and practices in mines lead to a number of accidents and which in turn may cause loss and injury to human lives, damages to property, and loss of production. Hazard identification and risk assessment is an important task for the mining industry which needs to consider all the risk factors at workplaces (Ghosh et al, 2004). Applications of risk management approaches in mines are necessary to identify and quantify potential hazards and to suggest effective solutions. Moreover, human factors based safety management system represents a promising approach to the improvement of workers' safety.

Risk Assessment

Assessment of risks in the workplace is essential so that plans can be made to control the risks. If the risk assessment process and the risk management approach are not properly developed or not done at all, the appropriate preventive measures are unlikely to be in place. Risk assessment is part of a good management approach, taking into account the different needs of individual employers as well as the changing workplace. Risk assessment is recognized as an integral part of a successful health and safety management system. The effective management of health and safety will depend, amongst other things, on the implementation of a suitable risk management plan. According to Joy (2004), the approach of risk management is characterized by the four-stages. These stages/steps are as follows:

(i) Risk identification - identifying the hazards and the situations that have the potential to cause harm or losses (sometimes called "unwanted events")

(ii) Risk analysis - analyzing the magnitude of risk that may arise from unwanted events.

(iii) Risk control - deciding on suitable measures to reduce or control unacceptable risk.

(iv) Implementing and maintaining control measures - implementing the control and ensuring that they are effective.

Risk Assessment is a common first step in a risk management process. Risk assessment is the determination of quantitative or qualitative value of risk related to a situation and it involves risk identification and risk analysis. Risk assessment forms a crucial early phase in the disaster management planning cycle and is essential in determining what disaster mitigation measures should be taken to reduce future losses. Any attempt to reduce the impact of a disaster requires an analysis that indicates what threats exist, their expected severity, who, or what they may affect, and why.

Process of Risk Estimation

The process by which risks are assessed increases in importance as society becomes more cognizant of risk, particularly risk that is inequitably imposed on certain individuals by the technological activities. The term "risk assessment" is used here to describe the total process of risk analysis, which embraces both the determination of levels of risk and the social evaluation of risks. Risk determination consists of both identifying risks and estimating the likelihood and magnitude of their occurrences. Risk evaluation measures both risk acceptance, and the acceptable levels of societal risk and risk aversion, or methods of avoiding risks, as alternatives to involuntarily imposed risks. In risk assessment, three questions need to be answered: "What can go wrong?"; "How likely is it that this will happen?"; "If it does happen, what are the consequences?" (Kaplan and Garrick, 1981).

In this paper, the following risk estimation techniques are discussed: (i) DGMS risk rating criterion, (ii) NIOSH approach and (iii) Modification of NIOSH approach including the concept of human error.

DGMS Risk Rating Criterion

The DGMS risk rating criterion uses three parameters to calculate risk rating pertaining to a specific hazard. The maximum risk rating for this criterion can be 500. The three parameters are: "consequence", "exposure" and "probability". The risk for this criterion can be calculated by following equation:

$$\text{Risk} = \text{Consequence} \times \text{Exposure} \times \text{Probability}$$

Consequence is the size of the loss or damage resulting from the occurrence of an hazard. Exposure indicates the amount of time personnel are exposed to the hazard; whereas the probability indicates the probability of occurrence of the hazard. It should be remembered that consequence of a hazard need not only be in terms of safety criteria but could also be in terms of a money loss, incurred costs, loss of production, environmental impacts as well as public outrage. Likelihood is the chance that the hazard might occur which is the product of exposure and probability. The scores for each of the individual parameters are presented in Fig. 2.

Consequence		Exposure		Probability	
Several dead	5.0000	Continuous	10.00	May well be expected	10.0
One dead	1.0000	Frequent (Daily)	5.00	Quite possible	7.0
Significant chance of fatality	0.3000	Seldom (Weekly)	3.00	Unusual but possible	3.0
One permanent disability	0.1000	Unusual (Monthly)	2.50	Only remotely possible	2.0
Small chance of fatality	0.1000	Occasional (Yearly)	2.00	Conceivable but unlikely	1.0
Many lost time injuries	0.0100	Once in 5 years	1.50	Practically impossible	0.5
One lost time injury	0.0010	Once in 10 years	0.50	Virtually impossible	0.1
Small injury	0.0001	Once in 100 years	0.02		

Fig. 2: DGMS Risk Rating Criteria

NIOSH Approach

This approach uses five parameters to calculate risk rank, which are: number of miners exposed, frequency of exposure, likelihood of the occurrence of hazard (events/year), maximum reasonable consequence and likelihood of that consequence. First total exposure is calculated based on number of miners exposed and frequency of their exposure. The scales used to define the number of miners exposed are shown in Table 1. The total exposure is calculated and is divided into five categories (A, B, C, D, E) based upon Table 2.

Total exposure and Likelihood of hazard being realized (Table 3) are than used to determine overall likelihood as given in Table 4. Overall likelihood is divided into five categories (a, b, c, d, e) based upon Table 4.

Most Likely Consequence is then determined utilizing maximum reasonable consequence and likelihood of that consequence as given in Table 5. Most Likely Consequence is divided into five categories (P, Q, R, S, & T) based upon Table 5. Finally the risk ranking and risk ranking matrix with scale are presented in Tables 6 and 7 respectively.

Table 1. Scales used to define the Number of Miners Exposed to Risk

% of Workforce	Exposure
>50	Most
>30-50	Many
>10-30	Several
>5-10	A few
≥1-5	Very few

Table 2. Total Exposure using a 5 by 5 matrix

Total Exposure						
No. Workers Exposed of ↓	Frequency of Exposure →	Continuous	Several times daily	Daily	Weekly	Monthly
Most		A	A	B	C	D
Many		A	B	C	D	E
Several		B	C	D	D	E
A few		C	C	D	E	E
Very few		D	E	E	E	E

Table 3. Likelihood Categorization

Likelihood	Events per year
Highly Likely	≥5
Likely	≥3 and <5
Possible	≥1 and <3
Unlikely	≥0.5 and <1
Very unlikely	<0.5

Table 4. Overall Likelihood

Overall likelihood	Total exposure (scale) → / Likelihood ↓	A	B	C	D	E
Highly Likely		a	a	B	c	d
Likely		a	b	C	d	e
Possible		b	c	D	d	e
Unlikely		c	c	D	e	e
Very unlikely		d	e	E	e	e

Table 5. Most Likely Consequence

Most Likely Consequence	Likelihood of the consequence → / Maximum reasonable consequence ↓	Very high	High	Moderate	Low	Not likely
Multiple fatality		P	P	Q	R	S
Fatality		P	Q	R	S	T
Serious		Q	R	S	S	T
Average lost time		R	R	S	T	T
Minor		S	T	T	T	T

Table 6. Risk Ranking

Risk Rank	Most Likely Consequence → / Overall likelihood ↓	P	Q	R	S	T
	a	1	2	3	7	11
	b	4	5	8	12	16
	c	6	9	13	17	20
	d	10	14	18	21	23
	e	15	19	22	24	25

Table 7. Risk Ranking Matrix (with scale)

Risk Rank	Most Likely Consequence (scale) → / Overall likelihood (scale) ↓	P (10)	Q (8)	R (6)	S (4)	T (2)
a	(10)	1	2	3	7	11
b	(8)	4	5	8	12	16
c	(6)	6	9	13	17	20
d	(4)	10	14	18	21	23
e	(2)	15	19	22	24	25

Modification of NIOSH Approach

For incorporating human error in risk estimation first risk score is calculated by following equation:

$$\text{Risk Score} = \text{Most likely consequence} \times \text{Overall Likelihood}$$

The value for most likely consequence and overall likelihood are determined from scaling given in Table 7. The final risk score is than calculated by multiplying human error value (Table 8) and risk score found earlier.

$$\text{Risk (with human error)} = \text{Human Error Value} \times \text{Risk Score}$$

Table 8. Human Error Scaling

Human error	Value
Significant	3
Exists	2
Insignificant	1

Summary

The mining industry makes a significant contribution to the national economy and the well being of the society as a whole. Because of the hazardous nature of the mining as an activity and the complexity involved in it, it is not possible to be inherently safe. It is now widely accepted that the various techniques of risk assessment and risk management contribute greatly towards improvement in the safety of mining operations. It has now become essential and mandatory that the risk assessment be undertaken for all hazardous operations and machinery. Introduction of risk management is a innovative technique compared to the traditional reactive accident prevention strategies. Risk management not only integrates safety with productivity but also can be used as a very good tool for reduction of cost. The safety systems stand on the premise that all risks need not be eliminated and different control measures can be adopted for different levels of risks.

Effective application of risk assessment tools is necessary to enhance identification and quantification of potential hazards and to suggest effective solutions. In this paper several risk assessment techniques are presented which includes DGMS approach, NIOSH approach, Moreover, research on behavioural based safety represents a promising approach to the improvement of workers' safety. As a result, a modified risk assessment approach based on human error concept is proposed in this study. This paper presents the risk assessment approaches used in mines in India and proposes behavioural based approach as a risk assessment tool for the Indian mining industry. The effective management of health and safety will depend, amongst other things, on suitable and sufficient risk assessments being carried out and their findings being used effectively which will greatly contribute towards improvement in the health and safety of mine workers.

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Importance of Geotechnical Engineering in Mining Operations

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Introduction

To address the hazardous and complex nature of underground and open pit mining, sound geotechnical engineering knowledge and expertise are essential to assess ground conditions. In depth geotechnical studies are precursor for design of ground support nod rock reinforcement and also for determining the size, shape and orientation of openings, pillar design, optimization of stoping parameters, pit slope and dump slope design. Good geotechnical engineering practices can definitely result in safe and economic mining operations.

Global Status

In many countries, about three decades ago, only some mines employed site based geotechnical engineers. Geotechnical studies for design and operational support were primarily carried out by specialized consultants and/or research institutions. However, strict mine safety regulations enacted in 1990s brought an important change when global mining companies started developing in-house geotechnical expertise at corporate and mine levels and hire consultants to undertake milling project studies or assist in solving specific ground engineering problems. In India, large hard rock mining companies, since long have their own Geotechnical Engineering/Rock Mechanics wings and the coal companies have started setting up similar cells. Nevertheless, comprehensive geotechnical studies, often required for planning and design, are commonly done by research/academic institutions or other cousultancy firms, with a few exceptions,

Scope and methodology

Geotechnical engineering studies aim to provide:

- scientific design of various structures to enhance stability of the excavanons.
- valuable support to achieve mille production targets.
- opportunities to improve geotechnical aspect of mine design, and
- timely advise to the mine management On the need to change the mine design and/or mine plan to address the geotechnical risks.

Following processes are generally adopted in geotechnical studies:

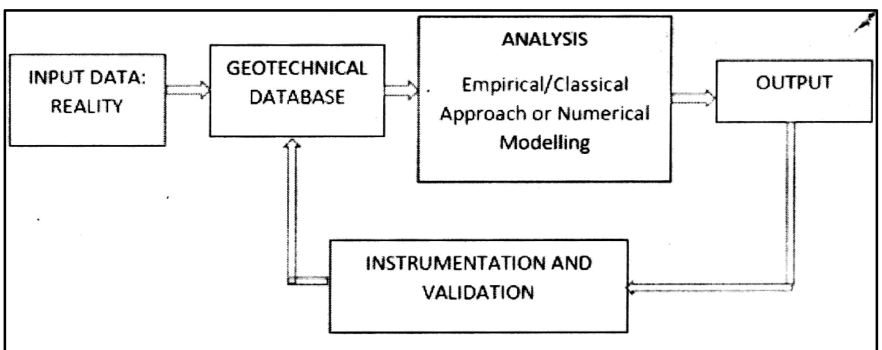

Figure: **Process Flowsheet for Geotechnical Studies**

Input data: Reality involves:

I. Geological field studies, hydrological studies, in-situ tests for rock properties, virgin stress field and

II. Collection of mining detail such as plans, sections and rock excavation methodology.

Predictability of geotechnical studies largely depends on generation or realistic database.

Following steps are generally practiced for this purpose:

I. Determining/estimating virgin stress regime.
II. Lab tests for determination of physico-mechanical properties: strength and modulus.
III. Rock characterizations based on geological structures, discontinuities and disturbances and groundwater impact.
IV. Translating rock properties to rock mass properties.
V. Idealization of mining geometry,
VI. Formulation of ground control management plan and
VII. Mesh generation of mining geometry and input parameters for numerical simulation, if this technique is adopted.

The analytical procedure may he a) Empirical b) Classical and c) Numerical Modeling or combination of these. Steps involved are-

I. Selection of methodologies.
II. Empirical Approach: RMR, Q System. MRMR, SMR etc.
III. Classical Approach: Limit Equilibrium, Kinematic Analysis, Beam Theory, Arch Theory, Ground Reaction Curve etc.
IV. Numerical Modeling: Continuum modeling, Discontinuum modeling, Hybrid Techniques etc.

Instrumentation and Validation

Instrumentation is required for prediction of geotechnical risk to safeguard men and machineries. They also provide very important information for validation of the adopted methodology for safe design. Some of the important aspects are-

I Preparation of instrumentation plan,
II Selection of instruments e.g. Stress Meter, Remote Extensometer, Slope stability Mining Rader (SSMR), 3D Terrestrial Scanner (TLS) etc.
III Periodicity of monitoring: Periodical (with defined interval) or Continuous (with data logger).
IV Data analysis and validation of conducted studies and production, and
V Repetition/iteration of studies with different inputs, if conducted studies cannot be validated and/or predictions and recommendations fail.

Important Geotechnical studies

The presentation include the state-of-the-art geotechnical engineering studies necessary for scientific planning. design and operation of opencast and underground mines. Some important studies in the field of geotechnical engineering conducted mainly in CSIR-CIMFR Dhanbad are also discussed. These include:

I. Geotechnical Studies in Opencast Mines

1. Slope Stability Analysis in a Hard Rock Mine
2. Dump Slope Design
3. Impact of Earthquake on Mining Slopes
4. Slope Monitoring by Stability Mining Radar (SSMR). 3D Terrestrial Scanner (TLS)

II Geotechnical Studies in Underground Mines

1. Design of stoping sequence in a Hard Rock Mine
2. Support design in a coal mine by Empirical Method i.e. Rock Mass Classification Systems
3 Pillar and support design by Numerical Modelling
4. Monitoring of strata and pillar behavior

About Mining Engineering Division Board

The Institution of Engineers (India) has established Mining and Metallurgical Engineering Division in the year 1961. Thereafter, Mining Engineering Division was established separately in the year 1984. This Division consists of quite a large number of corporate members from Government, Public, Private sectors, Academia and R&D Organizations. Various types of technical activities organized by the Mining Engineering Division include All India Seminars, All India Workshops, Lectures, Panel Discussions etc., which are held at various State/Local Centres of the Institution. Apart from these, National Convention of Mining Engineers, an Apex activity of this Division is also organized each year on a particular theme approved by the Council of the Institution. In the National Convention, several technical sessions are arranged on the basis of different sub-themes along with a Memorial Lecture in the memory of '**Prof S K Bose**', the first Professor of Mining Engineering at Indian School of Mines, Dhanbad (now known as IITISM, Dhanbad) and eminent Mining Engineer in India, which is delivered by the experts in this field.

In order to promote the research and developmental work taking place in the field of mining engineering, the Institution also publishes Mining Engineering Division Journal twice in a year, where mainly the researches and its findings are focused. Due to multilevel activities related to this engineering discipline, this division covers different subareas such as:-

- Amended mines regulations and its Impact on Mining Industry
- Coal bed Methane and Unconventional Fuel Gases
- Coal to Oil Technology
- Developments in Mineral Dressing and Beneficiation Techniques
- Emerging Technologies for Dimensional and Ornamental Stones
- Environment, Health and Safety in Mines
- Interdisciplinary Mining Research
- Paste Technology
- Reclamation of Mines
- Resettlement and Rehabilitation of Mine affected People
- Robotic Mining
- Sustainable Open Cast Mining
- Underground Mining

In order to promote the research and developmental work in the field of Metallurgical & Materials Engineering, the Institution also publishes '**Journal of The Institution of Engineers (India): Series D**' in collaboration with Springer, which is an internationally peer reviewed journal and Scopus Indexed & UGC-CARE listed. The Journal is published twice in a year and serves the national and international engineering community through dissemination of scientific knowledge on practical engineering and design methodologies pertaining to Metallurgical & Materials Engineering and Mining Engineering.

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