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CONTENTS

PRESIDENT'S COLUMN

Since last 25 years, SGAT has been emphasing the importance of sustainable development. This year we had examined the issues of hexavalent chromium pollution is Sukinda Chromite belt. Subsequently in a press meet organized by SGAT at Bhubaneswar, it was clarified that the existing pollution level around the chromite mining area is not that alarming as it has been exaggerated by certain sectors. This view was also accepted by the representatives of by State Pollution Control Board.

Further, SGAT proposed various remedial measures for reducing pollution level and also local area development so that the chromite belt which accounts for more than 90% of chromite production in the country does not suffer. State Government, owners of chromite mines and allied industries accepted the proposals of SGAT and action plan has now been prepared. It is expected to help in growth and prosperity of the area.

As water is essential for sustenance of man, the issue of availability and supply of water to mining and mineral based industries has become a serious concern. Realising this SGAT has decided to hold a workshop in July 2008 at Bhubaneswar on water for an indepth discussion by inviting planners, water resources experts and executives of mining and mineral based industries. Hope, deliberations in the workshop would bring solutions to the problem.

SGAT has been interacting with the mining community and the Government on the New Mineral Policy – 2008 and has advised for steps to be taken to ensure rapid development of mining activities. SGAT has been assigned by Government of Orissa for preparation of a Vision Document for Mineral Development – 2020 for which activities have been initiated.

Dr. R. C. Mohanty
(President, SGAT)

SGAT Bulletin
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SEA FLOOR MINERAL DEPOSITS: A REVIVAL OF INTEREST IN DEEP SEA MINING

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Abstract

Because of increased demand and prices in the world metal supplies, interest in the mineral resources of the deep seabed has experienced a revival in recent years. This offers competitive opportunities on the underwater technology and frontier . This is quite unlike that of the late 1960s and 1970s. Current interest is based on scientific research and economic understanding. Both oxide deposits comprising polymetallic manganese, and crust have been found to contain high levels of Cu, Ni and Co respectively. Seabed sulfide deposits on the plate boundaries are rich in Cu, Zn, Pb, Au. These deposits would possibly the first to be mined on the deep sea bed.

In the futuristic term, increase in demand as well as increase in the level of economic growth in the emerging economy such as India, China, Brazil and others would possibly lead to tighter supplies and higher prices. These trends would support serious consideration of the commercial development of deep sea bed mineral deposits.

1. OPPORTUNITIES ON THE UNDERWATER MINERAL DEPOSITS

The existing phase of commencement of deep sea mining in the coming years is before us. Recent developments in marine geology and deep sea technology have combined to make it possible to go more than 2000 meter under water for gold and other mineral treasures (Nautilus 2006). It is a transformation that has evoked a knee-jerk reaction over the possible environmental impact of the mining, which many believe would be less destructive than terrestrial mining.

Presently, the world's new first entry in marine mining companies (2007), namely, Neptune Minerals, and Nautilus Minerals are actually exploring the possibility of mining deep sea floor deposits. Neptune Minerals is assessing deposit in territorial water of the north east coast of New Zealand's North Island where the company holds exploration and mining rights. Nautilus Minerals and its joint venture partner Placer Dome, a Canadian gold mining company, are collecting samples from a deposit to which Nautilus Minerals in the Bismarck Sea, off the eastern coast of Papua New Guinea where it holds the mining rights.

The big question before all concerned is in the economic potential of under sea deposits of not only polymetallic sulfides but of manganese nodules, crusts and others. These are being discussed here.

After the first phase of interest in the deep sea mining during the seventees, the interest died because of economic reasons, particularly the falling metal prices due to surplus production. Today, with the emerging economics such as China, India, Brazil, Russia, and others, the demand for metals is increasing. This should continue in the foreseeable future. This contention is supported by an examination of existing metal price as given here in Table 1. Two decades back, e.g. after 1980s, most mining consortia and companies did not want to hear about this possibility. They thought it was too difficult. But now some are seeing that it is a lot easier to go down through a couple of thousands meter of water than through a couple of thousand meter of rock (Roonwal 2006, 2007). Presently the under-sea mineral deposits ore that of – diamond mines off the coast of southern Africa – under just a few hundred meter of water. We would like to look at the offshore oil and gas industry as a right example of the possibility for change. The international oil and gas industry went offshore starting in the mid 1940s. Today, about a third of the world's oil comes from under the sea. There are producing wells in 1500 meters of water depth off the coast of Brazil, and a there is drilling conducted at 2,500 meters depth in the Gulf of Mexico.

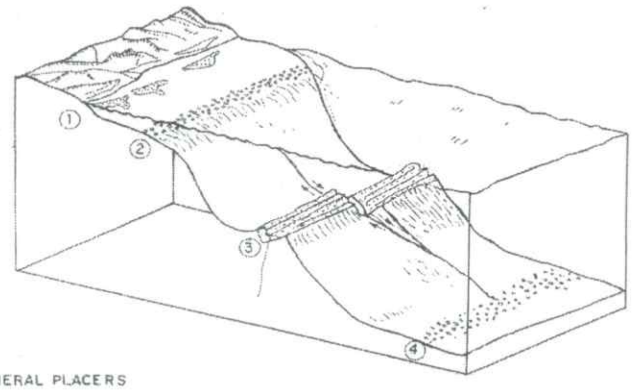
The key challenge for new mining consortia and companies would be developing the technologies to extract the ore from the under water deposits. The future development of autonomous underwater vehicles (AUV) and subsequent use of "deep sea versions of robotic coal mining machines" with the ore piped upto mining ships or semi-submersible platforms as used by the offshore oil industry. Today the deep sea robotic is a mature industry, driven in the large part by the needs of offshore oil exploration and recovery. Deep sea mining technology was given a major kick-start by the approximately US$650 million spent internationally in an aborted effort to develop sea floor manganese nodule technology in the 1970s and 80s. Manganese nodules often rich in nickel, and copper, are formed by the slow precipitation of the minerals from the sea water. The nodules cover vast area of the deep ocean flow, known as abyssal plain.

Effort in the development of nodules collecting module by the National Institute of Ocean Technology (NIOT) based in Chennai is noteworthy. Equally significant is the small prototype AUV "Maya" developed by the Instrumentation Division of the National Institute of Oceanography, Goa.

2. FORMATION OF SEAFLOOR MINERAL DEPOSITS

We know that ocean and seas cover about 71% of the earth's surface, an area almost equal in size to two Moons plus two Mars. About 60% of Earth's surface is deep ocean basins beyond the continental slope at water depths typically in excess of 2000 meters. The surface area of the Pacific Ocean accounts about twice in size to that of all the continents. Both the shallow continental margin and the ocean basin harbour mineral resources, many of whose economic potential and especially those in the deep basin, we are only beginning to appreciate. Figure 1 gives their occurrence in varying water depth, such as:

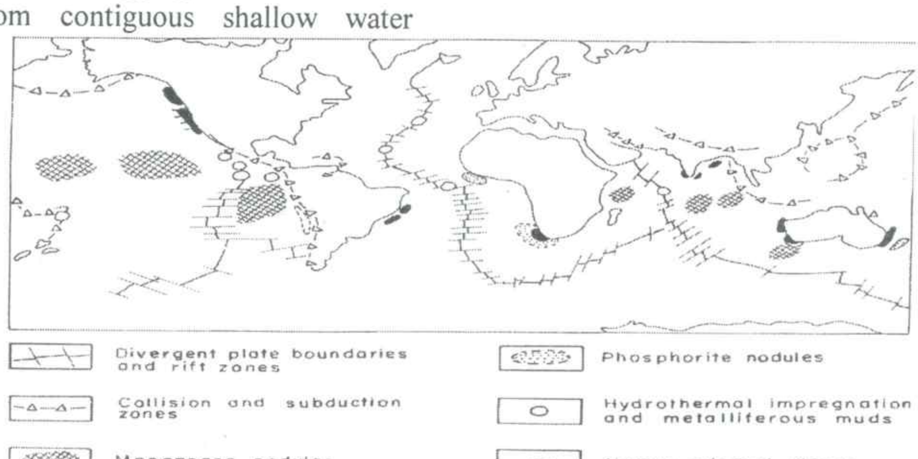
1. Placer deposits (heavy mineral sands) and very shallow water placer.
2. Phosphorite in middle shallow water in the shelf region.
3. Metalliferrous muds and metal impregnations, the volcanogenic massive sulfides on the mid oceanic ridges and subduction related environment specially the back-arc and fore-arc basins.
4. Manganese nodule in the deep sea zone.



(Figure-1 showing seafloor mineral deposits in different depth environment)

The regional occurrence of these mineral is depicted in Figure- 2.

Marine mining is not a new venture. Throughout much of the past century and earlier, there has been placer mining of heavy minerals (gold, tin, titanium, zirconium, rare-earths, and others), diamonds, and aggregate from beaches and from contiguous shallow water (Roonwal 1986). Present day recovery of gem quality diamonds from the seabed off the Atlantic coast of southern Africa in the water depth of about 100m water, the exploration extending to 250 m represents a potential half trillion dollar industry utilizing advanced marine technologies.



(Figure-2 Regional occurrences of major seabed minerals)

Although it is not mining in the traditional sense, the oil industry led the way into the offshore in the mid 20th century. Critics of the day questioned the need for recovering the oil when there was plenty on land and industry lacked the technologies. Today, as mentioned earlier about one third of world petroleum production comes from their source, and is increasing as technologies allow for increasing deeper installation. Wells are producing from 1500 m. water depth offshore Brazil. In the Perdidi Fold Belt in the Gulf of Mexico, exploration is taking place at 2700m depth (World Oil, Nov. 2005, p. 75-82), and a lease at 3379 m. water depth was issued in 2000 (US Mineral Management Ser.). Off Canada's east coast, oil exploration lease extend to 4000 m. (J. Witford Environmental).

In this lecture, I have attempted to examine and focus on phosphorite, manganese nodules, ferromanganese crusts, and seafloor marine sulfides of base and precious metals. In this context, Table 2 is given a summary of where the industry stands now, the most pressing issues, where in industry needs to in the future, and how it can get there.

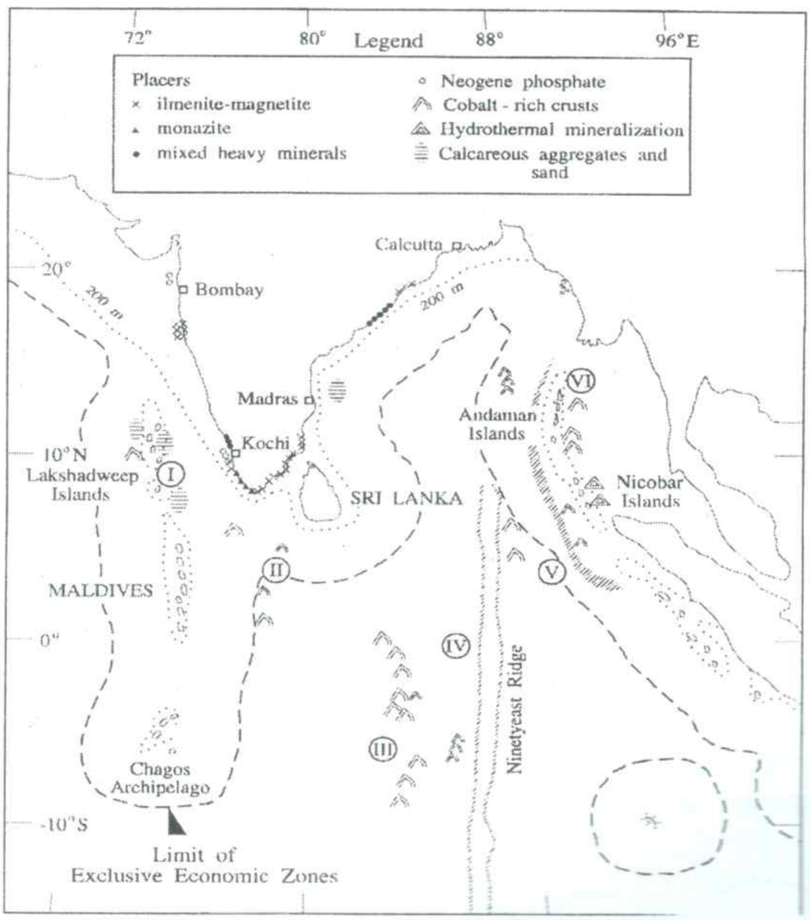
Table 2 lists the various marine minerals that are or could be recovered from the sea. Detailed compilation may be seen in Rona (2007), Lenoble et at 1995, Cruickshank (1998) Antrim (2005, 2006), Hein, et. al., (2005): For the marine minerals in the Indian Ocean one may refer to Roonwal 1986, 2005, amongst others. Fig. 3 shows major seabed mineral occurrences in the northern Indian Ocean, broadly corresponding to the exclusive economic zone (EEZ) of India.

Table 2
Commodities in the marine minerals

1	Setting	Statue	Growth potential
Aggregates (sand and gravel)	Beach and shallow marine	Operational	High
Cobalt	Deep sea nodules	Non-operational	Moderate
Cobalt	Crust on sea mounts	Non-operational	Low
Copper	Deep sea nodule	Non-operational	Moderate
Copper	Deep sea sulfide	Non-operational	High
Diamonds	Shallow marine	Operational	High
Gold	Shallow marine placers	Mostly non-operational	Moderate
Gold	Deep sea sulfide	Non-operational	High
Heavy minerals (chromium, rare-earth thorium, titanium, zirconium)	Beach and shallow Marine placers	Operational	Moderate
Lead	Deep sea sulfide	Non-operational	Moderate

1	Setting	Statue	Growth potential
Lime (coral, shells)	Beach	Operational	Moderate
Methane (gas hydrates)	Shallow/intermediate marine	Non-operational	Moderate
Nickel	Deep sea nodule	Non-operational	Moderate
Nickel	Crust on sea mounts	Non-operational	Low
Phosphate	Shallow marine and sea -mounts	Non-operational	Low
Platinum group metals	Crust on sea mounts	Non-operational	Low
Salt	Very shallow marine (evaporation)	Operational	Moderate
Silver	Deep sea sulfide	Non-operational	High
Tin	Shallow marine places	Operational	Low
Zinc	Deep sea sulfide	Non-operational	High

After ECCRn /ISA, 2006



2.1 Placer Deposits

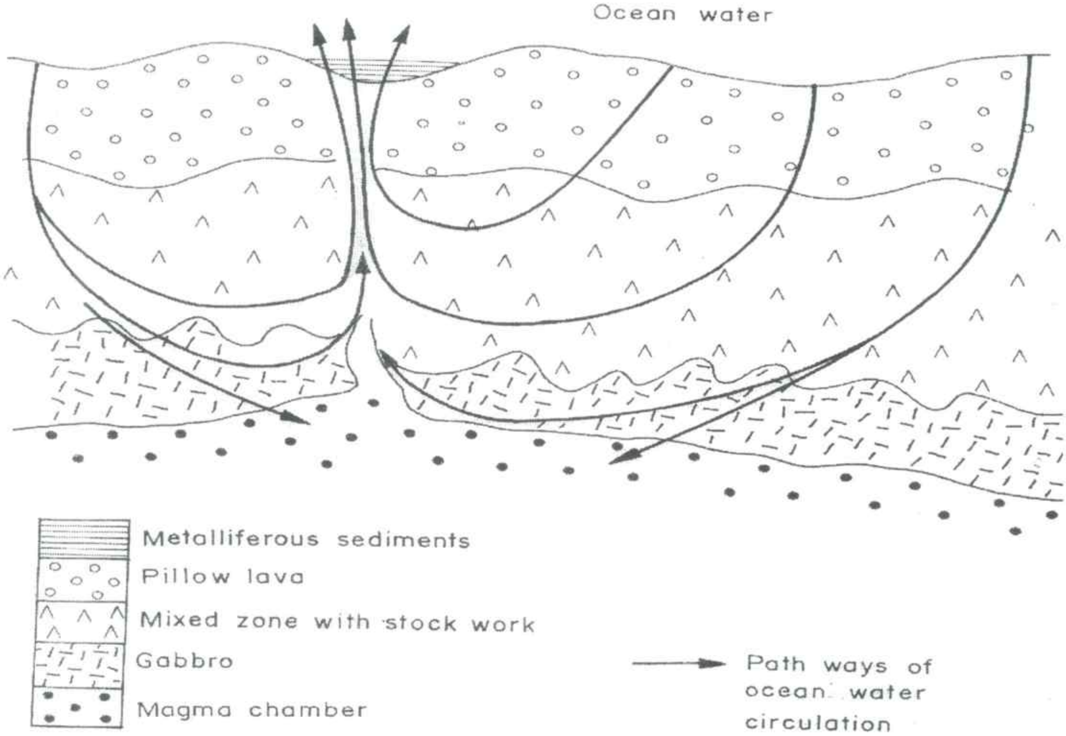
As a sequel to the weathering and transport in river, and through the action of waves and currents in seas, the heavy mineral sands are concentrated along the banks of the river, or in the areas of flat water spread. From the point of economic interest what is important is there source in the rock in the hinterland from where they are eventually derived through process of weathering and transport. Casseterise is an important placer mineral for the extraction of tin, and is extracted through the heavy mineral sands in the offshore areas of Mayanmar, Thailand, Malaysia and Indonesia. The major production of titanium mineral rutile (TiO_2) and ilmenite ($FeTiO_3$) comes from the beach areas of India, Australia and South Africa. Similarly the important thorium mineral monazite [$Ce(Th)PO_4$] and zircon ($ZrSiO_4$) are found on Indian Coasts. Fig. 3 shows occurrence of heavy minerals beach placer along the costs of India.

2.2 Phosphorite Deposits

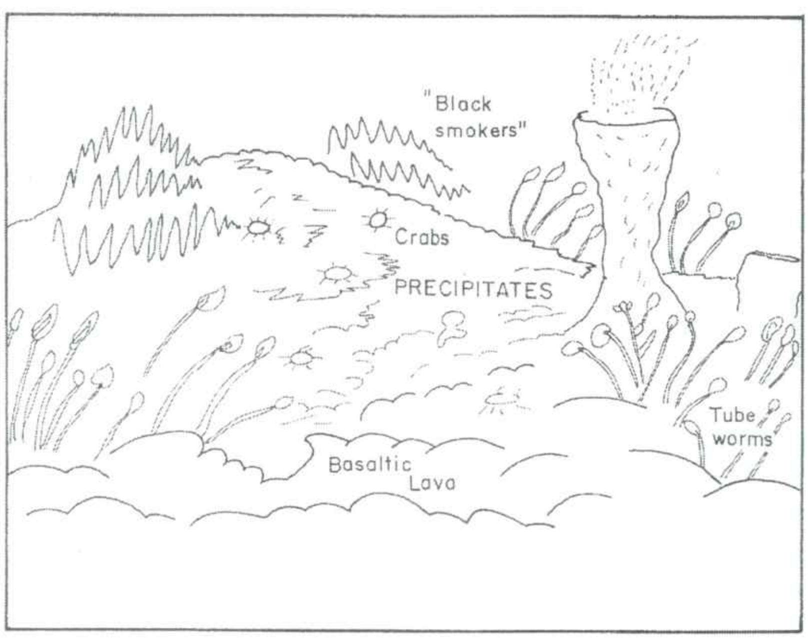
In the shelf zones and in the upper zones of continental shelf zone in a water depth of about 400 m are obtained phosphate nodules in specific areas. Their major occurrence is located in the west coast of South America and Africa, and at Chetan Rise near New Zealand. Smaller deposits have been reported from the western coast of India, and in the Andaman Sea. Phosphorite [$(Ca\ (PO_4)]_2$ is a major source of phosphorous. No doubt that the present day marine phosphorite with 24% to 36% P_2O_5 content is low compared to that on the land but they have advantage in their readily soluble nature than the land deposits of phosphate.

2.3 Seabed sulfides

Almost all the occurrences of oxidized iron and manganese deposits as also pyrite, zinc, copper, gold and silver deposits are formed under marine environments. In 1963 it was for the first time such an occurrence as the Red Sea was discovered, and it was presumed that the sources of this sub-marine hydrothermal metal muds and impregnations belonged to recent activity. The Red Sea discovery generated added interest and work was undertaken on mid oceanic ridges. This led in the 1980s to the discovery of present day forming similar deposits in southern Pacific in Galapagos and East Pacific rise. In Galapagos hydrothermal field man has been able to observe for the first time, Cu – Zn, sulfide deposit from the hot brines on the seabed. Such hot brines sources are always associated with the formation of new crust in diverging plate boundary zones in the marine environment. The seawater enters in the deep crust through numerous fractures and reacts with newly formed lava basalts (Fig.4).



Through convection currents the hot brines rise and bring along the dissolved heavy metals with them to the already present basaltic country rocks on the sea floor and precipitate them in form of sulfide and oxides of Cu. Zn, Ag. Au. Pt. etc. in form of chimney called "black smokers". Figure 5 shows such an active chimney where precipitation of sulfides is taking place.



2.4 Manganese Nodules

During the H.M.S. Challenger expedition (1872 – 1876), manganese nodules were discovered for the first time on the seafloor. It took almost a hundred years since then, till the economic interest of manganese nodules were realized. During the late 1960s started the prospecting and exploration of manganese nodules by some international consortia. This activity continued till the end of 1970s and we in India conducted detailed surveys in the central Indian Ocean Basin around during 1990s delineated mine site areas. As a result of this work India has since been given the status of "Pioneer Investor" by the International Seabed Authority (ISA) of the U.N.

Manganese nodules (Fig.2) occurs in large areas of the deep sea regions of the ocean. They comprise mainly the oxyderates of Mn. and Fe. And can contain upto 3% Ni. + Cu + Co. They also contain some amount of Zn. V. and Mo. The metal content of nodules, together with their occurrence, shape, size varies both on regional and local level. This is due to different mechanism of formation and growth of nodules. But in nodules with influence of digenetic, growth, one finds evidence of hydrothermal and hydrogeneous factors. Thus it may be said that a combination of factors lead to nodule formation.

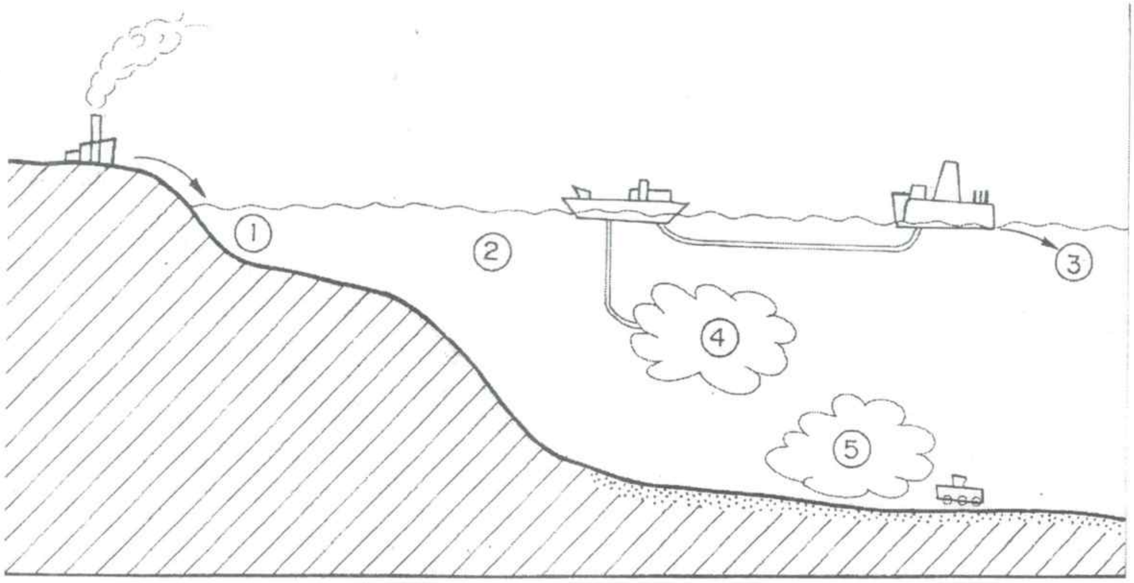
From the point of view of metal extraction experiments have been tried for Cu. Ni. Co. extraction from nodule with high influence of digenetic mechanism in their growth. Such nodules have relatively high values of Mn. Ni, and Cu.

Manganese nodules are cm. to dm. size potato shaped of manganese and iron oxide that litter much of the ocean sediment covered abyssal plains at about 4500 to 5500 m. water depths. In places these are in sufficient quantities, almost covering the seafloor sediment, particularly in the Clarion – Clipperton Zone (CCZ) of the central Pacific Ocean, and in the Central Indian Ocean Basin (CIOB), both sites are located in international waters to be considered potentially economic. The CIOB deposits are second best, next to the CCZ. Preliminary assessment suggest that at least 34 billion metric tonns of these deposit occur in CCZ, containing 7.5 billion tonns of manganese, 340 trillion tonns of nicle, 265 million tonns of copper and 78 million tonns of cobalt (Morgan 2000). The better deposits, perhaps representing 10% of the total area of nodule accumulation averaging about 2.4% copper + nickel +, Cobalt a grade similar to that of terrestrial sulfide nickel copper ores such as at Sudbury, Canada (Exon et. al., 1992).

Seafloor nodules as a copper resource are about 10% of that of known land reserves. Manganese, an essential element in the steel that is also finding other industrial uses constitutes 25 to 30% of the high grade nodules and may some day itself become economic to recover as land mines close. Propriety economic assessment (eg. C.G. Welling, 1995) have concluded that the key constituents of these deposits for commercial extraction is nickel which occurs in concentration between 1.2% and 1.45% copper in CCZ deposits. The Indian mining site proposed is however, located in the CIOB between 73° to 79° E and 16° to 10°, covering about 1.5 Km Sq. area.

3. WHERE THE NODULE MINING INDUSTRY STANDS?

Between 1974 and 1982, several consortia of private companies and government organization spent at least US $ 1 billion in failed ventures to mine manganese nodules. The failures were due to a combination of unrealistic expectation brought about by inflated evaluations of the potential resource, high cost of metallurgical extraction, political interference, and collapsing metal prices, as already mentioned earlier in this synthesis.



A renewed effort is underway today, in international waters, under the control of International Seabed Authority (ISA), regulation on prospecting and exploration for nodules were accepted by the UN General Assembly in July 2000. Currently there are eight groups with contract with the ISA for seabed exploration in international water. These are (1) Government of India – Ministry of Earth Sciences (formerly Department of Ocean Development), (2) China Ocean Mineral Resource Research and Development Association, (3) Deep Ocean Resources Development Companies of Japan, (4) Government of Republic of Korea, (5) IFREMER of France, (6) Inter-Ocean Metal - a consortia by Bulgaria, Cuba, Czech Republic, Poland, Russia and Slovakia, (7) Yuzhmorgeologiyo – a Government of Russia – Ministry of Natural Resource, (8) Germany – Geological Survey (BGR).

4. WHERE SEAFLOOR SULFIDE MINING STANDS?

About 150 active and fossils seafloor sites are known in the world oceans and several seas (Fig. 2). The deposits mostly lie between 1500 and 3500 meters depth, although a few are in much deeper regions (Roonwal 2007, Rona and Scott 1993)..

The focus of scientists to date has been the hydrothermally active "Black smoker " vent fields that produce a ready signature which can be located upto 10 km away. There has been very limited considerations of the older dormant fields that would be a more attractive target for mining. One commercial geophysics programme has even been conducted to date (by Nautilus with Canadian company placer dome).

The companies have yet to locate and define a resource that justify detailed mining plan, Nautilus is closest with very encouraging results based on visual observation of core from systematic drilling of one of their deposits in the eastern Manus Basins off the Bismarck Sea in early 2006. Likewise Neptune's exploration targets in the water of Brother Sea Mount in the Kermedec region near North Island, New Zealand, encountered sulphides but did not show accumulation near surface of commercial quantities of mineralization. This is not discouraging because in land buried massive sulfide deposits, one drills a few hundred meter to prove the reserves. Such an exercise is yet to take place here.

The real issue of problem is the legislation to allow exploration in the EEZ of countries. This is not permitted under the UNCLOS.

The seafloor VMS industry is at a very early stage of exploration but its activities are ahead of those of phosphorites, crusts, or perhaps nodules where India has made substantial advances. There are only two serious commercial players Nautilus Minerals (listed in Toronto Stock Exchange as Ventures) and Naptune Minerals (listed in London Stock Exchange), I reckon that Russia and Central Asian Republics will tighten the market and which would push price for industrial and precious metal to higher level, as we are witnessing today. Changing pattern in economic growth, new demands in response to the growth of electronic sector, developments in the automotive technologies and long lead time for development of new mining and processing facilities, all contribute to a long term outlook for tighter supplies and rising prices (Antrim 2006).

5. MARKET CONSIDERATIONS

Because of increase demand and prices in the world metal supplies (Table 1), interest in the mineral resources of the deep seabed has experienced a revival in recent years. This offer competitive opportunities on the under water technology and frontier. This is quite unlike that of the late 1960s and 1970s. Current interest is based on scientific research and economic understanding. Today this optimism is based on realistic technology and capability.

Moreover, this outlook for development of deep seabed mineral deposit also give consideration to competing land based resources as well as future markets for metals (Table 1). Added to this interest is the national and international legal and regulatory regime for their development.

The factor that discouraged the earlier round of deep sea-bed mineral development, namely, the legal regime for seabed mining, has been resolved with the acceptance of the laws of the Sea (UNLLOS) from November 1994.

This regime for seabed mining has defined the 200 miles exclusive economic zone (EEZ) and the establishment of the International Seabed Authority (ISA) to satisfy the interest of the major industrialized and developing nations with the issue set aside, deep seabed mining for metals particularly, Ni, Cu, Co, Pb, Zn, Au and others will be developed as market pressures and metal prices dictate.

Greater demand for mineral depends upon economic growth and increase in industrial development around the world. The initial period of commercial interest in seabed minerals was cut short as the growth rate of metal demand declined when developed countries increasingly shifted to post industrial economies. New sources of mineral and increase efficiency have kept the growth of mineral demand low for many years. But this pattern is beginning to change. Economic growth is developing counties mainly China, India, and Brazil.

6. FUTURE OUTLOOK

To meet demands at a price not significantly higher than at present, land resources of Ni, Cu, Co, Pb, and Zu appear adequate for the next decade. In the futuristic tenure, increase in demand from new consumers application, as well as increase in the level of economic growth in our parts of the world. This would lead to tighter supplies and higher prices. Large land mineral resources assure that existing mineral would continue to be a source of metals, but eventually it would be necessary to develop new green field deposits. Trends in metal used and mineral production will support serious consideration of the commercial development of deep seabed mineral deposits.

We are probably witnessing dawning of an industry for deep sea mining of base and precious metals sulfides with manganese nodules soon to follow. Obstacles to overcome besides technical and financial, are public perceptions that such activity might be unacceptable harmful to the environment. The way forwarded is to whole open discussion among the stake holders including industry.

ACKNOWLEDGEMENT

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Table 1: Value of contained commercial metals ((US$/Ton)

Sulfide deposits	**Sulfide deposits**					**Ferromanganese Crusts**			**Manganese nodules**	
	$/ton	**Intra oceanic back arc**	**Intra – oceanic Continental back arc**	**Copper rich chimney**	**Mid oceanic Ridges**	**Marshall Islands**	**NW Pacific Crust**	**South Pacific**	**Indian Ocean**	**Clarion Clipperton Zone**
Nickel	6,771	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 38.70	$ 36.58	$ 36.35	$ 20.48	$ 86.67
Copper	1,652	$ 84.25	$ 33.04	$ 522.02	$ 67.73	$1.75	$ 1.78	$ 1.77	$ 2.51	$ 16.85
Cobalt	15,198	$ 0.0	$ 0.00	$ 2.43	$ 0.00	$ 119.88	$ 96.84	$114.50	$ 50.85	$ 36.48
Lead	969	$ 11.63	$ 111.45	$ 0.00	$ 1.94	$ 1.74	$ 1.72	$ 0.72	$ 1.00	$ 0.44
Zinc	881	$ 133.04	$ 162.11	$ 0.35	$ 103.08	$ 0.76	$ 0.60	$ 0.59	$ 0.45	$ 1.23
Titanium	7,770	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 85.47	$ 59.83	$ 77.70	$ 69.93	$ 41.18
Silver	14,5189	$ 28.31	$ 401.59	$ 0.00	$ 20.33	$ 0.00	$ 0.00	$ 0.00	$ 0.58	$ 0.00
Gold	9,797,042	$ 28.41	$ 37.23	$ 0.00	$ 11.76	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$0.00
Total value of commercial contained metals		**$285.64**	**$745.42**	**$524.80**	**$204.84**	**$248.30**	**$197.35**	**$231.632**	**$145.80**	**$182.85**

After Antrim 2006

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COAL OCCURRENCE AND RANK OF IB VALLEY COAL DEPOSITS ORISSA STATE

Dr. Achin Kumar Roy

ABSTRACT

The Ib Valley coalfield is known as store house of less matured non-coking coal. Some of coal deposits, particularly in Talabira central part and dip extension of Gopalpur Tract, exhibits some of the basic qualities which compel to assign the coals as comparatively mature and in turn, may posses some coking property also. Since this aspect was not conceived earlier, there is practically no specific determined quality data available to ascertain the maturity level of coal deposits at selective places. The present paper deals with available basic quality data and suggests further investigation to prove or otherwise possibility of B_3-B_4 group of coal, i.e., weakly to medium coking coal as per ISP classification 1977.

INTRODUCTION

The state of Orissa is considered a store house of power grade coal deposits in the country. There are two major coal basins, viz., Talcher & Ib Valley (Figure 1) beside many small insignificant Gondwana outliers (Figure 2). As per the inventory record of GSI, April 2008, Orissa state alone contains 65,263 million tonnes of coal reserve which amounts to 25% of the total coal reserve of the country. While Talcher coalfield has maximum coal reserves available within any individual coalfield in India, the Ib Valley coalfield ranks 3rd after Raniganj coalfield on available coal reserve. The table below exhibits geological reserve of 10 top coalfields in India as per GSI, April 2008.

Table – 1
Geological Reserves of 10 top coalfields in India (after GSI, April, 2008)
Figures in million tonnes

Sl. No.	Coalfield	Proved	Indicated	Inferred	Total
1	Talcher	13762	21949	7130	42841
2	Raniganj	13008	8075	4476	25559
3	Ib Valley	5460	9779	7183	22422
4	Mand Raigarh	2161	16857	2534	21552
5	Jharia	15078	4352	0	19430
6	Godavari Valley	9007	6711	2979	18697
7	North Karanpura	8078	5917	1865	15860
8	Rajmahal	2078	10597	1601	14276
9	Singrauli	5002	6309	2167	13478
10	Korba	4980	4500	830	10310

The entire coal reserve of Orissa state has been placed as inferior quality, low rank and non-coking in nature. The study of available analytical data of

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coals from Ib Valley revealed that the coal of certain seams at some places have attained considerable maturity where possibility of getting some caking characteristics needs to be studied in detail. An attempt has been made in the present paper to indicate the possibility of getting comparatively matured coal with caking characteristics in certain section of Rampur and Ib groups of seams.

GEOLOGICAL SET UP

Ib Valley coalfield lies between latitudes 21° 31' – 22° 14' North and longitudes 83° 32' – 84° 10' East covering an area of 1460 sq. km. and is located in the state of Orissa. There is geological continuity of the coalfield with that of Mand Raigarh coalfield located at Chattishgarh state. The southern and southwestern limit of the coalfield is defined by boundary fault, whereas, north and northeastern boundary has normal contact with Archaeans.

The coal bearing formation in Ib Valley coalfield is either Karharbari or Barakar. While the Barakar coals are generally thick and inferior in grade, the Karharbari coals are thin and comparatively superior in grade. The upper Gondwana horizon, viz., Kamthi/Raniganj and Barren Measures Formations are also present but have no potential coal deposits within them except few thin seams in Raniganj Formation. The general stratigraphic sequence is given below:

Table – 2
Geological Succession of Ib Valley Coalfield (after GSI)

Age	Group	Formation	Lithology	Thickness in metre
Recent / Sub-Recent		Recent & Sub-Recent	Alluvium, Laterite, gravels and conglomerate	
Lower Triassic to Upper Permian	L O W E R	Kamthi (Upper)	Pebbly sandstone, ferruginous sandstone and red shales	Upto 100
		Kamthi (Middle) or Raniganj	Fine grained sandstone, siltstone, coal seams (thin)	60 – 80
Lower Permian	G O N D W A N A	Kamthi (Lower) or Barren Measures	Grey shales, carbonaceous shales, sandstones, clay and ironstone nodules.	300
		Barakar	Grey sandstone, carbonaceous shale, siltstone with thick coal seams and fire clay	300 – 600

		Karharbari	Black carbonaceous sandstone, pebble bed, coal seams	90 – 125
Upper Carboniferous		Talchir	Diamictite, greenish sandstone, olive and chocolate shales, rhythmites.	60 - 125
-- Unconformity -- --				
		Pre- Cambrian	Granite, Gneisses, Schists etc.	

COAL QUALITY CLASSIFICATION AND MATURITY

Primary analysis for ascertaining the basic quality of coal is done through proximate analyses where moisture, ash, volatile matters fixed carbon (by difference) are determined in laboratory. An in depth study of the above parameter would reveal a great deal about the rank of the coal.

Moisture content of the coal is the most important parameter for rank assessment. With increasing level of metamorphism, the porosity of coal decreases and hence the moisture holding capacity in the coal is also reduced. As such, more the moisture, the coal is less mature, e.g., lignite has about 45% moisture whereas in anthracite the moisture is less than 1%. In normal bituminous coal moisture varies between 1% and 15% on equilibriated basis (60% RH & 40°C). One can look for caking property in the range of <1% to 4% of moisture on equilibrated basis.

Ash content is generally nothing to do with maturity as it depends on inclusion of extraneous inert materials. Ash content, however, restricts coal utility because of dilution effect.

The yield of volatile matter evolved under standardized heating condition provides fair idea about the rank of the coal. Volatile matter on dry mineral matter free basis records over 50% in lignite and less than 10% in anthracite. The volatile matter percentage on dry mineral matter free basis for mature bituminous coal ranges from 22% to 37% and is extendable for certain rank of coal upto 46%. The volatile yield decreases with increasing coal rank.

Beside proximate analyses, another important laboratory scale determination is elemental or ultimate analysis where mainly carbon, hydrogen, nitrogen, sulphurs and oxygen (by difference) are determined. The study of carbon content on dry mineral matter free basis can reveal the rank of the coal. It is well known that in the coalfication process there is progressive enrichment of carbon through the removal of moisture and oxygen. In lignite the carbon percentage on dry mineral matter free basis varies between 67% and 75%, whereas, in anthracite it exceeds 92%. The bituminous coal normally records between 75% and 92% carbon content on dry mineral matter free basis.

The basic function of caking coal is to produce coke with sufficient strength and hardness. The primary functions of coke in production of steel are (a) as energy source to provide heat of reaction, (b) as a source of reductant (from the oxide to the metallic state) and (c) support the charge of the burden in the furnace. In strict sense, only prime cooking coal produces strong metallurgical coke by the conventional technique of carbonization, while coals belonging to other groups, viz. medium and semi to weakly coking, yield hard coke only when used in admixture with matching proportion of prime coking coal. The coking coal occurrence is largely restricted in Damodar Valley coal basins.

To be precise, there is no laboratory scale standard parameter is available to identify a coking coal. A suit of property is generally used to prima facie identification of coking coal which in turn is confirmed by different tests viz. coking index, swelling index, GKLT coke type, dilatometric test, plastometric test, petrographic studies etc.

COAL CLASSIFICATION

Attempts to classify coal have been made widely to identify coals suitable to different usages as well as to scientifically understand the different properties of coal. Regnault (1837) first classified coals on the basis of their carbon, hydrogen and oxygen contents. Gruner (1874) extended the system by adding the criteria of volatile matter and coking properties in coal classification. In a classical work, Seyler (1890) classified coals into four main group or species according to the carbon content as Anthracite, Carbonaceous, Bituminous and Lignitous. The species were sub-divided by Seyler according to the hydrogen content in five varieties. Per-bituminous, Bituminous, Semi-bituminous, Carbonaceous and Anthracites. The bituminous species were further sub divided into three sub-groups: Ortho-, Meta- and Para-Bituminous. The Seyler classification laid the foundation for the understanding of different coals correlating the ultimate analysis with calorific value, volatile matter, coal petrography etc. The international classification of the International Standards Organization (1988) considers eight parameters, viz., random vitrinite reflectance, vitrinite reflectogram, maceral composition, swelling index, volatile matter, ash, total sulphur and gross calorific value. These properties are generally determined on 10% ash level.

The classification of Indian coal and lignite by ISP publication (I.S:770.1977) provides different types, e.g., lignite (L), sub-bituminous (SB), bituminous (B1 to B8), semi-anthracite (SA) and Anthracite (A). The primary identification is marked by volatile matter, calorific value, moisture, carbon and hydrogen, all in dry mineral matter free basis along with GKLT coke type. The relevant part of the classification involving B_2 to B_5 category of bituminous coal is reproduced below:

Table – 3
Classification of B_2 to B_5 category of Bituminous coal

TYPE	SYMBOL	NATURE	BASIC PARAMETERS			OTHER PROPERTIES		
			CV Kcal/kg (dmf)	VM Percent (dmf)	GKLT Coke Type	Moisture (60% RH) Part per 100 Parts of Unit Coal	Carbon (dmf)	Hydrogen (dmf)
Medium to High volatile	B_2	Non caking	7500-8250	27-43	A-B	7-11	79.5-83.0	4.7-5.2
High volatile	B_3	Weakly caking	8250-8400	33-43	C-D	5-7	82.5-83.5	5.0-5.4
High volatile	B_4	Medium to strongly caking	8250-8500	33-43	E-C	2-5	83.5-87.5	5.0-5.8
Medium volatile	B_5	Weakly to medium caking	8500-8700	22-33	C-F	<2	86.5-88.0	4.7-5.0

OCCURRENCE AND CHARECTERISTICS OF COAL SEAMS OF IB VALLEY

Five number prominent coal seams, viz., Ib, Rampur, Lajkura, Parkhani and Belpahar, in ascending order, occur in Ib Valley coalfield. Of the five seams, three older seams are more prominent and occur thoughout the coalfield. While the Ib seam of Karharbari occurs generally in 2 to 3 splits, the Rampur and Lajkura seams of Barakars occur in 5 to 7 splits. The southern part is known as Orient-Rampur area where many coal mines are developed. In this region Ib seam generally occurs as independent single coal seam or in two splits, whereas, Rampur seam occurs in 5 to 6 splits and Lajkura as single interbanded thick coal seam. Talabira area occurs further south where two splits of Ib seam and four to five splits of Rampur seam occur. The total thickness of coal in the above areas varies between 50 and 75 metres. The northern part is known as Gopalpur tract where above three prominent seams are present with enhanced combined thickness but are more splitted than their counterparts in southern part. The link between north and southern part represented by the area known as Link Up Block, where coal seams reduce in thickness and split in many sections with minor thickness (Figure 3).

A broad range of quality data for Talabira, Orient-Rampur and Gopalpur tract regions are provided below particularly for Rampur and Ib seams.

Table - 4

Broad range of quality data of coal of Talabira, Orient-Rampur and Gopalpur tract, Ib Valley coalfield

Region / Seam	Basic Parameters		Proximate Moisture on 60% RH & 40°C	Other Parameters			Remarks
	CV K.cal/kg (dmf)	VM% (dmf)		Moisture (60%RH) part per 100 parts of unit coal	Carbon% (dmf)	Hydrogen% (dmf)	
TALABIRA							
Rampur Top III	9109-9418	35.4-37.0	4.4-6.1	9.3-10.7	84.6-86.5	4.8-4.9	Generally for the north central part
Rampur Top II	9550	35.0-36.1	5.3-6.2	8.3-10.4	84.1-85.0	5.0	
Rampur Top I	9560-9810	35.4-36.0	4.8-5.6	7.6-8.6	84.5-85.8	5.0-5.1	
Rampur Bot. II	8588-8711	34.8	5.2-5.5	8.3-8.5	83.4-83.8	5.2-5.4	
Ib Top	8050-9558	28.5	4.8-6.1	7.0-8.7	84.2-85.5	4.8	
ORIENT-RAMPUR							
Rampur	7490-8025	36.2-42.86	6.0-7.9	10-12.9	80.5-83.5	4.7-5.0	CT-A. Different splits taken together
Ib Seam	7225-7990	28.0-34.6	6.6-8.4	10.1-10.4	80.1-84.4	4.0-4.8	CT-A
GOPALPUR TRACT							
Rampur -V	7644-8431	38.4-45.5	3.1-4.8	5.4-7.5	81.7-84.9	4.7-5.4	
Rampur-IV	7712-8225	36.6-40.8	2.6-4.3	5.7-7.9	78.5-85.6	4.6-5.0	
Rampur-IVB	7931-8218	35.3-39.4	1.7-3.8	3.7-7.0	83.0-85.4	3.3-5.4	
Rampur-III	7499-8144	32.0-40.9	2.5-4.7	4.1-7.4	82.3-84.8	4.6-5.4	
Rampur- II	8004-8178	38.5-40.6	2.8-3.4	4.1-5.5	83.1-85.9	4.9-5.5	
Rampur-I	7826-8234	35.4-39.8	2.5-3.3	4.1-5.7	82.5-85.0	4.8-5.2	
IB Top	7778-8354	31.6-42.9	2.1-3.8	3.5-6.2	82.8-85.5	4.6-5.4	
IB Mid.	7770-8213	32.0-41.5	2.5-4.5	4.2-6.4	83.1-86.1	3.4-5.0	

DISCUSSION ON MATURITY OF COAL SEAMS

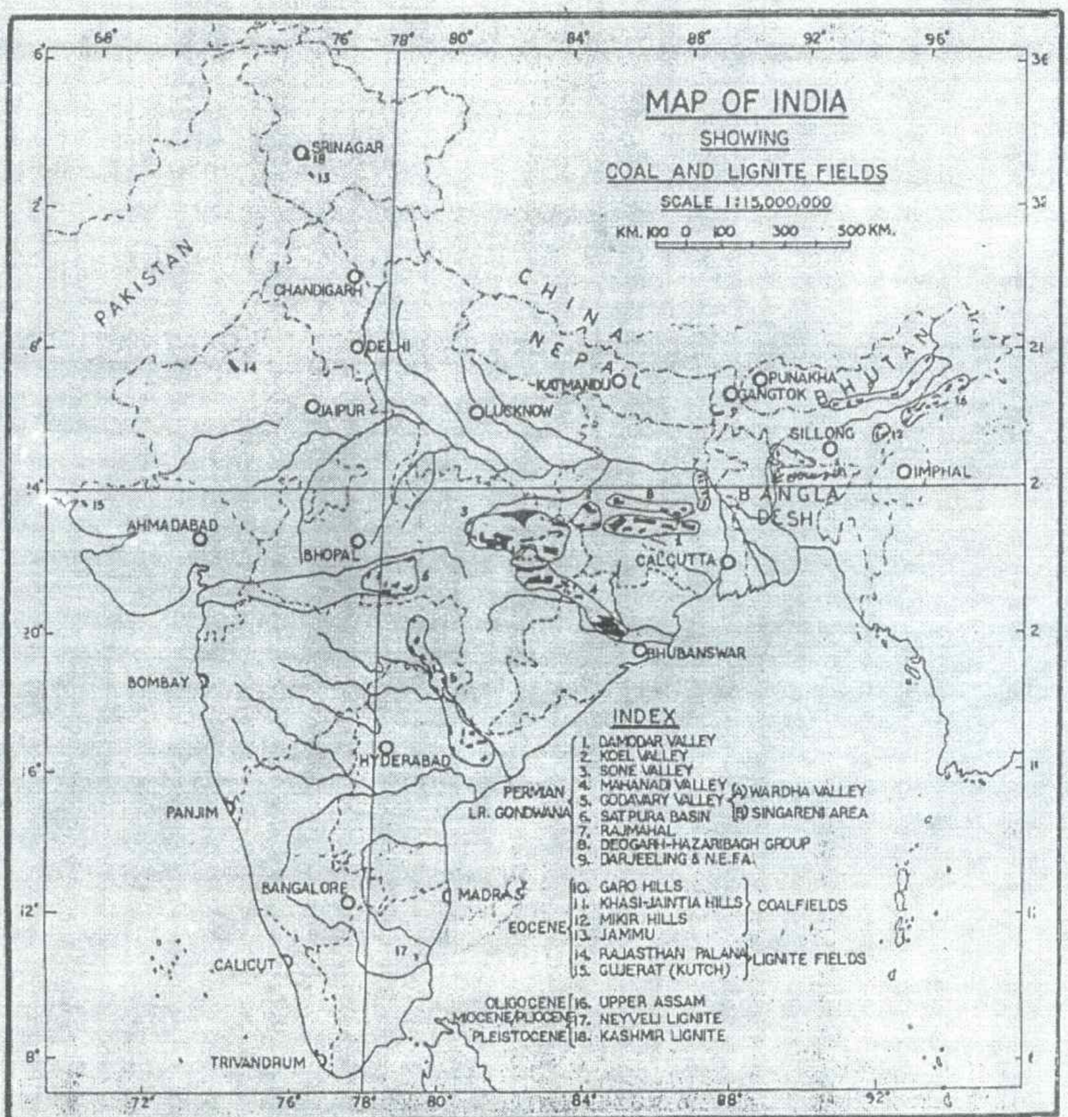
The Lajkura and other younger seams do not posses any characteristics of mature coal as per the available analytical data. However, the Rampur and Ib seams in selective areas, particularly in the dip extension of Gopalpur tract, definitely indicate the comparatively higher maturity level. In north central part of Talabira also, the maturity of coal is high. The selected coal seams of above indicated areas are bituminous, high dmf volatile (>33%), medium moisture (largely within 7% M100 value), moderate dmf carbon (82% 84%), moderate dmf hydrogen (around 5%) but comparatively low dmf calorific value (8000 to 8100 k.cal/kg). The dmf carbon in certain samples even exceed 87% which indicates very high maturity in bituminous coal and deserve attention for further investigation. The GKLT coke type is available in certain samples, particularly representing Orient-Rampur area where it records generally as 'A' and a few cases as 'B'. The basic quality data in this area also reflects less maturity in comparison to the coal seams belonging to dip extension area in Gopalpur Tract. The detailed studies have not been carried out in dip extension of Gopalpur tract. It is worthwhile to give a re-look in this region for getting some high volatile weakly to medium caking (B_3 & B_4) coal. The commercial viability, however, will depend on ash percentage vis-a-vis economic washing prospect. There is huge reserve of coal in Ib Valley coalfield, a portion of which, if found suitable, can be used as a blend in metallurgical industry. If the finding is confirmed by further study, there will be quantum improvement in quality in the coal inventory of Orissa.

CONCLUSION

The available proximate and ultimate analyses suggest that particular coal seams in dip extension of Gopalpur tract are comparatively mature contrary to the expectation. Prima facie the coals from dip side of Gopalpur tract as per ISP (IS: 770-1977) may fall in B_3 or B_4 group i.e. high volatile weakly to medium coking. However, the maturity level, its proper classification and end use need to be ascertained by creating additional laboratory scale data, viz., caking index, GKLT coke type, swelling index, Mean Random Reflectance of vitrinite (Rr%) and Reactive content (volume percentage).

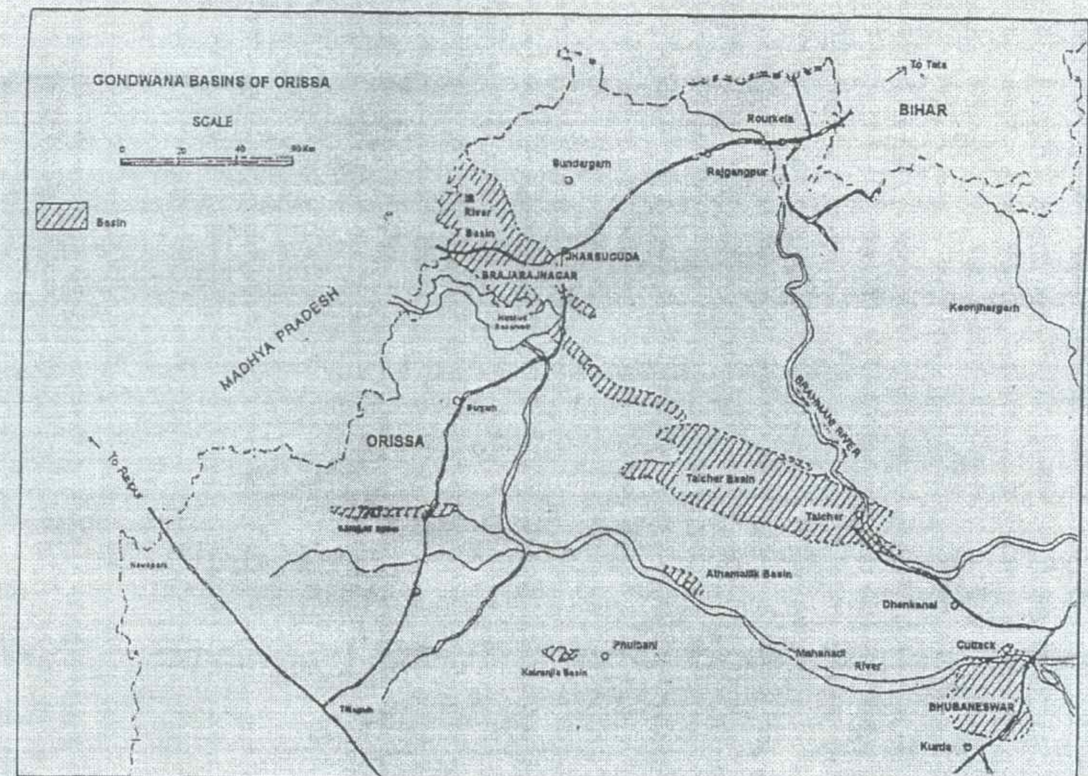
DISCLAIMER

The views expressed in this paper are author's own and not necessarily of the company he belongs.



SOURCE:- G.S.I. C.D. No. 88-69

Figure 1


GONDWANA BASINS OF ORISSA
SCALE
Basin
BIHAR
To Tata
Rourkela
Sundergarh
Rajgangpur
River
Basin
JHARSUGUDA
BRAJARAJNAGAR
MADHYA PRADESH
Keonjhargarh
ORISSA
To Raipur
Talcher Basin
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Dhenkanal
Phulbani
Mahanadi
River
Cuttack
Kalrangia Basin
BHUBANESWAR
Kurda

Figure 2

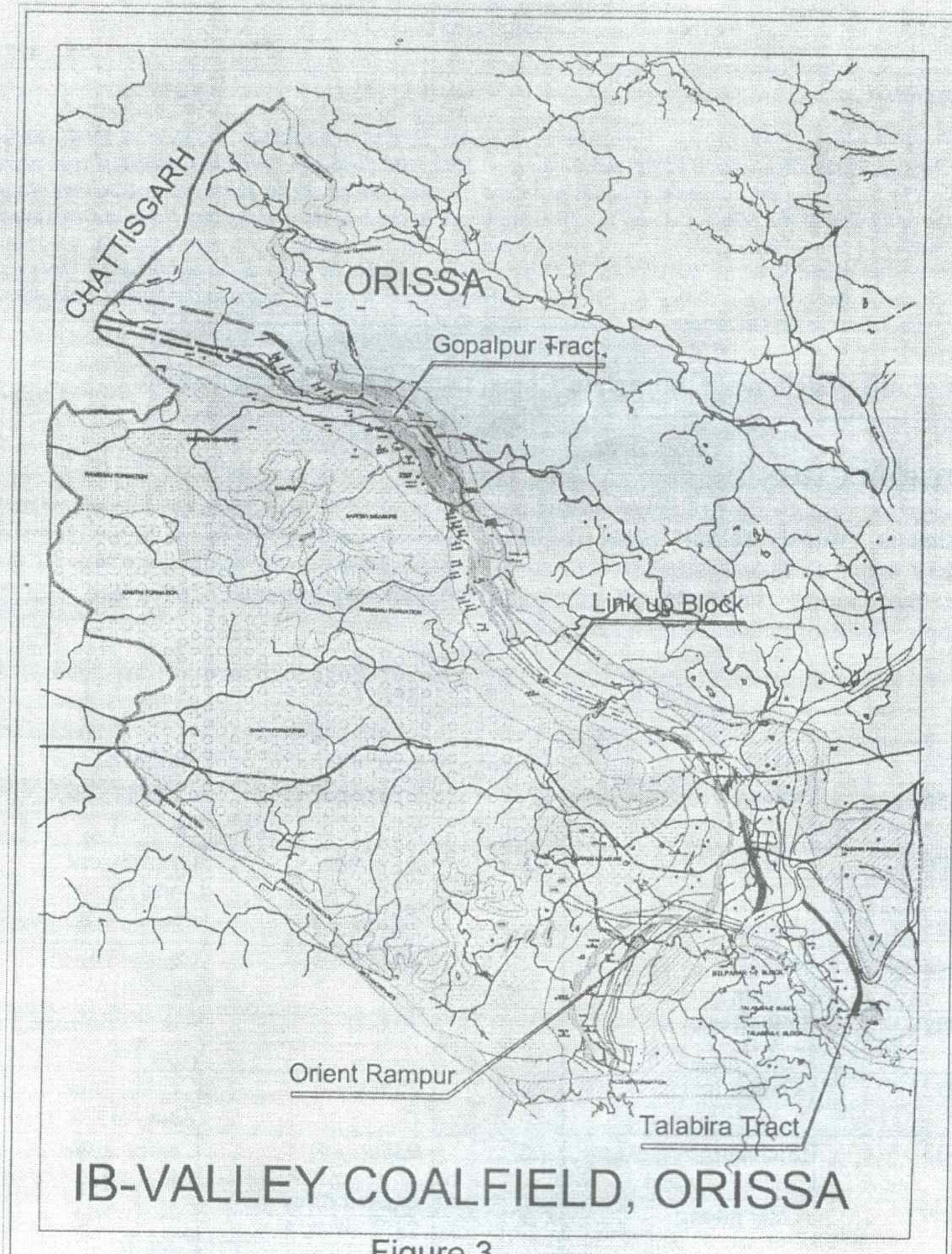
CHATTISGARH
ORISSA
Gopalpur Tract
Link up Block
Orient Rampur
Talabira Tract
IB-VALLEY COALFIELD, ORISSA

Figure 3

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A REVIEW ON THE EARTHQUAKE OF CHINA WITH SPECIAL REFERENCE TO THE 2008 SICHUAN EARTHQUAKE

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ABSTRACT

The paper reviews most of the destructive earthquakes in China including the May 12,2008 Sichuan earthquake which killed almost 70000 people by now. Most earthquakes in China are intraplate type and are caused by the northward movement of Indian plate and its convergence with the Euro-Asian plate. This has lead to the upliftment of the Himalayas and the Tibetan plateau at the boundary of the two plates accompanied by the motion of crustal materials to the east from the upliffed Tibetan plateau. It is believed that the movement of these crustal materials within the Chinese plate has been responsible for most of the earthquakes. Devastation to life and property are due to improper design of structures which can not stand to the high seismic stresses. Huge landslides in the hill terrains of China adds to the devastation.

Keywords : Earthquake, Intraplate, China, Indian plate, Plate movement

INTRODUCTION

China is a highly seismic prone country. Many major earthquakes have occurred in the past killing hundreds of thousands people. Some of the devastating earthquakes in China are shown in the Table below and Fig.1 shows their location. A few of these devastating earthquakes have been described below.

Table : Major Earthquakes in China.

Year	Area	M	Casualty	Remarks
1556	Shaanxi	8	830,000	Central zone, Zone III
1920	Gansu	8.6	230,000	Central zone Zone III
1925	Yunan	7	58000	Central zone, zone II
1927	Qinghai (Xining)	8.3	200,000	Central zone, Zone III
1931	Xingjiyang	8	10,000	Northwest zone, zone IV
1932	Gansu	7.6	70,000	Central zone, Zone III
1933	Sichuan	7.5	9300	Central zone, Zone III
1969	Guangdong	5.9	3000	Eastern zone, Zone II

1970	Yunan	7.5	15,620	Central zone, Zone III
1974	Yunan		10,000	Central zone, Zone III
1975	Hichang	7	1328	N E zone, Zone I
1976	Tangshan	7.8	242,000 (655000)	N E zone, Zone I
2008	Sichuan	8	70,000	Central zone, Zone III

Fig.1 Shows the devastating earthquakes in different parts of China. These are grouped in four geographical zones of concentration. The zone I includes earthquake in northeast, zone II in east coast China, zone III in central China and zone IV in northwest China. Maximum earthquake have occurred in central China from Yunan province in the south through Sichuan, Shaanxi and Gansu province in the north.

Fig. 1 Destructive Earthquakes in China

1- Shaanxi EQ (1556)
2- Gansu EQ (1920)
3- Quinghai EQ (1927)
4- Tangshan EQ (1976)
5- Sichuan EQ (2008)
6- Yunan EQ (1970)

DESCRICTION OF SOME MAJOR EARTHQUAKES

1. Shaanxi Earthquake (1556): It occurred in the Shaanxi province at the centre of China in the morning of 23rd January 1556. It had an estimated magnitude of 8 to 8.3 and intensity of XI in Modified Mercali scale. The destruction extended to 98 countries in 8 provinces in central China. A total of 830,000 people lost their lives, most from collapse of poorly constructed houses and of loess cave dwellings.

2. Haichang Earthquake, 1975: It occurred in Haichang town of Liaoning province in the northeast China. It is a major earthquake with magnitude 7.3. However it could be sensed earlier and people were notified to be careful. Most people left their houses before the earthquake struck. Only 1328 people lost their lives, though property damage was very high.

3. Tangshan Earthquake (1976): The most destructive earthquake of 20th century, it struck the populous industrial city of Tangshan of Hebei Province in northeast China on July 28,1976 with a magnitude of 7.5 to 8. The city was built on a fault affected area and the structures were built on a weak alluvial ground without proper aseismic design. It killed around 242,000 people though others estimate it as 655,000. The epicenter was within the city and about 90% houses collapsed. Inspite of this devastation, the city now grows fast with many high rise and fashionable buildings.

EARTHQUAKES IN SICHUAN PROVINCE

Sichuan province lies at the south central part of China (Fig.1). The north-south central part of China is the most sensitive region in China, zone III in Fig.3. Many major earthquakes have occurred along this zone. Earthquakes are very common in Yunan, Sichuan, Shaanxi, Ningxia, Gansu and Quinghai provinces of China. Several earthquakes have occurred in Sichuan province earlier (Fig.2). These occurred in 1923, 1933, 1955, 1976 etc. The latest earthquakes is in Wenchuan which struck on May 12, 2008 which has already claimed 70,000 people. The geomorphology of Sichuan Province has something special and is responsible for many earthquakes. The western part of Sichuan province is a continuation of Qinghai- Tibet Plateau and is extremely hilly while its central part is a sunken circular basin known as Sichuan Basin. Chengdu, Capital of Sichuan Province lies in this basin. There is a sharp boundary between western hills and the central basin, Fig.2.This boundary represents a weak zone which is seismically very sensitive and most earthquakes of Sichuan province occur along this boundary.

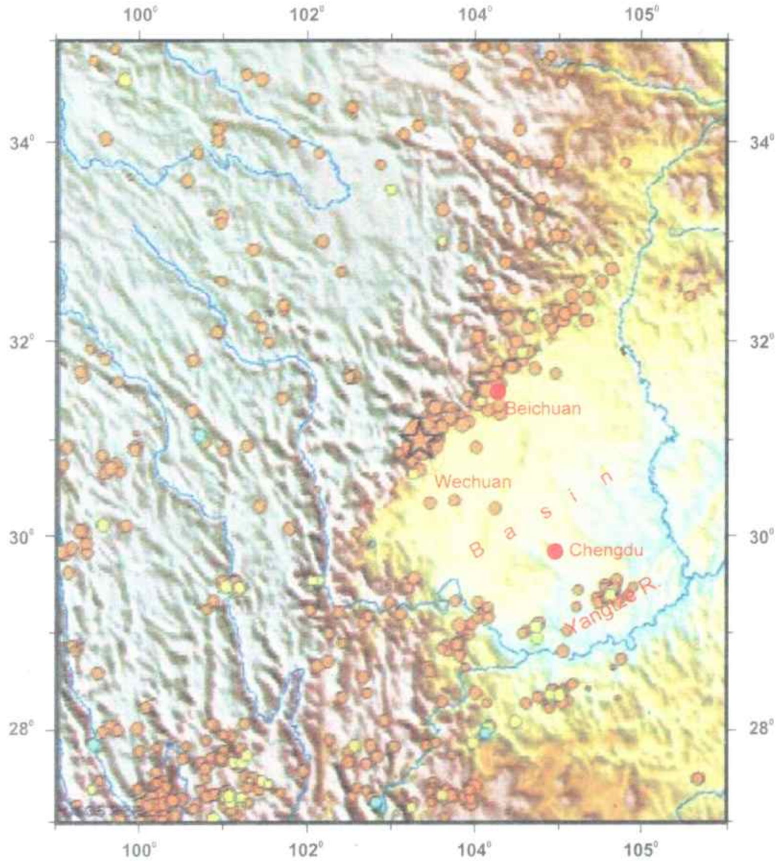

Fig. 2 Seismicity around Sichuan Basin, China

THE WENCHUAN EARTHQUAKE, 2008.

Wenchuan earthquake in Sichuan Province is the latest destructive earthquake in China after the Tangshan of 1976. It occurred on 12th May 2008 at 2.28 PM (CST).The epicentre was located at Wenchuan county about 100 km north west of Chengdu. It occurred along a thrust fault (Longmanshan Fault) which is about 240km and 20 km deep between Wenchuan on the southwest and Beichuan on the northeast. The fault marks the boundary between the hilly terrain on the northwest and the basin on the southeast. It is a shallow focus earthquake (19 km) with a magnitude 8 and intensity X to XI (Disastrous to Very Disastrous intensity). About 70,000 people have died so far. The earthquake was associated with massive landslides blocking roads and river courses. Many quake-lakes were formed by the landslide debris across drainage courses making the area unsafe from flooding.

Incessant heavy rains after the earthquake made rescue operation difficult. Most buildings failed because they were not properly designed to accommodate the seismic stress. It is believed that the earthquake is a result of movement of crustal material from the Qinghai-Tibet highland into the Sichuan basin which was accommodated by the formation of a thrust fault between Wenchuan and Beichuan counties and movement of opposing crustal blocks along the fault zone created the earthquake. The faulting generated a displacement of more than three metres on the ground.

CAUSES OF CHINESE EARTHQUAKES

Most of the earthquakes in China are truly intraplate type as they occur far away from the plate boundaries, such as the Indian-Eurasian plate boundary and the Pacific-Eurasian plate boundary (Fig.3). All the earthquakes occur within the Eurasian plate. These earthquakes in China can be grouped into four geographical zones: the northeast zone (zone I), the eastern zone (zone II), the central zone (zone III) and the western zone (zone IV). Of this four geographical zones, zone III is very significant as many earthquakes have occurred along this zone covering Yunan province in the south through Sichuan, Shaanxi, Qinghai and Gansu in the north. The next significant zone is zone I in northeast China where Tangshan and Hichang earthquakes took place.. In zone II along the eastern coast only mild quakes occur.

On a continental scale, the earthquakes in central and eastern Asia are a result of northward convergence of the Indian plate against the Eurasian plate. The convergence of these two continental plates is broadly accommodated by the uplift of Asian highlands accompanied by the motion of crustal materials to east away from the uplifted Tibetan plateau. The eastward flow of materials causes great stress in many parts of China which leads to faulting along weak zones and generation of earthquakes. In the Sichuan area the margins of Tibet-Qinghai plateau are being pushed under the weaker rocks of Sichuan Basin producing fault ruptures and sudden movement along these ruptures causes earthquake as it happened on the 12th May,2008.

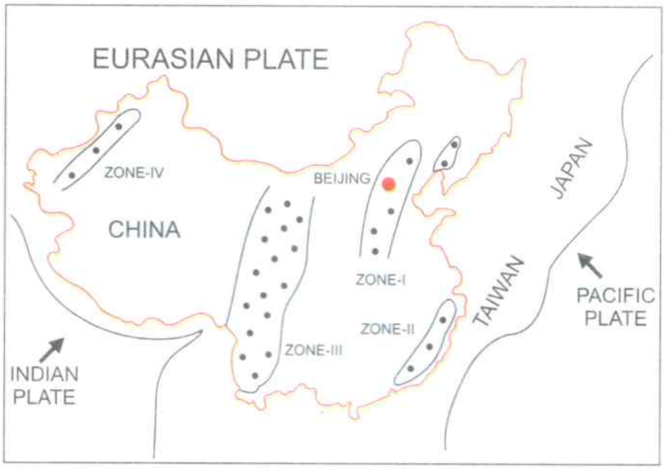

Fig.3 Zones of Intraplate Earthquakes in China

CONCLUSION

Earthquakes have occurred and recurred in many parts of China since the historical times killing hundreds of thousands people. Society has done little to save the people. People and Government do not give proper care to aseismic design. Prediction of earthquake has not been a reality yet. There will be many more earthquakes to come in known areas, but how much are we prepared to save ourselves from these future devastations?

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CHALLENGES BEFORE EARTH SCIENTISTS IN THE 21ST CENTURY

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I. Introduction

21st Century may be called INFORMAQTION AGE when information are extracted by sophisticated computer programmes and used for maintaining sustainable growth. Unprecedented industrial activities during the 20th. Century(ATOMIC-COMPUTER AGE) without regard to ecology has degraded the environment to alarming levels at local, regional and global scales which require immediate focused attention of all concerned(including the earth scientists) to achieve sufficiency in energy, materials, higher economy & living standards, simultaneously improving the present fragile ecology and environment. We not only require cleaner and greener technologies(Manaham,2007) with higher productivities but also need strictly optimal allocation and management of our finite resources(Sahu,2007 a,b,c,d). Fortunately, pollution-prevention through Industrial Ecology and control of economy within ~Carrying Capacity~ of Mother earth are now well-recognised as a boon which results in much valued Carbon Credits for future use. From the viewpoint of human economy, Environment comprise three mutually competitive (Resource, Amenity, Sink) functions which must be allocated for and managed well to achieve sustainable growth(Sahu,2007 a,b,c).

Earth comprise FIVE mutually interacting domains GEOSPHERE (solid); HYDROSPHERE (liquid); ATMOSPHERE (gas); BIOSPHERE (organisms), and ANTHROPOSPHERE (man's activities and influences), which together constitute ecology and environment. Earth Scientists study and deal with all these five spheres and hence, are eminently qualified to substantially contribute to sustainable growth without damage to the environment and our future generations. However, demands for energy and materials must be met by discovery of newer and augmentation of existing sources and by improvement of ecology through science and technology. So, earth scientists must acquire the latest and most efficient science and technology tools by study of subjects like, Global Tectonics and Climatology, Nonlinear Sciences, Stochastic Processes, Hard- and Soft-Computing, Modelling & Optimization etc.(Sahu,2003,2004,2005,2007 a,b,c).

II. Challenges and Suggested Solutions

Earth scientists today face tremendous challenges in order to fulfill their professional obligations to the society and to safeguard our existence for the future. These tasks are further magnified since they were taught very little about the latest sciences and technologies at the College/University stage; mainly because faculty lacked knowledge and experience in the newer fields of science and technology. However, we can overcome these problems by immediately introducing the new and desired subjects into Earth Sciences curriculum and by organizing periodic updating of faculty members through Summer/Winter courses and local week-end coursers (Sahu, 2004, 2007a). I suggest that at B.Sc. level: Matrices, Data Mining, Univariate Statistics, Optimization; at M.Sc. level: Multivariate Statistics, Time Series, Artificial Intelligence; and at M. Tech./ Ph.D. level: Image & Wavelet (time-frequency) analyses, Soft Computing, Nonlinear Physics may be introduced, pending which students and professionals must learn these by self-study (Sahu, 2007a) Attempts to utilize latest available tools such as Satellite Imageries, GPS, GPR, 4D seismic., Soft Computing Softwares etc. and also to introduce 'GEOSCIENCES' at the school level.

The primary factor for sustenance and growth is Energy (mainly hydrocarbons now) which is largely finite and which unfortunately generates greenhouse gases that are responsible for global warming and environmental degradation. Therefore, newer hydrocarbon energy resources must be discovered in the deepwater reservoirs (Sahu, 2008), coal bed methane, and gases in the fractured shales. Abundant hydropower energy, currently untapped, must be developed by construction of dams and reservoirs on riverbeds which benefits the society also for irrigation, agricultural products, waterways and water supply, recreation facility etc. India is lucky to possess sufficient Atomic and industrially required minerals, fertile soils, and a variety of natural resources waiting for sustainable development through time series modeling and long-run forecasting(Sahu,2003).Cost-efficient Si solar cells or As-B solar cells may also be developed and biofuels generation from molasses(rather than corn) are to be adapted. Optimal management of water resources is of utmost importance and allocation, pricing and linking should be developed watershed-wise (Sahu, 2006a, b; 2007c, d). Neuro-fuzzy-genetic algorithms accounting for inherent nonlinearities, imprecissions in geologic processes & products and yielding global rather than local maxima/minima are needed for sustainable decisions and to discover optimal indicators for energy and material resources managements (Letcher & Giupponi, 2005; Sahu, 2003, 2006 a, b; 2007 a, c, d).

Earth scientists also face challenges from natural disasters like flash floods, draughts, cyclones, landslides, earthquakes, tsunamis, volcanisms and natural and anthropogenic pollutions. These events cannot be predicted nor can be stopped. However, their destructive intensities can be reduced through public availability of hazard mitigation policies and practices developed by studying hazard-zonation and accompanied risk function maps prepared by earth scientists and other professionals I hope that this note would be useful to the authorities and the public concerned with sustainable growth in the 21st Century. I welcome suggestions and comments from the readers.

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IRON ORE DEPOSITS OF ORISSA- ITS PRESENT AND FUTURE STATUS WITH SPECIAL REFERENCE TO THE DEVELOPMENT OF STEEL INDUSTRIES

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Abstract

Orissa has become a prominent state in India and worldwide for its vast iron ore deposits. Now it is the highest iron ore producing state in the country. The major iron ore deposits associated with Banded Iron Formation (BIF)are clustered surrounding the North Orissa Iron Ore Craton excepting some other discrete pockets. Huge quantity and high-grade iron ores have attracted a good number of industrial giants of national and international stature to set up steel industries in Orissa. The per capita consumption of iron is increasing day-by-day and reached as much as 400kgs. After fulfilling the domestic needs, Orissa has vigorously entered into the export trade of iron ores. Research and technological development has brought the evolutionary changes in steel industries to consume the low-grade iron ores. This provides a scope in increasing the reserve quantum by adding the ore rejects of as low as 45% Fe to the main domain

Key words: Iron ore, BIF, export, reserve, Orissa

INTRODUCTION

Orissa has vast resources of iron ore deposits of varying grades. They are restricted to the Precambrian supracrustals, the oldest rock masses in the state. Geographically they are distributed in the northern and southern part of Orissa. Excepting a small deposit, namely Hirapur in Nawrangpur district, the rest iron ore deposits are confined to the mineral nucleus zone, known as Ore Supergroup of north Orissa. It constitutes mainly three iron ore groups encircled around the craton known as North Orissa Iron Ore Craton (NOIOC).

The first iron ore deposit in Orissa was discovered in Badampahar area of the Badampahar-Gorumahisani-Suleipat belt in the year of 1904 by P.N. Bose. Based on the iron ore deposits of this area, the first ever Steel plant in Asia was set up at Jamsedpur by TATA Co. in 1911. Thereafter the iron ore deposits of Bonai-Keonjhar belt came to limelight during the period from 1922 to 1925. Much of the effort of Geological Survey of India and state mining and geology agency brought out a number of other deposits amongst which Daitari-Tomka belt is the prominent one.

The proto-ore of the iron ore deposits in Orissa is the Banded Iron Formation (BIF). Though the age-old concept depicts that iron ore is derived from the BIF, recent research and development has enunciated BIF as the ore in some special circumstances. Different types of iron ores such as hard massive, laminated, biscuity and blue dust are available in Orissa. So far as grade of iron ore is concerned, iron ore deposits of Orissa present high grade ores ranging from 68 to 59% of Fe and a variable grade of as low as 52-45 % of Fe as has been compatible to the modern industrial units of steel sector.

THE MAJOR IRON ORE DEPOSITS

Orissa possesses a number of iron ore deposits of varying dimensions, reserves and grades. All most all of them are clustered in the north Orissa and a single deposit in

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south Orissa. The Precambrian iron ore deposits are located in the periphery of the Orissa Singhbhum craton, which has been later known as North Orissa Iron Ore Craton (NOIOC). The only deposit in the south Orissa is situated in the domain of Eastern Ghats Supergroup.

The major iron ore deposits are as follows.

(i) Badampahar-Gorumahisani-Suleipat belt
(ii) Bonai – Keonjhar belt
(iii) Daitari-Tomka belt
(iv) Kamakshyanagar-Jhilli area
(v) Malayagiri-Pallahara area
(vi) Gandhamardan area
(vii) Hirapur area

The first three belts have been designated as the iron ore groups, which constitutes the Iron Ore Supergroup of North Orissa. They are situated encircling the NOIOC. The arcuate shaped Badampahar-Gorumahisani-Suleipat belt is situated in the eastern flank of the craton. The Bonai-Keonjhar belt (BK belt) is lying to the western boarder of the craton, otherwise named as horseshoe belt. The southern part of the NOIOC comprises the Daitari-Tomka belt. Other three deposits of north Orissa are away from the NOIOC and occurred as segregated or outlier iron ore deposits.

Badampahar-Gorumahisani-Suleipat belt

The Badampahar-Gorumahisani- Suleipat belt, popularly known as BGS belt (Beura et al, 2006), is situated in the Mayurbhanj district of Orissa with a part of Gorumasani region extended in Jharkhand state. This belt comprising of iron ore deposits occurs in the geographical segment that lies in the eastern part of the NOIOC and north west of the Similipal biosphere. This is an arcuate shaped belt extending from Badampahar area in the south to Gorumahisani in the north through Suleipat. The litho-assemblage of the area represents the oldest iron ore deposit (BIF-I) (Acharya, 1984 and 2000; Beura, 2002, 2006 and 2007). The litho units of the area consist of Banded magnetite quartzite (BMQ), Banded magnetite grunerite quartzite (BMGQ), Banded grunerite (BG), banded chert, fuchsite quartzite and quartz schist. The iron minerals present in this area are magnetite, hematite, martite, goethite, specularite, grunerite and pyrite. The BIF has been metamorphosed to lower amphibolite facies of metamorphism. The rocks of the area have undergone multiple episodes of deformations with three phases of folding, which result in intricate interference patterns through successive superimposition of folds.

Daitari-Tomka belt

The Daitari-Tomka belt is situated in the Jajpur-Keonjhar districts and constitutes an area in the southern part of the NOIOC. The litho assemblage of the area is assigned as BIF-II (Acharya, 1984 & 2000; Beura, 2002), which remains intermediate between BIF-I and BIF-III so far as the age is concerned. The BIF of this area comprises banded hematite jasper (BHJ), banded hematite quartz (BHQ), banded chert and banded ferruginous shale. The iron minerals include hematite, martitised magnetite, martite, magnetite and limonite. Martitised magnetite is the predominant mineral in this belt. Iron ores of various types such as massive, hard laminated, soft laminated and blue dusts are available in the belt. Negligible amount of Manganese ore is deposited in pockets. The area experiences at least three phases of deformation with co-axial tight isoclinal folds. The rocks of the area are metamorphosed up to green schist facies of metamorphism.

Bonai – Keonjhar belt

The Bonai- Keonjhar belt constitutes part of Keonjhar and Sundergarh district of Orissa. This belt has been termed as Horseshoe belt by Jones (1934). This lies in the western edge of the NOIOC. The litho-assemblage of the area belongs to the youngest Iron Ore Group (BIF-III) of the Iron Ore Supergroup (Acharya, 1984 & 2000; Beura, 2002). The litho-units comprise of banded hematite quartzite (BHQ), banded hematite jasper

(BHJ), banded hematite shale (BHS), banded shale, banded manganese formation (BMnF), ferruginous shale, and iron ore bodies. The phyllites and shales of carbonaceous nature have been observed. The rocks are subjected to polyphase deformation with at best three phases of folding and show NE-SW trend, which result in more open type cross folding. They have undergone little or no metamorphism. The iron ore mineral comprises of hematite, martitised magnetite, martite, specularite and goethite. Hematite is the dominant mineral in this region.

Malaygiri –Pallahara region

This Iron-formation is located on the top of the Malaygiri range, southeast of Pallahara township of Anugul district. Banded – specularite-quartzite has been traced on the hill slopes along with quartzite and other parametamorphites towards eastern side of the township (Prasad Rao et al., 1964). These rocks are co-folded in NW-SW with high plunge towards WSW. Sheared conglomerate, quartz-schist and metapellite formations are exposed SE around Bankhol and Sapthara. Granite is the older litho unit that forms the base and is exposed both around Pallahara and Bankhol. The iron formation of this area comprises of oxide facies only.

Kamakshyanagar - Jhilli region

Banded Iron Formation and associated rocks occur in the Kamakshyanagar - Jhilli region of Dhenkanal District of Orissa. This is equivalent to the BIF-I of BGS belt. BIF of this belt consists of quartz hematite schist (QHS), quartz specularite schist (QSS), banded hematite quartzite (BHQ) and banded magnetite quartzite (BMQ). The associated rocks comprise of almandine, staurolite, kyanite and sillimanite. The BIF and associated rocks in this region are metamorphosed to epidote-amphibolite and almandine-amphibolite facies conditions. These rocks are affected by kyanite-sillimanite grade of metamorphism.

Hirapur region

Hirapur occupies a compact area of iron-formation in the Nawrangpur district of Orissa. It is made equivalent to the BIF-I of BGS belt. The litho assemblage including banded magnetite quartzite (BMQ), banded grunerite quartzite (BGQ), ferruginous phyllitic shale are underlain by older granite and intruded by younger granites. The rocks are folded on E-W axial planes and have westward medium plunge. The rocks of the area have attained amhibolite facies of metamorphism.

Gandhamardan region

Gandhamardan iron ore deposit is situated in the Keonjhar district. Towards the west of Keonjhar town, isolated exposure of BIFs as well as iron ores are observed. The stratigraphic sequence is almost equivalent to BIF-III (Acharya, 1976). The litho assemblage comprises of banded pyritic chert, banded shale, banded hematite jasper/chert and younger shale. Griety sandstone and volcanics of Dhanjori Group underlie the iron-formation, which is unconformably rests over the Keonjhar granite ($\approx$ Singhbhum granite). The BIF is sandwiched by the lower iron ore of syngenetic origin and upper ore of supergene enrichment.

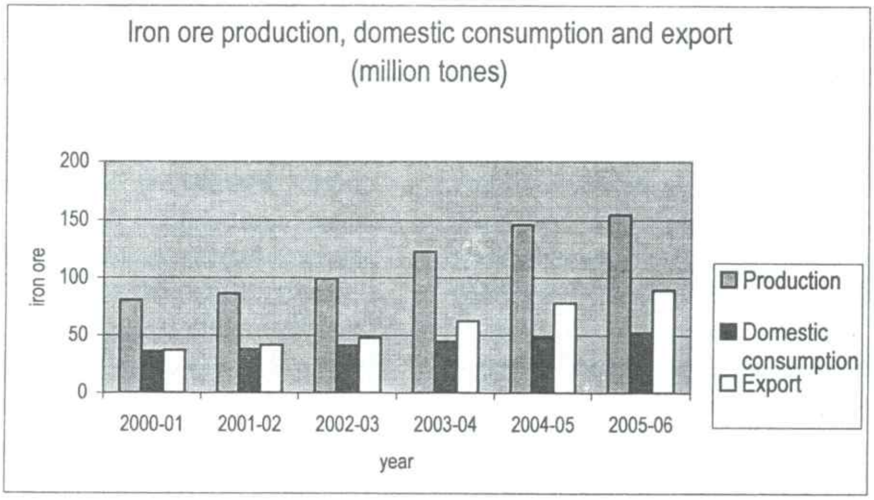
STATUS IN THE COUNTRY

Steel sector in India moves on the immense growth tract. Contemporary large scale investment in steel sector has projected a target production of crude steel of 80 million tones by 2011-12, while the base lies with a total crude steel production of 34.8 million tonnes in 2004-05. In addition to the indigenous steel production, India has boomed in exporting the iron ores to flourish country's foreign currency exchequer. This has been possible only because of its enormous amount of high-grade iron ore deposit. India enjoys 5.45 percentage of the total iron ore reserve of the world, which has been estimated to be 229,000 million tones with an average grade of 46 percentage of Fe content. Indian iron ore represent an average Fe content of 63 percent, which is one of the highest ones in the world. An increasing trend in production, consumption and export of iron ore in India during a period of last five years is given in the following table (Table-1).

Table-1 Iron ore production, consumption and export in India (Figures in Million tones)

Year	Production	Domestic consumption	Export
2000-01	80.76	36.02	37.27
2001-02	86.22	37.71	41.64
2002-03	99.07	40.94	48.02
2003-04	122.84	44.97	62.57
2004-05	145.94	48.15	78.14
2005-06	154.43	52.23	89.27

Source: Indian Bureau of Mines
JPC, Kolkata
MMTC, New Delhi



Orissa has emerged as the highest iron ore producing state in the country. The iron ores are of high grade and include only hematite ores. As per the estimation of Indian Bureau of Mines, Orissa possesses a total reserve of 4177 million tones of hematite ore with the allocation of 34 percent of the total reserve in the country, which indicates the highest in India. The state's total production of iron ore during the year 2004-05 is 41.75 million tones (Table-2).

Table-2 State wise iron ore production in India (Figures in million tones)

state	2001-02	2002-03	2003-04	2004-05	2005-06(p)
Chattisgarh	18.66	19.75	23.36	23.11	14.75
Goa	14.78	17.88	20.24	22.67	23.74
Jharkhand	13.06	13.70	14.68	16.71	17.43
Karnataka	22.59	24.79	31.63	37.96	33.66
Orissa	**16.60**	**22.07**	**31.28**	**41.75**	**49.88**
Others	0.51	0.82	1.62	3.72	4.95

Source: Indian Bureau of Mines, p- provisional

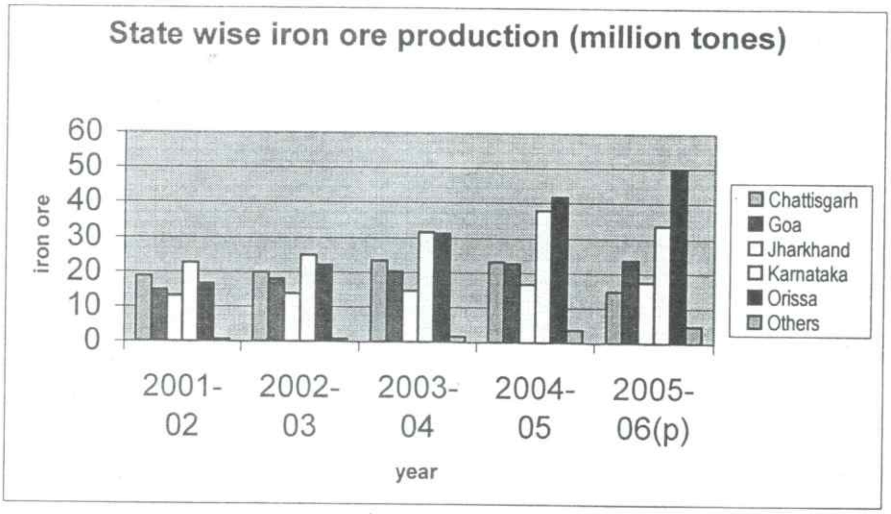


Table-3 iron ore production of in Orissa (million tonnes) and YoY growth (percentage)

Year	Production	YoY Growth
1999-2000	11.93	-
2000-01	14.38	20.54
2001-02	16.60	15.44
2002-03	22.07	32.98
2003-04	31.28	41.73
2004-05	41.78	33.56

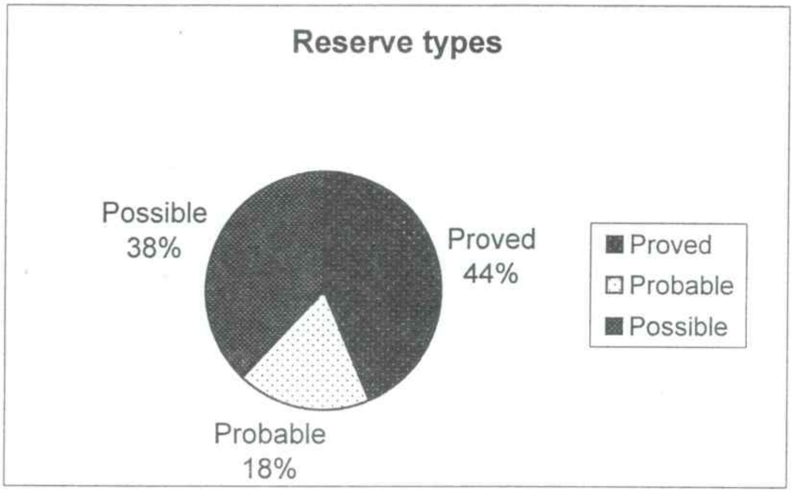
Source: Indian Bureau of Mines, Nagpur

The increasing trend of the iron ore over the years in the country and the state as well indicates that continuous activities in intensifying the exploration and mining has been undertaken. Technological upgradation in industries, now days, start using the low-grade ores, which has increased the resource potential as well as the production of iron ores. The total reserve of iron ores of Orissa is given below (Table-4).

Table-4 Iron ore reserve of Orissa (Figures in '000 tones)

Reserve type	Reserve
Proved	1,824,172.68
Probable	762,910.37
Possible	1,590,270.65
Total	4,177,353.70

Source: IBM, Nagpur



The total reserves of iron ore in the state are estimated at 4177 million tones. All iron ore mining operations in the State are opencast and the methods range from manual to mechanized. Most of the mechanized mines have crushing and screening facilities as well. At present, the state produces 46.06milion tones of iron ore (2004-05).

In view of growing worldwide demand for steel, there has been a major surge of interest in this sector. As Orissa possesses a total reserve of 4177 million tones of high-grade iron ore, which is 33.91% of the country's deposit, the steel makers of national and international repute have shown interest to establish steel plants in the State. Government of Orissa have already signed more than 43 Memoranda of Understanding (MOU)/agreement with private parties desirous of setting up steel plants with an investment of INR.1, 37,156.00. crore to produce about 58 MTPA steel.

INDUSTRIAL SCENARIO

World wide increasing trend in consumption of steel demands a similar trend in steel production (Table-5). In 2006, the world steel production has increased about 9%. China is the highest steel producing country in the world (Table-6). In China only, the steel production is increased by 18.5% between 2005 and 2006. In this year it accounted for 34 % of the global steel production.

Table-5 World crude steel production (figures in Mt)

Year	1999	2000	2001	2002	2003	2004	2005	2006
Crude steel production	789	848	851	904	970	1069	1140	1240

Source: World Coal Institute

Crude steel production

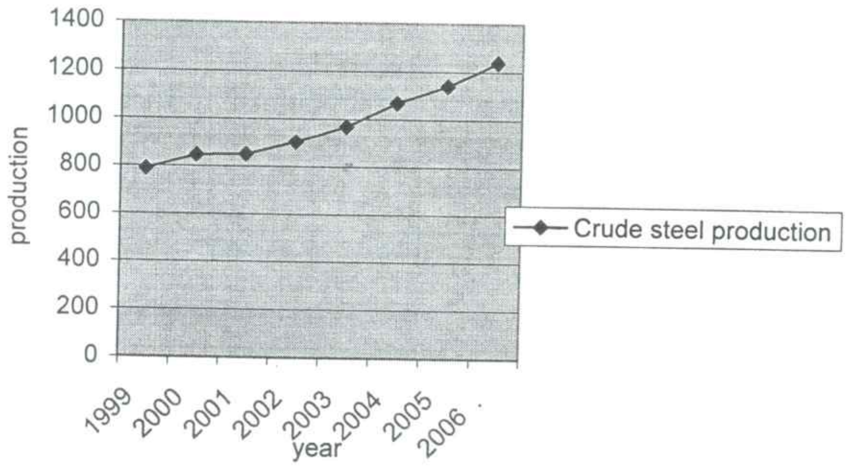


Table-6 Top ten producers of steel in the world in 2006

Country	Production	Country	Production
PR China	419Mt	Germany	47Mt
Japan	116Mt	India	44Mt
USA	99Mt	Ukraine	41Mt
Russia	71Mt	Italy	32Mt
South Korea	48Mt	Brazil	31Mt

Source: World Coal Institute

Worldwide steel requirement corroborates with the steel production. Combiningly they put stress on the iron ores. Hence the worldwide demand on iron ore has attained a continuous growth (Table-7).

Table-7 Global demand of iron ores (Figures in Mt)

Year	Demand
2001	1050
2002	1120
2003	1200
2004	1260
2007 (F)	1400

Source: JPC Bulletin, April 2004, (F)- Forecast

Orissa, the synonym to the steel state, has now the capacity to produce 58 million tones per annum by the mega steel projects only. A massive investment in the steel sector is expected to be INR 165,000 crores. A large number of MOUs have been signed with various companies to set up the steel plants (Table-8). The major companies that have already decided to set up steel plants are POSCO, TATA, JINDAL, ESSAR and BHUSAN. Among them the South Korean steel major, the Pohang Iron and Steel

Company (POSCO) is going to set up a steel plant of 12 million tones per year with an investment of INR 52000 crores. Recently Arcelor-Mittal with an MOU with the Government of Orissa has entered to build an integrated steel plant of 12 million tones capacity against an approximate investment of INR 40,000 crores.

Table-8 Company wise capacity and investment in Orissa

Company	Capacity (MT)	Investment (INR, Crore)
Arcelor-Mital	12.00	40,000
Tata steel	6.00	15,400
POSCO	12.00	52,000
Jindal stainless	1.6	7,000
Jindal Steel and Power	2.00	4,000
Ispat industries Ltd	5.00	12,000
Bhushan steel strips	1.2	1,650
Vedanta Resources	5.00	12,000
VISA industries	1.5	1,600
Sunflag I&S Co	1.0	1,000
Neelachal Ispat Nigam	1.0	1,000
Essar Steel Ltd	4.00	10,000
Tube investments	2.5	6,000
Total	**58.8**	**163,650**

In Orissa, the production of iron ores are disseminated sector wise. Most of the companies possess leaseholds of iron ores, which dominates the production arena over the freehold areas. The reserves in the freehold areas under non-captive leaseholds can be mined out to meet the needs of the upcoming steel projects. The company wise break up of the leaseholds of iron ores are given below (Table-9).

Table-9 Company wise leaseholds of iron ore reserves in Orissa (Figures in Mt)

Company	Leasehold (Mt)
Orissa Mining Corporation Ltd. (OMC)	414
Steel Authority of India Ltd.	732
BOMEL and OMDC Ltd	153
Nilachal Ispat Nigam Ltd.	110
Tata Steel	410
Essel Mining and Industries Ltd.	155
Rungta Mines Ltd.	149
S. L. & M. L Sarada	248
Freehold Areas	
Malangtoli	371
Mankarnacha	250
Baliapahar	131
Badampahar	49
Thakurani 'A'	270
Kiriburu (Orissa portion)	65

EXPORT

The export business of iron ores of all grades has reached the acme of these days in India. This has become possible because iron ore production is much more than what is required by the steel plants and the low grade ores that have no use here are consumed in other countries. The figures appeared in the Table-1 indicate the rapid increasing trend of iron ores. This is entirely due to the increase in export demand of iron ores by China. Still there is surplus of iron ores after consumed by domestic demands and exports. Last three financial years 2003-04, 2004-05 and 2005-06 show quite a good amount of surplus of iron ores of 15.30 mt, 19.30 mt and 12.93 mt respectively. The fines with no domestic value have attained substantial increase in export, which is about 74% in 2002-03 and 84% in 2005-06. Besides China, lumps are mostly exported to Japan and South Korea against the long-term contracts of MMTC and Goan exporters. The following tables (Tables-10 and 11) show the export distribution.

Table-10 India's iron ore export- Lumps and Fines (Figures in Million Tonnes)

Year	Fines	Lumps	Total
2002-03	35.72 (74.39)	12.30 (25.61)	48.02 (100)
2003-04	49.12 (78.50)	13.45 (21.50)	62.57 (100)
2004-05	64.60 (82.67)	13.54 (17.33)	78.14 (100)
2005-06 (P)	77.67 (87.00)	11.61 (13.00)	89.28 (100)

Source: JPC Bulletin, April 2004, (P)- Provisional
Figures in parenthesis ( ) indicate percentage to the total export.

Table-11 India's iron ore export- Grade wise (Figures in Million tones)

Year	+64% Fe	64-63% Fe	62% Fe and below	Total
2002-03	24.11 (50.21)	5.44 (11.33)	18.47 (38.46)	48.02 (100)
2003-04	21.87 (34.95)	15.61 (24.95)	25.09 (40.10)	62.57 (100)
2004-05	20.15 (25.79)	34.22 (43.79)	23.77 (30.42)	78.27 (100)
2005-06 (P)	18.07 (20.25)	39.26 (43.98)	31.94 (35.78)	89.27 (100)

Source: GMOEA, KIOCL, NMDC, MMTC and ROS/PRIVATE MINE OWNERS
Figures in parenthesis ( ) indicate percentage to the total export.
(P)- Provisional

Orissa exports the highest amount of iron ore of different grades. (Table – 12)

Table-12 Mineral export in Orissa in 2003-04

Minerals	Export quantity in %	Export value in %
Iron	81	72
Chromite	15	22
Ilmenite	03	05
Others	01	01

Source: Govt. of Orissa, 2005

FUTURE

This has prompted to develop the steel making technologies utilizing low grade iron ores. It has created a platform to adopt the advanced exploration technologies to assess the low grade iron ore resources in India.

In India also, the resource base has increased (Table-13) for iron ores but not solely due to the additional mines by new explorations. Unlike Australia and Brazil, the contribution of exploration in increasing the reserve is less in India because of lack of technological advancement. In fact India has achieved the increasing trend mainly due to lowering of the cut-off grade. The cut-off grade, previously, was restricted to 58% Fe and above. In due course of time it has been come down to 55% Fe in estimating the iron resources. At present it has become still low i.e. in the range 48 to 45 % Fe as the technological advancements make the steel plants compatible to utilize 45% Fe ore and above.

In Orissa the reserve base for iron ore is in the same tune with the national trend. Lowering of cut-off grade plays the dominant role in maintaining the increasing reserve trend for iron ore (Table-14). Discovery of new mines due to exploration works are very few and hardly supports the additional indigenous consumption and export trade. Two years back iron ore mines were producing iron ores of 65-60% Fe. Now the grade has come down to about 48-45%. This has resulted in increasing the known reserve to about 30-35%.

Table-13 Status increase/decrease in iron ore resources and production (quantity in million tones)

Grade	Resources as on 1.1.1980	Production between 1980-1990	Resources as on 1.4.1990	Production between 1990-2000	Resources as on 1.4.2000	Production between 2000-2005	Resources as on 1.4.2005
Hematite	11469		12197 (+728)		11428 (-771)		14630 (+3204)
Magnetite	6095		10590 (+4495)		10682 (+92)		10619 (-63)
Total	17564	470	22787 (+5223)	656	22108 (-697)	532	25249 (+3141)

The resources are estimated with a cut-off grade +55% Fe upto 50 metes depth and exclude around 1000 MT hematite in Kabirdham district, Chattisgarh.

Source: Indian Bureau of Mines, Nagpur

Table- 14 Increasing trend of world iron ore recourses (Quantity in million metric tones)

Year	Crude ore		Iron content	
	Reserves	Reserve base	Reserves	Reserve base
1969	90,540	195,050	NA	NA
1980	NA	266,210	NA	95,250
1990	147,400	210,100	66,100	96,600
2007	160,000	370,000	79,000	180,000

Source: USGS, NA- Data not available

Recent research and development in iron ore metallogeny has changed the status of banded iron formation (BIF) to iron ore (Singh et al, 2007). In a BIF where the hematite/magnetite band has much more thickness than quartz/jasper, can satisfy the definition of ore. Had the concept been utilized in future in estimating the reserve of iron ore the Orissa iron ore reserve would have been nearly doubled.

CONCLUSION

Orissa being endowed with vast Iron ore resources of various grades has become a suitable platform for the development and establishment of numbers of steel making industries. The iron ore consumption pattern projected by these steel industries has created a temporary threat on the availability of the basic raw materials. However, with the adoption of advanced technologies utilizing low grade iron ores (35% - 40% Fe) and with the ongoing exploration, has undoubtedly increased the status of iron ore resources in the state. This would no doubt assist in prompting more and more steel making units in the future which would help in substantial economic growth of the state.

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News about members

- Chairman of Institution of Engineers (India), Kolkatta has co-opted Shri G.S. Khuntia as member of Mining Engineering Board for the year-2006-07 which looks after for advancement of Technology in Mining Engineering. He has also been inducted as member of Building committee of Institution of Engineers (India) as well as special invitee member in Indian National committee of World Mining Congress.

  Shri G.S. Khuntia also chaired a special meeting on 25.1.08 organised by IBM along with representative of Director of Geology /Director of Mines, Orissa, IBM, Bhubaneswar/ RRL, Bhubaneswar & representative of Mining Industries of Orissa in NALCO guest house,Bhubaneswar as Chairman of meeting on fixation of thresh hold limits for Iron ore in Orissa/India in view of UNFC norms adoption by IBM. He shared his experiences in mines of NMDC/SAIL/Essar Steel Orissa Ltd & advised for adopting total mining concept for utilisation of scarce Iron ore resources in India in view of envisaged Steel demand of 190 MT by 2020 covering mechanised Iron ore mining/intentive mineral beneficiation with high tech application like HGMS/WHIMS /detailed exploration of Iron ore by one & all mine operators /Reassement of Orissa/India Iron ore resources at 52% Fe cut off /Ore bgedding & blending facilities in mines/recovery of Fe values from slime by Filtration /Ore modelling & geo-statical quality control in Iron ore mines /adoption of beneficiation in all future mines etc.

  Shri G.S. Khuntia is also nominated as a Director in Orissa Mining Corporation Ltd.

- Shri R.K. Paramguru, a council member of SGAT has got 2 years extension of his service as Scientist g in IMMT, Bhubaneswar.

- Shri N.K. Patnaik, a member of SGAT has recently joined in Uttam Galva & Steels Ltd. and posted in Keonjhar.

- Dr. B.K. Mahapatra, a member of SGAT has been promoted as Scientist G and at present working as head of Mineralogy section of IMMT, Bhubaneswar.

- Dr. B.C. Acharya, a member of SGAt is promoted as Scientists G and joind as Head-ES Dept., IMMT, Bhubaneswar.

- Dr. R. Bhima Rao, Dr. L.D. Sukla and Dr. Kulamani Parida, members of SGAT have been promoted as Scientist G in IMMT, Bhubaneswar.

- Prof. Dr. B.K. Mishra, a Council Member of SGAT is promoted to Scientist H and at present working as Director, IMMT, Bhubaneswar.

➢ New Members

1. **Dr. Pradip Kumar Pattjoshi**
Jr. Manager, NALCO
Qr. No. B-115, Sector – 3
PO: Damonjodi – 763 008
Dist: Koraput (Orissa)

2. **Ms. Madhusmita Khatua**
Environmental Scientist
Geomin Consultants (P) Ltd.
267, Kharavela Nagar
Bhubaneswar – 751 001

3. **Prof. Ganpat Singh Roonwal**
C-520, SFS Flat
Sheikh Sarai – I
New Delhi – 110 017

4. **Mr. Shyama Prasad Ghosh**
Geologist (Sr.)
Geological Survey of India
Gem Testing Laboratory
15 A & B, KYD Street
Kolkata – 700 016

5. **Mr. Bijay Mihir Kunar**
Research Scholar
Dept. of Mining Engineering
IIT, Kharagpur – 721 302 (WB)

6. **Mr. Devi Prasad Mishra**
Ph.D. Scholar
Dept. of Mining Engg.
Dept. of Mining Engineering
IIT, Kharagpur – 721 302 (WB)

7. **Dr. Anindya Mukherji**
Geologist
Administrative Building
OCL India Ltd.
Rajgangpur, Dist: Sundergarh
Orissa – 770 017

8. **Mr. Rajiv Lochan Singhal**
Associate Consultant
College Road
Bargarh
Orissa – 768 028

9. **Mr. Jayesh Pushpakant Patel**
15, Ankur Society
Sanskar Nagar
Bhuj, Dist: Kachchh, Gujarat
Mob: 09426217670

10. **Mr. Ashok Kumar Mishra**
M.D
IDCOL Ferro Chrome Alloys Ltd.
M/76, Rajiv Nagar, Iginia,
Khandagiri, Bhubaneswar

11. **Mr. Puranjaya Behera**
Dy. General Manager (Mines)
M/s IMFA
Flat No. 305, Metro Homes
Near Damana Chowk
Chandrasekharpur
Bhubaneswar - 751016

12. **Mr. Dinesh Shastri**
Executive –in-Charge
Ferro Alloys and minerals
Tata Steel Ltd.
Tata Centre, 12^{th}, Floor
43, Jawaharlal Nehru Road
Kolkata - 700071

13. **Anuradha Sarangi**
Geologist, Business Development
Rio Doce India Pvt. Ltd.
C/O Regus Business Centre
Level -12, Building – 8, Tower – C
DLF cyber city Complex
DLF Phase – II,
Gurgaon – 122002, Haryana

➢ SGAT News

• State Level ENVIRONMENT CUM MINERAL AWARENESS PROGRAMME (EMAP) 2007

With a view to spreading awareness among the student community, their teachers and parents about the need to protect degradation of environment and motivate them to take ameliorative measures. SGAT has been organizing EMAP in 10 major mining areas of the State for the last 18 years on annual basis.

The participant in the Regional Programme include students of Higher Secondary Schools located in the mining and industrial areas. The winner team of each region comprising two student accompanied by a teacher participate in the State Level EMAP.

This year's State level EMAP held on 2 & 3 February 2008 at Bhubaneswar was sponsored by the Orissa Mining Corporation Ltd. The following schools participated:

1. B.K. High School, Soso
2. Chrome Nagar Vidyapitha, Jajpur Road
3. Lanjiberna Shramik High School
4. Ispat High School, Barsua
5. Kerala Public School, Rairangpur
6. DAV Public School, Unit-8, Bhubaneswar
7. Belpahara English Medium School
8. Jeevan Jyothi Convent School, Semliguda
9. Tata DAV Public School, Noamundi
10. DAV Public School, Kalinga Area, Talcher

The programme comprised:

Visits to (a) Nandankanan Biological Park, (b) Meteorological Centre, (c) Regional Museum of Natural History, (d) Regional Science Park.

Identification of plant species and mineral samples, photographs, written test and oral quiz.

DAV Public School, Unit – 8, Bhubaneswar represented by Roshan Mishra and Vikram Mohanty was adjudged the overall best team.

Each participant was awarded certificate and prize. All the teachers were presented mementoes as well.

Shir S.K. Sarangi, IAS, Managing Director, OMC graced the concluding session as the Chief Guest, Shri Sarangi was highly appreciative of the efforts made by SGAT in spreading awareness about the need to protect degradation of Environment and exhorted the students to contribute their bit in this important area of global concern. He expressed that OMC would be too willing to support and extend all help to SGAT in making the EMAP successful and result oriented.

Dr. R.C. Mohanty, in his presidential address thanked the OMC Management for sponsorship and observed that evaluation and examination of various events done by experts have been unbiased and absolutely fair.

The State Level EMAP was attended by several members of SGAT Executive Council, representatives of Mining Industry, Officers of DOG, OMC, GSI, Tata Steel among other. The various tests and quiz programme were conducted and evaluated by Dr. N.K. Mahalik, S/shri T. Mahanta, Subhransu Misra, J.P. Behera, Bikas Sahu of DOG, Dr. T. Basa of OMC and Shri K. Ray with logistic input provided by GEOMIN GROUP.

Shri M.V. Rao, General Secretary offered formal vote of thanks. The programme was designed and co-ordinated by Shri B.K. Mohanty, Advisor, SGAT.

- Record of Proceedings of the ***Workshop on Corporate Social Responsibility in Mining Sector***, organised by SGAT and MEAI, Bhubaneswar Chapter on 15 March 2008 at Bhubaneswar.

Present

Shri R.P. Gupta, President, Shri T. Victor, Vice – President Shri C.L.V.R. Anjaneyulu, Secretary General Shri Tarapada Mohapatra	MEAI
Dr. R.C. Mohanty, President, Dr. S. K. Sarangi, *Vice – President MEAI Shri M.V. Rao, General Secretary Dr. G.B. Misra Shri Shantanu Mohapatra Shri K.C. Pradhan Dr. S.K. Tamotia Shri B.K. Mohanty Shri R.N. Praharaj Shri Prabhakar Rout Dr. N.K. Mahalik	* Also National Vice President of SGAT
Shri Anurag Dikhsit, Tata Steel	
Shri S.R. Singh, Chairman Shri Sanjay K. Patnaik+, Vice Chairman Shri A.B. Panigrah+, Vice Chairman Shri U.K. Mohanty+, Shri G.S. Khuntia+ Shri K.C. Chowdhuri Shri J.P. Panda Shri N.K. Kherada Shri Santosh K. Patnaik	MEAI, Bhubaneswar Chapter +Also member of SGAT Executive Council

Dr. R.C. Mohanty, President, SGAT, welcomed the participants, introduced the significance of the workshop and requested Sri R.P. Gupta, President, MEAI to preside and conduct the proceedings.
Three papers were presented.

The papers by **Sri Anurag Dixit** of Tata Steel, gave an account of the historical background of CSR adopted by Tata Steel and practised over a century. The activities cover land reclamation in mines, plantations, health care, environment management, conservation, peripheral and socio - cultural development programme. Sri Dixshit mentioned that Tata Steel has set up an ICU at a remote place like Joda.

Sri R.N. Praharaj, General Manager (Mines), (IMFA Group) mentioned that

mining operations by IMFA are recent as also community development (CD) activities in mining areas. He informed that the Company's CD programmes are finalized in consultation with the local people and keeping their needs in view.
Dr. R.C. Mohanty, President, SGAT emphasized the importance of Corporate Social Responsibility of the companies. Analysing the failures, he advised the industries for proper planning of the projects from the beginning with adequate provision of funds. He observed that CSR of a company can not be successfully discharged without involvement and cooperation of the Government and Social/Political representatives of the locality.

Sri T. Victor, Vice - President, National Council of MEAI gave an account of his experience in Goa where the companies mining iron ore have joined hands to form a Mineral Fund created out of contributions by the mine owners. This fund has been utilized successfully for local area development like widening and concreting of roads and desilting of river beds affected by effluent discharged from iron ore washing plants.

Shri A.B. Panigrahi, Vice - Chairman, MEAI, Bhubaneswar Chapter, mentioned about deplorable road condition in Keonjhar - Koira Mining belt, dust nuisance, scarcity and contaminated drinking water and poor health infrastructure. He wanted the mine owners to voluntarily participate in the local area development and specifically in building proper infrastructure as a part of their CSR. He suggested that a proper benefit sharing mechanism should be put in place for inclusive growth.

Dr. G.B. Mishra, Sri Shantanu Mohapatra, Sri K.C. Pradhan, Sri J.P. Panda; Sri K.C. Choudhury, Sri Prabhakar Rout participating in the discussion expressed concern about the poor living condition of the people in the mining belts, although the industry generates pockets of affluence. They called upon the mining community to discharge CSR effectively so that some portion of their earning is utilized for benefit of the community.

Sri R.P. Gupta in his presidential address observed that the views and concerns expressed by the participants are genuine and relevant. He hoped that the mining industry would truthfully discharge its CSR to the benefit of all stake holders.

Summing up the deliberations, **Sri B.K. Mohanty,** Adviser, SGAT observed that CSR in the mining sector is largely cosmetic and directed for the purpose of complying the statutory obligations. It was the unanimous view that a lot is needed to be done and in this regard, the following were highlighted.

1. Government, Private Sector and the Civil Society need to play active roles in creating social infrastructure. This mechanism would be successful if the representatives of the community participate.
2. There should be integrated approach for creation and management of facilities in the fields of education, sanitation, health care and supply of drinking water particularly in rural areas.
3. Establishment of modern Diagnostic and Therapeutic centres

by Tata Steel, Jindal Group, IMFA Group, OMC, OMDC, SAIL and private mine owners for HIV - AIDS, Malaria and Cancer.

4. Provision of clean toilets in all schools and educational institutions particularly for girl students.
5. Construction of pucca concrete roads serving mineral traffic (like NH 215) and passing through villages and towns.
6. Cleaning of water ways, stream channels to be made free from debris, slimes, effluents.
7. All such programmes should be undertaken on a participative basis with funds contributed by each and every member of the mining industry, transport agencies, exporters,. owners of crusher units.
8. There was a suggestion endorsed by all participants that Tata Steel set up a Hockey Academy with modern facilities at Panpos in Sundargarh district.

Dr. S.K. Sarangi, Vice - President, SGAT, and Vice - President, National Council of MEAI offered vote of thanks.

- **PRESS MEET organized by Society of Geoscientists & Allied Technologists (SGAT) on 26 February 2008 at Hotel Swosti, Bhubaneswar to deliberate on issues relating to Hexavalent Chromium Pollution in Sukinda Valley.**

The meet was largely attended and participated by representatives of Print and Electronic media.

Present were

New Indian Express, The Statesman, The Hindu, Times of India, Business Standard, The Economic Times, Telegraph, Pioneer, Asian Age, India First.

The Samaj, Sambad, Dharitiri, Samaya, Pragatibadi, Prajatantra, Orisa Bhaskar, Swaraj, Anupam Bharat, Paryabekhyak.

ETV, OTV, Doordarshan, NDTV, UNI, PTI, EPA.

Members of SGAT Executive Council. IBM, MOEF, Mines Safety Directorate, State Pollution Control Board, Shri S.N. Padhi, Former DGMS, Dr. B.N. Mohapatra, Consultant for occupational diseases.

Dr. K.C. Sahu, former Professor of Geology, IIT, Mumbai.
Senior Executives of all Chromite Mine owners.

Copies of a Press Note prepared by SGAT setting out the issues arising out of the Reports of Blacksmith Institute of USA, IBM-BRGM, OSPCB, Orissa Voluntary Health Association and Centre for Science and Environment and views of SGAT thereon were circulated among the representatives of the media on the eve of the meeting.

Welcoming the invitees, **Dr. R.C. Mohanty**, President, SGAT explained the purpose of holding the conference.

Shri B.K. Mohanty, Adviser, SGAT mentioned that the need for convening a Press Meet was necessitated to deliberate and analyse the veracity of the reports of Blacksmith Institute (BI) ranking Sukinda as one of the10 most polluted places in the world with about 2.6 million people affected on account of incidence of hexavalent chromium in drinking and surface water much higher than national and informational standards, CSE reporting pollution of Brahmani river due to discharge of effluents from chromite mines. Shri Mohanty informed that SGAT had made an independent study of the status of Chromite mining in Sukinda valley, functioning of the Effluent Treatment Plants, contents of hexavalent chromium in Damsala nala at different points, dug wells and bore wells; incidence of diseases suffered by miners and people living in and around the Sukinda Mining belt.

Dr. K.C. Sahu, observed that though hexavalent Chromium is toxic, its incidence in Sukinda valley is well below the permissible level. He mentioned that the likely adverse impact of Cr on the health of people and animals can be contained by established and tested mitigated measures.

Dr. B. Misra, Member Secretary, OPCB termed the report of BI exaggerated and biased referring to the studies and findings of the OSPCB over the years.

Shri S.N. Padhi, former DGMS opined that CSE and BI should have carefully checked and analysed the position in the field before giving such adverse reports. He wanted to know if IBM is in agreement with the findings of BRGM, CSE and BI.

Clarifications sought by the media were furnished by **Shri B.K. Mohanty, Dr. R.C. Mohanty, Dr. G.B. Misra and Dr. S.K. Sarangi of SGAT.**

Summing up the deliberations, **Shri B.K. Mohanty**, observed that studies undertaken by SGAT, tests conducted by the chromite mining lessees, checks and monitoring by OSPCB and IBM, critical analysis of the reports of OVHA, BI and CSE revealed that while there is no cause for alarm or panic on account of possible toxic impact of Cr^{+6} on men and animals, there is no scope for complacency either. **The recommendations given in the Press Note were reiterated. These are again reproduced in the following paragraphs.**

1. Presence of Hexavalent Chromium in mine water, Damsala nala and ground water in Sukinda Valley is confirmed, though it is mostly within the permissible limits while occasional high values are not consistent and regularly observed due to dilution and reaction with organic compounds. There is no pollution of Brahmani river on account of Hexa –chrome contamination as its presence in Damsala nala at the points it leaves the Chromite mining area on its 15 kms. journey to Brahmani river has not been detected.

2. Hexavalent Chromium is toxic when present above the safe limits of 0.1mg/litre in surface water and 0.05 mg/litre in drinking water. It is quite possible to reduce

Hexavalent Cr to trivalent form by simple inexpensive technology and thereby prevent spread of its contamination.

3. Effluent Treatment Plants set up by the mine owners must be operational round the year with periodical and regular checks and monitoring by OPCB, IBM, DGMS and Directorate of Mines to ascertain concentration of Cr^{+6}.

4. Management of huge volume of waste already stacked and being generated which can give rise bleachable Cr^{+6} with possible contamination of ground water constitute the single most major problem. This must receive priority attention. Devices already known and partially adopted should be put in place.

5. Possible spillage from the COB plants must be plugged.

6. Plantation should be taken up on both the banks of Damsala nala as also in all vacant spaces in the valley.

7. The abandoned quarries should be rehabilitated forthwith.

8. In spite of the fact that suspected cases of cancer in the area is negligible, there has to be substantial improvement in health check facilities with emphasis on cancer detection. While the mine workers are statutorily covered under the programme, the mine owners need to extend such facilities to the community around.

9. There has to be base line data on health check to be periodically updated and a comprehensive study of status check to be periodically carried out. A comprehensive study on status of health in and around the area by a competent agency should be commissioned.

10. The dust nuisance can be minimized by thick avenue plantation and making Tomka–Mangalpr – Sukinda road 2 – lane with cement concrete.

11. The situation currently assessed in Sukinda valley on Environment and health front is within tolerable limits and the ominous picture painted by OVHA, BRGM, Blacksmith Institute and CSE based on incorrect data and hearsay reports are highly exaggerated.

12. Needed is a multi prong strategy with the Government, Statutory agencies and the Chromite mine owners playing a pro-active role.

13. Considering the strategic position of Sukinda valley, creation of a high - power SUKINDA DEVELOPMENT AUTHORITY to address, oversee and monitor the various concerns expressed is recommended.

- **Vision 2020**

SGAT is entrusted with the assignment of preparing a **Vision Document 2020 for Mineral Development in Orissa** by the Steel & Mines Department, Govt. of Orissa.

Dear Member,

Re: SGAT AWARD OF EXCELLENCE – 2008

Nominations are invited for SGAT Award of Excellence – 2008 in the Proforma enclosed. Persons awarded in the past should not be re-nominated. The proforma (7 sets) completed in all respects and duly signed by the proposer should reach the General Secretary, **Society of Geoscientists and Allied Technologists (SGAT)** at 267, Kharavela Nagar, Bhubaneswar – 751 001 on or before 30th September'2008.

The Award will be in the form of a citation and a cash award.

Any person (member or non member) who has made outstanding contribution in the field of geosciences, mining, metallurgical and mineral process engineering, mineral beneficiation, environmental management in mines or whose work has helped in upgrading the quality of life in mining environment or whose work has led to significant development of mineral resources of a region, state or country shall be eligible for the award. Self nomination is possible.

1. Name of the persons proposed :
2. Date of birth :
3. Designation & address :
4. Educational qualifications :
5. Professional experience :
6. Membership of Professional bodies :
7. List of publications with names of journals :
   Vol. and Issues (if possible, send important reprints)
8. Details of outstanding work
   (Please attach a separate sheet)
9. Any other information

Signature

Place:

Date:

Full name and address of the
Member/Institution proposing

(GENERAL SECRETARY)

Dear Member,

Re: SITA RAM RUNGTA MEMORIAL AWARD - 2008

Nominations are invited for Sita Ram Rungta Memorial Award in the proforma given below. Any person (member or non-member) who would have made significant contribution in Mineral Exploration, Planning and/or Mineral Beneficiation involving utilisation of mine waste/sub-grade ores and minerals will be eligible for the Award. Persons awarded earlier should not be re-nominated. The Award will be in the form of a citation and cash. Self nomination is possible.

Proforma for Nomination

1. Name of the persons (in Block letter) proposed :
2. Date of birth :
3. Designation & address :
4. Educational qualification :
5. Professional experience :
6. Membership of Professional Bodies :
7. List of Publications with names of Journals (Issues/volumes) if Possible, send important reprints :
8. Details of outstanding work (Please attach a separate sheet) :
9. Any other information :

Signature

Place:

Date:

Full name and address of the Member/Institution proposing

Note:

The work should be original, innovative and of applied nature in the areas of Mineral Exploration, Planning and/or Mineral Beneficiation involving utilisation of mine waste/sub-grade ores and minerals leading to its productive adoption in the field level.

The nomination (in 7 sets) in the prescribed proforma should reach the General Secretary, **Society of Geoscientists and Allied Technologists (SGAT)** at 267, Kharavela Nagar, Bhubaneswar – 751 001 on or before 30th September 2008.

(GENERAL SECRETARY)

Submission of Papers For SGAT Bulletin

(Guidelines to Prospective Authors)

Research papers, review articles, short communications, announcements and letters to editors are invited on topics related to geosciences, viz, mineral exploration, mineral characterization and beneficiation, mining, materials science, metallurgy, mineral industry and trade, mineral economics, environment, education, research and development, legislation and infrastructure related to mining, mineral policy and mineral development planning.

Submission of manuscript implies that it is original, unpublished and is not being considered for publication elsewhere. Two copies, complete in all respects (with copies of figures and tables), are required to be submitted. Originals tracings of figures and tables should be enclosed separately. Each manuscript must be accompanied by a computer diskette (floppy) containing the electronic version of the text. Electronic files of figures, if available, should be submitted in a separate diskette. In each case, the details of software and type of equipment used should be clearly indicated.

Journal Format: A-4 size

Language: English

Manuscripts

Manuscripts should be typed in double spacing with wide margins on one either by electronic typewriter or computer (size 12 point Times New Roman font). The title page should include the title of the paper, name(s) of author(s) and affiliation(s). The title should be as brief as possible. An informative abstract of not more than 500 words to be included in the beginning. Not more than 5 key words are to be listed at the end of the abstract. Text of research papers and review articles should not exceed 4000 words. The short communication is for quick publication and should not exceed 1200 words.

Headings

Different headings should be in the following format.

(a) Title: Centrally aligned, bold, capital
(b) Author(s): Centrally aligned, short name, bold, first letter of all words capital followed by communication address (Not Bold)
(c) Abstract: Left aligned, bold
(d) Key words: Left aligned, bold
(e) Primary heading: Left aligned, bold, capital
(f) Secondary heading: Left aligned, first letter of each word capital
(g) Tertiary heading: Left aligned, first letter of first word capital
(h) Acknowledgements: Left aligned, bold, first letter capital
(i) References: Left aligned, bold, first letter capital
(j) Figure Caption: Left aligned, first letter of first word capital, below the figure
(k) Table Caption: Left aligned, first letter of first word capital, at the top of the table

Illustrations

All illustrations should be numbered consecutively and referred to in the text. They should confirm to A-4 size and carry short captions. Lettering inside figure should be large enough to accommodate upto 50% reduction. One set of hard copy of all figures (either tracing in ink or laser prints) should be provided in a separate envelope marked "Original Figures". Photographs should be of good quality with excellent contrast, printed on glossy paper. Colour photos are acceptable, provided the author(s) bear the cost of reproduction. Figure captions should be provided on separate sheet.

Tables

Each table must be provided with a brief caption and must be numbered in order in which they appear in the text. Table should be organised within A-4 size and should be neatly typeset for direct reproduction. Tables will not be typeset by the printer, so their clarity and appearance in print should be taken into account while the author(s) prepare(s) them. Use of 10 points Time New Roman/Arial Font for table is recommended.

References

(a) References in the text should be with the name of the author(s) followed by the year of publication in parenthesis, i.e. Patnaik (1996); Patnaik & Mishra (2002); Nayak et al. (2001)

(b) Reference list at the end of the manuscript should be in alphabetical order, in the following format: Sehgal, R.K. and Nanda, A.C.(2002) Paleoenvironment and paleoecology of the lower and middle Siwalik sub-groups of a part of North-western Himalayas. Jr. Geol. Soc. Ind, vol. 59, pp. 517-529

(c) Articles from the books should follow the format given below:Windley, B.F. and Razakamanana, T. (1996) The Madagascar– India connection in a Gondwana framework. In:Santosh, M. and Yoshida, M. Eds.) The Archaean and Proterozoic terrains of South India within East Gondwana. Gond. Res. Group Mem. No.3, Field Sci. Publ., OSAKA, pp. 25-37

(d) Books should be referred to as:Sengupta, S.M. (1994) Introduction to Sedimentology. Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi, 314 pp.

Submission of manuscript

Manuscripts strictly confirming to the above format should be mailed directly to Editor in his mailing address available in the bulletin. Manuscripts not conforming to the format of the journal will be returned.

All the manuscripts conforming to the standard format of the bulletin will be reviewed by specialist referees before publication.

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AN APPEAL

GOVT. OF ORISSA HAS ALREADY ALLOTTED A LAND MEASURING 90'X45' AT BHUBANESWAR TO SGAT (VIDE LETTER NO. AL (INST) 2/98 83/CA, BBSR DATED 04.01.2006). IN A VIEW TO FACILITATE THE DAY TODAY ACTIVITIES, SGAT IS PLANNING TO CONSTRUCT THE OFFICE AND AUDITORIUM COVERING MORE THAN 4500 SQ. FT. PLINTH AREA WITH ALL THE FIXTURES FOR THE OFFICE AND THE AUDITORIUM. ACCORDINGLY SGAT HAS OBTAINED APPROVAL OF THE BUILDING PLAN FROM BHUBANESWAR DEVELOPMENT AUTHORITY (VIDE LETTER NO. 881/BP DATED 04.02.2008). THE CONSTRUCTION OF THE BUILDING WITH ALL FIXTURES SHALL COST NOT LESS THAN RS. 70.00 LAKHS.

SGAT REQUESTS YOUR GOODSELF TO CONTRIBUTE GENEROUSLY TO THE BUILDING FUND OF THE SGAT THROUGH CHEQUE/DEMAND DRAFT IN FAVOUR OF **SOCIETY OF GEOSCIENTISTS AND ALLIED TECHNOLOGISTS,** PAYABLE AT BHUBANESWAR. THE CONTRIBUTION MAY BE SENT TO THE GENERAL SECRETARY, SOCIETY OF GEOSCIENTISTS AND ALLIED TECHNOLOGISTS, 267, KHARAVELA NAGAR, BHUBANESWAR - 751 001, ORISSA, INDIA. THIS DONATION IS COVERED UNDER RULE 80-G TO GET INCOME TAX REBATE.

YOUR GENEROUS CONTRIBUTION FOR THIS SCIENTIFIC INSTITUTION SHALL BE HIGHLY APPRECIATED.

THANKING YOU.

YOURS SINCERELY

M.V. RAO
(GENERAL SECRETARY)