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GRUHA PRAVESH PUJA OF SGAT BUILDING ON 11.09.2010

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CONTENTS

PRESIDENT'S COLUMN

Mining and mineral based industries are facing to-day serious challenges arising from various fronts. As ecological concern overrides the economic development, due to shrinking of land, forest, water and even limited mineral resources, there are oppositions to new developments of this sector. Further, due to recently reported scams and allegation of irregularities in mines, several investigations are in process which has defamed the mining community. Numbers of applications for new mineral concessions and renewal cases pending over the years, followed by litigations and hurdles in environment and forest clearances are the reasons of frustrations. In addition to this, there have been also adverse and biased publicities which has tarnished the image of mineral sector restricting its future growth. Time has come to face the challenges if we desire for economic growth by development of mineral sector.

Recently there have been wide spread coverage against bauxite mining stating that it would damage the eco-system by loss of land, forest, water etc. besides societal and environmental impacts. It also threatened that due to bauxite mining the rivers would dry up converting the area to desert. The objective was to stop all development prospects of aluminium sector in the country. The bright example of the only existing bauxite mine and alumina plant in the area was forgotten, which would have proved that all their allegations are not based on realities and scientifically proven facts. Our Society organised a Press Meet which was attended by representatives of national and regional press and electronic media. After participating in discussions, they realized the truth and covered the meet stating the real fact. A silence has there after prevailed. Time has come when professionals and intelligentsia have to come forward to upravel the truth to public notice. Simultaneously the mining and allied industries have to play a proactive role to improve their own environment.

In the mean time SGAT has organized a two days International Seminar on "Development of Chromite, Nickel and PGM Resources" which is very much essential from strategic and national interest. The recommendations of the Seminar has been sent to the authorities of both industry and Government for taking appropriate action. While our efforts will continue, we need adequate support from both the industries and the concerned authorities to promote Sustainable Development which would take care of both economical and ecological concerns.

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

FROM THE DESK OF EDITOR

Dear Members,

Encountering the preliminary struggle for sustenance, SGAT has marched ahead in achieving glorious accolade and commendation as a non-profit making scientific society in ushering the promotion of mineral development for a rich mineral resource state 'ODISHA'. Due to selfless service rendered by members, SGAT has gained paramount confidence both with State Regulatory Authority and also with the mineral industries. With the patronage of Steel & Mines Department, Govt. of Odisha, SGAT has prepared and submitted the 'Vision Document on Mineral Development – 2010 for Odisha' suggesting various redressal measures to develop the mineral industries in the State. Government of Odisha through Steel & Mines Department has also entrusted SGAT to draft 'State Mineral Policy' which is under active progress. SGAT has also published a book 'Geology & Mineral Resources of Orissa' – an encyclopedia on mineral resources of Odisha.

SGAT is regularly organizing Seminars, Symposias and Workshops on different prolific issues on Mineral Development and rendered useful suggestions to effect the exponential growth of the industries.

Since last 11 years, SGAT is publishing a biannual Bulletin and the most deploring fact is that members are not taking ample interest in contributing suitable articles to enhance the quality of the Bulletin. Are the scientific and intellectual members of SGAT scared of communication or afraid to express their views? Please be informed that your timely scientific contribution shall definitely make this "Bulletin" more valuable and informative.

JAGO MEMBERS JAGO.

Your sincere co-operations and contributions shall make SGAT more active and can acclaim more laurels in the Mining World.

LET THIS NEW YEAR BE THE MOST HAPPENING YEAR FOR SGAT.

Wish you all a PROSPEROUS & PURPOSEFUL NEW YEAR.

Dr. S.K. Sarangi
Editor
SGAT Bulletin

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CARBON BUDGETING FOR ORISSA WITH REFERENCE TO CARBON SINK POTENTIAL OF FORESTS AND INDUSTRIAL GREEN HOUSE GAS EMISSIONS

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ABSTRACT

Carbon sequestration is now a thrust area of research and understanding for countering climate change.. This paper estimates the green house gas emission potential of thermal power plants, and some important mineral based industries and the carbon sink potential of forest vegetation in Orissa.

Out of 30 districts, in the state, only 12 districts of Orissa have forests cover exceeding the National target of 33% forest cover for each district. Another 4 districts have forest cover exceeding 23.8% and less than 33% and 13 districts have forest cover less than 20%.Some districts such as Bhadrak, Jagatsinghpur, and Puri have forest cover of less than 5% and districts such as Baleswar,Kendrapara and Jajpur have forest cover less than 10% of the geographical area of the district. These are important districts from industrial development point of view.

The districts of Angul, Denkanal, Jharsuguda, Sundergarh and Sambalpur are under severe stress from industrial emissions.More than 61% of thermal power of the state is generated by plants located in Angul and Denkanal districts and many are in the pipeline. In view of this proper siting of industries and expansion and conservation of forest cover should get top priority in the state government development policy and should be reviewed frequently. It is right time to debate whether carbon dioxide should be declared as a pollutant or be included in the generic structure of Environmental Assessment document (EIA) in our country ?

Key Words: Green House Gas, , Industrial Emissions, ,Carbon sequestration, Soil carbon pool, Carbon sink.

INTRODUCTION

Climate flip-flop is now very common. Looking at the occurrence of rain, flood, and drought and weather disturbances and irregularity of monsoon occurrence in Orissa, the acceptance of the effect climate change appears to be confirmed. During the last few hundred years of human activities, particularly, industrialization, urbanization and ecosystem fragmentation have caused serious damage to the planet culminating in climate flip-flop that every nation is now concerned.

Three basic variations in Earth's movement affect global climate (Milankovitch, 1930). These variations are: **i)** Variations in earth's orbit around the sun follow one lakh year cycle ;ii) the tilt of earth's axis takes 41000 years to complete a cycle; iii) a 23000 year cycle is created by a top-like wobble of the earth's axis. These cycles together affect the planet's climate.

The Cycle of day & night is due to Earth's movements. The day length and seasons are due to its tilt and position. Axis of rotation tilts at 23.44 degrees from the vertical. Hence during the northern summer (southern winter), the North hemisphere is tilted towards Sun and the Southern hemisphere away from the sun. This accounts for temperature difference in summer & winter. In Northern winter (southern summer) the position is reversed.

In summer solar day is longer. The Earth rotates on its axis once every 24 hours as it orbits the sun. Days and nights are unequal except spring and autumn equinoxes because of the tilt.

Bhaskaracharya in 5th century calculated rightly for the first time in the world that the earth takes 365.25875684 days to orbit the sun .Around March 21(vernal equinox)and around September 22(autumn equinox) Earths' axis passes through upright position and none of the hemisphere is inclined towards sun. On these days day and night are of equal duration.Solastices are the longest and shortest days in the year, June 21-summer solstice (longest day), December 21-winter solstice(shortest day) in northern hemisphere and the opposite in southern hemisphere. These earth processes are happening but earth's atmospheric temperature is rising causing global warming. Scientific evidences indicate that the anthropogenic activities are aiding to the global warming. The following gases are called green-house-gases(GHG), produced largely by human activities (UNEP, 2007, CSE, 2009).

1. Carbon dioxide (CO2): Source (i) Automobiles, (ii) Industrials, (iii) Anthropogenic: Increased from 280 ppm to about 400ppm; Absorbs heat at three bands (nm):2.3 to 3.1, 4.1-4.5, 13-18μ. Residence time (RT): > 30 years to centuries, Global Warming Potential(GWP)=1.

2. Methane (CH4): Source (i) Organic Matter decay under anaerobic conditions, (ii) Agriculture fields. Increased from1 ppm to > 2 ppm. Absorbs heat at two bands (nm): 3.2 & 7.6μ. Residence time-14 years, GWP=25.

3. Nitrous Oxides (NOx): Source (i) Automobiles, (ii) Industries: Increasing. Absorbs heat at band (nm,): 7.66μ. Residence time: 114 Yrs, GWP-298.

4. Hydroflurocarbons (HFCs)/ Perflurocarbons (PFCs)/ Sulphur hexafluoride (SF6): Source (i) Refrigerants, (ii) Foam, (iii) Fire extinguishers, (iv) Aerosol products (v) Some mineral based industries- Increasing. Absorbs heat at bands (nm): 7-12μ . Residence time: 1.4 to 270 years, PFC-10,000-50,000 Yrs, GWP=124-14,800-22800.

5. Water Vapor: Source (i) Evaporation, (ii) Transpiration: Evaporation increasing. Absorbs heat at bands (nm,):1 to 8μ, Residence time ~ 9 days.

Taking the late 17th century as base year, scientists tell us that the carbon dioxide level was around 280ppm During the last 100 years or so, it has increased to 383ppm (1870 to 1986-240ppm to 340ppm, 1986-2005:340 to 383ppm and now at about 400 ppm) and at this rate (2 ppm per year) of increase, the CO2 level will reach about 550ppm by 2050 and 700-1200 ppm by 2100 AD. Besides, the concentration of other green house gases like methane, chlorofluorocarbons, perflurocarbons, oxides of nitrogen and some other gases, whose resident time in the atmosphere is very long has increased.

Climate change may be due to many factors, i.e. natural internal processes in the planet, external factors, but persistent anthropogenic activities from industrialization, use of fossil fuel as main energy source, transport (an estimate shows that 650 million automobiles run in the world), land use etc bring changes in the atmospheric composition.

This paper estimates the green house gas emission potential of Industries of Orissa, a fast growing state for coal based power plants, iron and steel, aluminium and cement plants and the carbon sequestration potential of forests and related issues. The estimation is based on the published data on industrial production, forest cover, and CO2 absorption capacity of forests in India

(Dash, 2010). The carbon sequestration potential of forests has been collected from the publications of MOEF, New Delhi (FSI, 2009). A reference has been made to the situation in Orissa as industrialization has been taken as a thrust area of development currently in the state due to rich mineral deposits. (The State of Environment: Orissa, Dash(Ed), 2006, Dash, 2010, Paribesh Samachar, 2010).

INDUSTRIAL GHG EMISSIONS

Industrialization has grown manifold in India after 1947.An estimate of GHG emissions and the basis of estimations are given in Table 1.

India annually burns > 300 million tonnes of coal in power plants and generates equal amounts of CO2 from this source.

Table 1.The basis of estimations of GHG emissions from energy sector and important industrial sectors in the country with the capacity of production

Energy sector: Thermal Power:

1MWH generation requires about 17 tons of Indian Coal, which contains 32% C. 1MWH power generates about 0.79tCO2 .Hence 1000MWH, generates about 6.92 million tons CO2 per year. India generates ~1.00,000 MW thermal power annually and emits about 692 million tonnes of carbon dioxide.

Industrial Process sector:

Iron & steel production: 1 tonne production of steel generates about 3-3.5 tons of CO2 (for sponge iron- about 2.5 ton) from coal & coke. India produced ~ 44 million tonnes of iron & steel in 2006 with about 10% annual growth. The estimate of current production is about 65 million tonnes of iron and steel per year. (65 x 3.5=227.5 million tonnes of CO2). Future projection is > 100 million tonnes by 2020.

FERRO-CHROME: 1 tonne production generates about 2.1 tonne of CO2. The current Ferro-Chrome demand is estimated as 8 million tonnes (8 x 2.1 = 16.8 million tones of CO2 generation). (Taking the values of 84%C and 50% C in metallurgical useable grade coke and coal respectively).

Alumina & Aluminium:

1 tonne alumina production using about 4 tons bauxite ore and 1 tonne aluminium production using about 2 tons of alumina generate about 21.66 ton CO2. India has the capacity of ~ 4 million tonne aluminum production per year. (CO2 emission amounts to 86.64 million tonnes).

Cement:

1 ton production generates about 0.9 ton CO2. In 2003, India produced about 117 million tonnes of cement. At present, India has ~ 200 million tonne annual production capacity. (180 million tonnes of CO2 emission).

India has huge reserves of thermal grade coal and therefore states such as Orissa with abundant coal reserves attract investors to set up thermal power plants if fresh water is available. Coal, therefore occupies important position in power sector. As two major rivers such as Mahanadi and Brahmani flow in Orissa, and the coal mining areas of Angul-Talcher and Ib valley are situated respectively near the rivers Brahmani and Mahanadi, many thermal power plants have been established and are in the pipeline in these areas and likely to be set up there. There is huge pressure on the rivers for fresh water.

There is increased need of energy in the farm, industrial and service sectors as the population continues to grow and to meet the developmental needs. Modern way and standard of living demand huge energy from unsustainable consumerism, transport facilities and increased construction work and other aspects of human use.

Energy is the key for survival, continuance and for sustainable development.

In 1947 India had electricity generating capacity of only 1470 MW with about 49% load factor .At present India has the capacity to generate >1,53,694.09 MW (105 times growth) with about 80% load factor. In spite of this increase, India is not able to meet the demand of energy from the farm, industry and service sectors.. Hence the situation has become critical. In the 10th and 11th plans, additional 27,283 MW & 78,700 MW could be achieved. It has been estimated that by 2016, the energy production capacity will reach 2, 15,804 MW. However, per capita energy consumption in India is only about 500 units per year compared to about 2600 units at international level in industrially developed countries.

India's Energy Source

About 70% of our energy source (1, 53,694.09 MW) is fossil fuels and 53 % is coal based.

Coal based thermal power plants are not environment friendly as these plants generate huge amount of GHG and pollutants such as SO2,NOx,Cox,,SPM, Fly & bottom ash, metallic dust,etc . About 120-150 million tons of fly ash is generated annually in India (Jain, 2010). The utilization is only 25%-30% in brick making, road construction, forest soil fertilization, and in agriculture etc (Jain, 2010). Hence it is a huge problem. One estimate (Paribesh Samachar, 2010) shows that the pollution load from 1 MW Indian coal based thermal power generation amounts to:

- ~19 tons of CO2 per day .MW
- >136 kg of SO2 per day.MW
- >7 tons of fly ash per day.MW

GHG Emissions from Orissa

Table 2 and 3 give estimation of GHG emissions from major industries in Orissa.

Three categories of thermal power plants (TPPs), depending upon the type of fuel used operate in the state, i.e. category-I, fuel is only coal either pulverized or sized. The capacity of power generation is 7331MW (Table 2), category-II, fuel may be low grade coal, washery rejects, and char. These TPPs use Atmospheric Fluidized Bed Combustion(AFBC) or Circulating Fluidized Bed Combustion (CFBC) boilers and these plants are usually small (usual capacity < 50MW), category-III,TPPs which use waste heat of some other processes to generate steam and the plants are usually of low capacity.

Table 2.Thermal Power Plants and their generation capacity in MW in Orissa

District/Area Name	Capacity	Category
Angul-Denkanal	4,666 MW	I & II
Jharsuguda- Sambalpur	1899.5MW	I & II
Sundergarh- Rourkela	242MW	I & II
Jajpur	250 MW	I
Cuttack-Jagatsinghpur	329MW	I & II
Kalahandi	75 MW	I
Koraput	55.5MW	I
Balasore	07.5MW	II
Keonjhar	33MW	II
Total Thermal Power	7607.5 MW	I & II
Category III Power generated from waste heat is not Included in this paper	378.625 MW	

Proposed thermal power plants: (State Pollution Control Board (SPCB) has cleared them):

Angul Area	8090MW
Jharsuguda Area	5454.5MW
Other Areas	4618.5MW
Total	18163 MW
Projects Pending with SPCB for clearance	7698MW
Grand Total	**33,468.5MW (Coal based)**

Angul-Denkanal area currently account for 61.33% of total thermal power generation. This area will generate >70% of thermal power if all projects are allowed to run.

Table 3.The estimate of currently GHG emissions from thermal power plants and from other industrial sources in Orissa.

Industry	Capacity of Production (MW/Million Tonnes)	Amount of GHG Emission (Million tonnes)
Thermal Power	7607.5MW	53
Iron and Steel & Sponge Iron	~ 17	59
Ferro-Alloys	~ 1	2.1
Aluminium (from mining to product)	2	44
Cement	7	6.3
Total		**164.4**

From these five industrial sources, Orissa emits >164 million tonnes of Green House Gas (GHG), which is not a pollutant as per the provisions of Air (Prevention and Control) Act, 1981. Currently the estimate of India's emissions amount to > 2115 million tonnes. Thus Orissa's emissions account for about 7.8 % of India's emissions. The emissions from other industries, transport, agriculture and households etc have not been taken into the calculation. Therefore, the GHG emission is huge.

THE GHG SINK POTENTIAL

Forest and tree cover of the country was 78.37 million ha in 2007(FSI, 2009), which was 23.84% of the geographical area and this includes 2.82% tree cover. Table 4 gives the forest and tree cover of the country in 2007(FSI, 2009).

Table 4. Forest and tree cover of the country in 2007

Class	Area (million ha)	% of Geographical Area (G.A.)	
Forest Cover			
VDF (very dense)	8.35	2.54	Note: 55.51 million ha lies <1000m, 11.67 m.ha. <1000 to 3000m and 1.91 m.ha <3000m altitude.
MDF (medium dense)	31.90	9.71	
OF (open)	28.84	8.77	
Total Forest Cover	69.09	21.02	
Tree Cover (Tree patches<1ha With canopy density >10%)	09.28	02.82	
Total Forest & Tree Cover	78.37	23.84	
Non-forest: Scrub	04.15	01.26	
Non-forest	255.49	77.72	
Total G.A.	328.73	100	

GHG Estimate as per FSI Report

It has been estimated that the CO2 removal by India's forests and tree cover was enough to neutralize 9.31%-9.50% of India's total emissions (CO2 equivalent) at 2000 level. In 2000 India's level of emissions was estimated as ~ 1454-1485, million tonnes (Sharma et al, 2006, Shukla, 2006)). 9.31% of 1485 amounts to ~138.25 million tonnes. Thus it appears 78.37 million ha of forests of all categories absorb 138.25 million tonnes of GHG per year amounting on the average to 1 ha of forest and tree cover neutralizing 1.764 tonnes of GHG per year (FSI Report,2009, Kishwan et al., 2009,Melkenia,2009) . This is a gross estimate and the site specific estimates would be different.

This average value appears to be an underestimate as it does not differentiate the rate of primary productivity on an altitudinal gradient, type of forests, the succession stage of the forest and the ground vegetation. However, this shows the importance of forests and tree cover and the urgent need to increase forest and tree cover in India. The grasslands, scrub lands, crops also neutralize GHGs and this has not been estimated separately. The other GHG sinks are soil, water bodies and planktons in the water bodies including Bays and Oceans.

Kishwan et al (2009) have also estimated component-wise carbon in India's forest biomass and in soil in 1995 and 2005. The total estimate for 2005 was 3755.811 million tonnes of carbon in soil amounting to 55.4723 tonnes per ha. The total estimate amount of carbon in forest biomass was 2865.739 million tonnes amounting to 0.3310 tonne of carbon per ton of biomass and 42.32 tonnes of carbon per ha of biomass.

Over the last two decades, the national forestry legislation and policies have transformed India's forests into a significant net sink of GHG. The carbon stocks stored in country's forests and tree cover and soil have been estimated as 6,621.55 million tonnes in 2005 with an annual increase of 38 million tonnes (equivalent to 138.15 million tones of CO2) since 1995(carbon stock was 6,245 million tones).

The soil organic carbon pool (SOC) in Orissa amounts to about 5.96% of India's SOC pool .The tropical dry deciduous and moist deciduous and littoral and swamp forests of Bhittarkanika contribute significantly to India's SOC pool(Table 5). This situation can be improved if efforts for forest conservation will be effective.

Table 5. Soil Organic Carbon pool Estimates (0-30cm) in India's Forests (million tonnes in 2005), Estimates for Orissa in parenthesis (Based on Kishwan et al, 2009)

Forest Type	Area in '000ha in 2005	Mean Soil Organic Carbon(SOC)	Total SOC in 2005
Littoral and swamp forest	481 (234.5)	71.062 (71.062)	34181.021 (16664.039) (48.75%)
Tropical dry deciduous	19156 (2833.59)	34.195 (34.195)	655037.332 (96894.61) (14.79%)
Tropical moist deciduous	24284 (1954.2)	55.009 (55.009)	1335848.398 (107498.59) (08.04%)
Tropical semi-evergreen	2946 (33.221)	54.625 (54.625)	160925.000 (1814.70) (1.12%)
Plantation/Tropical open	- (53.252)	20.375 (Tropical thorn forest) (20.375)	- (185.009)
Total	India-67706 ha including other types (2005),78370 ha(2007),Orissa-(4883.8ha -2005, 4885.5 ha)(2007)		3755811.310 (223056.95) (05.94%)

Estimation of Carbon fixation by Net Primary Productivity Method

In field condition in 40-50 year old forest of tropical-subtropical and temperate regions, the annual growth on dry weight basis (NPP) would be about 13-30 tonnes/year/ha in mid latitudes and below 2000m altitude (Lieth, 1972, 1977, Singh & Joshi, 1979, Swain and Behera,1998,Karmachari and Singh,1992,Dash and Dash,2009) and considering 40 % of the NPP as carbon(C) (Kishwan et al,2009),the value comes to 5.2 to 12 tonnes of NPP-C per ha.. This in terms of CO2 sequestration (3.68 tonne of carbon dioxide=1 tonne of carbon), amounts to about 19- 44 tonnes of CO2, which might have been used. This estimation is significantly higher than the estimation made in FSI report. One hectare forest may possess about 1000 trees of about 40-50 year old.1000 trees hold 19-44 tonnes of C02 in NPP (average 19-44/1300= 0.019 -0.044 tonne =19-44 kg C02 per tree per year).

Table 6 gives data on forests cover and estimation of GHG neutralization potential of forest cover in different districts of Orissa.

Table 6 District wise forest cover (DFC) in Orissa in 2007 and Green House Gas (GHG) mitigation potential. (Area in km2, (1 km2=100ha), GA-Geographic Area (KM2.)

District	GA	DF Cover (% of GA)	GHG Absorption Potential FSI	NPP
Angul	6375	2669 (41.47)	0.471	5.07-11.70
Baleswar	3806	301(7.91 %)	0.053	0.57- 11.7
Baragarh	5837	897 (15.37)	0.158	1.7-3.95
Bhadrak	2505	24 (0.96)	0.0042	0.046- 0.105
Balangir	6575	934 (14.21)	0.165	1.77-4.11
Boudh	3,098	1255 (40.51)	0.221	2.38-5.52
Cuttack	3,932	659 (16.76)	0.116	1.25-2.90
Deogarh	2,940	1341(45.61)	0.236	2.54-5.90
Denkanal	4,452	1344 (30.19)	0.237	2.55-5.91
Gajapati	4,325	2485 (57.46)	0.436	4.7-10.93
Ganjam	8,206	1965 (23.95)	0.347	3.73-8.64
Jagatsinghpur	1,668	22 (01.32)	0.0039	0.042-0.097
Jajpur	2,899	255 (08.80)	0.045	0.484-1.121
Jharsuguda	2,081	300 (14.42)	0.0529	0.57-1.32
Kalahandi	7,920,	2,306(29.12)	0.41	4.38-10-14
Kendrapara	2,644,	194 (07.34)	0.0342	0.369-0.853
Keonjhar	8,303	3,229(38.89)	0.569	6.135-14.20
Kandhamal	8,021	5,484 (68.37)	0.967	10.42-24.12
Khurdha	2,813	375 (13.33)	0.066	0.712-1.65
Koraput	8,807	1,678(19.05)	0.296	3.19-7.38
Malkangiri	5,791	2,195(37.90)	0.387	4.17-9.65
Mayurbhanj	10,418	3,990(38.30)	0.703	7.58-17.55
Nawapara	3,852	1237(32.1)	0.218	2.35-5.44
Nawrangapur	5,291	1135(21.41)	0.200	2.16-4.98
Nayagarh	3,890	1,166(42.83)	0.294	3.165-7.33
Puri	3,479	95 (02.73)	0.0167	0.180-0.418
Rayagada	7,073	3,126(44.20)	0.551	5.939-13.75
Sambalpur	6,657	3,307(49.68)	0.583	6.283-14.54
Sonepur	2,337	324(13.86)	0.0583	0.61-1.42
Sundargarh	9,712	4,063(41.83)	0.716	7.72-17.9
FSI-Forest Survey India, NPP-Net Primary Productivity method				
Total	**1,55,7077,**	**48,855(31.38)**	**8.62 (Mean=153.85 mill tons.)**	**92.82-214.89**

30 districts: 12 districts with > 33% Forest Cover,
05 districts with >20% & < 33% FC,
13 districts with < 20% FC (6 districts < 10%FC

Orissa has 155,707 km2 geographical areas which constitutes 4.74% area of the country. The recorded forest area of the state is 58,136km2 (37%) of the geographic area) but the forest cover in the state based on October-December, 2006 satellite data interpretation is 48,855 km2 (48, 855, 00ha, (31.38% of the geographic area).

In terms of forest canopy density classes, Orissa has 7,073 km2 very dense forest, 21,394 km2 moderately dense forest, and 20,388 km2 open forest (FSI, 2009).

Out of 30 districts, only 12 districts of Orissa have forests cover exceeding the National target of 33% forest cover for each district. Another 4 districts have forest cover exceeding 23.8% but less than 33% and 13 districts have forest cover less than 20%. Some districts such as Bhadrak, Jagatsinghpur, and Puri have forest cover of less than 5% and districts such as Baleswar, Kendrapara and Jajpur have forest cover less than 10% of the geographical area of the district. These are important districts from industrial development point of view. The GHG sink potential is negligible in these districts.

The industries have been concentrated in districts such as Angul, Sundargarh, Jharsuguda, Denkanal, Balasore, and Jagatsinghpur, Jajpur, and Sambalpur.

The GHG sink potential of Jagatsinghpur, Jajpur, Jharsuguda, Baleswar, Bhadrak, Cuttack, Puri, Kendrapara and Balangiri need urgent attention.

Further concentration of thermal power plants in Angul, Denkanal, Jharsuguda are to be avoided.

FUTURE PROSPECTS

Marine Algae grown in seacoast ponds enriched with thermal power plant flue gas (N2,CO2,SO2,water vapor and other pollutants) may produce NPP of 20 g per m2 per day, which amounts to 7.3 tonnes NPP per year per ha(amounts to ~ 438 ton CO2 per ha per year).

The cost of producing one kg algae is estimated to be $0.34 ($340 per ton, $ 2482 for 7.3 tons of algae per ha) and the algae can be sold for $0.4 a Kg ($400 per ton, $2920 for 7.3 tons grown in 1 ha) or can be used to trade for carbon- algae on a 3000 m2 surface can earn $1.08 a day in carbon trade.($3.60/ha/day or $ 1314 /year/ha).

(NTPC collaborating with Naom Menczel-director of business Development For Seambiotic Inc. at Visakhapatnam-proposal stage). (Times of India news, 2010).

These efforts will help to neutralize GHG emissions to some extent. Fresh water algae and soil algae can sequester GHG at a higher rate than the land plants and less than the marine algae. Research in this discipline will be profitable for the country. However, India has >80 mega thermal power plants and most of them are situated at a distance from the coast.

Regulatory Mechanism

Carbon dioxide, a green house gas is not considered as a pollutant in India and in most of the countries. It should be considered as a pollutant if the emission concentration is very high than its natural range of occurrence in the atmosphere.

Environmental Protection Agency (EPA) in USA has declared carbon dioxide as a pollutant and has brought it under environmental regulatory provisions (Raha and Mishra 2009). They also have cited a legal case, which has been filed at the New South Wales, Australia Land and Environment Court at curbing carbon dioxide pollution from coal fired thermal power plants. If the court declares CO2 as a pollutant, the case will have a very positive step to control climate change.

In India, thermal power from coal based plants is the most important energy source.

More than 80 mega thermal power plants operate in India and it is right time to debate whether carbon dioxide should be considered as a pollutant in India.

India's voluntary Policy Shift

Considering about 8% GDP growth rate per annum in 2002-2007, the estimate of GHG from all sources in 2000 in India was about 1485 million tons. An assessment of the current and projected trends indicate that green house gas emissions grew @ 4% annum during 1990 & 2000 and projected to grow further due to developmental needs. The absolute level will not be less than 5% of global emissions in 2020. (Sharma et al, 2006).The estimate is>3000million tons of GHG emission in India by 2020. India has announced 25% cut in emission level by 2020 taking 2005 as the base year before the Copenhagen meet. It means that the dependence on energy from coal to renewable will receive priority. (Dash, 2010)

Prime Minister's council on climate change has approved eight missions under India's National Action Plan on Climate Change. The policy frame work emphasizes, (i) Achieving energy efficiency; 'Perform, Achieve and Trade' (PAT) mechanism (ii) Promoting Renewable energy; (iii) Promoting sustainable development especially through clean technology development & transfer, (iv) Promoting afforestation, & enhanced forestation(from 23.8% to 33% of land cover) to increase sink factor (v) Promoting sustainable agriculture

The PM's Office has announced that by 2015, India will save about 5% of annual energy consumption & nearly 100 million tonnes of CO2 emissions per year.

The National Solar Mission has approved enhancement of solar energy generation.These actions indicate India's concern and positive voluntary actions.

Some good progress has been made in India on this matter. CO2 produced in >80 power plants in India can be collected and pumped underground to store for indefinite period. This is known as Carbon Sequester and Storage Technology (CSST) ands is being attempted in advanced countries. For underground storage suitable geological formations such as porous and leak proof rocks are required.(under ground abandoned coal mines may be suitable).A major parts of Indian off-shore region has soft sedimentary rocks which are considered ideal for carbon sequestration and storage(CSS). India annually burns >300 million tonnes of coal in power plants and generates equal amounts of CO2 from this source. If CSS technology materializes, India's off-shore sediments will be a fertile field for future carbon sequestration. In recent years there have been few international conferences on CSS Technology in New Delhi attended by delegates world over to discuss this possibility. Thus India's huge off-shore region not only offers promise of large oil and gas reserves, it has enough space for underground storage of CO2 gas sequestered from thermal power plants (News item in Times of India). Research funding in this field and policy intervention will be required.

CONCLUSION

Deforestation is one of the largest contributors to climate change. Rain forests provide countless services to humanity, often unnoticed.50% of world's biodiversity are found in rainforests. The Amazon forest released 20 billion tonnes of moisture every day, helping to water crops around the world. Healthy rainforests absorb about 10% of man's carbon emissions every year. Deforestation releases more CO2 than all the transport. Saving the rainforests will be an essential first step. Five million hectares of tropical forests are lost every year-larger than the size of England. The situation in India for forest conservation is improving; a very

positive situation (FSI, 2009).However the situation in all states is not the same. Constant effort to conserve forests and to create public awareness is required.

About 50% of best-selling products in supermarkets of Developed countries contain palm oil, linked to rainforest clearance in Southeast Asia. Brazilian farmers make $3000 /ha by clearing forest and growing soybeans for export. Subsistence agriculture in Africa clears forests. Rainforests may disappear in next 50 years-How you shop determines the future of rainforests.>40 million dollars may be needed over the next five years to tackle the problem. (Source: The Prince's Rainforests Project: Rain Forests: The Burning Issue, 1996). The mean estimates of GHG neutralization potential of the forests in Orissa is about 154 million tonnes. Unless effective steps are taken to neutralize the GHG, the situation in future will be dangerous. There is need to implement intensive and extensive plantations, other avenues of GHG emission reduction and neutralization. Planting trees & increasing tree and forest cover is key to increase sink area.

The state's policy of concentrating of thermal power plants in Angul area and Jharsuguda area require immediate review. The carrying capacity studies of these areas in particular and follow up actions are immediately required. However the change over to renewable energy source should be planned for a long term basis in accordance with the national policy

Arresting climate change will require transforming the global economy from a high carbon to low carbon energy base. High carbon base include coal and petroleum. Low carbon base is corn oil, Jatropha oil, Biomass gasification. No carbon base is: Solar, wind, hydroelectricity, hydrogen & Nuclear. For sustainable development and to prevent climate change, switching over to eco-friendly energy source on a large scale is urgently required to address the call of the earth. The alternative energy source should get top priority (solar, wind, biomass-gasification, nuclear etc).

There should be rider on consumerism if we want to leave some resources for the future generations and make the earth habitable for them. Adoption of environmental discipline at individual/ family, state and national level is need of the time.

REFERENCES

A Report of the Intergovernmental Panel of Climate Change, 2007 (4 volumes), UNEP, Switzerland.

Centre for Science and Environment (CSE), New Delhi.2009. Climate Change: Facts and Politics, 125 pages, CSE, New Delhi.

Dash, M.C.2010. A Comparison of industrial green house gas emission (GHG) and carbon sink potential of forest vegetation in Orissa, a fast thermal power growing state in the context of climate change. The Ecoscan,(In Press)

Dash, M.C. 2010. Climate Change: Facts and Politics (In Oriya language), Bigyan Diganta, 6th issue, 3-14, Orissa Science Academy, Bhubaneswar,

Dash, M.C. and Dash, S.P.2009. Fundamentals of Ecology. Tata-McGraw-Hill Publ., New Delhi.

Dash, M.C. 2007. Save the Planet from Global Warming, Society of Geoscientists & Allied Technologist Bulletin, 8(2), 43-59.

Dash, M.C. (Edited).2006. The State of Environment of Orissa, MOEF, New Delhi and SPCB, Bhubaneswar.

Forest Survey of India Report, 2009, Government of India, MoEF, New Delhi.

FAO, 2005.State of the World's Forests, FAO, Rome.

FAO, 2006.Global Forest Resources Assessment 2005: Progress towards sustainable forest management.FAO Forestry Paper 147. FAO, Rome.

Jain, M.K.2010. Suitability of Fly ash as a mine void- fill material-A critical Review, Minenvis, 64, 1-6.

Karmachari, S.B.and Singh, S.K. 1992.Biomass and Net production of Teak (Tectona grandis) in dry tropical region in India. Forest Ecology and Management, 55,233-247

Kishwan, Jagdish, Pandey, R.and Dadhwal, V.K.2009. India's Forest and Tree cover: Contribution as a Carbon Sink, Indian Council of Forestry Research and Education, Dehradun, 1-12.

Leith, H. 1972. The Net Primary Production of the Earth with special emphasis on the Land Areas, In Perspectives on Primary Productivity of the Earth.
ed.R.H.Whittaker, Symposium at the American Institute of Biological Science., Second National Congress, Miami, Florida.

Lieth, H.1972. Modeling the Primary Productivity of the World, Tropical Ecology, and 13,125-130.

Lieth, H.1977.The Gross Primary Productivity Pattern on the Land Vegetation: a first attempt, Tropical Ecology, 18,109-115.

Melkania, N.P. 2009. Carbon Sequestration in Indian Natural and planted forests, Indian Forester, 380-392.
Paribesh Samachar, 2010. Biodiversity-Ecosystems Management and the Green Economy, Volume XV and XVI, 1-25, State Pollution Control Board, Orissa, Bhubaneswar.

Raha, Debashis.and Mishra, P.C.2009.First ever Legal action on carbon dioxide pollution and its future consequences. The Ecoscan 3(3&4): 209-210.

Rain Forests: The Burning Issue.1996 .The Prince's Rainforests Project, Forest Stewardship Council, London, 48 pages.

Singh, J.S. and Joshi, M.C. 1979. Primary Production, In Grassland Ecosystems of the World ed.R.T.Coupland, Cambridge University Press, London, 197-218.

Swain, S. and Behera, N.1998. Biomass and Net production of Tectona grandis (Teak) in a regenerating teak forest. Ecology, Environment and Conservation,4(1 & 2),1-7.

Sharma, S., S.Bhattacharya and a, Garg.2006.Greenhouse gas emissions from India: a perspective, Current Science, 90(3), 326-333.

Shukla, P.R.2006. India's GHG emission scenarios: Aligning development and stabilization paths. Current Science, 90(3), 384-395

The Prince's Rainforests Project. (The Prince of Wales- Prince Charles- Rain Forests: The Burning Issue, 1996).

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GROUNDWATER RESOURCES OF THE COASTAL TRACT OF ORISSA AND PROBLEMS OF MANAGEMENT

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ABSTRACT

The evaluation of the coastal tract of Orissa since the Upper Cretaceous period has been discussed. It was associated with rifting of Gondwanaland, Pleistocene glaciations, transgression and regression of the sea at different geological times. The probable paleocoastlines have been shown. Sediments that constitute the coastal tract were deposited under fluvial, marine, esturine and aeolian conditions and the nature of sediments e.g. their texture, thickness and continuing vary very much in space and time. There is all possible inter layering of sediments of different origin and texture.

The Sediments till presents a multilayered aquifer system rich in water bearing properties. Salinity of aquifers at different levels is the biggest problem of management. A map of the salinity distribution gives an average picture of the coastal ground water quality. The ground water in the coastal tract has not been developed in a big way and there is a big scope for future exploitation. However, hydrogeochemistry of the groundwater would be the biggest constraint for exploration of this valuable resource.

INTRODUCTION

Water is key to life, without water Earth would be a desert. With rising population and modern development less and less water is available, per capita, as we move with time. The world will face a major crisis for water. Hence the need to properly manage the resource with all possible conservation measures is necessary.

Groundwater is a major component of water resource. This is fast depleting before us because of excessive withdrawal for different uses. In hard rock terrain, it is poor reservoir condition and in soft sediments like coastal plains, it is salinity in aquifers which are major constraints for groundwater development.

In Orissa 80% of the area is underlain by hard rocks and 20% is coastal plains. Orissa has problems in managing groundwater both in hard rocks as well as in coastal plains. The present presentation will discuss on the groundwater situation in the coastal terrain and strategy to manage salinity distribution in multilayered rich aquifers.

THE COASTAL TRACT OF ORISSA

Fig.1 shows the coastal tract of Orissa covering around 25000 sq.km area stretching from Subarnarekha river on the north to Bahuda river on the south. It was formed by deposition of sediments under fluvial and marine environments over a great span of time and controlled by global phenomena of tectonic and climate changes (eustatic movement, glaciation, sea level rise and fall, transgression and regression).

THE FOUNDATION OF THE COASTAL ALLUVIUM

The thick alluvial fill of the coastal tract sits over different basement rocks e.g., Iron Ore Group of rocks in north Orissa, Gondwana rocks in Central Orissa and Easternghat Group rocks in south Orissa, (Fig.2 & Fig.3.).

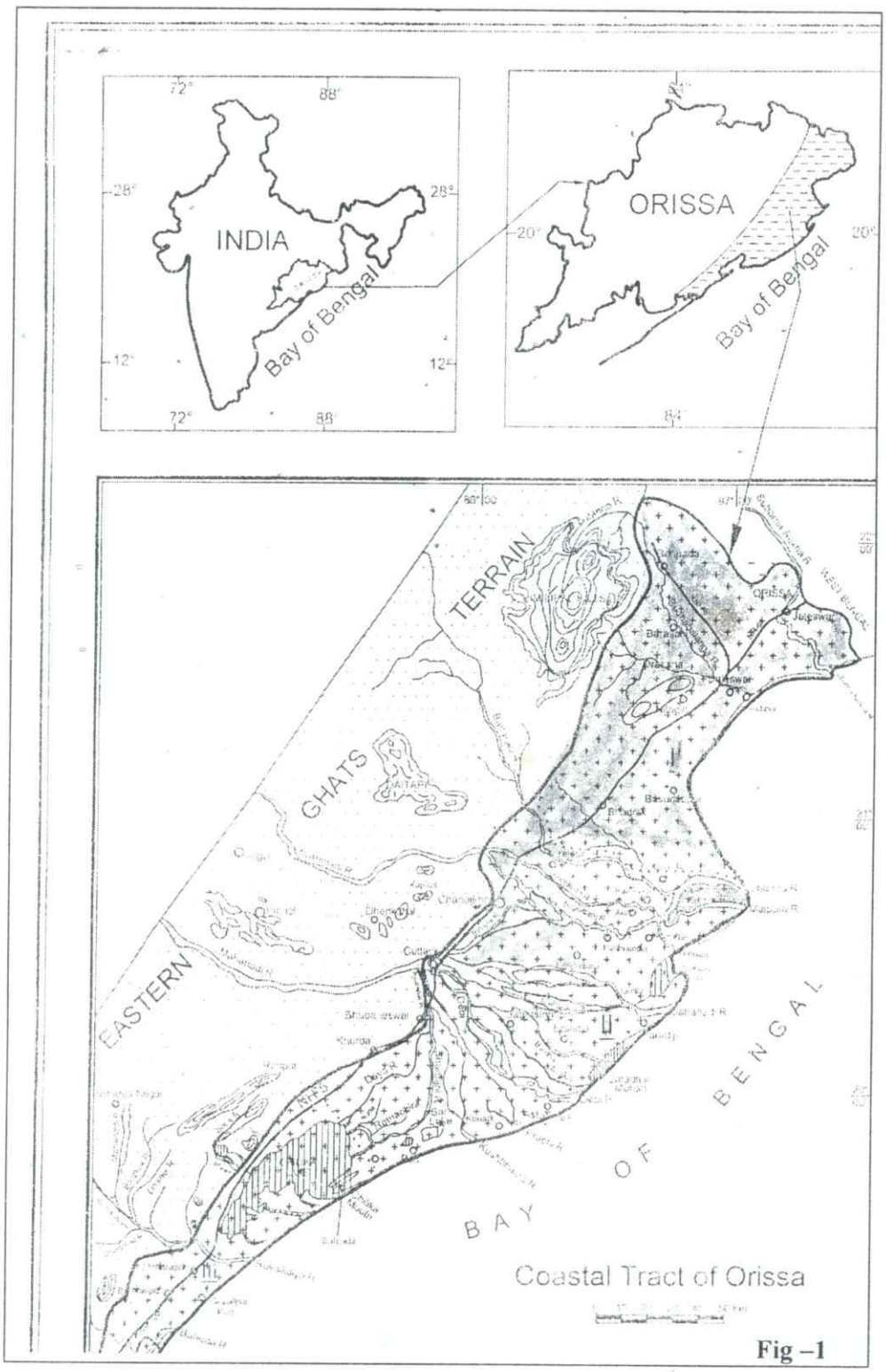
INDIA
Bay of Bengal
ORISSA
Bay of Bengal
TERRAIN
GHATS
EASTERN
BAY OF BENGAL
Coastal Tract of Orissa

Fig –1

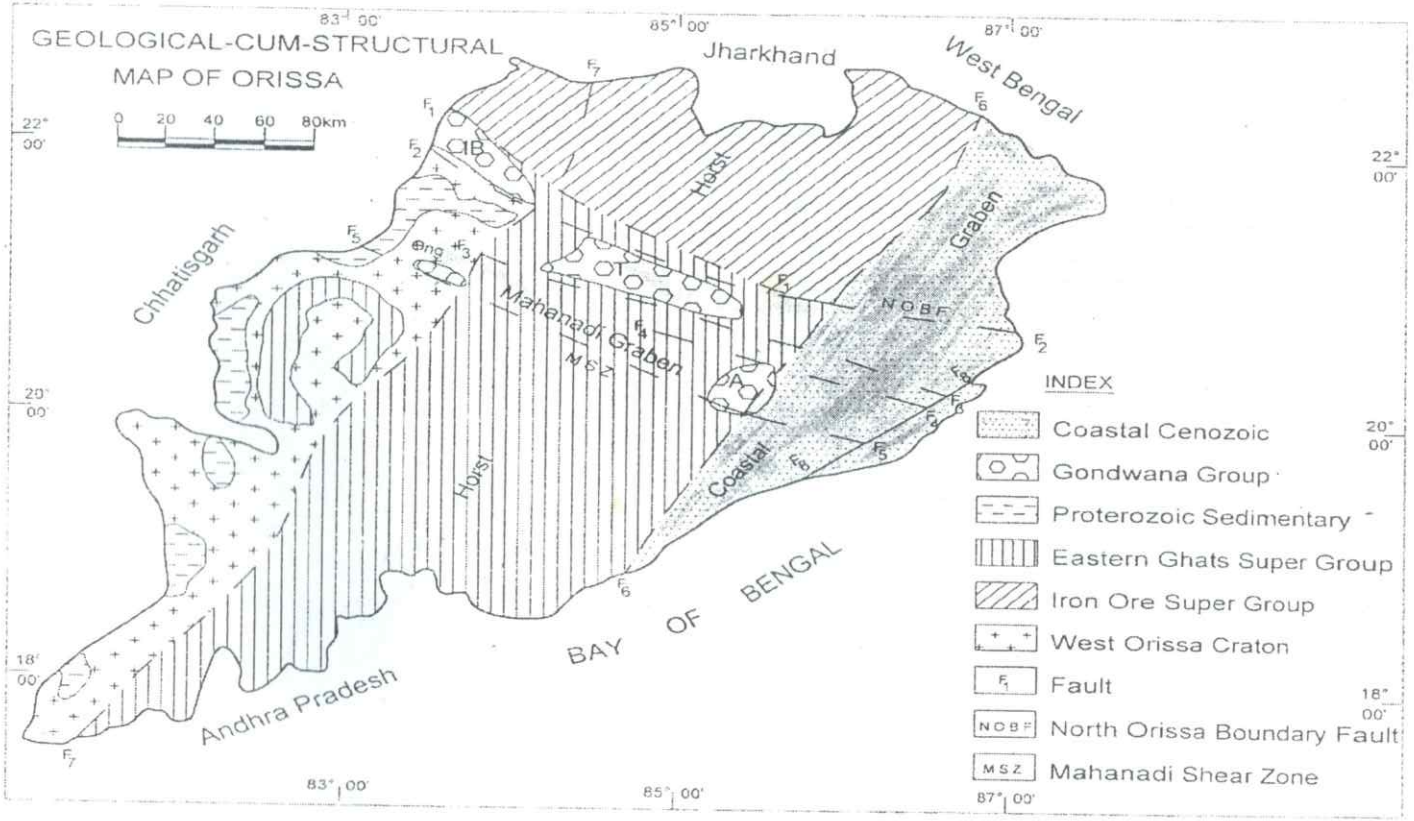
GEOLOGICAL-CUM-STRUCTURAL
MAP OF ORISSA
0 20 40 60 80km
83° 00'
85° 00'
87° 00'
22° 00'
20° 00'
18° 00'
Jharkhand
West Bengal
Chhatisgarh
Andhra Pradesh
BAY OF BENGAL
Horst
Graben
Mahanadi Graben
MSZ
NOBF
Coastal
CB
INDEX
Coastal Cenozoic
Gondwana Group
Proterozoic Sedimentary
Eastern Ghats Super Group
Iron Ore Super Group
West Orissa Craton
Fault
North Orissa Boundary Fault
Mahanadi Shear Zone

Fig. 2

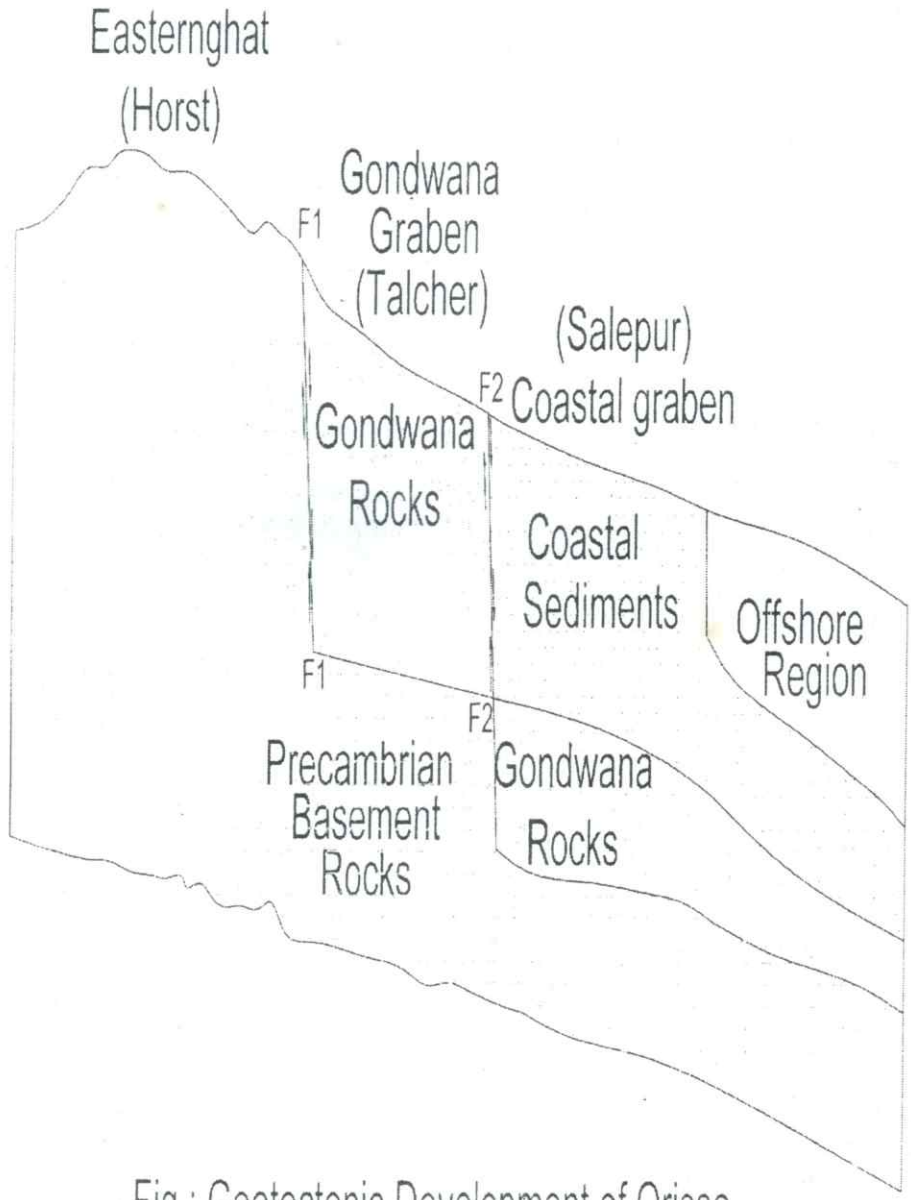

Fig : Geotectonic Development of Orissa
during the phanerozoic
Pre-Rift (F1) and Post-Rift (F2) Developments

Fig. 3

EVOLUTION OF THE COASTAL TRACT

The coastal tract has evolved with rifting of the Gondwanaland separating India from Antarctica and coming in of the marine basin since the Upper Cretaceous period, more than 100 million years back. It has seen transgression and regression of the sea into the land as a response to eustatic movement and glaciation of northern continents, etc.

Fig.4 shows the movement of the sea on Orissa back and forth with transgression and regression.

PROCESS ENVIRONMENT OF DEPOSITION OF SEDIMENTS

The sediment fill of the coastal tract has been deposited by different agents under different environmental conditions such as fluvial (by rivers), marine , esturine, lacustrine and aeolian. River deposits are formed along river channels, levees, flood plains and swamps. Marine sediments were deposited by waves, tides and littoral drifts. Both river and sea took part in estuarine deposits. Wind deposits are dune sands and are found either at sea marginal or river marginal areas. The nature of deposits e.g., size, shape, roundness and sorting are variable, influencing porosity, permeability storage etc. Similarly the geomorphologic features produced out of these sediments are different which influence land use. Important are their water bearing capacities. Geologic time brought changes in marine/ riverine systems. Transgression, regression changes in river courses etc bring in changes which are overprinted on the old sedimentary disposition. Thus one could imagine the sedimentary profile in a coastal terrain will be variable and complex in space and time. Marine/esturine/ lacustrine associations of sediments will bring in saline waters into the sedimentary bodies causing groundwater as saline or brackish interwoven with fresh water deposits.

HYDROGEOLOGY

As has been described above hydrogeological system in a coastal belt is dependent on the process environment in which sediments were deposited. There would be great complexity in the arrangement (layering) of sedimentary beds e.g., sand/ gravel/ silt/ clay, their thickness, continuity and quantity and quality of groundwater stored in them. Some beds will be thicker and continuous or lenticular and alternating with other types such as coarse bed (sand, gravel) alternating with clay and silt etc. Fig.5 gives a picture of alternating aquifer systems.

Hydrogeology describes the disposition, nature and hydrologic properties (Porosity, permeability storage and yield) of the lithology of the area. It concerns with quantity and availability of groundwater. In a coastal sedimentary system one would expect alternating sediment types such as coarse (sand, gravel) alternating with fine (clay, silt) which change in space and time. Thus we would expect multilayered aquifer systems in Orissa coast. Some aquifers on the top are unconfined aquifers and those at the bottom form semi-confined to confined aquifers. Some confined aquifers are in artesian (auto flow) condition. Summarized hydro-geological data of wells drilled in coastal area and their aquifer characteristics are presented in Table I and 2 (Choudhury etal, 2009)

Being unconsolidated formations, the coastal aquifers are rich aquifers with good yield and other positive hydrologic properties.

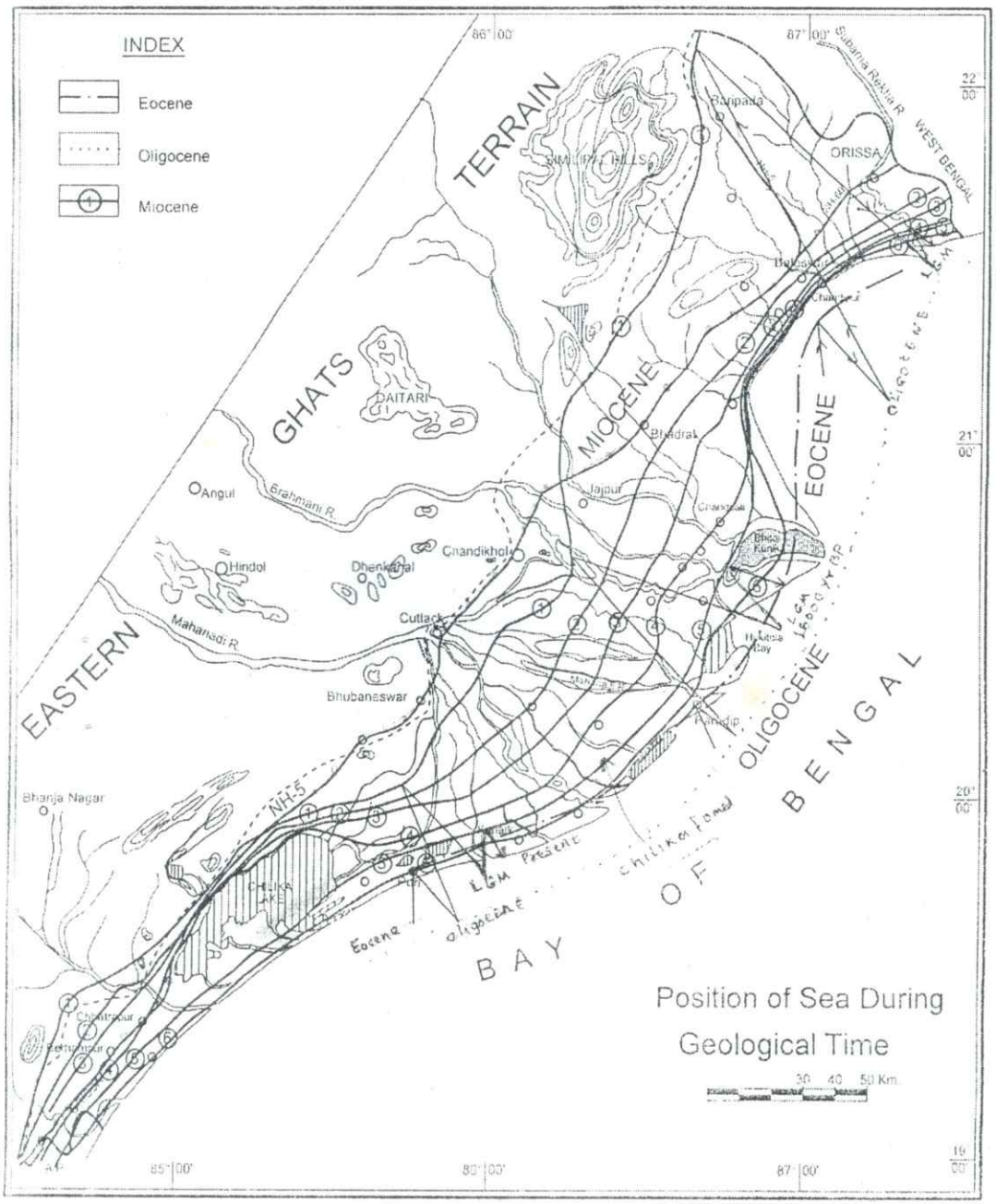
INDEX
Eocene
Oligocene
Miocene
EASTERN GHATS
TERRAIN
MIOCENE
OLIGOCENE
EOCENE
BAY OF BENGAL
ORISSA
WEST BENGAL
DAITARI
Angul
Brahmani R.
Hindol
Dhenkanal
Chandikhol
Cuttack
Mahanadi R.
Bhubaneswar
Bhanja Nagar
NH-5
Jajpur
Bhadrak
Balasore
Baripada
Subarnarekha R.
Chilika Lake
Position of Sea During
Geological Time
30 40 50 Km

Fig. 4

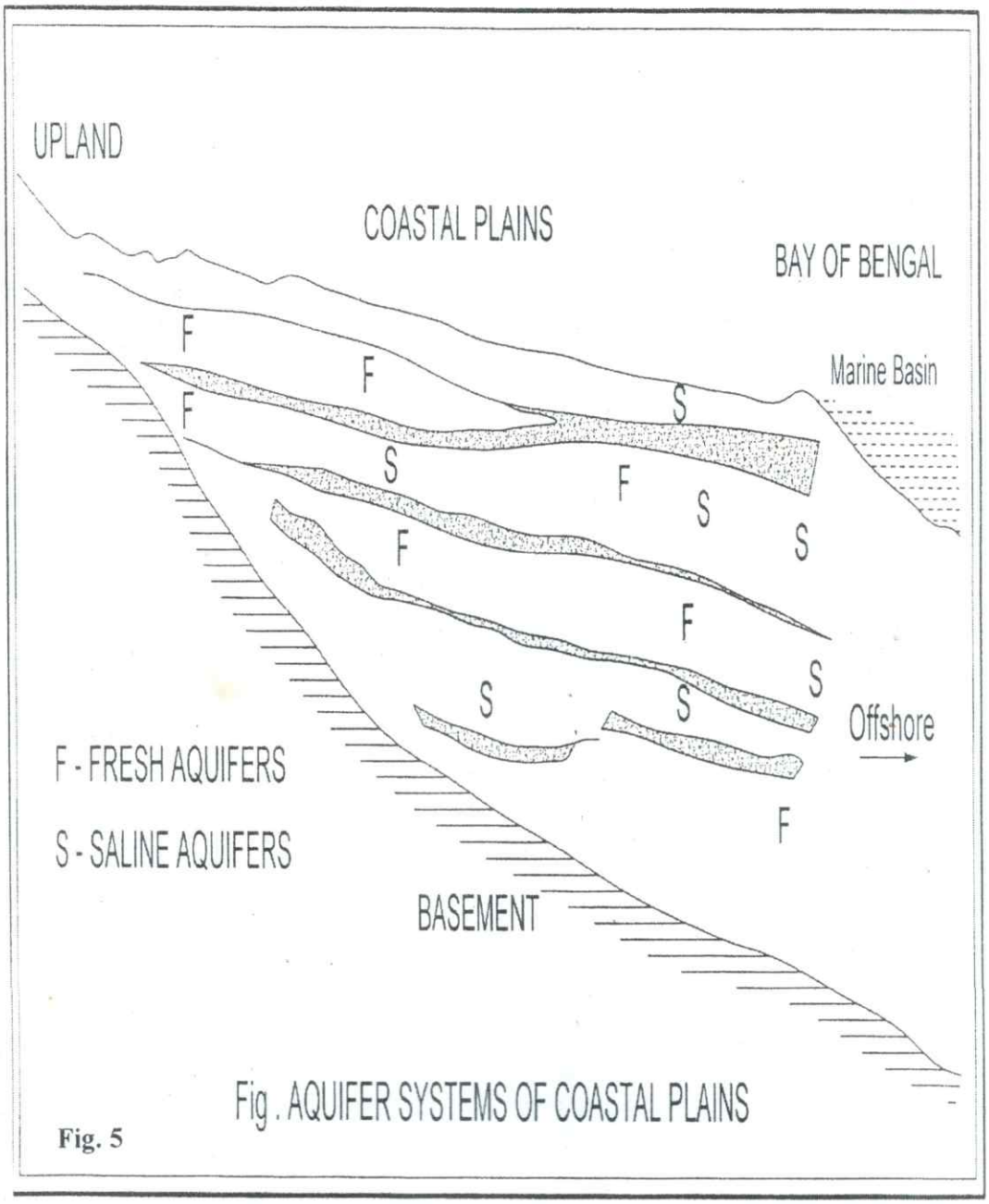

Fig . AQUIFER SYSTEMS OF COASTAL PLAINS

Fig. 5

Table – 1 : Summarized Hydrogeological data of Wells drilled in Coastal Area.

District	Depth range of wells (mbgl)	Cumulative Thickness of Aquifers(m).	Yield (lps)		Draw down (m)	
			Range	Avg.	Range	Avg.
Balasore	68-211	12-69	12-61	25-35	4-24	12-15
Bhadrak	82-320	23-55	30-60	35-45	5-21	10-15
Cuttack	50-80	20-40	22-69	50-60	3-13	6-10
Jagatsinghpur	80-291	14-37	38-69	40-50	3-13	6-10
Jajpur	38-190	20-76	39-62	40-45	5-23	12-16
Kendrapara	155-365	20-69	13-75	35-45	9-25	12-18
Khurda	50-80	20-40	22-69	50-60	3-13	6-10
Puri	31-312	26-45	3-75	40-50	3-18	6-8

Table – 2 : Aquifer Characteristics in Coastal Areas

	No of wells	Aquifer thick-ness (m)	Static Water Level (mbgl)	Discharge (lps)	Draw down (m)	Yield factor (lpm/m/m)	T (m^2/day)	K (m/day)	S
Unconsolidated Quarternary	40	10-55	0.8-7.6	12-75	3.1-13.1	1.9-42.8	256-8198	4-330	1.3×10^{-4} to
Alluvium									7.5×10^{-5}
Semi Consolidated Sediments (Tertiary)	27	8-76	7.7-17.7	4.5-28	3-25.3	0.73-11.1	151-2650	1.5-60	8.9×10^{-4} to 1.9×10^{-6}

HYDRO-GEOCHEMISTRY

The aquifers may be very good quantitatively but there is a quality constraint which makes the water unfit for any use (drinking, agriculture etc). This quality constraint is a footprint of their origin under marine condition. As has been said there were several marine transgressions which affected the costal tract. Fig 6. gives an average picture of distribution of salinity in costal tract. Close to coast the sediments are saline at he top and in the interior, it is fresh at top underlain by saline at the bottom. At the land margin the aquifers are fresh at all depths. Sediment disposition and marine influence has, given rise to very interesting situations such as a fresh aquifer at top is separated by a confining layer (clay bed) from a bottom saline aquifer; sometimes there is no confining layer in between so that the fresh aquifer sits directly over the saline aquifer. A well drilled in such a situation would yield fresh water initially which changes to saline water over a length of pumping. It is also seen that an inland fresh aquifer becomes saline at the sea marginal area. Table 3 & 4 gives the different chemical parameters of the coastal aquifers both for shallow and deep aquifers.

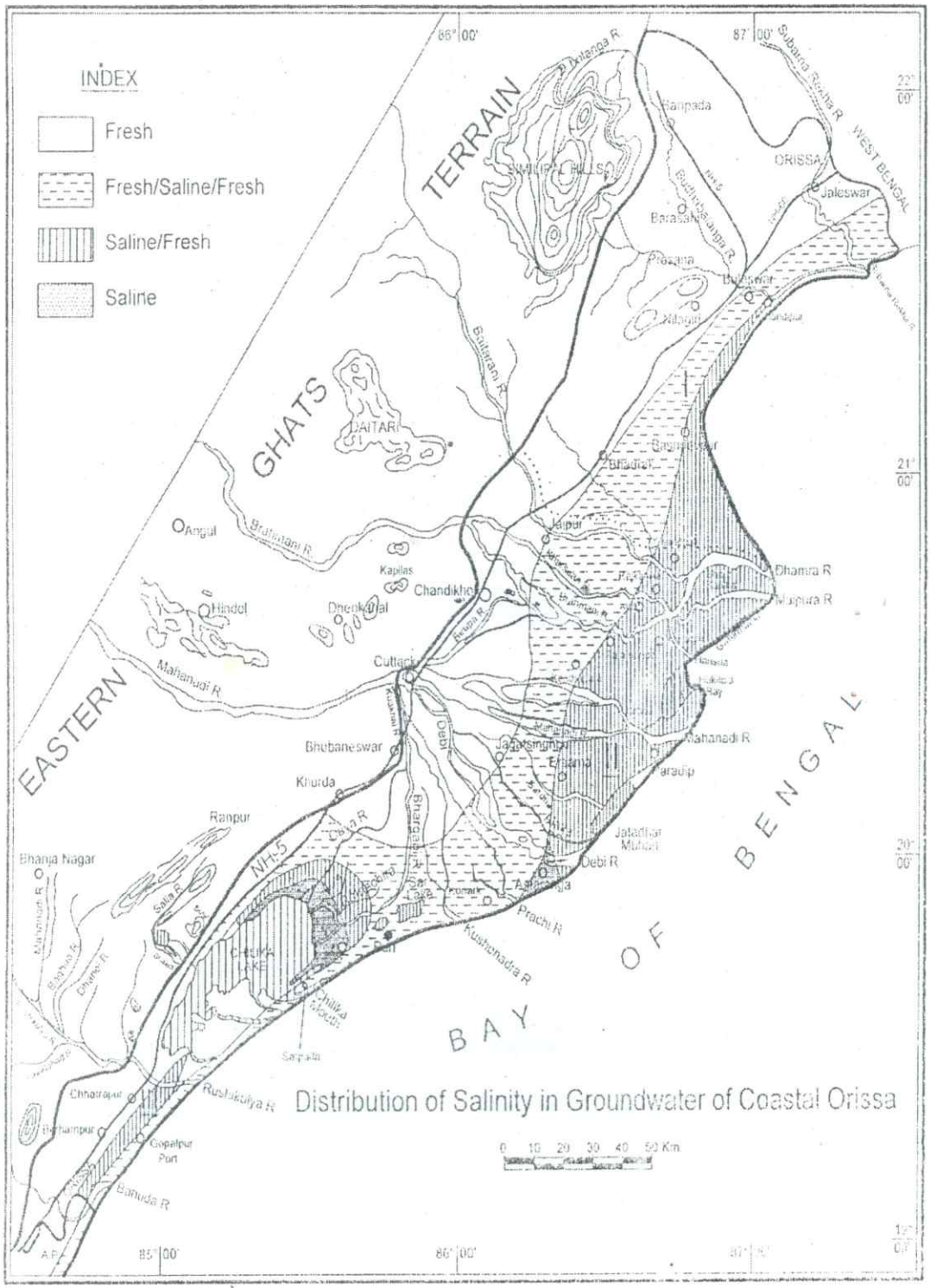
INDEX
Fresh
Fresh/Saline/Fresh
Saline/Fresh
Saline
TERRAIN
GHATS
EASTERN
BAY OF BENGAL
ORISSA
WEST BENGAL
Distribution of Salinity in Groundwater of Coastal Orissa
0 10 20 30 40 50 Km

Fig. 6

Table -3 : Range of different chemical parameters in Shallow Aquifers

Chemical Parameter	Unit	Northern part Bhadrak, Balasore	Central part Cuttack, Jajpur, Jagatsinghpur, Kendrapada	Southern part Puri, Khurda, Nayagarh
pH		7.1-8.2	7.1-8.2	6.4-8.2
Electrical Conductivity	µS/Cm at 25°C	203-2350	74-1446	134-1638
HCO_3	mg / L	24-836	18-433	18-525
Cl	mg / L	21-249	7.1-300	7.1-260
NO_3	mg / L	Nil-80	0.4-89	Nil-91
F	mg / L	0.1-1.5	0.08-1.2	0.07-1.5
TH(as $CaCO_3$)	mg / L	45-740	30-2125	25-535
Ca	mg / L	8.0-202	6.0-393	6.0-144
Mg	mg / L	6.1-92	2.4-359	2.4-73
Na	mg / L	12-299	1.0- 2300	6.9- 403
K	mg / L	12 - 112	0.8 -174	1.2-156

Table – 4 : Range of different chemical parameters in Deeper Aquifers

Chemical Parameter	Units	Northern part (Balasore)	Central part (Cuttack)	Southern Part (Puri, Khurda)
pH		6.8-8.45	7.1 - 8.4	7.3-8.6
E.C.	µS/cm at 25°C	350-1150	133-1292	542-1400
HCO_3	mg / L	92-350	92-390	125-478
Cl	mg / L	11-250	7.1-210	60-200
T.H.(as $CaCO_3$)	mg / L	20-280	75-200	40-180
Ca	mg / L	6.0-56	6-240	8-80
Mg	mg / L	5.0-39	3.6-121	4.9-44
Na	mg / L	32-586	6.9-385	90-322
K	mg / L	1-7.8	1.7-25	4.7-8.2
NO_3	mg / L	-	-	0.8-18

E.C. : Electrical Conductivity ; T.H. : Total Hardness

Classification of Chemical Quality

A large number of water samples, have been analysed and chemical type of water is presented by the standard Piper diagram and sodium hazard (s) salinity hazard (c) diagram (Fig7, after Choudhruy etal, 2009). From Piper diagram it is seen that the chemical quality of water is very variable. There are two important groups: $CaHCO_3$ (fresh) type and NaCl (saline) type. Other mixed type of water are also seen. For irrigation, all waters show low sodium hazard (S_1) with variable salinity hazards (C_1,C_2,C_3 etc.)

Problems of Groundwater Development and Management

The problem of 'Management of groundwater in the coastal tract relates to both quantity and quality (salinity). As we go into future, there would be tremendous need of more water for drinking, agriculture and industries. We can not draw as much groundwater as we like as it may lead to depletion of the valuable resource. Then there is the problem of siting of fresh aquifers. The groundwater domain must be known well about its quantity, quality and the needs of people before they are developed. So far we have not overdeveloped the aquifers except locally as in Bhograi and Baliapal area in Balasore District. So there is a big future of groundwater development in the coastal tract. Table 5 gives an idea of state of development of groundwater in coastal districts of Orissa (Pati, 2009).

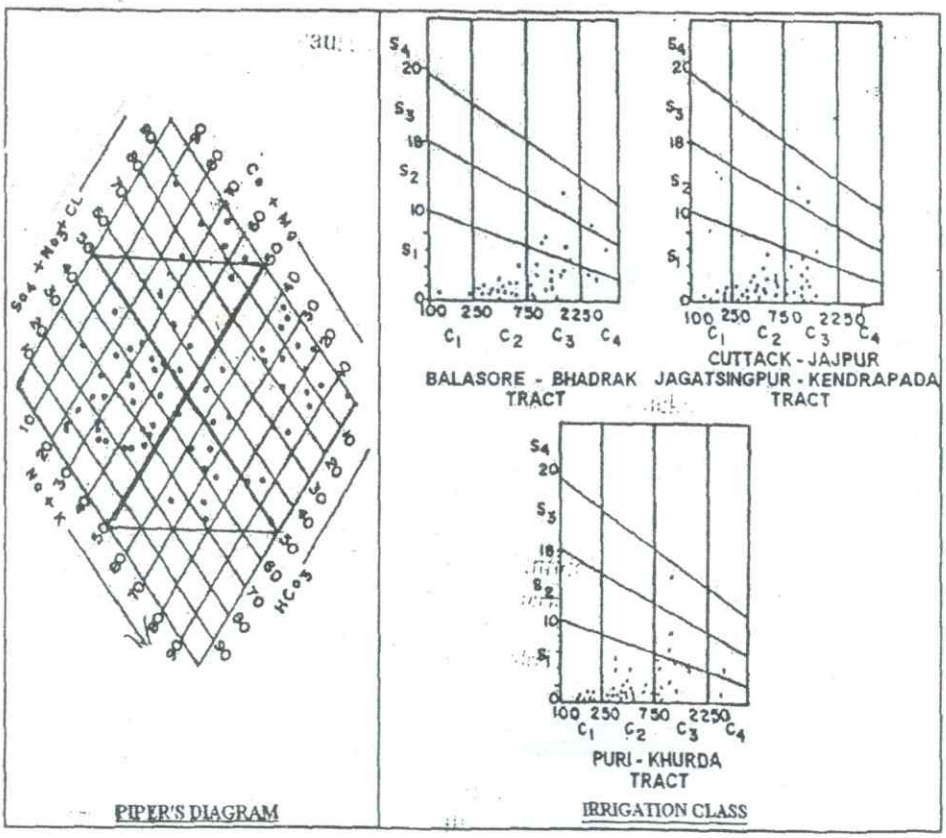

Fig.7 : Chemical Characteristics of water samples of deeper aquifers of the coastal tract of Orissa

Table 5. District wise Groundwater Resources of Coastal Orissa (Pati 2009)

Coastal Region	Districts	Availability of Groundwater (Ham)	Gross draft for different uses (Ham)	State of Groundwater development %
North Orissa Coast	Balasore	99882	47404	47.49
	Bhadrak	52210	23172	45.25
Central Orissa coast	Jajpur	58900	21141	35.83
	Kendrapada	32147	10247	31.88
	Cuttack	105366	19641	18.64
	Jagatsingpur	139697	20349	14.47
South Orissa coast	Khurda	90184	12464	13.82
	Puri	88351	9287	10.57

Note: As of now the groundwater development in the coastal tract may be taken as 25% on a higher side.

REFERENCE

Choudhury, A., Sarkar, S., Das, P.K. and Pati, G.C. (2009). Coastal aquifers of Orissa- A simplistic overview. Workshop on" Water quality management in Eastern Region, India". CGWA & CGWB, South Eastern Region, Bhubaneswar PP24-39.

Pati G.C. (2009) Groundwater resource scenario & quality in Orissa. CGWA & CGWB, SE Region, Bhubaneswar, PP 1-8.

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DISASTER MANAGEMENT & COMPULSIVE MODERN QUALITY OF LIFE: A GEOLOSCIENTIFIC PERSPECTIVE

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ABSTRACT

The geological history of planet Earth is replete with major catastrophes, all the assaults from Mother Nature and mostly influenced by cosmophysical anomalies and intraplanetary geological reorganizations. Even by the tail end of history, after descent of man Some 4 million years ago; natural disasters like continental glaciation, ocean level fluctuations and seismo-volcanological annihilations etc. have had their ways. But the modern approach to a steady escalation in the quality of life, in its eagerness to really achieve rapid perfections in quality of human life in it self, ignored the basic tenets of safe posterity and eventually have led to exponential losses of life and property, as events of both short-term and long-term periodicity/repetitivity

While most natural disasters could not be averted with human ingenuity, efforts to make timely forecasts and warnings have been prized with occasional and limited success. In this backdrop, mitigation may mostly involve settling of the aftermath and motivating to absorb the fury after the same may have lapsed into pages of history. Manmade disaster phenomena own a redeeming feature of possible circumvention in most cases with due care and timely caution. Tapering down the age of chloro-fluoro-carbon in everyday life, controlling radioactive emissions from nuclear power plants, effecting firmly the mining-specific reconditioning, optimizing ground wastes and banning biological warfare etc. amongst the many more artificial innovations, can be the main mitigative process, which are easy and practical and hence worthy of timely preventive steps for such potential disaster-causing initiations on local, regional and global scales.

EARTH AND ITS CATACLYSMS

Our living planet, the Earth is bestowed with a stout history behind it, since creation, of apocalypses, annihilations, habitat renewals and physical reconstructions. Perhaps the planet coming out of the pristine stellar mass with a big bang some 4.6 billion years ago was in itself, a beginning. Deciphered geological history reveal major disturbance at Eparchean hiatus, some 2.5 billion years ago in its prelife or protolife days. Then came Cambrian Period, 600 million years back, making the onset of evolution of life. The Caledonian shift of land and sea possibly made a coalescence of total landmass now named as Pangea and naturally circumscribed by the unitary supersea we named as Panthalassa around. Hercynian revolution by about 300 m.llion years ago broke up the single landmass in to 2 supercontinents of Angaraland at north and Gondwanaland at south. Again about 60 million years back, the two supercontinents restructured their geography and drifted towards each other compressing the equatorial Sea of Tethys, resulting in the Tehyan revolution, which has left off the most visible landscape on the surface of Earth today in form of Alpine-Himalayan mountain chain. The north-south movement may be yet continuing, with the Himalayas increasing heights, earthquakes girdling the orogen belt volcanic eruptions and so on, so characteristic of the unstable earth. Much of these disasters were well before the appearance of mar.

THE HUMAN-AGE CATASTROPHES

After the biped humanoids stated roaming about 4 million years ago, geological history evidences show the multiple glacier and interglacial era, the last inferred chilliest maxima having

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occurred around 20,000 years before present. We are yet in the globally warming interglacial. Within the current time span, the earth has witnessed relatively lesser destructions such as the dry monsoon epochs 4,000 years ago leading to desertification of Thar region, drying up of River\Sarswati, submergence of land like Krishna's Dwaraka with sea rise and flooding and so on.

How much more the civilizations have overcome through earthquakes, vulcanicity, miniglacials, supercyclones, land slides, meteoric bangs, tsunamis, continental floodings, megadroughts, eustatic macrovibrations, cosmic radio flushes and large scale soil toxicities with heavy metal accretions etc., have no accounts. All these natural disasters have befallen on different parts of the globe with contemporaneity, homotaxiality or staggers and taken many spasms of life with massive destructions looming large. Only the last few millennia experiencing the disastrous consequences, have driven more and more of consciousness and thinking on possible ways and means to diminish the damage and salvage out the best.

As if all these were not enough, man made disasters have come to form the evil corollary of modernization ethics and hence endowed with continuous efforts to thrust up the quality of human life in terms of comforts and conveniences besides faster applications and instant results and so on. Of the numerous anthropogenic disaster breeding systems at work; polluting land-water-air of the ecology, impairing ozone content of the stratosphere (with greenhouse gases, CFL and even space trash), creating territorial irradiation and spread of petrochemical/biochemical aerosols in the atmosphere; take the fore seats in the savagery drives. Mine excavation, biosphere carnage, soil-profile salinization, indifferent effluent drainage, inappropriate waste disposal, periodic oil sleeks on sea, biological warfare and high-voltage electrocutions are some of the main themes towards invitation to disasters due to human failures.

DISASTER MANAGEMENT PERCEPTION

Natural disaster scenario may not provide much scope to bypass, though worldwide researches are on for advance estimation of the likely time slots, so that more of life and property could be suitably mobilized to escape devastations. Of course, the foremost environmental change brought forth by the civilized life, must be but attributed to land use and management consequent upon agriculture and establishments of habitats,urban and rural. But this much is unavoidable *per se*, it is admitted.

Seismological and related curses of nature such as volcanism, tsunamis, subsidence/subduction, rain soaked landslips and neotectonic landslides are yet to be forecast-harnessed though massive efforts are on for some scientific hints and symptoms, capable repetitive applications with cause and effect relationship established beyond doubts. The climatic vicissitudes and weather-affected physiographic cosmetics are somewhat better predictable these days with the meteorological advances and instrumental strides put into service in the West. Our Indian subcontinent, of course, lags far behind. Therefore, Indian arena receiving better benefits of the progress of this science suffers both from instrumental backwardness and delays of transmission informatics. General warnings on land subsidence, sea water inundation or harbour-mouth saltations etc, have been in the attempts but any precision in the time evaluation aspect, is still in elementary and nonproductive stages in our part of the world.

Contrastingly, manmade disasters have better predictive attributes today and therefore preemptive and regenerative measures have started yielding results in suburban situations, although yet as products of mere time series analyses. For example, ecosystem balancing efforts, biospehere-biting minimization,

mine subsidence preventions, CFL decline and carbon-gas reduction to reshape ozone gaps, waste confinement and recycling etc. have been accepted and partially practiced as compulsory steps in disaster mitigation and management. Of course the results have been still very local and warrant widespread global consensus. Geopolitical goodwill and agreement are being internationally attempted today as the world has marched on through Kiev, Rio-92 and Montreal Protocol days to the most recent world conventions and assurance between the developed and developing nations. Indian benefits have to accrue out of these international moves. Yet a lot more has to be done even to undo the damages done so far by the mankind's greed, selfishness and imbalanced outlook of the past, what to speak of the currently generated imbalances and/or likely imbalances.

Many governmental and NGO efforts to build up general awareness have set in, to attune mindsets in several countries. However countries like India have keep up constant check on population decrease and educational improvements for appreciating the awareness campaign and go guided by it down to rural population level. India indeed lives in its villages and the disasters affect the villages most and make the throbbing millions hapless victims, often bereft with minimum level of mitigation.

MINERAL EXPLOITATION HAZARDS

A specific dealing with the mining related proneness to disasters may not be out of place, since mining industry has been often referred to as the prime mover to cause disasters directly or indirectly, be it locales of collieries, metal mines, industrial mineral recovery centres including roadmetals & building-stones, oil wells, gas pipelines or refinaries. The common accident potentials from this sector may be enumerated for a ready reference, as under:

1. Roof caving, quarry slope failures, ground subsidence and face collapse with or without surface water seepage.
2. Gas toxicity and asphyxiation through ventilation defaults.
3. Fire hazard on surface and down the pits in coal and lignite due to spontaneous combustibility.
4. Rock bursts and ground water inundation with dewatering lapses.
5. Ignition of petroleum hydrocarbons in wells, pipe lines and refineries.
6. Mine waste effluent discharges poisoning surface and ground water, both physically and chemically.
7. Artificial earth tremors and living areas damages.
8. Deforestation and unguarded destruction to ecosystem and biodiversity habitats.
9. Decibel pollution and mine-dust wreckage on biodiversity.
10. Heavy road-rolling earth movers disturbing peace and transport system obstructions and road accidents.

The list is meant to be illustrative rather than exhaustive and absolute.

A close look at the present day living may indicate that almost all household articles of everyday use can be traced back to their states of origin linking with the earth resource materials, exploited and processed. Be it a coal-based or petroleum-based source or a metallic or nonmetallic mineral product; the geological commodities are the base for every bit of a thing that we need to live with. Therefore, extraction of earth resource materials for human life is such a compulsion since time immemorial, that there cannot be any escape from the continuance of mining industry at all.

However, a glance at the accident-prone corollaries which are complementary to mining, will indicate that almost all of them are preventable with proper planning, systematic progress on the steps with ever jumping the queue, either through greed or through boredom or complacence; though not totally eradicable perhaps. For comfortable life on ground therefore, mining is a must but the precautions too are necessarily must. Mining with proper care on conservation, economy and safety through state controls of rules and regulations in force thanks to modern devices and gadgetary, conscientious and not contentious steps, rapid communication systems, GPS & GIS applications and computerized chance-elimination of human errors; are the in-things of human demand. There should not be an attempt to curb or stop mining whimsically or in a biased state - the finger that pains should not necessarily be cut off rather than cured.

THE MITIGATORY SCENARIO

The exact aspect of "mitigation" in disaster management, which shortlisted measures for alleviation or abatement, is another side of the picture. In place of inhibiting disasters which are possible in mining sector; the question of mitigability is a moot point for many of the man-made disasters of ozone depletion (e.g. ozone hole over Antarctica), gas disasters (e.g. Union Carbide at Bhopal), radiation disasters (e.g. Chernobyl in CIS), pedosalinity, oil sleeks or biological warfare and so on. The effect-lessening steps or soothing processes have to take care of neutralizing the ill effects at the earliest suffix of time after the events, irrespective of short-term or long-term approaches, as needs may be to the respective problems at large.

The natural disasters have no chances of inhibiting or pre-empting. Mitigative efforts and mitigative results are the saviours of misery to a large extent through speedy relief and alternate living arrangements. Efforts to consolidate scientifically dependable early indications and evaluate the cause and effect for reliable assurance, are parts of global research, yet with very limited success, often mistaken with chance coincidences on the predictive aspects.

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EVOLUTION OF CONTINENTAL CRUST & OCEANIC CRUST: THE HYDROPRESSURE THEORY OF CRUSTAL EVOLUTION & TECTONIC PLATE MOVEMENT

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ABSTRACT

Only the planet Earth has been bestowed with the HYDROSPHERE which is solely responsible for the life on it which other celestial bodies are denied of. Till date no other planet has been discovered in the universe that contains watermass. It is very much surprising that this waterbody surrounds and covers the 70.9 percent of Earth's surface while the land mass covers only 29.1 percent. Is it coincidental or any scientific thought exists behind it ? Since the time of Earth formation 4500 million years ago, the Earth's surface has been changing a lot and the division of the continents have been proved by the theories of continental drift & plate tectonics. Since then many a part of land mass have been submerged in the oceanic water and other areas have been emerged out from the sea floor which is demonstrated by a plenty of evidences on the beds as well as on the exposures on the crust . But fortunately the proportion of the land mass area to that of the oceanic surfaces remain the same throughout the Earth's history and surely it is not supposed to be coincidental . So it can be concluded that the OCEANIC WATERMASS has some or other bearing upon the existance of land mass that evolved on the Earth's surface because of the fact that the submergence and the emergence of land mass would likely to be the same. Again has the ROTATION of the earth add some reason behind the evolution of landmass ? All these surfacial manifestations on the Earth's crust can be well answered by the HYDROPRESSURE THEORY OF CRUSTAL EVOLUTION AND TECTONIC PLATE MOVEMENT . This hypothesis has again been confirmed by the study of facts & figures of MOON's surface which does not have any WATERMASS and does not have any signature of drifting of its surface as found till date.

INTRODUCTION

Assume if The Earth were rounded enough without mountains & oceanic depression and that let the water mass to spread all over the sphere uniformly, then we would have got the water level upto a height of 2000mts over our head all through the earth's surface. Fortunately **it is not merely a coincidence** that Earth's surface made up of 29.1% land mass restricting the water body in rest 70.9% .Whole water mass contented in the depression with an average depth of 3800mts below the mean sea level .If the water mass became multiple due to the melting of ice from the frozen area then what percent of the land mass get submerged? Certainly it is not 10% of the existing land as calculated but a very lower percentage than that because of the fact that in that case the average depth of the ocean would be like 5000mts to accommodate all the extra mass of water produced by ice melting. This phenomenon leads to the development of a new theory of crustal evolutionary tectonic plate movement.

HYDROPRESSURE THEORY OF CRUSTAL EVOLUTION & TECTONIC PLATE MOVEMENT.

The Hydro pressure theory (hypothesis)of crustal evolution & tectonic plate movement postulates that it is the mass of oceanic water that is responsible for the crustal evolution as well as land formation on the Earth. For example if one will take an water wet ball & spin it with a high speed it is observed that the water particles will thrown out of the surface of the ball. That is due to the effect of centrifugal force developed due to the spinning of the Ball. When the ball spins speedily the centrifugal force will be more than a slow spinning ball. It is directly proportional to the velocity & can be calculated from the formula

$$F = MV^2 / R$$

Where F= centrifugal force M= mass of water V= velocity of earth's spin R=radius of the earth.

This **experiment is simulated** in case of the Earth .The water mass of the Earth try to escape to the space with the centrifugal force but fortunately restricted by the gravitational force of the earth. A reactional force equals to the magnitude of the centrifugal force is generated which tries the whole water mass to move towards the centre of the earth as far as possible. This force is the **centripetal force** which is developed according to the principle of Newton's third law of motion that every action have an equal & opposite reaction .So the water mass put pressure on the earth's surface to get the depression proportionate to the force thrusted upon the crust. This is the process of formation of oceanic crust which is as deep as an average of 3800mts below the mean sea level. Due to the flexibility of the crust as it is supposed to float over a viscous mantle, the rest part of the earth surface bulges out to an average height of 840mts above the MSL. The depth of water in the ocean & the height of the land mass will proportionately generated and depend upon the mass of the water The calculation of different forces are as follows:

Centrifugal Force of Earth $= MV^2/R =$ Reactional centripetal force approximately $\frac{(1.44 \times 10^{15} \text{ kg}) \mathbf{X} (400 \times 400) \text{ m2/s2}}{(6376000\text{mt})} = 2.30 \times 10^{19}$ Newton Force

Where M= mass of oceanic water as one object, V=spin of the Earth, R= radius of the earth

This reactional force is compensated by the creation of the depression in the shape of ocean & bulging out of land mass proportionately which is related to the specific gravity of the water and that of the upper crust.

Again another force came in to existence i:e the pressure of water which exert pressure on the sides of the oceanic crust walls & responsible for the movement of continents. Oceanic water amounts 1.445×10^{15} kg mass and its pressure calculated according to the PASCAL'S LAW FORCE=PRESSURE **X** AREA and PRESSURE= **ρgh** where **ρ=** density **g** =acceleration due to gravity & **h** = height of water **D**=thickness of the ocean floor. Total pressure on 1 mt column of the crustal block is calculated with the formula

$$\mathbf{1/2\ \rho g h \times h \times 1/3\ (h + D)}$$

This huge force acted on the continental slope like the thrust of reservoir water on dam walls & distributed in different parts of the ocean.

The imbalance in this distribution of such force cause breaking of continents like Africa , South America ,Australia& India from the Gondwanaland. after causing deepest troughs in the middle of the Gondwanaland.. This force also enables the oceanic floor to touch the Mantle to

facilitate the formation of Mid Oceanic ridges at the very middle part of the oceans. In the boundary of the continental mass & oceanic crust, trenches are the site of subduction of oceanic crust below the continental crust where the continents resists the plate movement due to better balance of different kind of forces acted upon it .So the Trenches are located discontinuously near the continental crust unlike that of the uniformly created Mid Oceanic Ridges .This theory also supplements the theories of Ocean floor Spreading, Plate Tectonics & Formation fold Mountains, theory of Isostasy which warrants more research activity.

Evidences in support of the Hydropressure theory:

1-Formation of continental shelf & continental slope-The continental shelves which is considered to be the part of the continental crust is gentle sloping like less than 15 degree where as the continental slope considered to be the part of the oceanic crust slopes more than 45 degree which confirms the action of a force i:e hydrostatic pressure for this drastic change of angle of the slope between the continental shelves & continental slope as in the absence of any pressure or force ,the continental slope would have been as gentle sloping as that of continental shelves.

2- Location of Mid Oceanic Ridge:-The location of Mid oceanic ridges are also the juncture of the crust & the mantle where the forces from upward & downward supposed to neutralize each other .These mid oceanic ridges located in the middle part of the sea confirm the fact that only in the case the Hydrostatic pressure, the middle part can be the point of maximum pressure to touch & expose the mantle and no other force except Hydrostatic pressure would put pressure in the very middle part of the ocean around the earth.

3- Ocean Floor Topography:- The ocean floor topography is made up of volcanic mountains and abyssal plains. If we discard this volcanic mountain from the floor topography , we can find only a plain & smooth ceanic floor at a depth below 4000 mts. This crustal topography would have not been possible without the action of Hydropressure which don't allow any elevated topography to develop in the ocean floor. The fissure type ,not central type eruption, the magmatic liquid leads to the accumulation of lava in form of hillocks in the ocean floor as a result of resultant excessive internal pressure from inside the mantle.

4-Formation of Mid Oceanic Ridges:-
The present shape of the Earth is never been the only result of cooling of the Earth from the time of its formation from Sun as a hot gaseous material. If this had been the only cause then there would not have any fracture developed in the middle of the oceanic crust to touch the mantle of the Earth at the locations of Mid oceanic ridges.. There would never be any better explanation than the Hydropressure Theory which explains that water force compel the crustal evolution process to extend up to the mantle at depth at the middle part of the ocean in the location of the Mid oceanic ridges..

5- Thickness of continental Crust:-The thickness of the continental crust & oceanic crust depends upon the total mass of water present in the oceanic depression. This is corroborated by the fact that the oceanic crust is very thin up to maximum thickness of 5 kms where as the continental crust is more thicker up to maximum 80 kms below the mountain ranges. Lesser volume of oceanic water would give rise to less thickened crust where as doubled the water would have given rise to a more thickened crust. as the cooling of the crust depends primarily upon the water of the hydrosphere for its cooling. The position of the mantle at depth below the crust depends largely on the hydrosphere & the Hydropressure exerted by it.

6- Rotation of The Earth :- Though the rotation of the earth is greatest at the equator & hence the centrifugal force is more there , the water at the polar region get the uniformity in pressure distribution & create the depression at par with the depression in the equatorial part of the Earth. Still then the mid oceanic ridges are formed near to the equatorial line perpendicular to the direction of rotation of the Earth in Atlantic & Pacific ocean& their distribution in the ocean floor confirms the Hydropressure Theory. The surface tension facilitates the spherical shape of the Earth including the hydrosphere of the planet.

7-Proportion of Land & Oceanic Surfaces:- Formation of land mass & its proportion to the water body on the earth surface depends largely upon the volume of the water mass . The pressure which has acted upon to create the oceanic depression is also responsible for bulging out of the continental crust on the other hand as the lithospheric crust is supposed to float on a semi viscous asthenosphere. So it can be concluded that to what ever be the volume of the water body of the ocean multiplied , it can never submerge the whole land mass because in that case the bulging part of the crust would be elevated to an average height doubles the present average height of the land mass This proves the total submersion of the land mass wrong & supports the theory of Hydropressure in shaping the crust of the Earth.70.9 %(70.9/29.1)=2.44 parts of the oceanic water with specific gravity one (1.0) compensates the 29.1% (one part)of the land mass with average specific gravity nearly 2.5 over the line of compensation located probably just at the juncture of sial & sima. If the Earth's specific gravity were uniform throughout i.e. 5.5 then the proportion of land surface & water surface would be like 1 : 5.5 i:e nearly 85 % of oceanic water would have surrounded 15% of the land surface and the average height of the land mass above water would be like 1500 mt and the average depth of the ocean floor below would be like 8000mts with the maximum trench depth coming to 20000mts . The proportion of oceanic surface to that of the land surface will remain constant i:e 70.9 :29.1, It is denying the fact of submersion of coastal land by ice melting as it reduces the land surface by nearly 10%, which contradicts the Hydropressure Theory of Crustal Evolution.

8. Orientation of Mid Oceanic Ridge & Trenches:- The orientation of Mid Oceanic Ridges and the Island arcs extending approximately North-South confirms the fact that these are generated perpendicular to the direction of the spin of the Earth to minimize the pressure at the mid part of the oceanic crust, which is exerted by the Hydropressure.

9- Earth's Cooling:- During the cooling history of Earth, it seems as if it is not necessary on the part of the oceanic crust to touch the Mantle at the middle part of the ocean but other wise it confirms the action of hydropressure force to expose the Mantle in that part of the ocean.

10- Balance of Forces i:e Weight: over the line of compansassion:-- The three part of water mass with specific gravity 1 (one) must equally compansated by the proportionate land mass with specific gravity nearly average(70.9/29.1) nearly 2.5 lying over the line of compansassion confirming to the theory of Isostasy . The weight of the water multiplied by the V^2/r factor i:e square of Velocity division radius of the earth get the force equally compansated with the weight of the sial block which form the land mass over the line of compansassion. When rotation slows down the total pressure exerted by the watermass would be less to create depression of lesser depth whereas if the rotation became faster there would develop a chance of escape of watermass into the space.

11-Surface Tension- The mass of the Earth can not exclude **the mass of oceanic wat**er which gives the shape as rounded as a sphere by the theory of surface tension which again confirms the HYDROPRESSURE THEORY ,otherwise the shape of the Earth became a different shape other than that we found today.

CONCLUSION

It can be concluded that if hydropressure were not acted upon the crust ,it would be a different Earth than that we see today. The Earth wouldn't have any mid oceanic ridges at the middle part of the ocean and also no trenches would not have found in the present location. There would be uniformity in crustal thickness throughout the spherical Earth where the average depth of the ocean and average height of the Earth would have decreased considerably. The peaks like Mount Everest would have a shorter relief and the Mariana trench would have not existed. The global warming which may cause havoc to the coast would not be the point of worriness as the hydropressure plays a critical role in the formation of the crust & thereby fixing the average radius of the earth to a constant which goes against the **sea level rise** as it would increase the mean radius of the Earth. Really the HYDROPRESSURE THEORY OF CRUSTAL EVOLUTION AND TECTONIC PLATE MOVEMENT warrants more research.

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OPPORTUNITIES OF MINERAL DEVELOPMENT IN TANZANIA

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INTRODUCTION

Mining sector contributes about 2.3 percent of the GDP, which is projected to account 10 percent in 2025 as stated in the **Development Vision 2025**. It is one of the leading components in generating foreign exchange earnings within the non-traditional exports. Further, it has great potentials for employment opportunities and spearheading for both the forward and backward linkage of the Tanzania's economy.

GEOLOGICAL FRAMEWORK

The geological framework of Tanzania is comprised of an Archean block, the Tanzania Craton surrounded by Proterozoic Mobile belts. The Precambrian terraces have been disrupted episodically throughout the Phamerozoic by rifting most recently in the Cenozoic with the development of the East African Rift System.

The Tanzania Craton consists largely of granitoids and belts of volcano sedimentary rocks (greenstone). The stratigraphy of greenstone belts is reasonably consistent with a basal mafic volcanic series, overlain by carbonaceous and pyritic sediments, tuffs, banded iron formation (BIF) and chert and then by felsic volcanic. The sequence is known as Nyanzian Group. This group is uncomfortably overlain by the Archean Kavirondian Group composed of conglomerates, quartzite, argillite and pyroclastics. A major period of granitoid emplacement followed the Kavirondian and in turn was followed by major tectonic deformation. Many hypabyssal intrusive cut these Archean sequences. Abundant younger dykes are related to Mesozoic and Tertiary tectonic events.

At the end of the proterozoic the entire region was effectively peneplained and covered by a group of continental sediments, the Bukolan system.

During Mesozoic, sediments of the Karoo series was deposited in rift basins throughout eastern Tanzania. The oldest Karro sequences are cut by a wide range of alkaline intrusive including carbonatites, kimberlities and alkaline syenites.

The geological and tectonic framework of Tanzania as discussed becomes more vulnerable for becoming stone house for different economic mineral deposits.

MINERAL RESOURCES ENDOWMENTS

Tanzania has a great potential particularly for gold, base metals, diamonds, ferrous minerals and a wide variety of gemstones, some of which are unique such as tanzanites. Coal, uranium and various industrial minerals such as soda, kaolin, tin, gypsum, phosphate and dimension stones are available at an attractive economic rates. The following are minerals that has attracted most interest in the recent years.

- Gold found in greenstone belts located in the east and southern of Lake Victoria, and rock formation in southern and southwestern of the country.
- Basemetals found in a belt running from Kagera through Kogoma to Mbeya, Ruvuma and Mtwara regions and,

- Gemstones, which are found in eastern and western belts running from Kenya border in the northern part to Mozambique in the south and Mbeya and Rukwa regions.
- Gold and diamonds have always been the mainstay of the country's mineral production.

DIAMONDS

Tanzania has been a significant diamond producer for several decades, with the bulk of production coming from the Williamson Diamonds Mine at Mwadui where commercial production began in 1925. Over 300 kimberlites are known in Tanzania of which 20% are diamondiferous. Some 600 dipolar magnetic anomalies with similar geophysical characteristics to known kinberlite pipes have been recorded during recent geophysical surveys. Also of relevance are the pseudo-kimberlite or para-kimberlites along the young craters where diamonds have been discovered.

Alluvial diamonds have been recorded but a large deposit of economic exploitation has not yet been found. Locating shallow buried superficial deposits using airborne infrared surveys may prove useful.

GOLD

Gold offers one of the best areas for investment. The current perceived opportunities range from former mines in the Archean Greenstone belts around Lake Victoria, Proterozic rocks and conceptual grass root plays in Karoo and younger rocks.

Gold exploration has grown rapidly during the 199's using modern technology and refined models. Investigation has mainly been focused on the greenstone belts around Lake Victoria with particular attention on the shear hosted gold mineralization associated with banded iron formation (BIF), tufts and volcano-sedimentary exhalatives.

Several "world class" gold deposits have already been discovered in the Lake Victoria Goldfields and are at different stages of development. These deposits have reached various stages of development.

Gold targets have also been revealed in the Proterozoic rocks in the Southwest of Tanzania. In this case, gold is associated with BIF, and in gneisses and granites in shear zones.

BASE METALS AND PLATINUM GROUP MINERALS (PGM)

Geologically, both the Archean and the Protozoic rocks are prospective for base metals and PGM.

Recent exploration in North West Tanzania has revealed extensive nickel-cobalt-copper mineralization associated with ultramafic rocks of Karagwe-Ankolean System. Sutton Resources is evaluating the resources where diamond drilling has outlined contained resources of 500,000 t nickel, 75,000 t copper and 45,000 t cobalt, so far.

In addition, chromium and platinum group of metals (PGM) have been recorded. Substantial deposits of nickel enriched laterite with cobalt have been delineated over the ultramafics in the Kagera region. There is also an indication of stratiform copper-silver-uranium type mineralization in Shinyanga region.

FERROUS METALS

Numerous iron ore bodies have been identified in the Proterozoic rocks. Titaniferrous magnetic bodies associated with anorthositic gabbro occur at Liganga SW Tanzania and is in close proximity (80 kin) to the coal resources of Ketewaka-Mchuchuma. Shallow drilling established a resource of 45 million tonnes grading 52

percent Fe. The Titanium resources are also known in beach sands along the coast.

TIN-TUNGSTEN

Tin and Tungsten have been produced from both lode, alluvial and eluvial deposits from the Karagwe Tinfields in the extreme Northwest of Tanzania. Mineralisation is associated with the Late Proterozoic karagwe-Ankolean System.

GEMSTONES

Tanzania is endowed with various species of colored gemstones including the beautiful Tanzanite (blue zoisite) occurring in the Proterozoic metamorphic rocks of the Usagaran and Ubendian Systems.

Tanzania is mined at Mererani from weathered rock, sometimes in association with bands, which are also of commercial value. Other gemstones mined in the country include ruby, rhodolite, sapphire, emerald, amethyst, chrysoprase, peridot and tormalline. Recently, a major alluvial occurrence was discovered in the southern region of Ruvuma, Mtwara and Lindi. Varieties include chrysoberly, spinels, sapphire, garnets, zircons and diamonds.

Official gemstone exports were approximately US $ 10 million in 1996 majority of which were exported uncut. Great potential exists in the establishment of lapidary and jewelry manufacturing industry.

CARBONATES

Well over 20 carbonates associated with Mesozoic-Cainozoic volcanis have been identified in the country which could prove to be useful source of rare earth elements, niobium and phosphates.

COAL

Coal resources similar in quality to the Gondwana coals of southern Africa occur in the Ruhuhu and Songwe-Kiwira basins in the Southwest Tanzania. A total of about 1.5 billion tonnes in reserves have so far been identified.

The country's only coal mine at Kiwira has an average annual output of 35,000 tonnes – all of which is consumed mostly locally for power generation.

INDUSTRIAL MINERALS

Limestone and dolomite-good resources of high purity occur in the white marble deposit of the Morogoro Region. Potential for dimension stone and refractory grade limestone is therefore excellent.

A variety of clays – bentonite, kaolin and fullers earth – in sizeable deposits have been identified and are only scantily exploited. The Pugu kaolin deposit located some 30 kms West of Dar es Salaam has a great potential for development.

Evaporates and saline deposits of economic significance are associated with the rift valley lakes. Investigations of the Soda ash deposits at Lake Natron revealed a potential recovery of over one million tonnes a year. Currently, salt production stands at 105,000 tonnes per annum.

Graphite occurs in high-grade gneisses mainly ion the Usagaran system. Sufficient reserve have been identified at Merelani, northern Tanzania, for a 40 years operation at a mining rate of 15,000 tonnes per year of high grade flake graphite of 97-98% purity. The mine will also producer Tanzanite, which occur in association with graphite.

Phosphate deposits have been exploited at Minjingu in Arusha Region at around 48,000 tonnes per year in order to support fertilizer manufacturing. Following the closure of the fertilizer plant in Tanga, current production is mainly used for direct application.

MINERAL SECTOR POLICY

The Mineral Polity of Tanzania, stresses on private sector led mineral development while the major roles of the government are regulating, promoting and facilitating. The public roles consist of the inter alia.

- Policy formulation to accommodate the overall and sectoral government policy framework.
- Advising on legislation, regulation and fiscal matters related to the sector.
- Revenue collection through royalties, annual rents, prospecting rights and licenses.
- Monitoring of mining activities.
- Collection and maintenance of geo-technical data for promotional purposes.
- Provision of extension services to small scale miners.
- Administration and inspection of mining activities, and
- Carrying out research on minerals.

The mineral policy objectives are:

- to stimulate exploration and mining activities
- to regulate and improve artisanal mining
- to ensure that wealth generated from mining support sustainable economic and social development, to minimize or eliminate adverse social and environmental impact of mining activities.
- to promote and facilitate mineral and mineral based products' marketing arrangements.
- to alleviate poverty especially for artisan and small scale miners
- to promote and develop Tanzania as the gemstone centre of Africa.

MINERAL SECTOR LEGAL AND REGULATORY

Salient features of the Mining Act 1988 are as follows:

i. right to trade in mineral rights
ii. simplification and consolidation of past statues on mining and mineral trading
iii. improved security of tenure through removal of most past ministerial discretionary powers and introducing a mining advisory committee responsible of advising the Minister on decisions to make
iv. enhanced clarity and transparency
v. fair, streamlined and non-discriminatory licensing procedure and
vi. environmental management

The mining Act of Tanzania is aimed to deter information hoarding on new discoveries, freezing of exploration acreage for speculative purpose, transfer pricing and tax evasion.

The fiscal incentives provided to exploration and mining activities include the following among others.

- Exemption of import duty and Value Added Tax (VAT) on equipment and essential materials up to the anniversary or start of production, thereafter 5 percent seal applies;
- Depreciation allowances of 100 percent;
- Repatriation of capital of capital and profit directly related to mining and,
- Non-mandatory government participation.

➢ MINERAL DEVELOPMENT PROMOTION AND AWARENESS PROGRAMME – 2010 (MDPAP)

The MDPA Programme was held on 28 & 29 August 2010 participated by following 13 teams :

1. IIT, Kharapur (Geology & Geophysiscs)
2. IIT, Kharagpur (Mining Engineering)
3. Calcutta University (Geology)
4. Utkal University (Geology)
5. Jadavpur University (Geological Science)
6. Khallikote Autonomous College (Geology)
7. Bengal Engineering and Science University (Geology)
8. Andhra University (Geology)
9. IGIT, Sarang (Met. & Materials Engineering)
10. Bengal Engineering and Science University (Met. & Materials Engineering)
11. NIT, Rourkela (Met. & Materials Engineering)
12. NIT, Rourkela (Mining Engineering)
13. ISM University, Dhanbad (Mining Engineering).

The teams visited Sukinda Chromite Mining area, Chrome Ore Beneficiation plant and Ferrochrome Plant of Tata Steel at Bamnipal on 28 August. They were also shown environment management practices being adopted in Sukinda Valley and FeCr Plant.

The programme on 29th August comprised:

- Interpretation of Satellite Imageries and Aerial photographs.
- Identification of rock, ore and mineral samples; samples of metallurgical products and photographs.
- Oral Quiz.

The Geology and Geophysics Department team of IIT, Kharagpur represented by **Radhika Patro** and **Jinia Sikdar** bagged the First prize.

Prof. M.S. Chakraborty, Director, IIT, Bhubaneswar graced the occasion as the Chief Guest and adjudged the students.

The event was sponsored by Eastern Zone Mining Association and was well attended.

All the student participants were given mementos. The winning team has received the prizes.

➢ **VISION DOCUMENT ON "MINERAL DEVELOPMENT – 2020 FOR ORISSA"** prepared by **Society of Geoscientists and Allied Technologists (SGAT)**

Geological Society of India has made a detailed review of the Vision Document, published in December 2010. Main extracts are:

This comprehensive vision document, prepared for the Department of Steel and Mines, Government of Orissa by SGAT, perhaps is the first of its kind published by a Society aimed at a holistic growth of the mineral industry in a State of the Indian Union.

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The "Vision Document on Mineral Development – 2020 for Orissa", by SGAT is thus a model document to emulate by any State interested in developing and realizing their mineral potential and thus raising the economic standards and status of the State and its people.

➢ **INTERNATIONAL SEMINAR ON DEVELOPMENT OF CHROMITE, NICKEL AND PGM RESOURCES**

International Seminar on Development of Chromite, Nickel and PGM Resources organised by Society of Geoscientists and Allied Technologists (SGAT) in collaboration with Department of Steel & Mines, Government of Odisha, held on 27-28 November 2010, Bhubaneswar.

➢ **EMAP**

Regional Level EMAP at Bhubaneswar, Sukinda-Daitari, Boula-Nauasahi-Bangur, Gorumohisani – Badampahar - Joshipur, Ganjam, Gomardihi and Koira areas have been completed successfully. State Level Final Day EMAP shall be organized on 28th & 29th January 2011 at SGAT Building, Bhubaneswar.

➢ **WORKSHOP**

- **Workshop on Geo-Science Education in Secondary Schools**

A half day Workshop on "Geo-science Education in Secondary Schools" was organised by SGAT at Bhubaneswar on 24th July, 2010. It was attended by fifty teachers (Principals, Headmasters and Science and Geography teachers) of both Oriya medium and English medium Schools. Many important personalities of State and Central Government organisations, universities and Institutes were present. The Workshop was presided by Dr. R.C. Mohanty, President of SGAT.

Prof. N.K. Mahalik, the Convener of the Workshop, mentioned that Geology/ Geoscience as a subject of significance is not known to many in the schools and the public. He emphasized that it is time that geology is given due recognition like physics, chemistry and biology and placed under science stream of the syllabus. This will enable the young students at secondary school level to know and appreciate the importance of the subject and its relation to mother Earth.

Dr. B.P. Das discussed on the dams, tunnel and foundation works etc. where geological knowledge is required. Prof. Madhumita Das of Utkal University deliberated on earthquake, tsunami, landslide, avalanche, coastal erosion etc. in which geoscientists pay a major role. Dr. R.C. Mohanty, discussed on the involvement of geoscientists in resources mapping, exploration of minerals, mining and processing of minerals for utilisation in various industries. Some teachers agreed on the importance of geology in the present day society and stressed for its inclusion in the secondary school syllabus, while some

others expressed the problem of teaching the subject in view of the lack of infrastructure facility such as teacher, books and teaching aids. Shri Satyakam Mishra, President, Board of Secondary Education, Govt. of Orissa and the Chief Guest, felt about infrastructure problems in teaching geology as of now. However, he proposed to constitute a panel to examine the constraints and to make room for geology or Earth Science. The proceedings of the Workshop was duly highlighted in the media, both print and electronic. At the end, Dr. S.K. Sarangi, Vice President of the Society thanked all for their participation in the Workshop.

- **Workshop on Odisha Mineral Policy**

SGAT is organizing a Workshop on Odisha Mineral Policy on 11th January 2011 at SGAT Building.

➢ **AGM**

30th AGM of SGAT was organized on 28th November 2010 at SGAT Building, Bhubaneswar. About 90 members have attended the AGM. Dr. R.C. Mohanty, President have presided over the meeting. Prof. G.B. Mishra, Vice President welcome and appealed the members to support for the growth of the Society. Sri B.C. Patnaik, General Secretary, presented the Annual Report and Sri K.C. Pradhan, Treasurer, presented the Statement of Accounts for the year 2009-2010. K.S. Mahapatra Memorial Lecture was delivered by Sri Manoj Ahuja, IAS, Commissioner-cum-Secretary, Department of Steel and Mines, Government of Odisha. He has highlighted on the modernization of activities relating to mineral administration. **Dr. More Ramulu** was conferred on **SGAT Award of Excellence – 2010** and for the first time **Dr. Sundara Narayana Patro** was conferred on **Smt. Veena Roonwal Memorial Award - 2010** for his significant contribution in the field of environment. Dr. S.K. Sarangi, Vice President, proposed vote of thanks.

➢ **SGAT Building**

Gruha Pravesh Puja of SGAT Building was held on 11th September 2010 (Ganesh Puja). Puja was performed by Dr. S.K. Sarangi, Vice President. Dignitaries like Dr. Bansidhar Panda of IMFA; Dr. H.P. Mishra; Sj. Saswat Mishra, MD, OMC; Dr. R.C. Mohanty; Dr. S.K. Tamotia; Sri G.B. Mohapatra; Sj. Nanda Kishore Patnaik; Prof. Dr. S. Acharya; Dr. M.C. Das; Sri B.C. Patnaik and other members of SGAT have graced the Puja.

➢ SUMMARY OF PROCEEDINGS OF THE INTERNATIONAL SEMINAR ON DEVELOPMENT OF CHROMITE, NICKEL AND PGM RESOURCES

Welcoming the delegates, Guest of Honour **Shri Manoj Ahuja,** Commissioner-cum-Secretary to Government of Odisha, Department of Steel & Mines and the Chief Guest **Shri Naveen Patnaik,** Hon'ble Chief Minister of Odisha, **Shri B.K. Mohanty**, Advisor, SGAT and Convenor of the Seminar presented the scope and the objective of the event. Shri Mohanty mentioned that the Seminar is intended to deliberate on the genesis of Chromite, Nickel and PGM (Platinum Group of Metals), approach and techniques of exploration to be adopted, problems to be faced for extraction of chromite from deeper levels (beyond 250 meters vertical depth) in Sukinda valley and solution thereof, utilisation of ultra low chrome ore containing 10% chromic oxide, analytical strategies for platinum group of metals, world ferro-chrome scenario, extraction of Nickel from low grade nickeliferous limonite occurring as overburden in the chromite mines in Sukinda valley, optimization of reduction parameter for production of ferrochrome, environmental problems arising out of chromite mining among others.

As many as 167 delegates from India and abroad attended the Seminar which included participants from USA, Canada, Finland and Turkey. The organizations represented include Indian Bureau of Mines, Geological Survey of India, Orissa Mining Corporation, Tata Steel, IMFA Group, NGRI, IMMT, Bhubaneswar, Mineral Exploration Corporation, State Directorates of Mining & Geology, M.N. Dastur & Co., Geomin Consultants, Balasore Alloys, FACOR, Visa Steel, The IDC of Orissa Ltd. , IDCO, JSL Stainless Ltd., IIT, Bombay, Geological Society of India, Utkal University, Tata Refractories Ltd. Orissa State Pollution Control Board, Misrilall Mines, B.C. Mohanty & Sons., Vale India, Cronimet Alloys and M/s M.G. Mohanty among others.

Shri Manoj Ahuja in his address mentioned about the vast potential for development of the rich mineral resources of Odisha on sustainable basis and called upon the geoscientific community, mining, metallurgical and environmental engineers to evolve cost effective technology for mining, extraction of metals from low grade ores.

Shri Naveen Patnaik, Hon'ble Chief Minister of Odisha expressed happiness to find the assemblage of such large number of experts from India and abroad. He extended hearty welcome to the experts from USA, Canada, Finland and Turkey and hoped that their participation in the Seminar and stay at Bhubaneswar would be productive and pleasant. Chief Guest called upon the metallurgists to evolve an appropriate technology for recovering Nickel from the low grade limonitic ore lying as overburden in the Chromite mines in the Sukinda valley, utilisation of ultra low grade Nickel ore by suitable beneficiation and economise in the consumption of electricity in production of ferro alloys. Shri Patnaik felt the need for an integrated development of Sukinda valley, which contains about 95% of the total resources of Chromite of the country and Nickel ore. He hoped that the galaxy of experts participating in the Seminal will surely enhance our concept and knowledge on this vital topic. With great pleasure, Shri Patnaik, Hon'ble Chief Minister inaugurated the Seminar and wished the deliberations to be meaningful and productive.

Dr. R.C. Mohanty, President, SGAT mentioned about the activities of the Society of Geoscientists and Allied Technologists and its contribution to mineral development. He informed the

delegates that Society has prepared a road map for mineral development of the State.

Dr. S.K. Sarangi, Vice President, SGAT offered formal vote of thanks.

Although the Seminar deliberated global perspective, considerable attention was devoted to Sukinda valley in Odisha State, India because it hosts the only known commercially workable Nickel ore occurrences and possesses about 98% of the total resources of chrome ore of India besides showing promising indication of PGE mineralization together with Boula-Nuashai-Bangur ultramafic belt also in Odisha.

Technical Session – I (Geology and Exploration)

The Session was chaired by **Dr. Peter Charles Lightfoot**, Principal Geologist, VALE and **Prof. Dr. N.K. Mahalik,** a member of the Executive Council of SGAT.

As many as 9 papers were presented. The authors include Prof. Dr. B.K. Sahu, Emeritus Professor, IIT, Bombay; Prof. Dr. Alan Rice of the Dept. of Earth and Planetary Sciences, American Museum of Natural History; Dr. R.K. Sahoo, retired Sr. Scientist of IMMT, Bhubaneswar; Dr. V. Balaram, Director-Grade Scientist and Head, Geochemistry Division, NGRI; Shri R.H. Sawkar, Secretary, Geological Society of India; Dr. K.C. Sahu, former Professor, IIT, Bombay; Dr. D. Beura of Utkal University, Shri Kanhu Charan Sahoo of GSI and Dr. Peter Charles Lightfoot.

Prof. Dr. B.K. Sahu suggested to undertake regional microgravity and aeromagnetic surveys along the entire Sukinda Thrust to delineate possible positive anomalies for checking by drilling and to perform microgravity and vertical magnetic survey in the lateritic and alluvium covered areas of Sukinda valley, especially within the southern limb of plunging syncline and the regions west of fold closure at Kansa, which we thought would provide valuable guides for chrome, nickel and PGM mineralisations and help delineating target areas for exploration.

Prof. Dr. Alan Rice presented some results arising from computational fluid dynamic (CFD) modeling compiled over a period of time to address the cooling history of magma chambers and run off lava flows and demonstrated the potential of CFD as an exploration and mining tool. The ultimate outcome of the modeling demonstrates that boundary layers are potential repositories for important economic minerals, e.g. PGEs. The ability to quantify the processes suggests fluid dynamic modeling to be a useful supplement to exploration efforts. Particularly enticing is the clear importance of generating eddies in lava flows. These eddies provide an efficient mixing mechanism, allowing sulphides to readily scavenge metal: an observation that has application to nickel targets.

Dr. R.K. Sahoo mentioned that while the world chromite resources would be sufficient to meet the global demand for well over a century and the Indian resources at the current level of consumption would last for about 60 years, there is need for taking up detailed exploration in the Precambrian intrusives to locate newer deposits.

Dr. V. Balaram mentioned that the last two decades have seen a dramatic increase in the quality of data available for PGE, which is mainly due to some striking advancement in analytical instrumentation. He presented a detailed account of about recent developments in the estimation of PGE using different analytical techniques. Dr. Balaram observed that despite the remarkable advances in instrumental analysis, use of traditional fire assay methods for the estimation of noble metals is not likely to be replaced in the near future.

Shri R.H. Sawkar outlined four important factors that stand out in the genesis of chromite, nickel and PGE deposits. These are the parental magma, their evolution to acquire sulphur saturation/chromite precipitation, concentration of the sulphides and the increase in tenor of the sulphides with regard to Ni, Cu and PGE by repeated interaction with large volumes of magma in the magma-plumbing system. He emphasized the need to elucidate these factors thoroughly before an area is taken up for exploration or rejected after preliminary investigation. Shri Sawkar observed that there is good prospect to locate new resources of Ni and PGE as numerous ultrabasic and basic complexes in India including the Deccan remain to be explored.

Dr. K.C. Sahu mentioned that considerable information on the mechanism of leaching and concentration of elemental constituents in the rock and overlying residuum particularly the zone of enrichment of nickel along the alteration profile has been obtained from experimental investigation on alteration of nickeliferous ultramafic rocks. The investigations revealed that the metal is lodged predominantly in the finer particles (non-crystalline matrix) of goethite. He felt that because of the heterogeneous nickel, mineralogical and particle characterization of the limonitic material piled up in the chromite mining area in Sukinda can be exploited and utilized.

Dr. D. Beura presented a structural and tectonic approach to decipher the genesis of chromite occurrences in Sukinda ultramafic complex. Field disposition of chromite bodies with structural and textural features suggest a stratiform nature and the occurrences of the chromite bodies as lensoid, bouldery, brecciated type represents the deformed parts of the ore body due to post tectonic activities.

Shri Kanhu Charan Sahoo of GSI and **Shri S.K. Nayak** of OMC presented the potentiality and exploration strategy of PGM in the mafic-ultramafic suite at Bangur area, Odisha. They mentioned that as extraction of PGE is the ultimate aim, a new metallurgical process (Panton Process) for the recovery of PGM + Au developed by Platinum Australia and Lonmin Plc could be the answer.

Dr. Peter Charles Lightfoot in his paper on "Geochemical signatures of giant ore systems in Siberian Trap basalts at Norli'sk: implications for exploration beneath the Deccan Trap" mentioned that tectonic setting is the prime control of ore localizations since it dictates the formations of sedimentary basins with associated volcanisms and plutonisms, evolution of faults and shear zones providing conduits for fluid migration and required space for mineralization. Plate tectonic modes are now accepted to be highly successful for ore genesis. The studies carried out in the Noril'sk Region have indicated that the metal-depleted and contaminated geochemical signatures of the basalts are indicative of ore forming processes. Geochemical data from the Deccan trap area show extensive evidence of contamination and no evidence of the loss of Ni,Cu, or PGE to magmatic sulphides. On these grounds, it is argued that the contamination process was unable to trigger sulphide saturation: this is likely because the addition of crustal S is required to achieve S-saturation of the magma. The potential exists for other basaltic rocks to record evidence of an ore-forming process.

Technical Session – II (Mining)

The Chairpersons for this Session were **Prof. Dr. G.B. Misra,** former HOD of Mining Engineering, IIT, Kharagpur and **Mr. V.S. Rao**, former Executive-in-Charge, Tata Steel.

4 papers were presented which included a paper by Prof. Dr. G.B. Misra and Shri H. Behera of Tata Steel, Shri T.P. Mohanty of Visa Steel and

Shri D.K. Mohanty, Vice President (Commercial), IMFA Group.

Prof. G.B. Misra has suggested possible methods of mining suitable for extraction of Chromite from deeper levels in Sukinda valley. He has proposed to start underground mining below the open pits by first filling up by waste and providing a layer of cemented fill. For the wide ore body (Seam No. I) which has weak wall rocks, the most suitable method will be cut and fill method of stoping using hydraulic filling.

Shri H. Behera laid emphasis on structural and geotechnical exploration for a proper design of underground mine.

Shri T.P. Mohanty outlined the various elements of mine planning for designing open pit chromite mining in Sukinda valley.

Shri D.K. Mohanty reviewed the global ferro chrome and stainless steel scenario – current status and future prospects. He felt that both demand for both ferro chrome and stainless steel during 2010 and beyond will be robust. The areas of concern, he pointed are China's ability to maintain the growth rate of stainless steel, adequate availability of power in South Africa, exchange rates specially Rand vs USD, tax regime in various countries.

Technical Session – III (Technology and Value Addition)

The Chairperson for this Session were **Prof. B.B. Dhar,** former Director, CMRI & Director Research, Associaiton of Indian Universities and **Shri B. Mishra**, Advisor (Mining), Balasore Alloys.

This Session had 7 papers. The presenters were Shri P.K. Sahoo of IMFA Group, Prof. Dr. Onuralp Yucel of Istanbul Technical University, Turkey; Dr. R.P. Das, former Director, IMMT, Bhubaneswar and a freelance consultant; Dr. G.V. Rao, Sr. Scientist, IMMT, Bhubaneswar, Shri Peter Jokinen, Sales Manager of Outotec, Finland; Dr. B. Bhoi, Sr. Scientist of IMMT, Bhubaneswar and Shri K.S. Raju, Chief (Ferro Alloy Production), Tata Steel, FAM.

Shri P.K. Sahoo analysed the cost factors contributing to the production process of ferro chrome and outlined the measures to reduce consumption norms of input raw materials including power. He advocated increasing use of chrome ore fines and concentrates (products of beneficiation) in view of shortage in the availability of high grade hard lumpy ore.

Prof. Dr. Onuralp Yucel presented the results of study of Aluminothermic and Carbothermic processes for production of ferrochrome from Turkish Chromite concentrates in laboratory scale. The experiments showed that production of LC-FeCr is possible without external electrical energy.

Dr. R.P. Das discussed about the viability of various processes available for processing of the limonitic nickel ore of Sukinda, capital and operating costs, cost of ore, capex and opex and attempts made by different agencies during the last two decades. Processes like heap leaching, arc furnace and blast furnace routes for nickel pig iron have not been fully tested. Dr. Das observed that tests carried out by MECON in low shaft furnace and thermal beneficiation carried out at IMMT, Bhubaneswar may be suitable for processing the nickeliferous overburden occurring in the chromite mines in the Sukinda valley. He suggests recovering both iron and nickel values in the overburden, operation of smaller coal-based pyrometallurgical plants production of nickel pig iron of low phosphorus low grade ferro-nickel produced from blended ores.

Dr. G.V. Rao described the metallurgical performance of a chromite beneficiation

plant and improvement. The feed grade was ferruginous chrome ore but owing to inconsistent and erratic grade of feed, the results were not satisfactory. The troubleshooting methods with partial modification of the circuit undertaken resulted in increase in yield. The tests indicated that high grade concentrate with high Cr/Fe ratio can be obtained from -0.75 mm size fraction of the ore.

Mr. Peter Jokinen mentioned about developments in equipment and automation by Outotec for the processes to be able to achieve high availability of the plant and better quality products with energy efficient manner and with low emissions. Outotec has provided solutions depending on specific client requirements worldwide. Mr. Jokinen observed continuous improvement of reduction processes, decrease in primary energy consumption, loss of material and heat, maximum utilisaiton of unavoidable by-products as CO gas and slag have been the targets of Outotec and these have been by and large achieved.

Dr. B. Bhoi presented an account of the technology developed by IMMT, Bhubaneswar for processing the nickel bearing chromite mine overburden of Sukinda valley for commercial production of ferro-nickel. The techniques involved include reduction roasting followed by magnetic separation and smelting.

Shri K.S. Raju described the advantages of using closed type furnaces for production of HC ferro chrome. Shri Raju discussed about optimisation of slag chemistry and spinals that are formed in the process of FeCr production and how to select the right type of chrome ore which in turn yields the best recovery. When large quantity of briquettes is used, carbon in the alloy tends to increase beyond 8%. Maintaining carbon within the limits and ensuring the Cr recovery depends on the ore characteristics. To overcome the problems arising out of variation in the ore characteristics, it is essential to understand the reducibility of that particular ore by optimizing the relations between various gangue spinals.

Technical Session – IV
(Marketing, Areas of Environmental Concern and Corrective Measures)

The Session was chaired by **Prof. G.S. Roonwal,** Visiting Professor at the Inter-University Accelerator Centre and **Dr. R.C. Mohanty,** President, SGAT.

4 papers were presented. The presenters were Shri Ranjan Mishra, President, Visa Bao Ltd.; Shri K. Banik of Tata Refractories Ltd.; Dr. K.C. Sahu, former Professor, IIT, Bombay and Shri Nihar Ranjan Sahoo, Sr. Environmental Engineer, Orissa Pollution Control Board.

Shri Ranjan Mishra presented an overview of the international trade in chromite and FeCr. The International Chromium Development Association has observed that there is an increasing trend in metallurgical and foundry sectors for chromite consumption while there is a deceasing trend in the use of chromite for chemical industry. Shri Mishra was of the view that demand for chromite and ferrochrome would remain strong mainly due to continuing growth of China's stainless steel industry. Ferrochrome companies who have already integrated backwards into chrome ore mining and power plants have on edge to "Outperform" for a long period. Apart from augmenting efforts to locate new chrome ore resources, R & D process innovation is called for to directly manufacture stainless steel from chrome ore/liquid chrome.

Shri K. Banik highlighted the technological developments in the usage of chromite refractories.

Dr. K.C. Sahu discussed the origin of chromite toxicity, mitigation measures including 'Atechnological' steps particularly with reference to possible chromite pollution in Sukinda chromite

mining area. Possible mechanism of Cr^3–Cr^6 conversion in natural chromite deposits has been discussed. The study carried out shows that hexavalent chromium generated in chromite deposits is converted back to Cr^3 and immobilized either along the stream channels or absorbed in goethite mineral of the overburden material. Dr. Sahu is of the view that an integrated approach of mining, agriculture, animal husbandry and dairy practices for a balanced socio-economic development would counteract the negative impacts of monotrack development of mining, which has led to the spectre of chromium pollution and adverse publicity associated with it.

Shri Nihar Ranjan Sahoo has made an attempt to map various chrome related activities in the state of Odisha, identify and quantify the environmental risk associated with release of chromium to the environment and mitigation measures.

Technical Session – V (CSR and Integrated Development)

The Session was chaired by **Shri Manoj Ahuja,** IAS, Commissioner-cum-Secretary to Government of Odisha, Steel and Mines Department.

2 papers were presented. One was by **Shri S.K. Das**, Director of Geology & Mines, Government of Odisha on Status of Development of Chromite, Nickel and PGM Resources of Odisha and Future Prospects. Shri Das presented a detailed account of exploration carried out in the State, status of resources, mining, production and mineral based industries, beneficiation and prospects.

The other paper was by **Shri Ajit Mahapatra**, President, Orissa State Productivity Council. Shri Mahapatra dwelt on Concept of "Corporate Social Responsibility" in Mining Sector. Shri Mahapatra mentioned that there are 4 agencies who are responsible for CSR. They are (a) The Government, (b) Corporate, (c) Civil Society and (d) the people in general. He called upon the Government to convert its 'outlays ' to 'outcome', the corporate to apportion and link some of their 'wealth' to 'welfare' and the civil society to change their attitude from 'confrontation' to 'collaboration' and 'criticism to cooperation'. In regard to the mining sector, it has an obligation to ensure that the region and the community are not subjected to air and water pollution, rise in temperature, toxicity, shortage of water supply.

VALEDICTORY SESSION

The valedictory Session was chaired by **Shri Manoj Ahuja.**

Shri B.K. Mohanty, Convener, presented a Summary of the Proceedings of the Inaugural and Technical Sessions and introduced the Chief Guest **Shri Baijayant Panda,** Hon'ble Member of Parliament.

Shri Panda in his Valedictory Address mentioned about inherent contradiction in the two Central Legislations namely the MMDR Act and The Forest Rights Act. He observed that while MMDR Act recognizes mining as a legitimate economic activity, promotes and regulates mining, the Forest Rights Act in a way puts all possible restrictions to carry out legal mining operations in India. This contradiction needs to be addressed by the law makers of the country. He queried "can we have a situation where every village or hamlet is empowered to veto a mega project ignoring the greater good for the community and the state? Shri Panda observed that it is easier to carry out mining abroad than in India. Continuing, he observed that when we discuss about mining in India, it degenerates to illegal mining. This is not a correct approach. Government of India is now in the process of amending the MMDR Act and our concern is that the amended Act does not curtail the powers of the State Governments.

Shri Panda did not mince words in observing that the UPA Government's overzealous concern for environment has resulted in stalling of mega projects in Odisha. He however asserted that the mining sector must need to adapt its approach and activities taking into account the real environment concerns such global warming and climate change. He urged upon the geoscientific and mining community to guide the Government of the State and the Centre about our futuristic developmental goals.

Concluding his address Shri Panda thanked SGAT for inviting him and giving an opportunity to express his thoughts on a topic relating to development of Chromite, Nickel and PGM resources which he considers to be of vital and strategic importance for a mineral rich state like Odisha.

Shri Manoj Ahuja said given the kind of market capitalization that is taking place, the mining sector will be the engine to propel growth and development of the state. He observed that investment on exploration needs to be stepped up. Shri Ahuja called upon the mining community to discharge their CSR without waiting for statutory compulsions. He agreed with the Chief Guest that the legal contradiction and the conflict should be addressed so that, mineral exploration and mining can be carried out within the ambit of a conducive legislative framework.

The Session and the Seminar ended with a vote of thanks offered by the **Shri B.C. Patnaik,** General Secretary, SGAT.

➢ NEWS ABOUT MEMBERS

- Orissa Vigyan Congress felicitated Prof. Dr. S. Acharya, one of our esteemed founder members for his longstanding contributions in the Geology of Orissa with special reference to iron formations.
- Dr. Kulamani Parida has been awarded the prestigious Biju Patnaik Science Award for the year 2008 on 23rd December 2010 by Orissa Vigyan Academy.
- Dr. B.M. Faruque, former Director, GSI, Vice President, Orissa Environmental Society was nominated member of the Regional Committee for Scrutiny of Projects for NEAC 2010-11, Eastern Region, under the Ministry of Environment and Forest, Govt. of India. He participated in the meeting of the Regional Committee during 29 November - 1st December 2010 at Jamshedpur.

  He had presented the synopsis of the entire proceedings of the 13th Orissa Bigyan Congress in the Valedictory Session of the two day (9-10 December, 2010) Conference held at Regional Museum of Natural History, Bhubaneswar.

  He has been invited to deliver a lecture on the theme of CLIMATE CHANGE at the 98th Indian Science Congress to be held at Chennai during 4 - 7 January 2011.

- The following Deputy Directors of Geology and members of SGAT are promoted to the post of Joint Director of Geology (JDG) with their postings as mentioned below.

  1. Sri Arun Kumar Mohanty – O/o J.D.G, Dhenkanal with additional charge of North zone, Sambalpur.
  2. Sri Trilochan Mahanta – Directorate of Geology, Bhubaneswar
  3. Sri S.N. Parida – O/o J.D.G., Keonjhar.

- Sri A.K. Brahma, Joint Director of Geology of Central Zone, Keonjhar retired on 30th Sept'10 due to superannuation.

➢ NEW MEMBERS

1. **Shri Haladhar Mahanta**
Asst. Manager (Liaison), SAIL, RMD
271, Bidyut Marg, Unit-IV, Bhubaneswar

2. **Shri Naresh Kumar Agarwal**
N/2, 134, IRC Village, Manorama Residency,
Bhubaneswar-751 015

3. **Shri Prasonna Kumar Mohanty**
C/o. R. M. Jena,
8/12, Lane – 12, Jagannath Vihar,
Bhubaneswar – 751 003

4. **Shri Prafulla Kumar Panda**
Former Director (SG), GSI,
Plot No. 3835(P), Near GGP Colony,
P.O.: GGP, Rasulgarh,
Bhubaneswar – 751 025

5. **Shri Manoranjan Mahapatra**
Geologist, Directorate of Geology(O),
C/o: Shri M.K.Mahapatra,
Jagannathpur,
Keonjhar – 758 001, Orissa.

6. **Shri Rajesh Mohanty**
Eng. in Env. Sc., Geomin,
C/O. Shree Raghunath Mohanty,
Arunodaya Nagar, P.C.Sarkar Lane
Cuttack – 753 012

7. **Shri Jayanta Kumar Mishra**
Mining Engineer (OMC)
F 8/4, Unit – IX (Flat)
P.O. Bhoi Nagar, Bhubaneswar – 751 022

8. **Shri Praddept Mohapatra**
Dy. Manager (G&E),
Orissa Minerals Development Co. Ltd.
Thakurani, P.O: Barbil

9. **Mr. Ashis Mohanty**
Manager (Geology),
Rungta Mines (P) Ltd..
2132/4734, Nageswar Tangi,
Bhubaneswar – 751 002

10. At - Chandrasekharpur,
P.O.: Olechandanpur
Via – Singhpur,
Dist.- Jajpur,
P.I.N. – 755 016

11. **Mr. Prasanta Kumar Nayak**
Asst. Manager (Geology),
The OMC Ltd.
OMC House, Bhubaneswar - 1

12. **Dr. Somnath Khaoash**
Reader (Geology),
Deptt. Of Geology, Ravenshaw College,
Cuttack – 753 003.

13. **Mr. Rabindra Mohanty**
Asst. Manager (Geology), OMC Ltd.,
At/P.O.: Kuradha,
Via – Kanakpur,
Dist.: Jagatsingpur – 754 136

14. **Mr. Peeter Charles Lightfoot**
Principal Geologist,
Vale India Pvt. Ltd.,
Level – 12,Tower – C, Building – 8,
DLF Cyber City – Phase – II,
Gurgaon – 122 002, Haryana

15. **Mr. Ashok V Rao**
Sr. Geologist,
Level -12, Tower – C, Building – 8,
DLF Cyber City, Phase – II,
Gurgoan – 122 002, Haryana

16. **Mr. Manas Ram Misra**
President,
Cronimet Alloys India Ltd.,
C/o. Dr. Radhanath Rath,
Samantasahi, Cuttack – 753 001

17. **Mr. Subhranshu Sekhar Paul**
Mines Manager,
Saruabil Chromite Mines,
M/s. Misrilall mines (P) Ltd.,
P.O.: Jajpur Road, Dist.: Jajpur – 755 019

OTHER NEWS

IRON ORE IMPORTS OF CHINA

Year	Iron Ore Inputs in 1000t	Production	
		Pig Iron	Crude Steel
2000	69970	131034	127236
2001	92393	147067	150906
2002	111494	170745	182249
2003	148120	213785	222413
2004	208090	25638	280486
2005	275230	344732	355790
2006	326300	407554	422989
2007	382830	469446	489241
2008	443540	471100	502010
2009	627780	543748	567842
2010 (October)	503300	---	525095

(FIMI News Bulletin – 1, December 2010)

CRUDE STEEL PRODUCTION

Region	October 2010	October 2009	Growth Rate
European Union (27)	15,444	14272	8.21%
Other Europe	3087	2699	14.38%
C.I.S (6)*	9315	8975	3.79%
North America	9366	8509	10.07%
South America	3994	3877	3.02%
Africa	1488	1288	15.53%
Middle East	1680	1420	18.31%
Asia	72493	71676	1.14%
Oceania	694	698	- 0.57%
Total (Million Tonnes)	**117561**	**113414**	**3.66%**

(Source: MMR – 12th Dec'2010)

- Crude steel consumption can hit 596 million tonnes in 2010.

IRON ORE EXPORT SCENARIO IN INDIA

- Indian iron ore exports slip 30% in November 2010. This has gone down by 30.59 percent to 8.07 million tonnes. During the same period in 2009, India exported 11.53 MT of iron ore.
- India, third largest iron ore exporter, had produced 218 MT of iron ore and exported almost half of it. Of the total exports 80 percent had gone to China. At present, iron ore lumps attract an export duty of 15% while a 5% tax is levied on shipments iron ore fines.
- The Moatize coal mine in Mozambique owned by Vale is expected to produce around 8 MT coking coal and 4 MT Thermal coal in three years.
- Tata Power has acquired stake in Sorik Marapi Geothermal project in Indonesia which is estimated to generate 240 MW electricity.
- Manganese ore India Ltd. is undertaking a 768 crore expansion programme to increase manganese output to 1.5% million tonnes per annum by 2015-16. The current production stands at 1.1 million tonnes.

OBITUARY

Prof. Tara Charan Bagchi, my teacher and my promoter for doctoral degree, passed away on the 26th October 2010 in Kolkata. He was ninety-one and is survived by his only son Amit. His wife passed away sixteen years back and he was staying alone in his Kolkata residence.

Amit, who stays in U.S.A, reached Kolkata on his usual trip for a fortnight and while chatting with him, Dr. Bagchi suddenly fell unconscious and was taken by Amit in his arms. It was apparently a brain clot. Ten days later, he breathed his last.

Coming from erstwhile East Pakistan (now Bangladesh) his entire family including parents & brothers, settled at Varanasi. He was a lecture in Geology in B.H.U. from where he went to England and worked with Prof. H.H. Read for his Ph.D degree. After coming back to India, he was welcomed into I.I.T's fold to which he gave his heart and soul for betterment of the department and students.

Retiring as Deputy Director, he left I.I.T campus next day for his Kolkata residence where he stayed till his last.

For a year, he was the UNESCO Expert as a Professor in Manila, Philippines. I have seen him not only as my guide and philosopher, but also as a great teacher who is exceptionally kind hearted, disciplined and very practical human being. With his demise, I lost not only my Guru but also an elder brother. With time my family merged that of his and I saw an uncle in me for his son.

He donated money to philanthropic institutes at Varanasi and Kolkata and instituted a fellowship at I.I.T. in his wife's name. He has donated Rs. 50,000.00 to SGAT to confer an award to the best researcher on granite every alternate year in the name of Prof. H.H. Read. He has donated all his personal books and journals to the Department of Geology, Utkal University.

The SGAT, Bhubaneswar received from him an amount for a gold medal to be awarded to the best in India as judged by the Society. His entire personal books and journals collection were donated to the Geology Dept., Utkal University and I went to receive them from him in Kolkata.

His disciplined personality habit kept him in good health till his last. A very popular senior man in his neighbourhood, he was extremely kind and even taught a couple of School going children and also financed them for their studies.

A sage in life, he always used to tell his students to adhere to the principles of one's own philosophy.

Without troubling any one (even his son) he went to be sublimed with God.

May his soul rest in peace.

Prof. Dr. S. Acharya

- **SUBMISSION OF PAPERS FOR SGAT BULLETIN**
  (Instruction to Authors)

Research papers, review articles, short communications, announcements and letters to editors are invited on topics like geosciences, mineral exploration, 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 the same is original, unpublished and is not being considered for publication elsewhere. Two copies, complete in all respect (with copies of figures and tables) are required to be submitted. Originals of figures and tables should be enclosed separately. Each manuscript must accompany 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. The copies of manuscripts, strictly in accordance with the instructions to authors given below may be sent to the editor of the bulletin.

Journal Format: **A-4 size**
Language: English
Manuscripts: Manuscripts should be typed in double spacing with wide margins in one side of A-4 size paper 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 he 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
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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 be accommodate up to 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 cast 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 the 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

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(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) Palioenvironment and palioecology of the lower and middle Siwalik sub-groups of a part of North-western Himalayas. Jr. Geol. Soc. Ind, vol. 59, pp. 517-529

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Page proofs: One set of page proofs will be sent to the corresponding author, to be checked for typesetting only. No major changes are allowed at the proof stage. Proof should be returned within three days.

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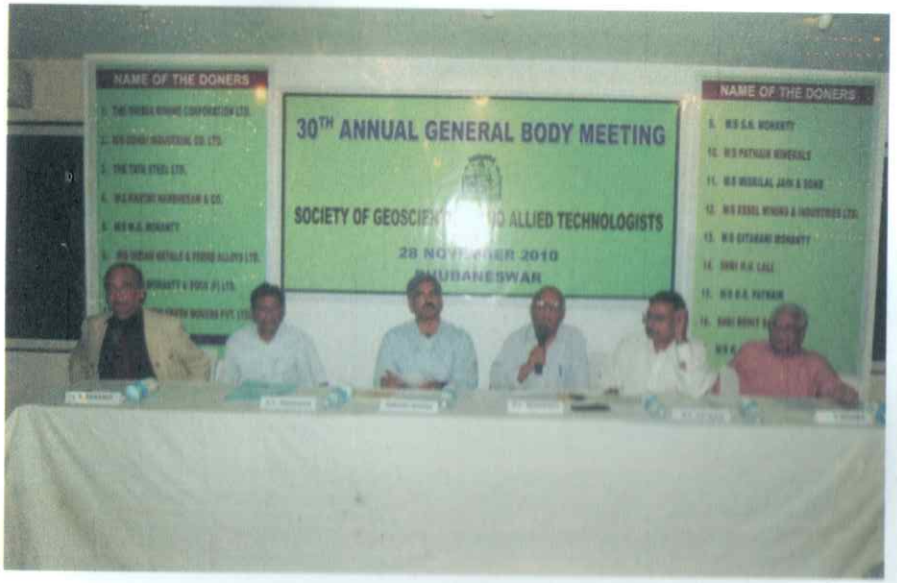


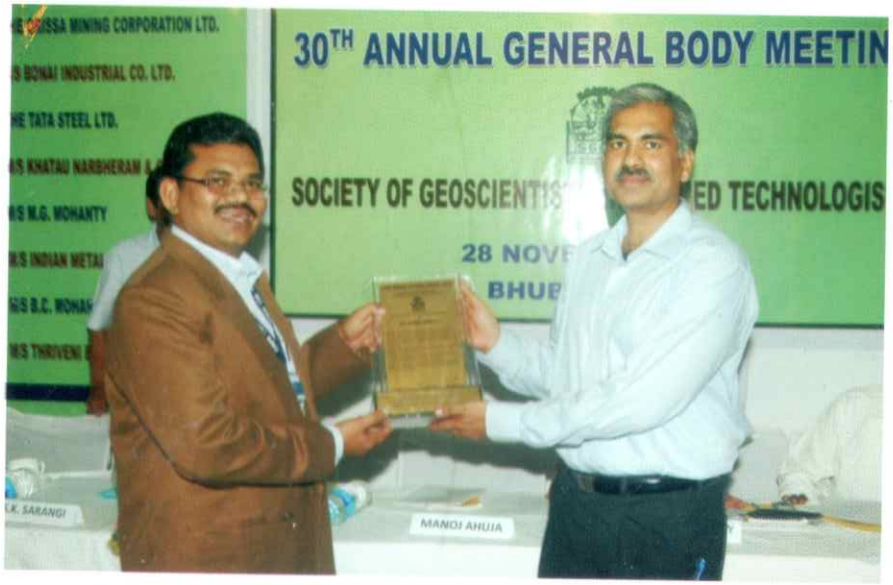
DIGNITARIES ON THE DIAS FOR AGM

MEMBERS ATTENDING AGM

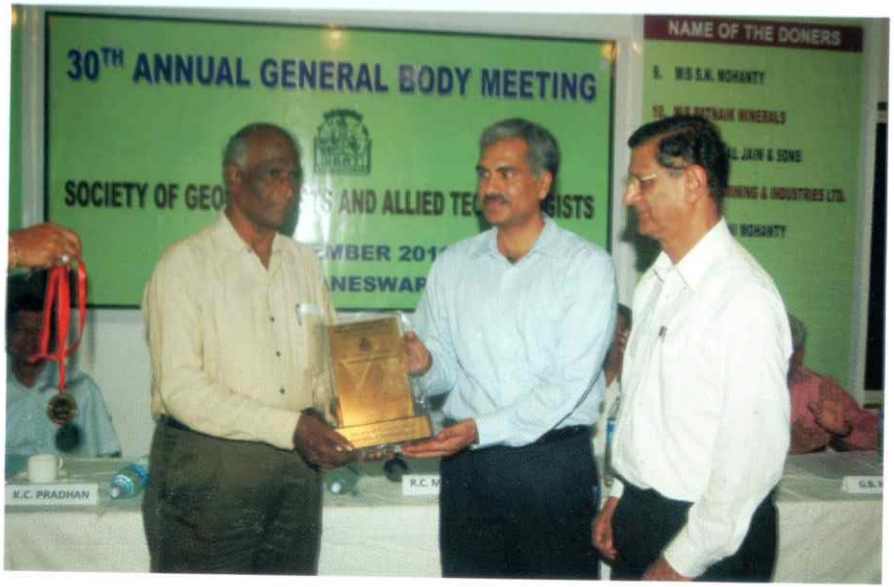
CHIEF GUEST MANOJ AHUJA ADDRESSING
KSMAHAPATRA MEMORIAL LECTURE

MEMBERS ATTENDING AGM

MEMBERS ATTENDING AGM



DR. M. RAMULU RECEIVING SGAT AWARD OF EXCELLENCE FROM SJ. MONAJ AHUJA, COMMISSIONER, S&M, DEPT. GOO



PRESENTATION OF SMT. VEENA ROONWAL MEMORIAL AWARD TO DR. S.N. PATRO