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## PRESIDENT'S COLUMN

Increasing trend in exploitation of existing mineral resources has been the concern of many who are afraid of little being left for future. This conservationist idea gets support from another group who resist the development of mineral sector as its impact on environment would deprive the younger generation a better life. As both the concerns have to be taken seriously, our activities today should give priority to the interest of future generation.

We talk about Sustainable Development considering environmental care by reducing pollutants, reclaiming mined out areas, conservation of forest and cultivatable land, extensive plantations, peripheral developments for improving social, cultural and economic conditions etc. While improvements are being brought in these areas by various legislations and enforcements, the other aspect of conservation is totally ignored. We have the responsibility to simultaneously find and establish resources for future while we consume today.

The efforts for mineral explorations made by the Govt. during 50's to 80's have slowed down. There is no emphasis today for steps to be taken for discovering new potential deposits or even adequate planning for utilization of existing resources. We have been simply planning progressively for enhancement of mineral production and establishment of new industries to achieve economic development. No doubt this is the need of the day, but there has to be concern for future as well.

The scheme for foreign direct investments (FDI) for exploration or private participations didn't yield desired results till date, even 15 years after liberalization, except discovery of some oil and gas fields which have not been productive so far. Even the attempts for reassessment of resources particularly marginal or sub-graded materials and R&D efforts for their up-gradation and utilization in future is not satisfactory. There is lack of Govt. initiative or directives to private sector in this regard. On the other hand very less activities for explorations being taken up today is also facing obstacles from forest administrations and public. Incidences like the one faced by GSI team engaged in iron ore exploration in Orissa are also deplorable.

Before the situation becomes alarming corrective measures are to be taken. In the present economic scenario Government can not take the total responsibility, but can initiate by contributing a part of its revenue earned from mineral sector for continuing mineral explorations and effective administrations with directives for conservation and proper utilization of mineral resources. Encouragements for public-private partnership towards exploration and R&D efforts can provide additional resources to ensure a better future.

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



## ELEMENTAL DISTRIBUTIONS AND CORRELATIONS IN SELECTED WEATHERING PROFILES HOSTING BAUXITE DEPOSITS, EASTERN INDIA – IMPLICATIONS IN UNDERSTANDING THE RESOURCES

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### **Abstract**

*Weathering profiles hosting bauxite deposits from 5 localities of eastern India such as Jaldihi, Baphlimali, Lohardaga, Karlapat and Dholkata were investigated for 8 geochemical parameters  $Al_2O_3$ ,  $TiO_2$ ,  $V_2O_5$ ,  $ZrO_2$ ,  $Cr_2O_3$ , Ba, total REEs and Ga. The profile variations of these elements show wide differential trends. Zonations of elements are distinct in deep profiles. Certain depth zones of Baphlimali has >10000 ppm Ba and  $\Sigma REEs$ , which are unique findings in weathering profiles of eastern India. Concentrations and correlations of elements in various bauxite profiles exhibit distinct nature as revealed from the study. Elements like  $TiO_2$ ,  $V_2O_5$ ,  $ZrO_2$ ,  $Cr_2O_3$ , Ba, Ga and  $\Sigma REEs$  may be considered as other resources of bauxite deposits due to their elevated contents in selected localities.*

**Key words:** Bauxite, Weathering profile, Elemental distribution in bauxite profile.

### **INTRODUCTION**

Eastern India covering the states of Orissa, Jharkhand and Andhra Pradesh hosts the major reserve of bauxite ores in our country. In the present work 5 deposits such as Jaldihi, Baphlimali, Lohardaga, Karlapat and Dholkata (Fig. 1) have been taken up for study. Various lithounits hosting the above 5 bauxite deposits are shale at Jaldihi, khondalite at Baphlimali and Karlapat, granite gneiss at Lohardaga and metavolcanics at Dholkata. The general geology, stratigraphy, tectonics, mineralogy, geochemistry etc. have been described by various authors like Rao and Ramam (1979), Banerjee (1983 & 1990), Mohapatra *et al* (1991), Indian Bureau of Mines (1992), Das and Mohanty (1998), Nayak (2002), Nayak *et al* (2002 & 2005), Nayak and Das (2005) and

Nayak and Rajeev (2005). The work on lateritisation and geochemistry has drawn attention from international researchers such as Valetton (1972), Norton (1973), Nesbitt (1979) Bardossy and Aleva (1990) and Romulo *et al* (1993).

Out of 5 deposits studied, Lohardaga is in Jharkhand and other 4 are in Orissa. A number of profiles have been sampled at an interval of 1 metre from soil till reaching lithomarge. Most of the samples are drill cores collected either during drilling or from the available stocks. The present work aims at understanding the distribution of valuable geochemical elements like  $Al_2O_3$ ,  $TiO_2$ ,  $V_2O_5$ ,  $ZrO_2$ ,  $Cr_2O_3$ , Ba, Ga and  $\Sigma REEs$  in the weathering profiles and understanding their distribution patterns through level of concentrations and correlations.

## SAMPLING AND ANALYSIS

Drill core samples were collected from top soil, laterites, bauxites and lithomarge in the bottom at an interval of 1 metre. Each 1-metre sample was taken as the representative of one metre thickness for all profiles. Half of each sample was powdered to extreme fine size by pulveriser and was analysed by XRF for  $\text{Al}_2\text{O}_3$ ,  $\text{TiO}_2$ ,  $\text{V}_2\text{O}_5$ ,  $\text{ZrO}_2$  and  $\text{Cr}_2\text{O}_3$  and by ICPMS (Balaram *et al*, 1996) for Ba, REEs and Ga.

## PROFILE VARIATIONS

All the data generated for profile samples of 5 bauxite deposits have been presented as variation diagrams in Figs. 2-6 and all profile averages are given in Table-1. The details of profile-wise variations and their implications are described below.

### Jaldihi

The Jaldihi profiles cover soil, laterite, bauxite and lithomarge, where the bottommost sample is commonly the lithomarge. Total 10 profiles have been studied for  $\text{Al}_2\text{O}_3$ ,  $\text{TiO}_2$ ,  $\text{V}_2\text{O}_5$ ,  $\text{ZrO}_2$ ,  $\text{Cr}_2\text{O}_3$ , Ba, Ga and total rare earth elements. Variation of all these elements are shown for 4 selected profiles (Fig. 2, profiles P1 to P4).  $\text{Al}_2\text{O}_3$  is the lowest in soil (0-1m depth). P1 is mostly a lateritic profile. P2 exhibits  $\geq 40\%$   $\text{Al}_2\text{O}_3$ , the richest average bauxite profile 46.09%  $\text{Al}_2\text{O}_3$  (Table-1) from 1m depth till lithomarge (12-13m depth), while P3 has laterite up to 7m and then bauxite with the maximum  $\text{Al}_2\text{O}_3$  at 8-9m depth. P4 profile shows the highest enrichment of  $\text{Al}_2\text{O}_3$  at 3-4m depth. Thus, variable trends are observed for  $\text{Al}_2\text{O}_3$  in different profiles. The maximum depth of bauxite sample was

12m. A totally laterite profile is represented by P8.

$\text{TiO}_2$  content in soil is minimum. P1 and P4 profiles have highest  $\text{TiO}_2$  at 1-2m depth and there is a gradual decline downwards while the other two profiles P2 and P3 have enrichments in the bottom half between 7 and 11m depth expressing the deeper bauxite with higher titania. P4 has the highest average  $\text{TiO}_2$  of 3.44%. Random occurrences of high grade bauxites ( $\text{Al}_2\text{O}_3 > 50\%$ ) are seen having  $\text{TiO}_2$  4-5% in this mine.

Lowest  $\text{V}_2\text{O}_5$  occurs in soil and the profile shows relatively uniform concentration and higher values are found at 1-3m and 9-11m depths. Most of the profiles have  $>0.1\%$   $\text{V}_2\text{O}_5$ . P4 profile has the highest average of 0.151%  $\text{V}_2\text{O}_5$  (Table-1).  $\text{ZrO}_2$  is slightly higher in soil than the following laterite or bauxite. The enrichment is observed in deeper profiles of P3 and P4 in bottom zone 7 to 11m depth and these two profiles have the average of 0.048%  $\text{ZrO}_2$ .  $\text{Cr}_2\text{O}_3$  is the lowest in soil. Some profiles exhibit higher concentration in upper zone while others in bottom half. Deep bauxite profiles show an overall increase towards bottom. P9 has the highest average of 0.203%  $\text{Cr}_2\text{O}_3$  (Table-1). The highest Ba is observed in soil which is commonly  $>2000\text{ppm}$ . In the laterites and bauxites of profiles Ba is much lower,  $\sim 25\text{ppm}$  only and exhibits a slight increase in bottom zone. Like Ba soil also shows higher total rare earth elements in comparison to the profile values. There is a slight increase of  $\Sigma\text{REE}$  in the bottom zone. Ga is the lowest in soil but in the topmost layer (1-2m depth) it has the highest concentration ( $>100\text{ppm}$ ) in P4 and then there is a gradual decline towards bottom (Fig. 2), which reveals

enrichment in the upper zone of weathering profile.

### **Baphlimali**

Five profiles have been studied in the present work. Here the profiles are deep and bauxite occurring up to a depth of 32m has been sampled. Variations in two representative profiles P1 and P5 are shown in Fig. 3a and 3b. There is an overall increase of  $Al_2O_3$  from top towards bottom. Commonly below 15 to 20m depth high grade ores are observed. Fluctuations in grade are observed in the top (1-10m) and middle (10-20m) zones. P1 has the highest average  $Al_2O_3$  of 46.62%. The weathering profiles bear low  $TiO_2$  with the highest average of 1.77% in P3. There are 2 main contrasting behaviours of distribution of  $TiO_2$  i.e. P1 showing a narrow fluctuation in the whole profile while in P5 in high grade bauxite zones (below 16m depth), there is a significant decline in  $TiO_2$  contents. The average  $TiO_2$  for all profiles is 1.45%.

$V_2O_5$  has a low value in soil and then it has higher contents in uppermost part and gradually exhibits a decreasing trend towards the bottom of profile with narrow fluctuations. P2 exhibits the highest average of 0.084%  $V_2O_5$ .  $ZrO_2$  generally fluctuates in the range 0.02-0.04% in the whole profile but in the middle (10-20m depth) it has a few extreme values reaching ~0.005% minimum and ~0.06% maximum.  $Cr_2O_3$  shows an overall decline pattern from surface towards bottom of the weathering profile. The highest average value of 0.115% is shown by P2 (Fig. 3a).

The Ba distribution is highly variable in the 3 profiles: P1, P3 and P4 studied for which the average values are

3985ppm, 166ppm and 22ppm (Table-1). The P1 profile shows a very distinct variation where in the bottom zone between 20-25m depth there is very high accumulations of Ba reaching up to 16000ppm at 21m depth (Fig. 3b). This type of enrichment of Ba in bottom zone is rare in Indian bauxite profiles. The total REEs (REE-t) distribution in P1, P3 and P4 show average values of 1144ppm, 115ppm and 92ppm respectively. In P1 between 15-16m depth there is high concentration of REEs reaching >10000ppm (Fig. 3b) indicating selective zonations in deep weathering profiles of Baphlimali. Overall Ga content varies in a relatively narrow range between 40 and 80ppm and bottom zones commonly exhibit a slightly higher concentration (Fig. 3b).

### **Lohardaga**

Total six profiles have been investigated for the Lohardaga belt. A thicker lateritic zone up to a maximum of 8m depth is commonly found on bauxite in different localities.  $Al_2O_3$  exhibits an increasing trend from surface to bottom and the later has the highest contents indicating the occurrence of bauxite in the lower zones of weathering profile. This is also revealed in the P1 and P4 profiles given in Fig. 4. The highest average  $Al_2O_3$  (52.83%) occurs in P2 profile. Some of the profiles are highly lateritic with small bauxite patches.

Concentration of  $TiO_2$  gradually increases in the laterites from top towards bottom and when the bauxite zone is encountered it suddenly rises to 5-10% indicating its enrichment in bauxites. Bottom zone bauxites have commonly the highest contents of  $TiO_2$ . The highest average 8.21%  $TiO_2$  (Table-1) is found in P2 profile.  $V_2O_5$  content follows similar pattern of  $TiO_2$ .

The upper bauxites have higher enrichment of  $V_2O_5$ . The profile P3 has the highest average of 0.319% of  $V_2O_5$ .  $ZrO_2$  shows a gradual decreasing trend from soil downwards in the laterites and in the bauxite zone it has an increasing trend and the highest values are mostly in the bottommost bauxite. P3 profile has the highest  $ZrO_2$  of 0.077%.  $Cr_2O_3$  occurrence is higher in laterites and then showing a decline towards bottom (Fig. 4).

Ba is commonly very high up to ~200ppm in soil zone and in laterites/bauxites it varies in a narrow range near to 35ppm. The bottom zone bauxites have slightly higher Ba (~50ppm, Fig. 4). The total average REEs in the profiles of Lohardaga are commonly >200ppm (Fig. 4) and higher concentrations (>500ppm up to 1500ppm) is mostly observed in the bottom bauxite zone. In the profile there is a gradual decline of  $\Sigma REEs$  from surface towards middle and from bauxite zone it starts increasing with the highest in the deeper bauxites. Profile P4 has the highest average of 379 ppm  $\Sigma REE$ . There is an overall increase of Ga from top towards bottom with a high jump when bauxite zone starts. Profile P5 has the highest average Ga of 93 ppm (Table-1).

### Karlapat

Two representative profiles have been studied in this deposit.  $Al_2O_3$  gradually increases from top to the middle of the profile where richest bauxite (>50%  $Al_2O_3$ ) occurs and then there is a slight decline in the ore grade towards the bottom (Fig. 5). This shows that high grade bauxites are between 10 to 25m depth. Profile distribution of  $TiO_2$  follows the path of  $Al_2O_3$  where the highest contents are in the rich bauxite zone. P1 has average 2.55%  $TiO_2$  in

the profile.  $V_2O_5$  is higher in the lateritic zone and in bauxite it gradually increases from upper bauxite to lower zones (Fig. 5). Soil has lowest  $ZrO_2$  and from laterite downwards there is an overall decline pattern towards the bottom. Higher concentrations of  $ZrO_2$  are seen in the middle zone.  $Cr_2O_3$  is the highest in laterites and in bauxites it declines with an increase in the bottommost part (Fig. 5).

Ba is high (>300 ppm) in soil. In laterites and upper bauxites there is higher concentrations of >200 ppm (Fig. 5). There is a gradual decline in  $\Sigma REE$  from surface to downwards but enrichment of  $\Sigma REEs$  (>100 ppm) in bottom zone is noted. There is a gradual increase of Ga from top to bottom in the profile with middle zone recording the highest.

### Dholkata

It has patchy occurrences of bauxite developed on metavolcanics. One representative profile has been sampled having 6 samples. There is an overall increase of  $Al_2O_3$  from surface downwards (Fig. 6). A decline in  $TiO_2$  towards bottom is distinct.  $ZrO_2$  and  $Cr_2O_3$  exhibit a similar pattern with enrichment while  $V_2O_5$ , REE-t and Ga have reduced concentration in bauxite (Fig. 6). Any relationship is difficult to bring out from analysis results of limited number of samples.

### MEAN ELEMENTAL VALUES AND THEIR IMPLICATIONS

The mean values in individual profiles, mean for all profile data of a deposit and mean for bauxites ( $Al_2O_3 \geq 40\%$ ) of each deposit for all the studied elements are given in Table-1. Baphlimali has 44.35% average  $Al_2O_3$  for profile data. It is the highest among all 5 deposits while average value for

bauxites is 51.33% for Lohardaga deposit which implies that a large section of the studied profiles represent laterites. Average value of  $TiO_2$  for bauxite is minimum i.e. 1.48% for Baphlimali revealing it a low titanium bauxite deposit. 6.03%  $TiO_2$  is the profile average for Lohardaga and bauxites contain an average of 8.23%  $TiO_2$ , which are the highest value among all the deposits studied. Very high quantity of  $TiO_2$  can be recovered as by product from Lohardaga bauxites, which is one of the highest in Indian subcontinent. Jaldihi bauxites have average 3.12%  $TiO_2$ . Average  $TiO_2$  is always higher in bauxite ore in comparison to profile average indicating its enrichment as residual product with  $Al_2O_3$ . On an average 0.294%  $V_2O_5$  occurs in the bauxites of Lohardaga, the highest among the 5 deposits studied. The 2<sup>nd</sup> highest average is 0.131% in Jaldihi bauxite. Again  $ZrO_2$  is the highest in Lohardaga bauxite, which is 0.077%. Average  $ZrO_2$  values for profiles and bauxites are more or less uniform with slightly higher values in bauxite indicating enrichment with  $Al_2O_3$ .  $Cr_2O_3$  is the highest in bauxite of Jaldihi. It has the average value of 0.147%. Here also the profile average is lower than bauxite suggesting enrichment in bauxite, but at all other deposits the profile average of  $Cr_2O_3$  is higher than the bauxite concentration, which shows that laterites bear more  $Cr_2O_3$ . Average Ba content in profiles of Jaldihi, Lohardaga and Dholkata are higher than bauxite indicating its association with soil and laterites. Bauxite has average Ba very high (2089 ppm) at Baphlimali and high at Karlapat. Very high content reveals unusual accumulation of Ba in certain weathering profiles of Baphlimali. Similar high contents of  $\Sigma REE$  are also observed at Baphlimali indicating anomalous zonation which is not

consistent through out the deposit. Highest average Ga of 104 ppm is found in Lohardaga bauxite, but Jaldihi, Baphlimali and Karlapat bauxites contain average Ga 65-73 ppm.

## INTER-ELEMENTAL CORRELATIONS

The correlations of various studied elements with  $Al_2O_3$  have been found out for profile data and bauxites (Table-2). These correlations are based on data generated for all the samples of a given deposit. In profiles,  $TiO_2$  and  $ZrO_2$  exhibit +ve correlations with  $Al_2O_3$  for all the deposits. Strong and +ve correlations are more often found in profile data (Table-2a, Fig. 6). Strong +ve correlations indicate that with the increase of  $Al_2O_3$  the given element increases. A weak +ve correlation is found when the relationship in different individual profiles data are opposing in nature. This interpretation also holds good for weak -ve correlations. In case of strong -ve correlations the element behaves antipathically with  $Al_2O_3$  in the profile data of a deposit revealing its higher concentration in soil and laterites.

The correlations of various elements with  $Al_2O_3$  are given for bauxites ( $Al_2O_3 \geq 40\%$ ) of all the deposits (Table-2b, Fig. 7).  $V_2O_5$ ,  $Cr_2O_3$  and REE-t exhibit a -ve correlation with  $Al_2O_3$  for all the deposits. The -ve correlations are more prevalent in bauxites than profiles and also the value of correlations has been reduced to a large extent in bauxites. The -ve correlations reflect that the high grade ores are commonly depleted in minor and trace elements and higher concentrations are found in the bauxites having  $Al_2O_3$  40-50%.

## RESOURCE IMPLICATIONS

The detailed profile study reveals that highest grade bauxites are prevalent in bottom and middle zones in some of the weathering profiles. Although  $\text{Al}_2\text{O}_3$  is the main resource, other elements occur in appreciable quantities associated with bauxite which should also be considered as a part of total valuable elements. In this regard average  $\text{TiO}_2$  content of 8.23% in bauxites of Lohardaga is a major resource and in addition to this >2.5%  $\text{TiO}_2$  occurring in Jaldihi, Baphlimali and Karlapat may also be considered. Average  $\text{V}_2\text{O}_5$  contents of 0.294% in Lohardaga bauxite and 0.131% in Jaldihi bauxite may also be our resources. Average  $\text{ZrO}_2$  0.077%, Ga 104ppm and  $\Sigma\text{REE}$  504ppm of Lohardaga and 0.147%  $\text{Cr}_2\text{O}_3$  of Jaldihi could be resources for recovery. More than 10000ppm of Ba and  $\Sigma\text{REE}$  of Baphlimali in localized zones must also be major resources and their extent should be studied for a detailed evaluation and understanding.

## CONCLUSIONS

- (1) The study shows that the high grade bauxite is found in the bottom or middle of the profile.
- (2) The trends of variation of other geochemical parameters such as  $\text{TiO}_2$ ,  $\text{V}_2\text{O}_5$ ,  $\text{ZrO}_2$ ,  $\text{Cr}_2\text{O}_3$ , Ba, Ga and  $\Sigma\text{REE}$ s in a weathering profile are variable depending on locations.
- (3) Elemental zonations are distinct in many profiles and more so in deeper ones. Baphlimali has enriched zones of Ba and  $\Sigma\text{REE}$ s, which are noteworthy.
- (4) High average contents of  $\text{TiO}_2$  (2.5-8.23%),  $\text{V}_2\text{O}_5$  (0.13-0.29%),  $\text{ZrO}_2$  (0.077%), Ga (104 ppm),  $\text{Cr}_2\text{O}_3$  (0.147%), Ba and  $\Sigma\text{REE}$  (each >10000ppm) occurring with bauxites add value to the resources.

(5)  $\text{Al}_2\text{O}_3$  commonly has higher correlation with other studied elements in profile samples in comparison to only bauxites ( $\text{Al}_2\text{O}_3 \geq 40\%$ ) of profiles. Most of the correlations in bauxite are -ve suggesting depletion of other elements in high grade bauxites ( $\text{Al}_2\text{O}_3 \geq 50\%$ ).

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Table-1 : Mean values for Al<sub>2</sub>O<sub>3</sub>, TiO<sub>2</sub>, V<sub>2</sub>O<sub>5</sub>, ZrO<sub>2</sub>, Cr<sub>2</sub>O<sub>3</sub>, Ba, REE-total and Ga in eastern Indian weathering profiles hosting bauxite deposits. P1 to P10 are different profiles. Bauxite means Al<sub>2</sub>O<sub>3</sub> ≥ 40%.

1. Al <sub>2</sub> O <sub>3</sub> (%)	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	All profiles	Bauxite
Jaldihi	35.98	46.09	40.47	41.13	42.96	39.10	41.38	20.82	34.25	39.83	38.30	45.84
Baphlimali	46.62	37.76	44.52	44.70	44.45	-	-	-	-	-	44.35	47.79
Lohardaga	34.14	52.83	45.10	37.13	40.59	49.44	-	-	-	-	42.55	51.33
Karlapat	38.48	38.23	-	-	-	-	-	-	-	-	38.39	46.16
Dhokkata	36.75	-	-	-	-	-	-	-	-	-	36.75	43.56
2. TiO <sub>2</sub> (%)	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	All profiles	Bauxite
Jaldihi	2.29	3.18	2.47	3.44	2.85	2.35	2.35	0.97	2.31	2.12	2.41	3.12
Baphlimali	0.88	1.52	1.77	1.64	1.48	-	-	-	-	-	1.45	1.48
Lohardaga	4.08	8.21	7.63	4.72	6.12	6.47	-	-	-	-	6.03	8.23
Karlapat	2.55	2.24	-	-	-	-	-	-	-	-	2.45	2.61
Dhokkata	2.41	-	-	-	-	-	-	-	-	-	2.41	2.74
3. V <sub>2</sub> O <sub>5</sub> (%)	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	All profiles	Bauxite
Jaldihi	0.115	0.104	0.112	0.151	0.117	0.117	0.117	0.034	0.116	0.105	0.107	0.131
Baphlimali	0.049	0.084	0.079	0.065	0.072	-	-	-	-	-	0.070	0.067
Lohardaga	0.142	0.287	0.319	0.193	0.229	0.246	-	-	-	-	0.229	0.294
Karlapat	0.072	0.074	-	-	-	-	-	-	-	-	0.073	0.075
Dhokkata	0.093	-	-	-	-	-	-	-	-	-	0.093	0.094
4. ZrO <sub>2</sub> (%)	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	All profiles	Bauxite
Jaldihi	0.030	0.048	0.048	0.047	0.040	0.043	0.043	0.010	0.033	0.039	0.038	0.050
Baphlimali	0.035	0.029	0.049	0.044	0.036	-	-	-	-	-	0.039	0.044
Lohardaga	0.058	0.074	0.077	0.050	0.058	0.064	-	-	-	-	0.062	0.077
Karlapat	0.049	0.045	-	-	-	-	-	-	-	-	0.048	0.049
Dhokkata	0.018	-	-	-	-	-	-	-	-	-	0.018	0.019
5. Cr <sub>2</sub> O <sub>3</sub> (%)	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	All profiles	Bauxite
Jaldihi	0.135	0.118	0.166	0.093	0.096	0.167	0.124	0.028	0.203	0.151	0.132	0.147
Baphlimali	0.032	0.115	0.060	0.067	0.049	-	-	-	-	-	0.061	0.043
Lohardaga	0.054	0.043	0.050	0.062	0.073	0.088	-	-	-	-	0.062	0.051
Karlapat	0.049	0.049	-	-	-	-	-	-	-	-	0.049	0.047
Dhokkata	0.113	-	-	-	-	-	-	-	-	-	0.113	0.126
6. Ba (ppm)	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	All profiles	Bauxite
Jaldihi	-	-	-	326.1	244.3	-	-	-	-	243.4	270.0	25.2
Baphlimali	3985.3	-	166.4	21.9	-	-	-	-	-	-	1521.2	2089.0
Lohardaga	74.6	-	-	66.0	42.6	-	-	-	-	-	60.7	34.5
Karlapat	127.3	173.6	-	-	-	-	-	-	-	-	142.7	170.7
Dhokkata	24.9	-	-	-	-	-	-	-	-	-	24.9	22.1
7. REE-t (ppm)	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	All profiles	Bauxite
Jaldihi	-	-	-	65.6	57.6	-	-	-	-	72.6	64.9	61.3
Baphlimali	1144.1	-	115.5	92.3	-	-	-	-	-	-	485.0	656.5
Lohardaga	269.8	-	-	379.2	281.3	-	-	-	-	-	317.9	504.0
Karlapat	117.4	152.4	-	-	-	-	-	-	-	-	129.0	131.4
Dhokkata	58.5	-	-	-	-	-	-	-	-	-	58.5	55.0
8. Ga (ppm)	P-1	P-2	P-3	P-4	P-5	P-6	P-7	P-8	P-9	P-10	All profiles	Bauxite
Jaldihi	-	-	-	67.6	51.5	-	-	-	-	57.3	58.5	65.9
Baphlimali	68.8	-	70.7	67.9	-	-	-	-	-	-	69.2	72.9
Lohardaga	74.1	-	-	80.3	92.6	-	-	-	-	-	82.6	103.8
Karlapat	60.0	58.6	-	-	-	-	-	-	-	-	59.5	69.0
Dhokkata	48.4	-	-	-	-	-	-	-	-	-	48.4	40.0

**Table-2 : Correlations of various elements with  $Al_2O_3$ .**

(a) In profile data of different localities hosting bauxite deposits.							
	TiO <sub>2</sub>	V <sub>2</sub> O <sub>5</sub>	ZrO <sub>2</sub>	Cr <sub>2</sub> O <sub>3</sub>	Ba	REE-t	Ga
Jaldihi	+0.77	+0.61	+0.53	+0.49	-0.68	-0.34	+0.65
Baphlimali	+0.01	-0.30	+0.62	-0.62	+0.29	+0.23	+0.33
Lohardaga	+0.87	+0.70	+0.78	-0.24	-0.61	+0.39	+0.70
Karlapat	+0.38	+0.23	+0.35	+0.06	-0.21	-0.19	+0.80
Dhokkata	+0.39	-0.41	+0.77	+0.90	+0.09	-0.73	-0.54
(b) In bauxite ( $Al_2O_3 \geq 40\%$ ) data of different localities.							
	TiO <sub>2</sub>	V <sub>2</sub> O <sub>5</sub>	ZrO <sub>2</sub>	Cr <sub>2</sub> O <sub>3</sub>	Ba	REE-t	Ga
Jaldihi	+0.55	-0.01	+0.63	-0.17	-0.31	-0.12	-0.14
Baphlimali	-0.18	-0.25	+0.37	-0.44	+0.21	-0.16	+0.18
Lohardaga	+0.09	-0.42	+0.56	-0.07	-0.39	-0.29	-0.54
Karlapat	-0.31	-0.68	-0.07	-0.75	-0.60	-0.57	+0.41

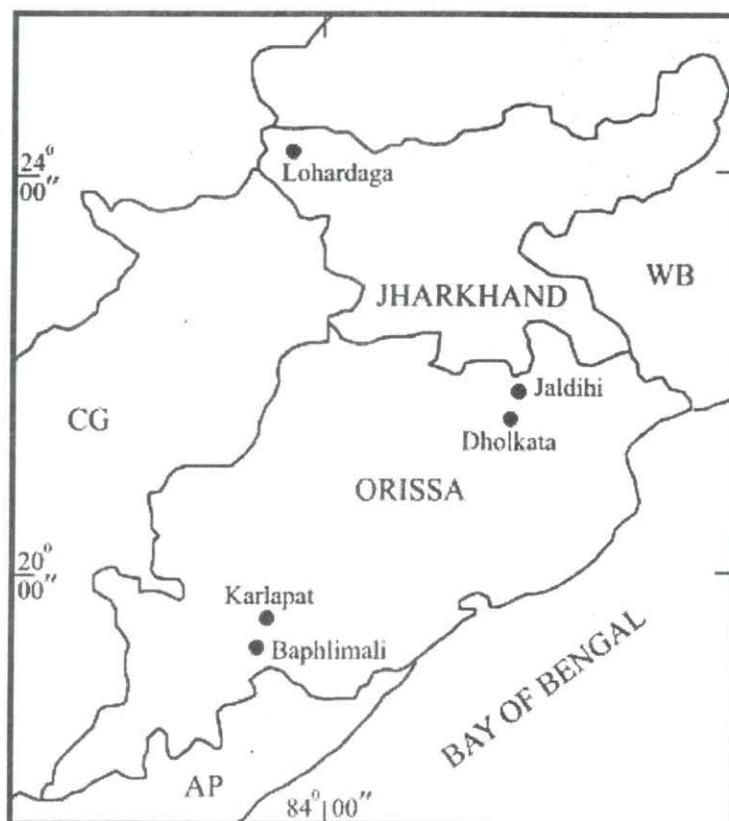
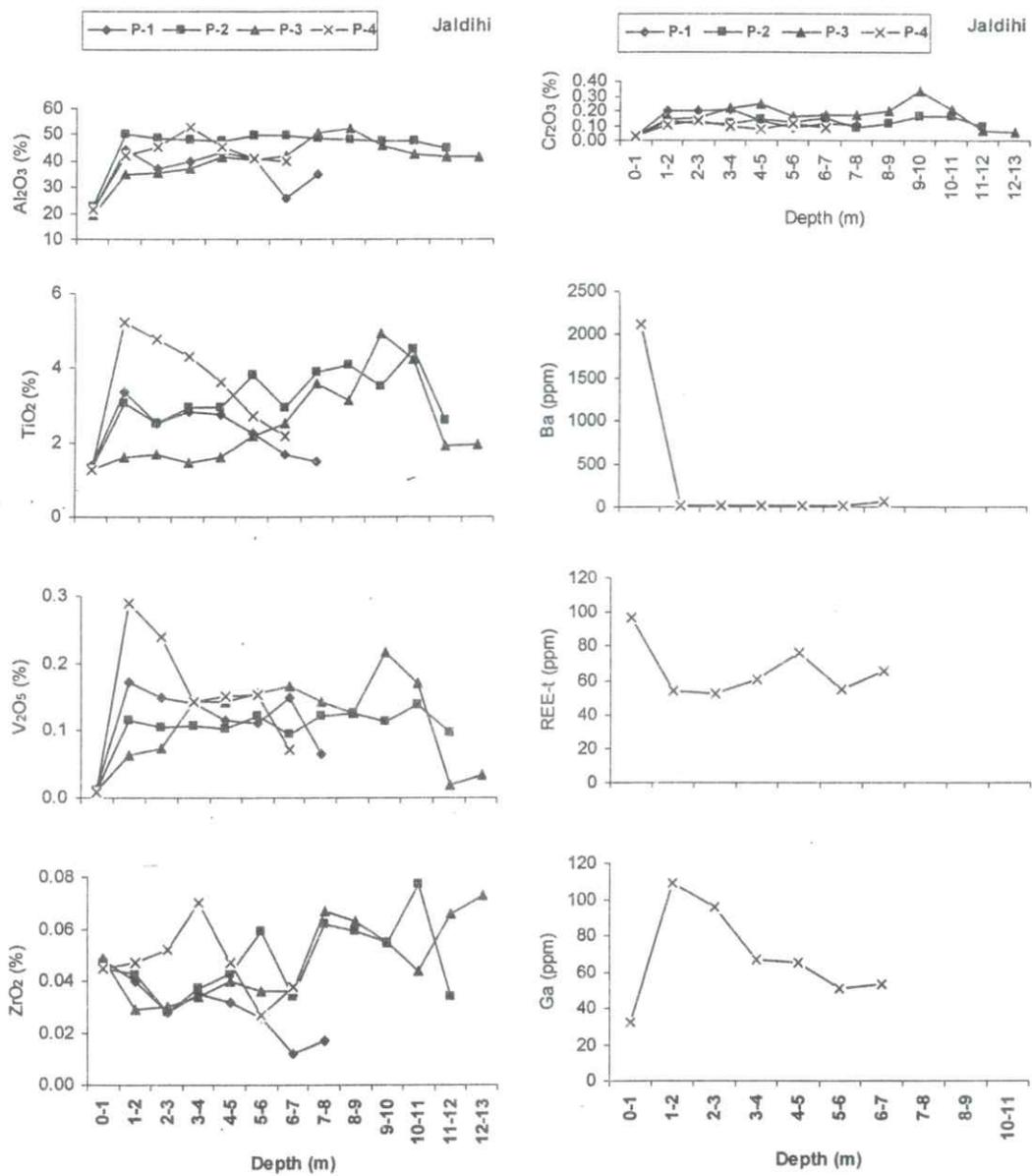
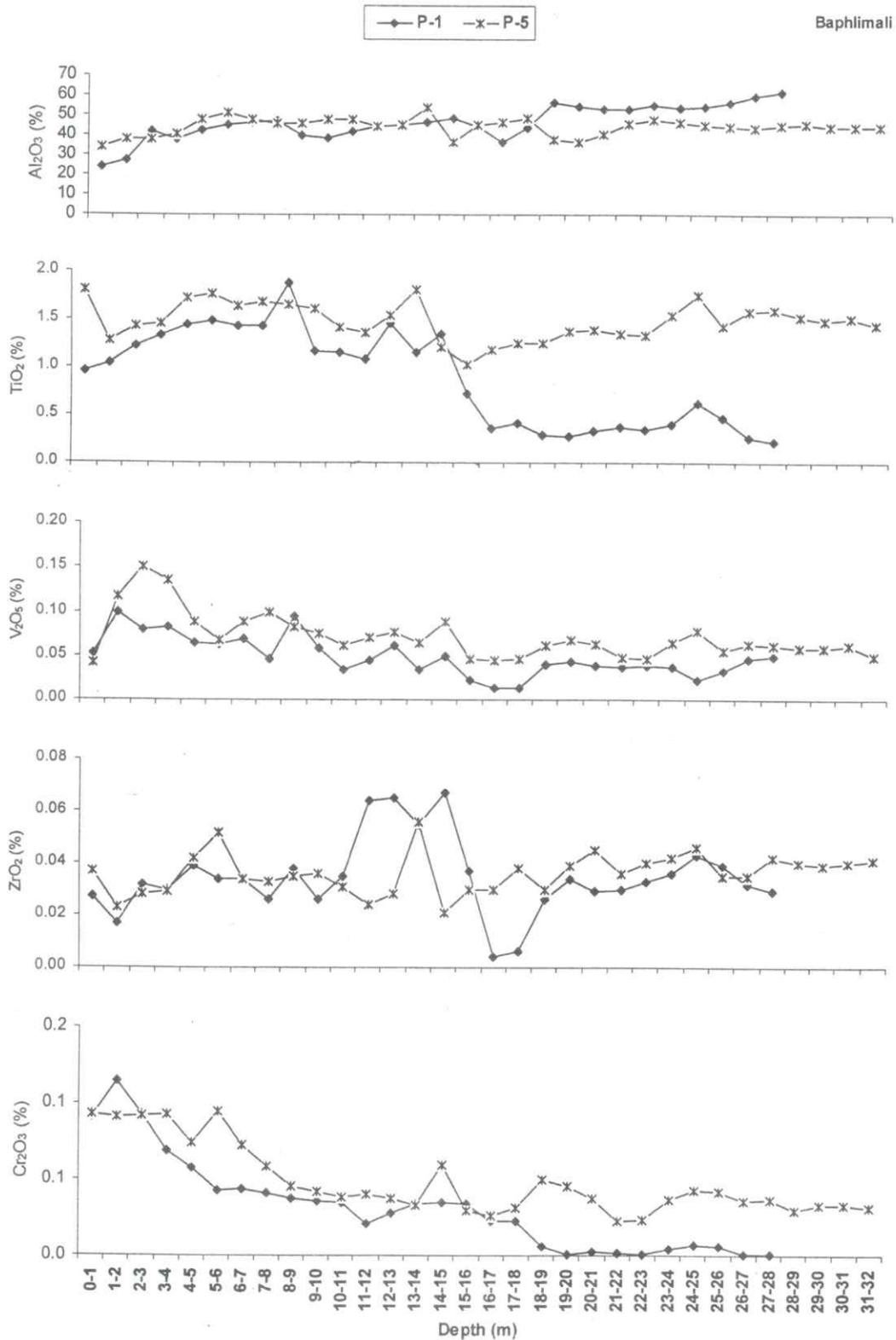


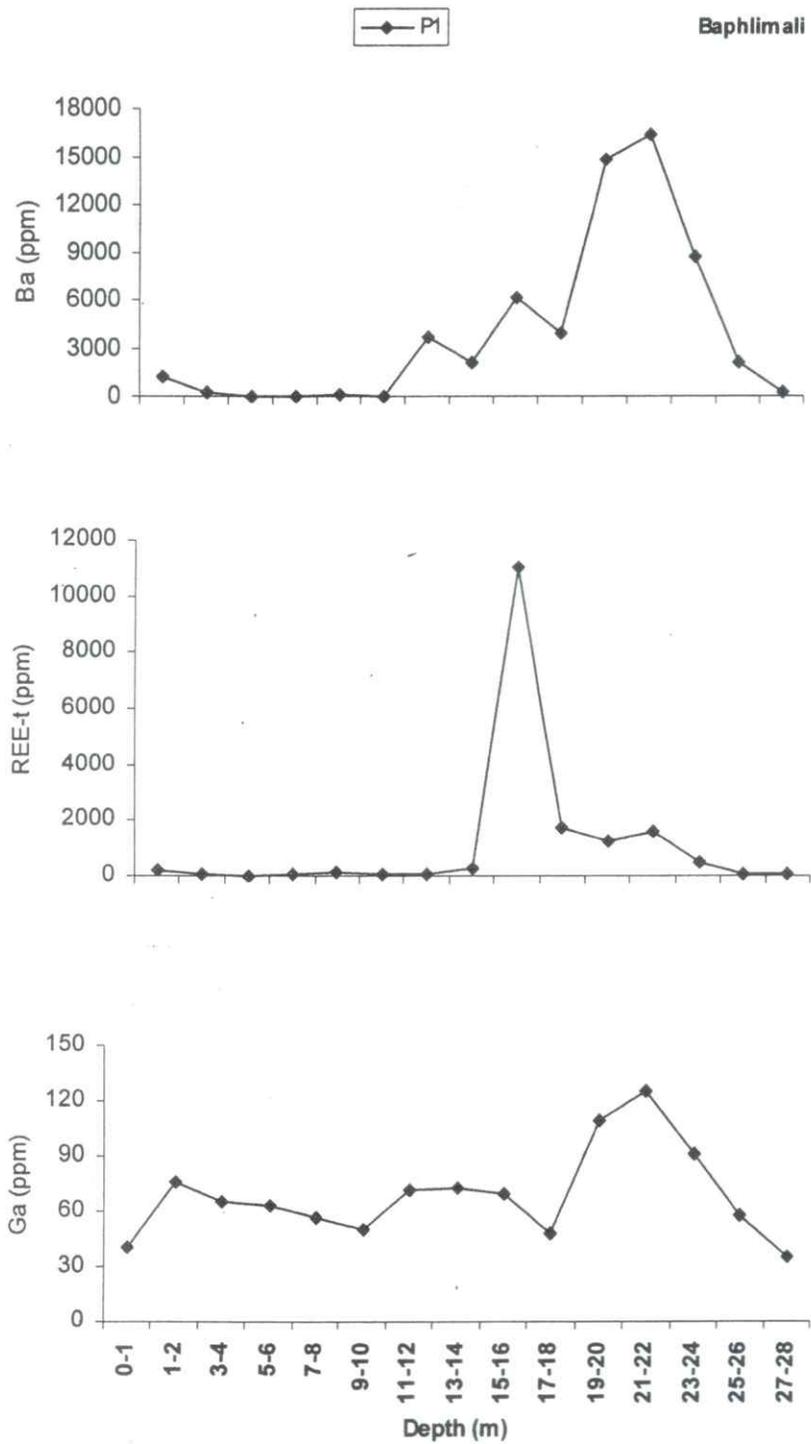
Fig. 1 : Location map of 5 bauxite deposits Jaldihi, Baphlimali, Lohardaga, Karlapat and Dhokkata in eastern India.



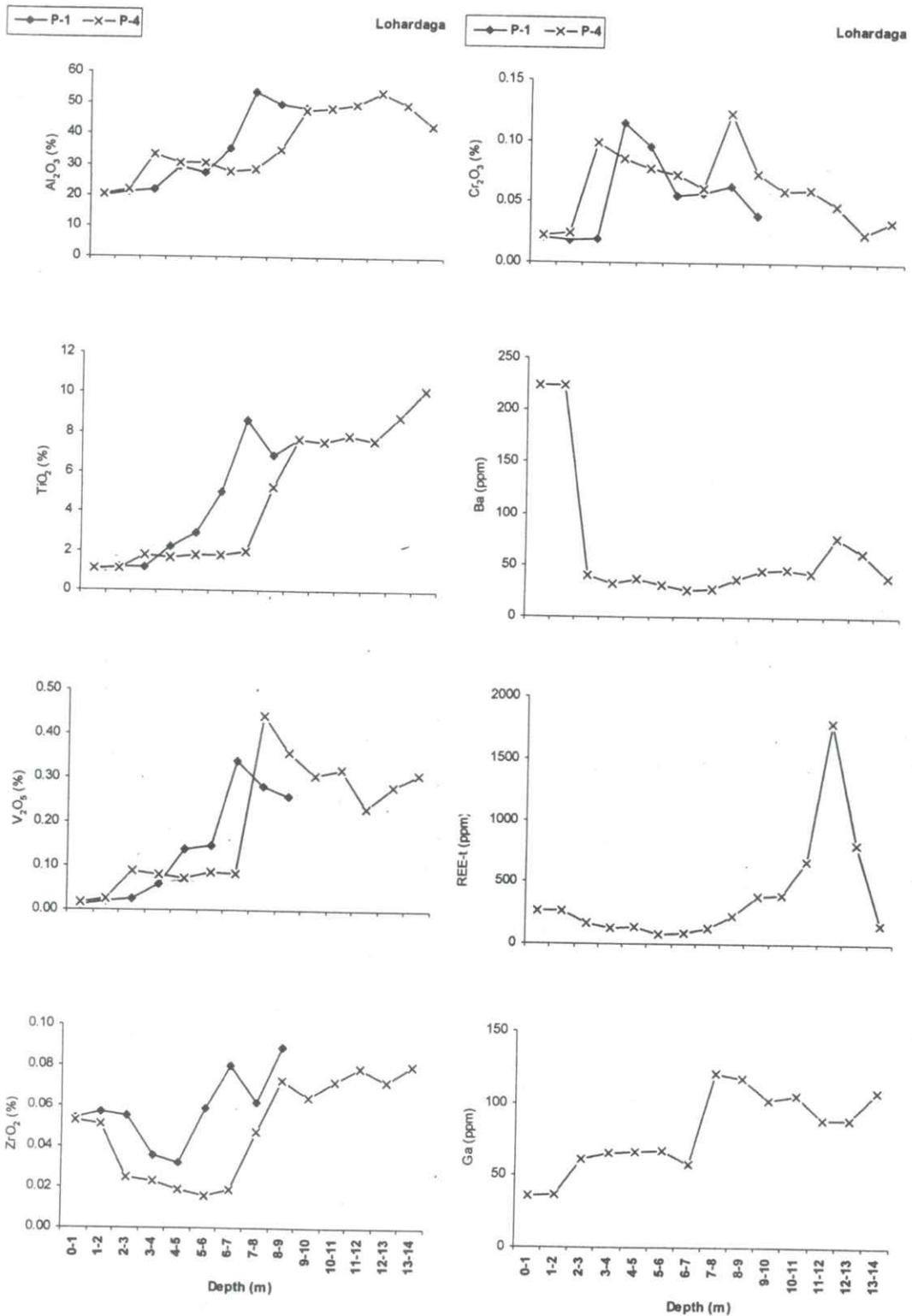
**Fig. 2** Variation of Al<sub>2</sub>O<sub>3</sub>, minor and total REEs in representative weathering profiles (P1 to P4) of Jaldihi, Orissa Results of Ba, total REE and Ga are given for P4 only.



**Fig. 3a** Variation of Al<sub>2</sub>O<sub>3</sub> and minor elements in representative weathering profiles (P1 & P5) of Baphlimali, Orissa



**Fig. 3b** Variation of Ba, REE-total and Ga in representative weathering profile P1 of Baphlimali, Orissa.



**Fig. 4** Variation of Al<sub>2</sub>O<sub>3</sub>, minor and total REEs in representative weathering profiles (P1 & P4) of Lohardaga, Jharkhand. Results of Ba, total REE and Ga are given for P4 only.

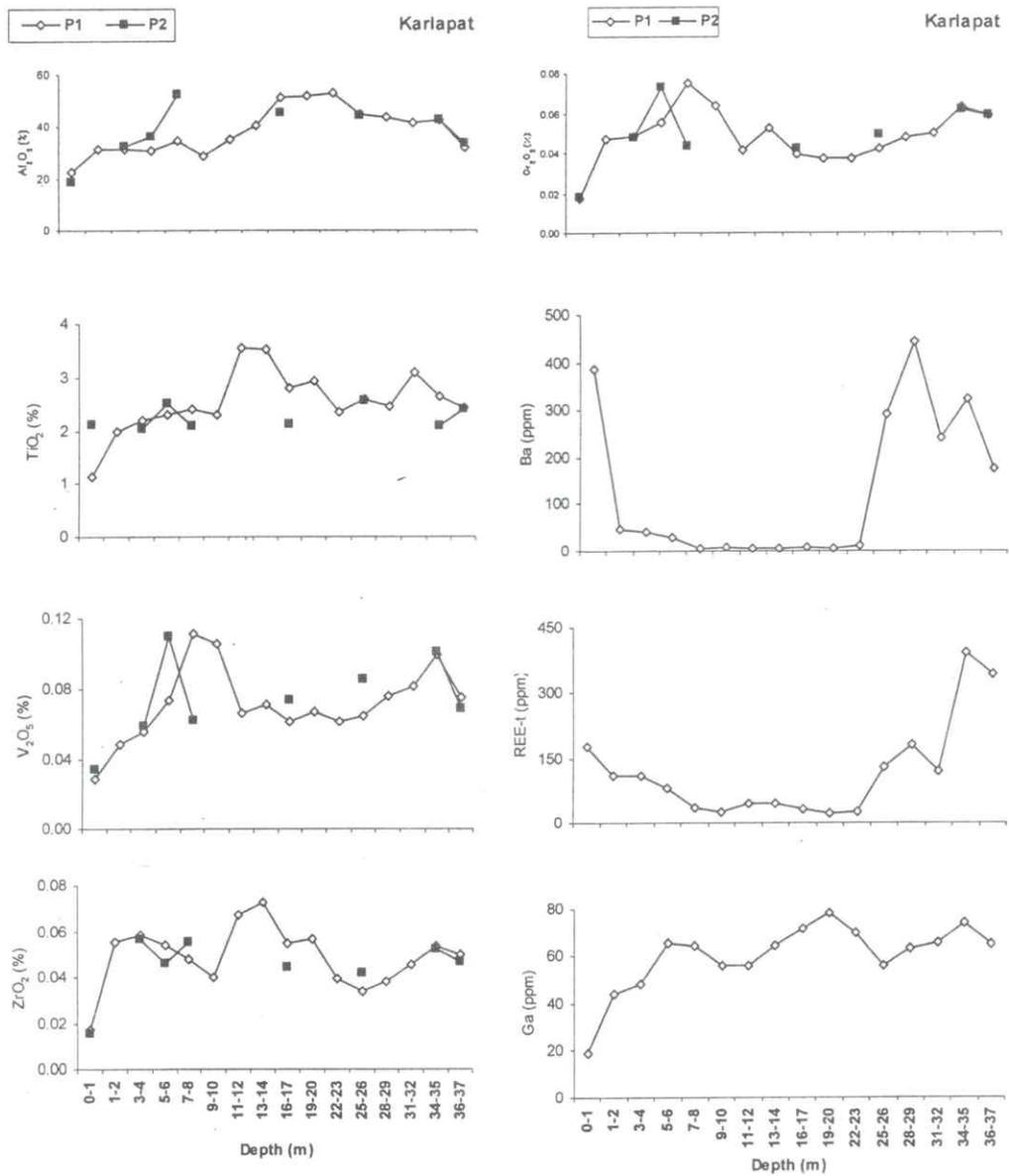
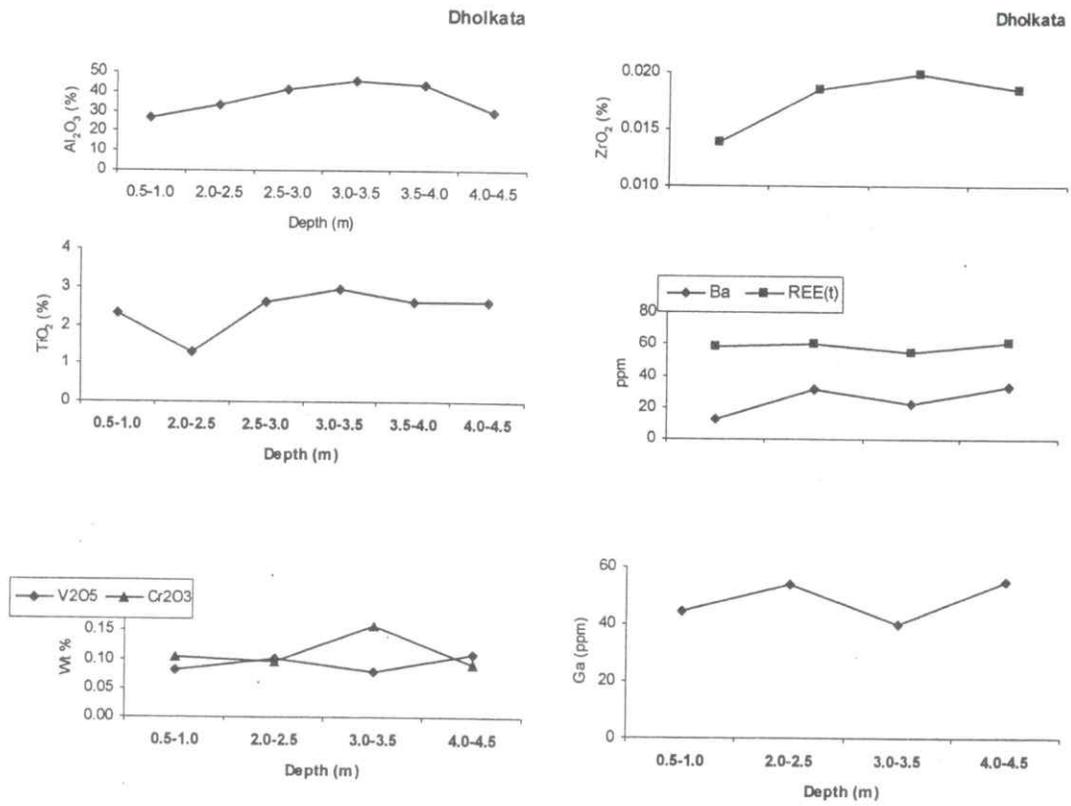


Fig. 5 Variation of  $Al_2O_3$ , minor elements and REE-total in weathering profiles (P1 and P2) of Karlapat, Orissa. Results of Ba, total REEs and Ga are given for P1 only.



**Fig. 6** Variation of Al<sub>2</sub>O<sub>3</sub>, minor elements and REE-total in a representative weathering profile of Dholkata, Orissa

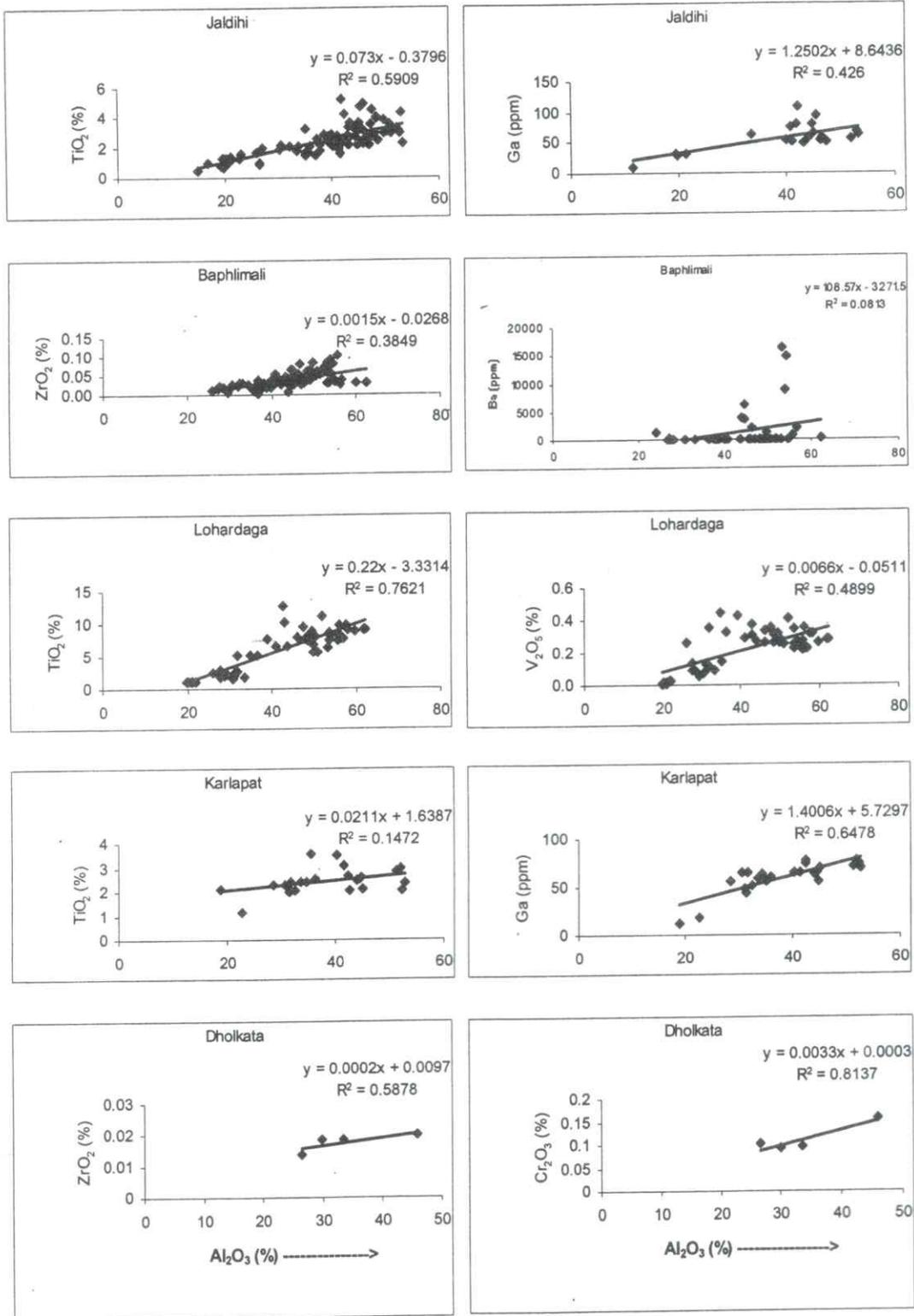


Fig. 7 Selected correlations of elements with  $Al_2O_3$  in profiles of various localities.

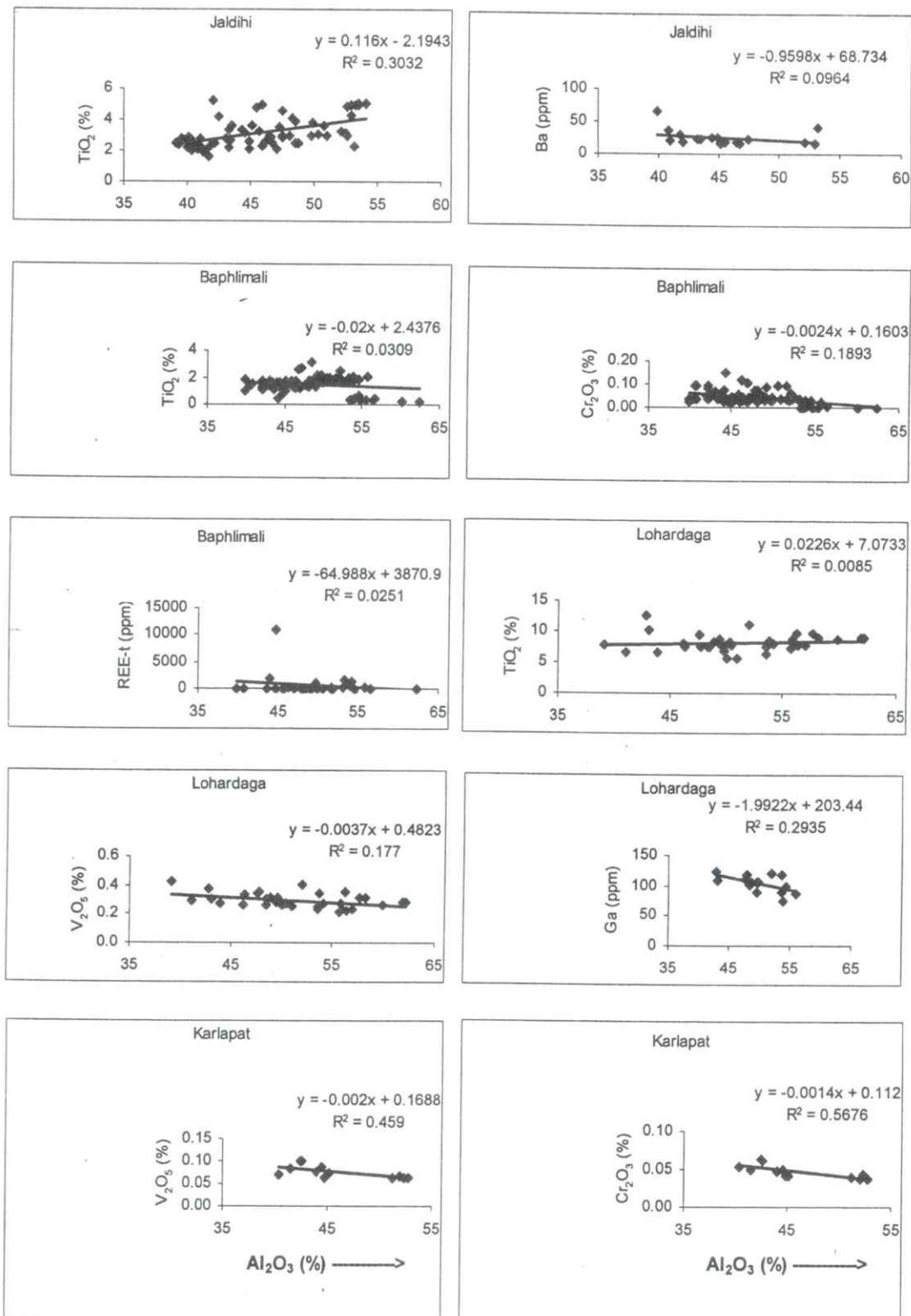


Fig. 8 Selected correlations of elements with  $Al_2O_3$  in bauxites ( $Al_2O_3 \geq 40$ ) of various localities.

## RESERVE ESTIMATION OF PROPOSED OPENCAST MINE OF RAMNAGORE COLLIERY

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### ABSTRACT

*As jhama and burnt coal are saleable items with sizeable demand in different small and medium scale industries, the management of Ramnagore Colliery of Steel Authority of India Ltd. (SAIL) has decided to mine jhama, burnt coal, coal and the strata of jhama intruded by mica peridotite from Salanpur D-2, Salanpur D-1 and Salanpur C seams in a-block near north-eastern boundary of the colliery, covering a total area of around 22.01 hectare. The proposed mine is located in Ramnagore part of Indikatta-Ramnagore Block on the eastern bank of the Barakar River in Raniganj Coalfield. This paper describes the methodology of reserve estimation along with estimation of pit life, waste and stripping ratio.*

*Geological report by Central Mine Planning & Design Institute Ltd. (CMPDI) in 1995 forms the basis of the geological information of the area. The report indicates that due to pyrolysis, the seams have been transformed into a combination of layers of jhama, burnt coal, coal and the layers of jhama intruded by mica peridotite. Of the 15 boreholes in and around the proposed opencast mining site, lithologs of only 13 boreholes are available with the mine management and only 8 boreholes fall inside the proposed mining area. The classification of seams in the lithology of the boreholes is neither very clear, nor very convincing.*

*The results indicate that it would be much more economic to mine the site en bloc than to mine Western and Eastern blocks separately leaving a 90 m wide barrier in between them to protect the existing high voltage electric supply line. In isolation, the West Block, which covers nearly two-third of the whole site, will run for two-and-half years, producing a little more than 40% of the total mineable reserve of the whole site and generating 63% of the total waste likely to be generated had the whole site been mined as one. Overall stripping ratio of the Western Block will be 8.36 m<sup>3</sup>/t, i.e. nearly one and half times of the stripping ratio of 5.47 m<sup>3</sup>/t expected for the mining of the whole site in one go. The Eastern block that covers only about 15% of the whole site will result in production for only two months. The production will comprise not even 3% of the total mineable reserve in the whole site, that too with a high overall stripping ratio of 12.82 m<sup>3</sup>/t. On the other hand, if the whole site is mined en bloc, the mine is likely to run for six years yielding more than 0.7 million tonne of minerals (coal, burnt coal and jhama together) with a stripping ratio of 5.47 m<sup>3</sup>/t approximately.*

**Key Word:** Coal, Reserve Estimation, Opencast Mining

### INTRODUCTION

Ramnagore Colliery of Steel Authority of India Ltd. (SAIL) is located in Ramnagore part of Indikatta-Ramnagore Block on the eastern bank of the Barakar River in Raniganj Coalfield. Three seams, namely Salanpur D-2, Salanpur D-1 and Salanpur C, outcrop/incrop near the northern and northeastern boundary of the colliery where a few major faults run drawing natural limits of mining

(Ghose et al 2007). As reported by the Exploration Division of Central Mine Planning & Design Institute Ltd. (CMPDI in 1995) in their Geological Report on Exploration for Coal in Indikatta-Ramnagore Block, most of the coal seams in this block have been affected by sills and dykes of mica peridotite to a varying extent. Consequently, the mining potential of the coal seams has been impaired. All

seams have been mostly pyrolysed in the entire block. However, only the bottom part of Salanpur C seam is available in a small area along northeastern boundary of the block. The colliery management has decided to mine *jhama*, burnt coal, coal and the strata of *jhama* intruded by

mica peridotite from Salanpur D-2, Salanpur D-1 and Salanpur C seams near northeastern boundary of the proposed colliery, shown as ABCDEFGHIJ in Fig. 1, covering a total area of around 22.01 hectare.

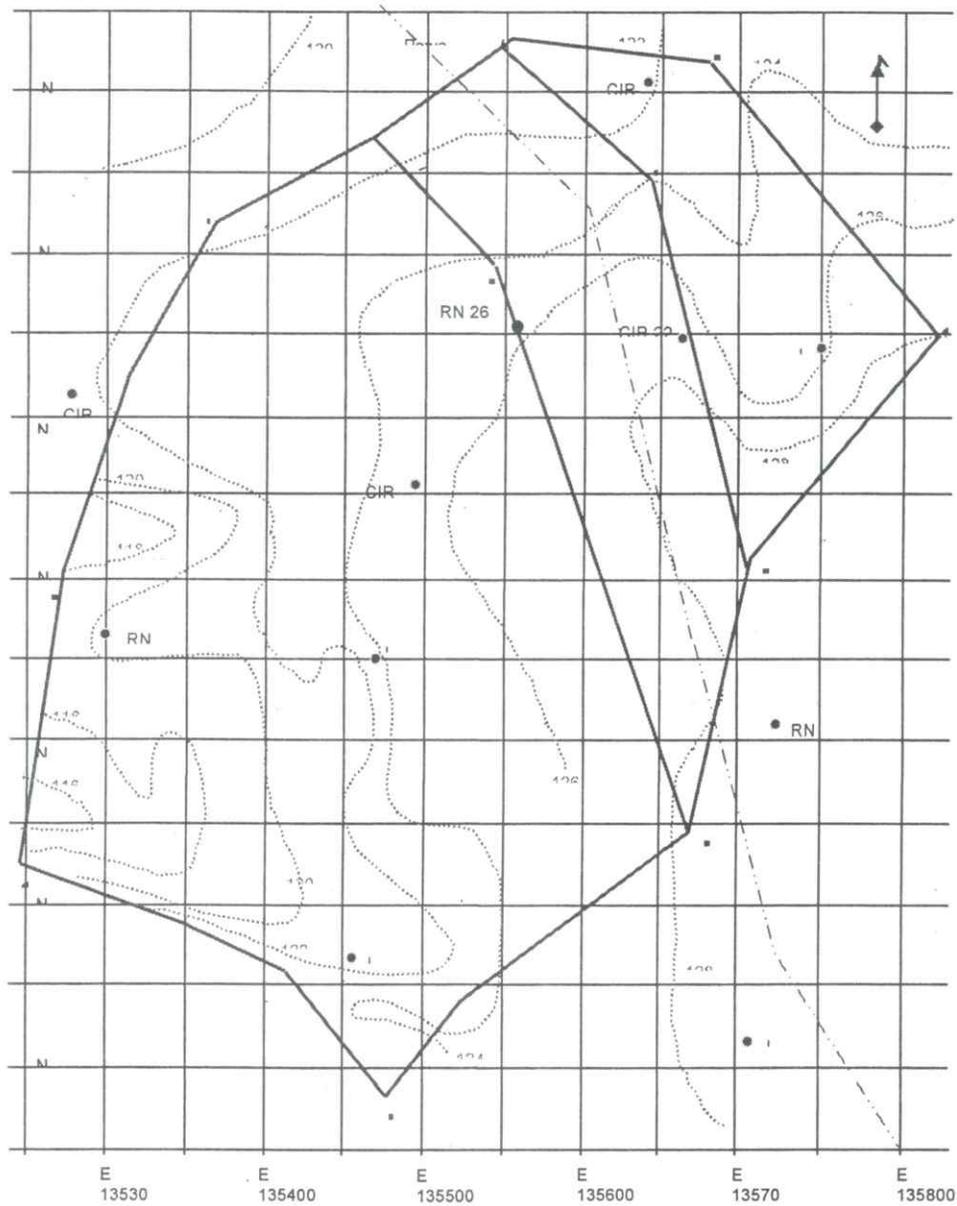


Fig. 1: Part plan of Ramnagore Colliery showing the proposed site ABCDEFGHIJ for surface mining of Salanpur D2, Salanpur D1 and Salanpur C seams

An overhead high tension electric supply line runs obliquely across this area. It is being planned to shift this electric line beyond the area ABCDEFGHIJ, leaving a minimum margin of 45 m from its boundary at any point. However, it has also been alternatively thought that if the high tension line cannot be shifted, the area ABCDEFGHIJ will be worked in two blocks, namely EFGHIJK and ABCDL, of area in the order of 14.68 hectare and 3.24 hectare respectively, leaving a 90 m wide ALDEKJ space of about 4.09 hectare area below the high tension electric line unmined to keep the limits of mining excavations at a minimum distance of 45 m from the present position of this high tension line (Fig. 1). The production from this mine is proposed at the rate of 11,200 tonnes per month.

#### **DATA ACQUISITION AND FIELD OBSERVATION**

Relevant topographical and geological information were obtained from the Geological Report prepared by CMPDI. Site visit was undertaken to collect on-field information about the seams and geological features encountered in the already opened portion of the proposed mine. Supplementary information such as proposed location of the mine opening, quality of the coal and typical proportion of recovery of mineral from

the layers of *jhama* intruded by mica peridotite was obtained by discussion with the mine official. These are summarised below:

The ground surface is mildly undulating with a gentle slope towards south-west. Block EFGHIJK has already been opened at its northern end, near the points I, J and K (Fig.1). Exposures in existing mining excavations indicate existence of local faults within the study area. Frequent faulting has resulted in irregularity in dip and thickness of seams in this area, making the precise identification of seams very difficult. Though general dip of the concerned seams in this area is along S 18° W, the seam/s appeared to be much steeper and varying in direction at the site where the mine has been opened.

Core drilling was conducted in 15 boreholes in and around the proposed mining site. Of these boreholes, only 8 boreholes are inside the proposed mining area. Rest 7 boreholes are located outside the concerned area. Five of these boreholes are located 120 to 155 m away from the area ABCDEFGHIJ, on east or on west, while the maximum stretch of this area along east-west at any place does not exceed 490 m. Lithologs are available with the mine management for 13 boreholes (Table 1).

**Table 1: Core drilled boreholes in and around the proposed opencast mining site**

CORE-DRILLED BOREHOLES INSIDE AREA ABCDEFGHIJ		CORE-DRILLED BOREHOLES OUTSIDE AREA ABCDEFGHIJ	
Borehole	Location	Borehole	Location
IK-2**	Near the southern extreme	IK-1	On southeast corner, about 130 m away
IK-4**	On N 103350, near the middle of the width	IK-3	120 m away from the eastern boundary
IK-5**	About 70 m inside the eastern extreme	IK-8T	On N 103450, about 155 m away on west
CIR-21**	Near the centre	CIR-10	On N 103290, about 125 m away on west
CIR-22**	Near N 103550, E 135650	CIR-19**	About 35 m away on west
CIR-24**	Near the northern extreme		
RN-26 <sup>X</sup>	Almost along N 103600, in the middle	RN-22**	40 m away on the east
RN-29**	Near the western boundary	DB-4 <sup>X</sup>	155 m away from the eastern boundary
** Refer Fig. 1		<sup>X</sup> No data available	

Eight boreholes (out of which no data is available for borehole RN-26) inside the proposed mining area are too less in number compared to the geological disturbances present in this area. Further, these boreholes are irregularly placed. It is more so in its southern part. While the proposed mining area extends from the south of N 103100 to beyond N 103700, there is only one core-drilled borehole, viz. IK-2, inside the property on the south of N 103350. Floor contour of Salanpur C seam is not available with the mine management. The classification of seams in the lithology of the borehole logging is not very convincing. The mine management conducted some non-core drilling primarily in the northern part of the area. However, information available from these boreholes is of little

use. Mine management has no programme for fresh/additional exploratory drilling in this area. The problem therefore is complicated because of geological complexity of the site and inadequate geological database available with the mine management.

## METHODOLOGY

As it is not possible to isolate the three seams very clearly and reliably from the available lithologs, especially the locations of their incrop/outcrop, all the three seams are taken together as "mineralised zone".

The mine officials intimated that 100% of layers of coal, burnt coal and *jhama* are recoverable. They also informed that

from the layers of *jhama* intruded with mica peridotite usually 30 to 40% is recovered. Accordingly in our estimation percentage of recovery is considered as 100, 100, 100 & 30 for coal, burnt coal, *jhama* and *jhama* with mica peridotite respectively. The average density of recoverable mineral is uniformly taken as  $1.4 \text{ t/m}^3$  (estimate of average density

of  $1.4 \text{ t/m}^3$  is provided by the mine management).

From the available lithologs and data, for each of the thirteen boreholes mineralised zone has been identified, depth of overburden has been determined, and percentage of recoverable mineral and amount of interburden have been estimated.

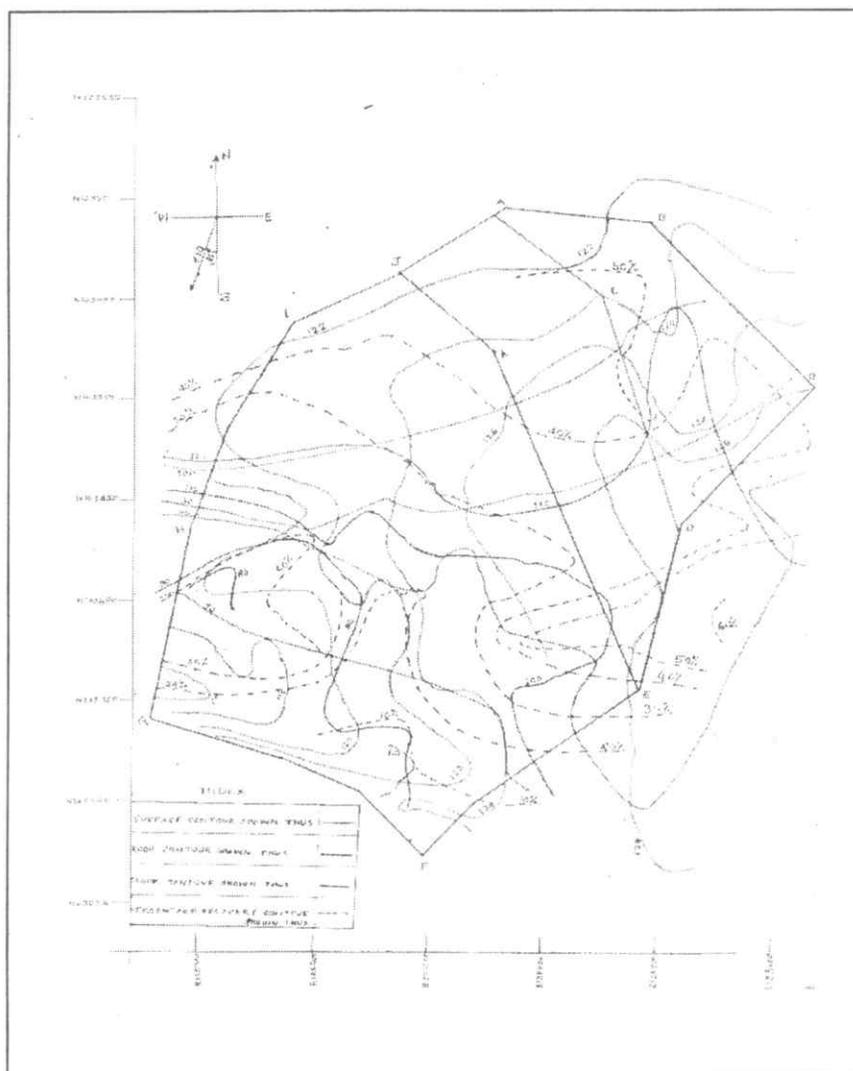


Figure 2: Part plan of Ramnagore Colliery showing surface contour; contours of roof, floor and mineral recovery percentage of mineralised zone in ABCDEFGHIJ

Using data available for 13 boreholes, 18 sections are drawn to extrapolate the data to cover the whole area. Contours of roof, floor and recovery percentage of the mineralised zone for the area ABCDEFGHIJ are prepared (Fig. 2).

Considering mining down the dip, the whole exercise was carried out by taking up the calculation for one block in each stage (the blocks are Western Block EFGHIJK, Eastern Block ABCDL, and the whole site ABCDEFGHIJ). The steps included (a) design of ultimate pit configuration with 45° as ultimate pit slope gradient, without any consideration of benching in ultimate pit slope, (b) preparation of a section of the block along the average dip direction of the seam/s or mineralised zone, (c) estimation of total recoverable mineral, interburden and overburden in the given block, (d) identification of the stretches of the mineralised zone to be mined in each month in the block to produce 11,200 tonnes of recoverable mineral, (e) estimation of corresponding yields of overburden and interburden in each month, and (f) calculation of stripping ratio, both month-wise as well as overall.

## RESULTS

The summary of the results for the Western Block EFGHIJK, the Eastern Block ABCDL, and the whole site ABCDEFGHIJ are given in Tables 2, 3 & 4 respectively. The production of first month is planned a bit low in case of

blocks EFGHIJK and ABCDEFGHIJ to take care of the ancillary work involved during opening of the mine.

Life of the pit EFGHIJK is about 2.5 years. In this period it will produce *jhama*, coal and burnt coal in excess of 3,20,000 tonne. Simultaneously the yield of total waste will be beyond 27,00,000 m<sup>3</sup>, of which more than 75% will be directly obtained as overburden and the rest will be generated as interburden. Stripping ratio is likely to vary from 5.14 to 16.83 m<sup>3</sup>/t, and overall stripping ratio is estimated to be 8.36 m<sup>3</sup>/t (Table 2).

Life of the pit ABCDL is about 2 months. In this period it will produce *jhama*, coal and burnt coal in excess of 22,000 t. Simultaneously the yield of total waste will be beyond 2,85,000 m<sup>3</sup>, of which about 85% will be directly obtained as overburden and the rest will be generated as interburden. Stripping ratio is likely to vary from 11.40 to 14.23 m<sup>3</sup>/t, and overall stripping ratio is estimated to be 12.82 m<sup>3</sup>/t (Table 3).

Life of the pit ABCDEFGHIJ is about 6 years. In this period it will produce *jhama*, coal and burnt coal in excess of 7,85,000 tonne. Simultaneously the yield of total waste will be more than 43,00,000 m<sup>3</sup>, of which about 65% will be directly obtained as overburden and the rest will be generated as interburden. Stripping ratio is likely to vary from 0.99 to 11.52 m<sup>3</sup>/t, and overall stripping ratio is estimated to be 5.47 m<sup>3</sup>/t (Table 4).

Month	Production (t)	Overburden (m <sup>3</sup> )	Interburden (m <sup>3</sup> )	Total Waste (m <sup>3</sup> )	Stripping Ratio (m <sup>3</sup> /t)
1	9822.4	91691	3309	95000	9.67
2	11200	52910	30525	83435	7.45

Month	Production (t)	Overburden (m <sup>3</sup> )	Interburden (m <sup>3</sup> )	Total Waste (m <sup>3</sup> )	Stripping Ratio (m <sup>3</sup> /t)
3	11200	53760	30464	84224	7.52
4	11200	54259	29455	83714	7.47
5	11200	63819	35280	99099	8.85
6	11200	71415	31740	103155	9.21
7	11200	67500	25650	93150	8.32
8	11200	80141	31778	111918	9.99
9	11200	64110	24859	88970	7.94
10	11200	78738	21474	100212	8.95
11	11200	81329	20791	102120	9.12
12	11200	72696	21216	93912	8.39
13	11200	99376	28598	127974	11.43
14	11200	108308	29273	137581	12.28
15	11200	129235	20223	149458	13.34
16	11200	75480	16983	92463	8.26
17	11200	104219	20781	125000	11.16
18	11200	73900	17428	91328	8.15
19	11200	102770	22705	125475	11.20
20	11200	43644	13914	57558	5.14
21	11200	57459	11556	69015	6.16
22	11200	53566	14410	67975	6.07
23	11200	29925	8400	38325	3.42
24	11200	74494	21406	95900	8.56
25	11200	35018	22511	57529	5.14
26	11200	54844	21206	76050	6.79
27	11200	43885	12048	55932	4.99
28	11200	40325	14832	55157	4.92
29	11200	89284	38360	127643	11.40
30	1739.36	21233	8046	29279	16.83
<b>Overall</b>	<b>3,25,161.76</b>	<b>20,69,329</b>	<b>6,49,219</b>	<b>27,18,548</b>	<b>8.36</b>

Month	Production (t)	Overburden (m <sup>3</sup> )	Interburden (m <sup>3</sup> )	Total Waste (m <sup>3</sup> )	Stripping Ratio (m <sup>3</sup> /t)
1	11200	123165	36210	159375	14.23
2	11149	119533	7568	127101	11.40
<b>Overall</b>	<b>22,349</b>	<b>2,42,698</b>	<b>43,778</b>	<b>2,86,476</b>	<b>12.82</b>

Month	Production (t)	Overburden (m <sup>3</sup> )	Interburden (m <sup>3</sup> )	Total Waste (m <sup>3</sup> )	Stripping Ratio (m <sup>3</sup> /t)
1	7489	5658	1733	7390	0.99
2&3	22400	43999	13846	57845	2.58
4 &5	22400	35256	26709	61966	2.77
6&7	22400	39690	27783	67473	3.01
8&9	22400	37180	25350	62530	2.79
10&11	22400	34425	20655	55080	2.46
12&13	22400	49000	27125	76125	3.40
14&15	22400	43341	23447	66787	2.98
16&17	22400	56840	31084	87924	3.93
18&19	22400	51480	29304	80784	3.61
20&21	22400	61250	32375	93625	4.18
22&23	22400	61681	33881	95563	4.27
24&25	22400	73256	43151	116406	5.20
26&27	22400	57453	47235	104688	4.67
28&29	22400	69956	42656	112613	5.03
30&31	22400	92138	60328	152466	6.81
32&33	22400	65258	45529	110787	4.95
34&35	22400	73624	55006	128630	5.74
36&37	22400	91448	71925	163373	7.29
38&39	22400	64484	48020	112504	5.02
40&41	22400	80379	50237	130616	5.83
42&43	22400	84126	43160	127286	5.68
44&45	22400	119543	53130	172673	7.71
46&47	22400	154733	62790	217523	9.71
48&49	22400	163703	67275	230978	10.31
50&51	22400	181276	76832	258108	11.52
52&53	22400	117322	48132	165454	7.39
54&55	22400	128194	51600	179794	8.03
56&57	22400	123600	50985	174585	7.79
58&59	22400	101000	42925	143925	6.43
60&61	22400	87400	38238	125638	5.61
62&63	22400	69400	32098	101498	4.53
64&65	22400	88468	42335	130803	5.84
66&67	22400	56942	27115	84057	3.75
68&69	22400	78030	38097	116127	5.18
70&71	18063	86909	43943	130851	7.24
Overall	7,87,152	28,28,436	14,76,032	43,04,468	5.47

## LIMITATIONS

Due to insufficiency of geological data that would be needed for evaluation of reserve and waste, and thus the estimation of stripping ratio for such small patches with so much of geological disturbances, the results may vary from the reality to an extent of  $\pm 20\%$ .

The recovery of *jhama* from the layers of *jhama* intruded by mica peridotite has been taken as 30%, the minimum recovery percentage suggested by the mine authority. However, if the actually recovery is closer towards 40%, mineral production will increase and consequently waste generation will reduce, leading to reduction of the stripping ratio from the estimated value.

## DISCUSSIONS AND CONCLUSION

The results indicate that, it would be much more economic to mine the site en bloc than to mine Western and Eastern blocks separately leaving a 90 m wide barrier in between them to protect the existing high voltage electric supply line. In isolation, the West Block, which covers nearly two-third of the whole site, will run for two-and-half years, producing a little more than 40% of the total mineable reserve of the whole site and generating 63% of the total waste likely to be generated had the whole site been mined as one. Overall stripping ratio of the Western Block will be 8.36 m<sup>3</sup>/t, i.e. more than 50% higher compared to the stripping ratio of 5.47 m<sup>3</sup>/t expected for the mining of the whole site in one go.

The Eastern Block that covers only about 15% of the whole site will yield for only two months and produce not even 3% of the total mineable reserve in the whole site, that too with a high overall stripping ratio of 12.82 m<sup>3</sup>/t. Compared to the mineral production, mine life and overall stripping ratio of the Western Block alone, there is slight deterioration in the corresponding values if Eastern and Western Blocks are put together. However, as the Eastern Block is too small, the changes are not significant.

On the other hand, if the whole site is mined en bloc, the mine is likely to run for six years yielding more than 0.7 million tonne of minerals (coal, burnt coal and *jhama* together) with a stripping ratio ranging from 5.47 m<sup>3</sup>/t approximately.

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## NEED OF ENVIRONMENTAL EDUCATION IN SCHOOL LEVEL

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### ABSTRACT

*The mother Earth has everything to satisfy our needs but not our greed. Hence whole world community should be aware that they have to protect the natural environment and to judiciously exploit natural resources. This would be more effective if this awareness is brought about in students of the nation to start with. Hence, 'education about environment' has been an integral part of the curriculum at all levels of schooling. Initiatives undertaken by Government and Judiciary, and especially the Environmental Education in School System (EESS) Programme launched by Government of India are discussed in this article. The means of evaluation and the structure of model syllabus of Environmental Education are also analyzed.*

*Institutions like DIETs, CTEs, SCERTs, IASEs, University Education Departments and other Teacher Education Institutions, have to function as resource centers on Environmental Education (EE). Appropriate training, orientation and awareness generation programmes for teachers, teacher educators, parents and educational administrators need to be undertaken simultaneously. Effective implementation of EE would require involvement of community, NGOs, electronic media and institutions/organisations dealing with areas and elements of environment.*

**Key words:** Environment, Education, School system, Syllabus

### INTRODUCTION

The planet earth houses animals, insects, birds, plants and other living beings and non living objects like water, air and soil etc. Man, an appealing creation of nature has been living with these members of his environment since its origin leading a peaceful life. Man influences and is influenced by all these living and non-living creations of nature. Each member supported the existence of the other on the planet -one complemented the other, with no contradictions. For example, man breathes the oxygen for his survival and gives out carbon dioxide. This would have increased the carbon dioxide content in air thus, resulting unduly acute global warming. In the contrary the plants take up carbon dioxide given out by man for preparing their food and release oxygen

into the atmosphere. As a result the content of carbon dioxide in atmosphere remains balanced and we get the oxygen required for breathing. Thus, man and plants help each other for their survival. This is an intrinsic harmony between man and his environment — a 'balanced' exploitation of one another for mutual survival (Clark, 1986; Bapat and Rao, 2004).

Subsequently, as civilisation progressed and science advanced, man started creating his own 'artificial' environment: machines, satellite, chemicals, missiles, bombs, weapons and tried to fit them into the natural environment. As a result the natural balance and harmony in the environment is disturbed and natural resources are overexploited. This is making serious problems such as

population explosion, environmental pollution and energy crisis etc (Bapat and Rao, 2004). The mother Earth has everything to satisfy our needs but not our greed. Hence whole world community should be aware that they have to protect and restore the natural environment and have to judiciously exploit or conserve our natural resources.

This would be more effective if this awareness is brought about in our 'future citizens' namely; our children and school students to start with. Thus, an 'education about environment' should form an integral part of the curriculum at all levels of schooling. This breeds values of life, self-confidence, self-possession and self-assurance among the young learners as envisaged in National Curriculum Framework for School Education – 2000 (Bapat and Rao, 2004).

#### **INITIATIVES OF GOVERNMENT AND JUDICIARY**

The Constitution of India overtly makes environmental conservation a duty. Article 48-A, Constitution of India explicitly states that Government has the responsibility to protect and restore the natural environment. Constitution of India, Article 51-G clearly opines that every citizen has the fundamental duty to protect and improve the natural environment including forests, lakes, rivers and wildlife.

The judgment of Supreme Court regarding Environmental Education (EE) in school programme is indeed an appreciated and cherished one. The Hon'ble Supreme Court's directive to develop a model syllabus of EE as a compulsory subject in a graded manner for the entire school stage was welcomed by one and all.

Mrs. Indira Gandhi, the then Prime Minister of India, was the only visiting head of State to attend the Conference on 'Human Environment' at Stockholm, 1972. It is on this occasion that she first

brought to fore the connection between environment and poverty (De Lucia, 1988). It was following this conference; different environmental acts such as The Water Act, The Air Act, The Water Cess Act, The Environmental Protection Act etc. were formulated. It was following this Conference that a Department of Environment was established by the Government of India in 1980, to act as the nodal agency for planning, promotion and coordination of various environmental programs in the country. Since its inception, the Department has emphasized the promotion of environmental education at different levels, making it a people's movement. Education departments also recognize EE as an essential part of education. Environment related programmes like the National Green Corps of Ministry of Environment and Forests and the school Eco clubs of the state governments have helped in providing learning experiences to deepen the understanding of environmental issues. The National Policy on Education (1986) of India also states that protection of environment is a value which, along with certain other values, must form an integral part of the curriculum at all stages of education (Government of India, Ministry of Human Resources Development, 1992).

#### **THE EESS (ENVIRONMENTAL EDUCATION IN SCHOOL SYSTEM) PROGRAMME**

##### **Background and Objectives**

Ministry of Environment and Forests is undertaking programmes for greening the school curricula. Properly planned hands-on environmental learning activities can help to enrich, vitalize, and complement content areas of the school curriculum, and at the same time it can contribute to the local capacity building process. In this backdrop, the Society is implementing the

project entitled 'Capacity Building for Hands-on Environmental Education in School System. Initially, the project was implemented only in eight states of the country (Maharashtra, Assam, Uttranchal, Jammu and Kashmir, Goa, Punjab, Orissa and Andhra Pradesh). Last year, the project was extended to eight additional states of the country (Kerala, Karnataka, Tamil Nadu, West Bengal, Sikkim, Himachal Pradesh, Chattisgarh and Tripura). The goal of the program is to promote effective environmental education in Indian School System, which translate knowledge into action and leads to participatory environmental conservation. Before undertaking of this programme by Ministry of Environment and Forests, the Bharati Vidyapeeth Institute of Environment Education and Research (BVIEER), Pune, did a two-year content analysis of more than 1,800 textbooks from all over the country, studying their handling of environmental subjects. Textbooks in General Science, Geography and Languages were analysed to assess the environment education inputs.

While most of the Geography textbooks did discuss the importance of the atmosphere, hydrosphere and lithosphere in detail, and focused on the greenhouse effect, ozone depletion etc, the researchers found that there is little effort to interlink environmental concepts and real life experiences. This means that most students learn the subject by rote and do not identify or believe in the cause of environmental protection. There is a serious absence of locale-specific information and several gaps in the appreciation of ecosystems, their structure, functions, uses, degradation and conservation. There is hardly any information on sustainable lifestyles and what individuals can and should do for environmental preservation as a part of personal day-to-day activity.

Several simple environmental topics such as the variety of plant and animal species in the world, in India and in each state, do not find appropriate representation in the curriculum. Very often, information provided is dated. For instance, DDT in most books is mentioned as a common pesticide, even though commercial production and use of DDT is banned in India. While solar energy is frequently focused on, other sources of non-conventional energy are not dealt with adequately. In most instances it is observed that the complexity and frequency of each concept does not progress over the years.

The BVIEER content analysis identified 99 environmental concepts including Natural Resources, Biodiversity, Pollution, People and Environment, Energy etc. Each concept was assessed for accuracy, relevance to the text, appropriateness to the age-group, consistency, bias etc. Once the matrix was complete it was easy to identify the lacunae or 'gaps' in the curriculum. Accordingly many recommendations are made by BVIEER for launching the EESS programme.

EESS programme is launched to enhance human resource and institutional infrastructure for environmental learning opportunity; to vitalize and enrich the content areas of the school curriculum through environmental learning activities; to build up student's capabilities to use latest environmental research tools and techniques and use of information technology; to rectify habits, values, attitudes and emotions to maintain and promote quality environment for human survival; and to grow a sense of responsibility and urgency to ensure appropriate action to solve environmental problems.

## DISCUSSION

Till the date all these efforts could not bring about the attitudinal change in students; equip them to face the environmental challenges; and help them in making the right decisions. We need to impart education such that it helps to develop responsible environmental behaviour leading to an improved environment.

Since environmental sciences have now been introduced as a subject, at secondary school levels in the formal education system, it has assumed greater importance. Does Environment Education (EE) in secondary schools merely mean a trip to the neighbourhood park? Or does it actually entail substantial understanding of ecological concepts such as biodiversity, natural resources, and pollution? Is the formal educational structure in four walled class rooms equipped to help school children imbibe important green lessons? How should the subject be taught? The curriculum developed seems to be exhaustive, but do we have the basic infrastructure for its effective delivery? The difficulties faced in teaching the subject are being discussed in the academic circle. Why is it difficult to teach environmental science? Why is it that earlier efforts have only partially reached the level of awareness they should have? These attempts have created environmental awareness, but Environmental Education (EE) has still not been achieved (Jackson, 2001a, b).

The answer lies in the complex nature of the subject and the interpretations of its various aspects. No single one of its aspects can be given greater importance. Nor can any one of them be ignored. It is a multidisciplinary area, where the overlaps and inter-linkages are intricate. Dexterity is required for handling the subject. For an in-depth understanding of environmental science at the graduate level, the students

must be prepared right from their school days (Vishvasrao, 2005).

A keen look at the science curriculum suggests that along with the basics in chemistry, physics and biology, a student learns that all known sciences have various applications, primarily, for the benefit of mankind. Many eminent scientists have devoted their lives to research in the field of science and awesome scientific and technological progress has been achieved. This must be communicated to the children, and no doubt, formal education is an excellent medium for it. It is now clear that technological progress, and the way it progressed, had a disastrously negative impact on our environment. This is something our school students should know as well (Vishvasrao, 2005).

Imagine a chapter from a science textbook devoted to basic science; the next devoted to technology or applied science; the third devoted to the positive and negative impacts of the development of science and technology; the fourth to the conservation of the environment; the fifth to biodiversity; and the sixth to agriculture and the use of fertilizers and biomagnification. The learner might end up being utterly confused. But this is virtually what students go through in a single academic year. The student learns to appreciate his curriculum thus: what he learns has to be reproduced during the academic evaluation, for which, he is expected to know everything that is taught, whether relevant or not. He has to score in a test that tells him how much he knows. Secondly the student learns that everything that is developed for the good, has a bad outcome as well, which is noticed a little or much later than the positive outcome, so one has to take care while planning curricula (Thurber, 1956; Vishvasrao, 2005).

To compound the problem, environmental sciences are linked to our daily life and good practices. EE was earlier introduced

as one of the values in value education. This is the most important concern that needs to be addressed right from the early days of schooling. Schoolteachers play a vital role in developing habits by setting an example. If a schoolteacher advocates the rejection of plastics but daily brings her/his meal to school in a plastic bag, her/his teaching, however well taught, becomes meaningless. To the pupil it might mean that this is only to be learnt and not practiced. In addition, if parents use and throw plastic bags, learning cannot take place. Everything only remains in print, which is exactly what is happening presently. It is true not only of plastic bags but also of all such type of habits. Thus, environmental science is not about urbanization alone, or energy crisis and pollution, but our daily habits and practices as well (Meena and Pandya, 1997; Rajput, 2003).

How can environmentally friendly habits be developed? The *gurukul* system once practiced in ancient India, is a very good example of how habits and practices were inculcated, which were in tune with the local environment. A guru had several disciples of various ages living with his family. They were taught rituals and the disciples copied the manner in which the guru behaved. The guru's behaviour had a profound impact on the disciples' minds. Habits were handed down religiously and a harmonious balance with nature was maintained. The guru was the role model (Vishvasrao, 2005; Covey Stephan, 1994). This was a balanced, time-tested approach and not the firefighter's approach that is now being used for teaching environmental sciences.

Habits have to be handed down from the earlier generation to the next; it is only then and thus, that the deep-rooted meanings of these actions are also conveyed. Awareness leads to understanding and understanding to action. Awareness leads to 'information', which

develops an understanding of the 'science' and leads to action, which is culture (ethics). Ancient Indian culture allowed the population to put environmental ethics into practice (Vishvasrao, 2005; Chavan, 2004). Thus teachers of Today should motivate the students to put environmental ethics into practice.

Besides this, students are expected to carry out some projects on the environment such as collecting information and pasting pictures cut from magazines, or something along these lines. These projects are expected to fuel their creative abilities, which might be the case, but most of the time children turn towards their parents for assistance and often, it is the parents who play a leading role in doing the project. What then, is achieved? The completion of such projects is mandatory as they are academically evaluated. Where and what is the value of the child's creativity? This is true of other subjects as well. But this is surely not education. Why have we come to such a stage? Where do the roots of such a disastrous change lie and how did it go unnoticed? Presently there are no responsible role models teachers for teaching environment as a science, ethics and culture. The complexity arises because it is everyday science, with links to the past and the future. Everything in this subject has a deep underlying meaning that speaks through actions, not words. Every significant environmental action has a cultural significance and a scientific base. It takes great skill to balance the two - the understanding and the action that follows. Each action has to be weighed as its roots lie in the past and its results will affect the future. Therefore the role of an environmental science educator is very important. Students follow/imitate an educator/teacher and consequently magnify through their actions whatever mistakes an educator/teacher makes. If an educator of environmental sciences is unable to practice what s/he preaches nothing can be achieved (Khoshoo, 1988;

Vishvasrao, 2005, Technical Teachers' Training Institute, 2001).

## CONCLUSION

Obviously the teacher has to educate the students about the environment. Since, the environment of each student is different in different region; the content of 'environmental science' also will be 'local specific'. It has been found that the most effective way of teaching environmental science is to allow students to observe, interact and know about the environment themselves. It is preferable to provide concrete situations familiar with his environment. While taking up the environmental issues, due importance must be given to the local phenomena that would generate the awareness of environmental issues in concrete terms (Vijayalakshmi, 2003; Das, 1996; Bapat and Rao, 2004; Regional Institute of Education, Mysore, 1987).

Thus, practice of teaching should be based on local contextuality, the indigeneous social perception of environment, cultural tradition and experiential learning strategies. Environmental Education needs to permeate the school system and be reflected both in the physical environment of the school (e.g., water and sanitation facilities, garbage management, green school campuses, energy conservation, etc.) and the attitudes and actions of all those who are part of the school education system (teachers, parents, administrative staff and the management). Field activities like camping and trekking, visit to botanical gardens, agricultural fields, factories, museums, natural history museums, cultural heritage sites and planetaria and other co-curricular activities provide opportunity for students to experience nature first-hand and can help to create an interest in environment (Macnaghten and Urry 1998). The transaction modalities of EE would include interactive mode, demonstration, discovery

approach, project based methods, action oriented practical, field visits, value clarification and community based approaches (Schwaab, 1982; Bhanumathi, 2003; Bhushan et al., 1990; Brown and Gabaldon, 1993; Caldwell, 1993; Edwards, 1993; Howell, 1993; Khoshoo, 1986).

Evaluation has to focus on cognitive, affective and conative learning in a balanced manner. EE as a compulsory subject needs to be assessed through continuous evaluation, group evaluation, peer evaluation, institution based evaluation and external evaluation through appropriate grades (Singh, 2003; Subramaniam et al., 1994)

The syllabus should aim at educating the future citizens in the science and art of knowing and loving their environment, protecting it from further degradation and improving it for better and healthier living. It must highlight the need for securing sustainable development through judicious consumption of energy and natural resources. The syllabus must help the learners identify the potential health hazards in their physical surroundings. It is intended to make students aware of the different forms of pollution and their causes. The syllabus should also include viable measures for abating pollution. Cultural traditions and indigenous practices - local, regional and national - should be included along with the modern scientific and technological developments (Bukit and Trenajati, 2003a; Jerath, 2003; Yusof, 2002; Li et al., 2003; Misola, 2003).

Parent-teacher associations could also play a major role in actualising the objectives of EE. Institutions like DIETs, CTEs, SCERTs, IASEs, University Education Departments and other Teacher Education Institutions, have to function as resource centres on EE. Appropriate training, orientation and awareness generation programmes for teachers, teacher

educators, parents and educational administrators need to be undertaken simultaneously. Effective implementation of EE would require involvement of community, NGOs, electronic media and institutions/organisations dealing with areas and elements of environment.

Today's students are tomorrow's leaders and decision-makers. They need to learn and practice the skills necessary to protect, preserve and restore the environment quality. Environmental education will lead to the acquisition of knowledge, the development of analytical skills, the beginning of environmentally conscious attitudes and ultimately, a responsible behaviour.

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## MINE WASTE DUMP MANAGEMENT – AN INNOVATIVE APPROACH

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### INTRODUCTION

Mining industries play a vital role in the development of the country's economic growth since pre-historic days and is regarded as a very complex process. Exploitation of the mineral resources involving processing and preparation of minerals shall no doubt create certain environmental disturbances of the region. Further mining industry being site specific shall not be shifter any other alternative sites. However, there should not be any trade-off between environment protection and economic development.

Some of the environmental aspects which mining companies must look into are:

- Promote balance between environmental protection and economic development,
- Deploy modern mine planning system,
- Reuse of mining products and importantly,
- *Promote mine site reclamation*

Mining and its ancillary activities damage not only LAND but also other aspects of environment like;

Air Pollution	:	Gets disturbed by blasting, excavation, transportation and dumping of excavated material
Water Pollution	:	Surface water quality gets disturbed due to mine run-off and while ground water quality and quantity gets disturbed by infiltration and ground water withdrawal
Flora & Fauna	:	Land-Water-Forest Eco-System gets disturbed and hence the flora & fauna
Aesthetics	:	Scenic areas are changed into barren depression and elevation
Socio-Economics	:	Forest, agriculture and other land uses are disturbed and so also the sources of income of the people are lost

### SOIL EROSION AND DAMAGE TO LAND BY MINING

Soil erosion has been identified as the main source of water pollution. Runoff sediment accounts for more than two-

thirds of all pollutants entering the waterways. The runoff sediments increase turbidity, reduce water holding capacity and create problems for aquatic organisms. Toxic heavy metal contaminants which can adhere to these

sediments may enter our waters and cause toxicity problems.

Mining and its allied activities increases erosion potential of the region which will ultimately silt the surface water bodies. Barren lands in dry season get exposed to scorching Sun and Wind, get further dry by loosing soil moisture, get more prone to erosion and hence get eroded.

### **EFFECTS DUE TO MINE REJECTION DUMP**

Amount of rejection in the open-cast mine depends upon the mode of occurrence of the deposit. The huge mass of material that lies above the mineral deposit needs excavation during mining.

These are left over land in the form of over-burden dumps. These occupy large amount of land, which loses its original use and gradually gets its qualities degraded. The possible impacts are;

The dumped material gradually roll down to the surrounding land,

The dump run-off during monsoon, may result in water pollution,

As the rejection dump is generally loose, fine particles from the dump become highly prone to blowing by wind. These get spread over the surrounding plants and disturb their growth specially sprouting of fresh leaves,

As the dump is loose, highly prone to rain washing, weathering and erosion. Fine particles generated out of these get spread over the surrounding regions of water bodies. Thus the water bodies get their turbidity increased, increased siltation, decreases water storage

capacity, gradual drying etc. The land, which receives, eroded and washed fines, get covered by these, which also damage the land's infiltration potentiality and greenery growing potentiality.

### **PRESENT PRACTICE OF DUMP MANAGEMENT**

**1. GULLY PLUGGING:** As the mine rejection dump consists of loose soil and always tend to erode due to rain. This will lead to formation of rills or micro-channels and number of rills leads to the formation of a gully. Therefore, it is important to protect these gullies avoiding further soil erosion. These gullies should be treated by providing suitable plugs filling up the width of the gully from the highest location downwards.

A typical gully plugging technique consists of two rows of driven-in stout branch-cuttings (or species that sprout readily), the spacing between each row being about 60cm to 1m.

On the down stream side of the plug, a boulder-lined apron needs to be provided. The interval between successive plugs should be such that the top of the down stream plug is at the same level as the bottom of the adjacent plug on the upstream side. To be really effective, the entire length of a gully may be covered by such barriers or plugs.

**2. CHECK DAM OR SPOIL DAMS:** These barriers are to be set across channels or water courses which carry the run-off material from the overburden dumps and are intended for holding up such run-off materials and preventing

transportation/deposition of those in downstream areas.

The effective check dams in preventing flowing of fine silt from the rejection dump area, in each water course/channel series of such check-dams, will be erected along the width of the channel, starting from the commencement of the channel. Each successive dam in a channel will be located in such a way that a line joining the bottom (ground level) of the upstream dam and the top of the next down-stream one will not have gradient in excess of 1 in 500. On the down stream side of each dam, there will be twice the height of the related check dam. The check dam are built by boulders available locally of approximately 30 cm dia, laid over wire netting at the bottom of the same wire netting raised along the sides also, so as to enclose the entire mass of boulders making up the dam. There will not be earth or sand put in the voids in between the boulders. The height of the first dam at the highest location will vary according to the height of the banks and those of subsequent dams on downstream. The wires of the wire netting used in these type of erosion control technique would be at least about 8-gauge category.

**3. TOE BARRIERS:** This is one more conventional technique to control dump erosion. These barriers made up of dry stone masonry, are erected parallel to the toe of the dumps, located 6 to 10 m away from the base of the toe. These barriers are not designed to serve the purpose of retaining walls for which a much more massive and costly structure will be required. The barriers are intended for containing the finer particles of run-off from spreading onto adjoining areas.

Typical design of a stone toe barrier would 2.5m height and it is generally stipulated that the width of the foundation would be about 4m, the width at the base should be at least be 3m and the slope of the wall on the outer or down hill side will be flatter (1 in 1) to provide.

**4. SEDIMENTATION PONDS:** This is another technique being followed in Indian Mining industry extensively to control/arrest the silt being washed from the rejection dump. All surface run-off water containing sediments should be guided to sedimentation ponds for settlement of suspended solids before discharge of water in to natural streams. Provision of such sedimentation ponds have, in recent times, increased in mining areas. However, the cleaning viz de-silting and maintenance of these ponds is required to be done periodically.

Another method being followed is **AFFORESTATION**. This afforestation is being carried out on dump slopes with minimum 2mX2m interval. This method is effective on long run towards slope stabilization and soil erosion. The saplings should be so selected that it should be suitable to local environment and fast growing with fibrous roots system. After care and maintenance is vital in improving the survival rate of the plants planted which costly affair.

While designing the sedimentation pond, technique for calculating the size of such ponds based on the required detention time for the run-off.

*It is important to state that all the above erosion control measures are corrective and being taken after occurrence soil erosion and its related problems to the*

*nearby eco-system and is not a solution at source.*

In recent years, few mining industries in India have tried with "Geo-Synthetics" technique towards controlling soil erosion during rainy season from the rejection dump slopes **at source** and it is understood that the performance and efficiency of the same is not encouraging with reference to soil erosion, slope stabilization, durability and faster vegetation.

In view of the serious problems being faced by the Mining Industry in India, Research & Development Division (RDD) of Sri. Venkateshwara Fibre Udyog (SVFU), Bangalore has developed an advanced, innovative & eco-friendly erosion control technique after intensive field studies to control soil erosion and its related environmental problems permanently and effectively **at the source itself.**

Non-oven erosion control blanket is made out of biodegradable coconut fibre reinforced with HDPE for enhancing the durability of the product. Coconut fibre, which is obtained from the husk of the fruit of the coconut tree. It is a natural organic fibre and it may also call as cellulose-lignin fibre.

Typical analysis of coconut fibre is given in the below table;

Sr.No.	Properties/Parameter	Content
1.	Lignin	45.84%
2.	Cellulose	43.44%
3.	Hemi-cellulose	0.25%
4.	Cold water soluble components	5.25%
5.	Pectins etc (soluble in boiling water)	3.00%
6.	Others	2.22%

Coconut fibre contains more lignin than all other natural fibers, such as jute, flax, linen, cotton etc and hence it is the strongest natural fibre among all the natural fibers.

Coir is quite hygroscopic in nature and absorbs good amount of moisture from the open atmosphere. Water absorption properties of the coconut fibre are given in the mentioned table.

Humidity in the atmosphere (%)	Moisture content in the fibre (%)
65	10 to 12
95	22 to 25
Fully soaked in water	40

### Design

- Use erosion control blankets on steep slopes and streambanks, where vegetation is slow to establish, and in channels where flow velocities are likely to wash out new vegetation.
- Blankets may be used on slopes that are as long as 5 to 30m (as measured along the slope), where runoff from adjacent areas flows over or across the slope, on dump slope as steeper as 250 up to 45° and depending on the critical nature of the area, the soil conditions and the quantity of runoff flowing over the slope.

These Blankets are being used to stabilize and protect the soil from rainfall impact, to increase infiltration, decrease soil compaction and crusting, and conserve soil moisture. They are very effective at critical areas and/or on steep slopes like mine rejection dump

slopes. Blanket is especially effective in controlling sheet erosion and in aiding faster seed germination.

SVFU has supplied this innovative Coco-Erosion Control Blanket (COCO ECB) to various environmentally conscious mining companies across India with different climatical conditions and the performance achieved was very satisfactory and encouraging.

This Eco-friendly COCO ECB application is very effective when compared to other conventional methods of erosion control from the mine reject because of the following reason;

The rainwater flows above the blanket without contacting the soil of the dump slope, hence mitigate the erosion at source.

It enhances the speed of germination and vegetation as it protects seeds/plants against wind and rain,

It gives stability to the dump slope which is one of the important factor as for as dump management is concerned,

It keeps moisture for longer duration which supports the vegetation

Application of COCO ECB on the mining areas is a total solution the various erosion problems being faced by the mining industry compared to other conventional methods of dump management.

Enhances soil fertility and permeability as this fibre degrade gradually, as it

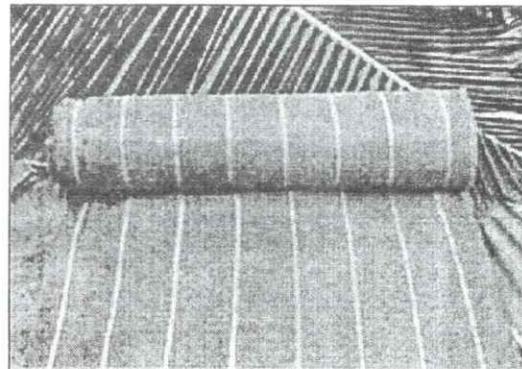
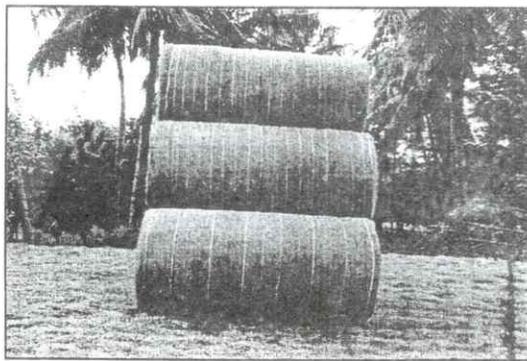
retains moisture and insulates soil & roots-against extreme temperature and therefore provides optimum conditions for seeds and early growth of vegetation, Greater turf durability and stability of soil surface as it reinforces turf against general wear and tear.

In view of protection against pollution, number of laws has been mandated to overcome these problems. Irrespective of the legal mandates, every human being is responsible for protecting the earth and its environment. Thus, it is time to educate the general public about the importance of protecting earth, its waters and wetlands. As human activities have created great threats to the environment, every reasonable human measure to prevent as well as to correct environmental problems should be taken. Any measure that will satisfactorily prevent or control the targeted problem but create additional environmental danger will not be a viable solution for today's environmental needs. Therefore, it is time to concentrate on cost

effective, environmentally safe methods to prevent and correct environmental problems.

Coco-ECB has been tested at M/s. The Bombay Textile Research Association, Mumbai and the findings are briefed below;

TEST CARRIED OUT	COCO-ECB-2.511-600	COCO-ECB-2.5-22-600
<b>Tensile Strength (KN/m)</b> ASTM D-4595-86		
Machine direction	5.9	9.4
Cross direction	2.5	4.0
<b>Elongation at max: load (%)</b>		
Machine Direction	35.5	45.8
Cross direction	41.0	50.4
CBR Puncture resistance (N)	751.4	1538.2
Equivalent pore size (microns) (porosity) ASTM D-4751-99 ISO- 12236-96	725	750
<b>Liquid absorptive capacity (%)</b> ISO =9073-6-2000	86.0	83.0

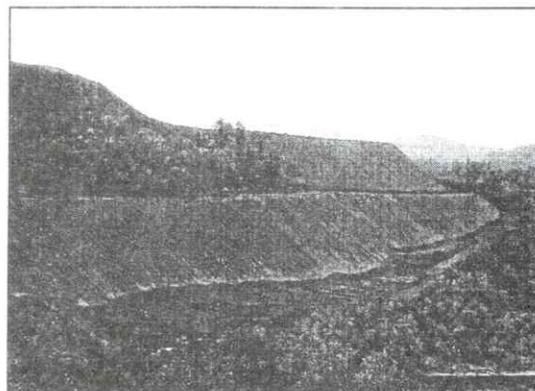


### Typical Coco-Erosion Control Blanket

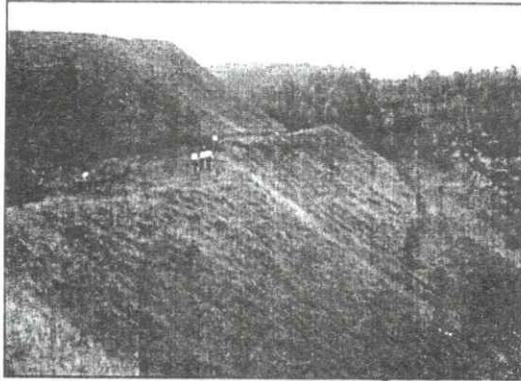
The following pictures show the application of COCO ECB and its performance by erosion control and faster vegetation on the mine reject dump.



Mine Rejection Dump in the Western Part of India



Uniform vegetation growth on applied COCO ECB dump within 8 weeks



**Thick grass growth on applied  
COCO ECB dump within 12  
weeks for dump erosion control.**

## SAVE THE PLANET FROM : GLOBAL WARMING

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### INTRODUCTION

- This year is a land mark year in the history of Environmental movements in the World. The Nobel Committee have recognized that Global warming is a matter of serious concern for the mankind and we have to sincerely act to save our planet for our existence and continuance by awarding the prestigious prize to Mr.Al Gore for championing the cause and to U.N.O.'s International Panel for Climate Change for providing conclusive scientific evidence that human activities are interfering in Nature's functioning and aiding significantly in causing global warming. Dr.R.P.Pachauri, being the Chairman of IPCC will be honoured with the Prize along with Mr.Gore.
- The Indian proverb says ! Only when the last tree has died and the last river been poisoned, the last fish been caught, will We realise we can not eat money !This proverb is important in the

present context of environmental degradation around the world and the civilization has not done enough as it should do. This is the time, although late better than never, to act and act with commitment.

### THE AGE OF OUR PLANET

- Based on scientific facts and analysis, Scientists tell us that Earth was born some 4.6 to 4.5 billion years ago and will continue to exist for few billion years more. But whether it will be suitable in future for the habitation of biodiversity including mankind depends upon our action. Human civilization has caused so much damage during the last few hundred years that earth is sending strong signals for us to rectify the error and to act fast.
- **Table 1** : Summary of the events that happened and happening in the planet during the last 4.6 billion years.

Age	Events	Life
<b><u>Precambrian</u></b>		
4.6 billion years ago	The Earth was formed	No Life
4.5 billion years ago		No Life
3.8 billion years ago	The Moon was formed	Cyano bacteria or Blue Green Algae
3.3 billion years ago		Single celled organism with a Nucleus.
2.1 billion years ago		Multi cellular Animals.
720 million years ago		

<p><b><u>Paleozoic</u></b>  Cambrian – 550 – 505 million years ago.  Ordovician – 505 – 438 million years ago  Silurian – 438 – 408 million years ago  Devonian – 408 – 360 million years ago  Carboniferous – 360 – 286 million years ago  Permian – 286 – 245 million years ago</p>	<p>Trilobites &amp; other Marine animals with hard cell.  Fishes without jaws &amp; corals.  Land plants &amp; Jawed fishes.  Land Animals, Insects &amp; Amphibians.  Reptiles.  Reptiles diversify.</p>
<p><b><u>Mesozoic</u></b>  Triassic (245-208 million)–Jurassic (208-144 million)- Cretaceous (144-65 million)</p>	<p>Reptiles Evol. Peak. Evolution of Birds &amp; Mammals.</p>
<p><b><u>Cenozoic</u></b>  Tertiary period (65 – 1.8 million years ago)  Paleocene (965 – 57 million years ago)  Eocene (57 – 34 million years ago)  Oligocene (34 – 23 million years ago)  Miocene (25 – 5 million years ago)  Pliocene (5 – 1.8 million years ago)  Pleistocene (1.8 – 10,000 million years ago)  Holocene Quaternary Period (15,000 years ago to present)</p>	<p>Birds diversify.  Flowering plants, Mammals &amp; Primates appear Ancestor of Modern man.  Other Mammals.  Homo erectus  Homo sp. Spreads. Human evol.  Modern man.</p>

**TIME SCALE OF LIFE**

If the 4.6 billion years since the Earth’s formation are crammed into One Thousand year from 1000 AD to 2000 AD it would appear like:

- 1000 years back - Earth formation
- 1173 years back - First life appeared
- 1543 years back - First single celled organism with Nucleus
- 1843 years back - Multi cellular Animals
- 1891 years back - The First land plants appear.
- 1950 – 1980 - The Age of the Dinosaurs
- Mid December, 1999 - Home Sp.
- December last week, 1999 - *Home sapiens sapiens*
- 2001 - Agriculture
- 2004 - Industrialization & severe threat to Biodiversity due to Anthropogenic Activity.
- 2005 - Exploration outer space. Remedial measures for Environment Restoration.
- 2006 - Globalization – Conflict in Civilizations, Frontiers of Science expands. Demand on Fresh Water, Energy and Bio-diversity. All related to Food Production Global warming
- Beyond 2006 - Science, Social Science- Humanism, Spiritualism – All merge for a better Future ?
- Distant Future - The ultimate deluge.
- Source: RDI Publications.

**Milankovitch Cycles: Milankovitch, a Mathematician by his study in 1930 opined that three basic variations in Earth's movement affect global climate. 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 combinedly affect the planet's climate. As per these cycles meteorologists and physical scientists tell us that the planet should have been in a period of cooling. But this is not happening.
- We know that although the planet Mercury is nearest to Sun but Venus is three times hotter than mercury. The scientific reason is that venus is full of Carbon dioxide, which traps solar energy and the temperature of venus is around 867 F(Earth has an average temperature of 59F).In view of this scientists look for reasons for increase in temperature of the earth's atmosphere during the last two centuries and the unprecedented increase happening in last 50 to 100 years.

### **GLOBAL WARMING**

- Planet's climate system is influenced by innumerable interacting variables and these are summarized below:
- **Solar input:** The Sun's rays travel 93 million miles to hit the upper atmosphere of Earth at about 100 watt or higher power per sq.metre. One third

of this energy is reflected back to space and the rest of the solar energy warms our planet and drives the weather cycles. The average surface temperature has remained around 14.5C for many hundred years because of the atmosphere, which consists of gases in a delicate balance. The gases which keep the earth warm are water vapour, carbon dioxide, methane, nitrous oxide and some other gases. The Ozone layer in Stratosphere absorbs the UV light to a large extent. Oceans which cover almost 70% of earth's surface are the chief source of water vapour in the atmosphere. Higher atmospheric temperature can mean increased water evaporation, melting of accumulated ice on earth's surface. Evaporation leads to also cloud formation, which reflect incoming solar radiation and absorb heat radiated from earth's surface. In recent times this balance is broken and human activity has significantly aided this imbalance. The snow cover on the Northern hemisphere has decreased atleast 10% in last two decades.

- **Land use** brings major effects on heat balance and climate. A closed forest(more than 40% canopy cover)will absorb significant amount of CO<sub>2</sub> where as an open or degraded forest will not absorb much CO<sub>2</sub> but because of human use, it may generate methane. Landfills, ranching, crop farming especially paddy generate CH<sub>4</sub>. Aerosols and sulfates ,generated by industrial

process and traffic are air pollutants but reflect sun light and may create localized cooling effect..

- Earth's atmospheric temperature shows increasing trend and the change in climate

is popularly understood to mean the effect of global warming. The following gases (Table 2, Figure : 1) are scientifically considered as green house gases responsible for global warming.

**Table : 2**

**The following gases are considered as green house gases.**

**Atmospheric Gases:** (i) Carbon Dioxide, (ii) Methane (iii) Nitrous Oxides (iv) Chloro Fluro Cabons (v) Water Vapour

**1. Carbon Dioxide:**

Source (i) Automobiles, (ii) Industrials, (iii) Anthropogenic . About 18 billion tonnes of carbon dioxide are being introduced per year to planets atmosphere. (India releases not less than 305 million tonnes Carbon (2001)and it is estimated to be 55% responsible for global warming .

**2. Methane:**

Source (i) Organic Matter decay under anaerobic conditions, (ii) Agriculture fields

In 1950 the average concentration was 1.1 ppm, 1990:- 2 ppm in the planets atmosphere. It is estimated that methane is 15% responsible for Global Warming. South-east Asia contributes significantly to methane production from agriculture and cattle dung etc source.

**3. Nitrous Oxides:**

Source (i) Automobiles, (ii) Industries

The average concentration in the atmosphere was 280 ppm – 1950 and in 2000, 400 ppm. It is estimated that oxides of nitrogen contributes to 5 % to Global Warming.

**4. CFCs and perfluorocarbons ( Which endanger ozone layer )**

Source (i) Refrigerants, (ii) Foam, (iii) Fire extinguishers, (iv) Aerosol products

It is estimated that CFCs contribute to 5 % to Global Warming.

**5. Water Vapour :**

Source (i) Evaporation, (ii) Transpiration

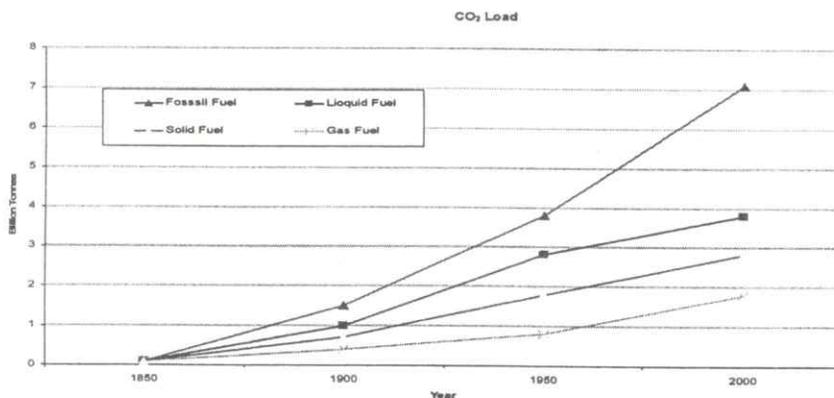
Atmosphere contains about 14000 km<sup>2</sup> of water, which contributes to about 20% to Global Warming.

**Anthropogenic and other causes of global warming.**

We have discussed about the (CO<sub>2</sub>, CH<sub>4</sub>, CFCs NO<sub>x</sub>, water vapour).

Green house gases. These gases retain heat. The carbon dioxide load in the world's atmosphere is about 18 billion tonnes per year as given below.

Figure : 1



Out of this 18 billion tonnes of CO<sub>2</sub> release, India contributes atleast 305 million tonnes per year, and considered as 6th largest contribution in the world. This emission amount is expected to be more than 700 million tones by 2015 as the country is getting industrialised and 66% of India's energy source is fossil fuels. Besides huge amount of methane and other gases are released into the atmosphere. (Table 3, The Indian situation).

The transportation facilities are increasing day by day and the green house gases released by automobiles and other transport sources are huge, significantly more than other sources. These green house gases absorb & retain heat, especially long wave radiation and cause warming of the atmosphere.

## ENERGY USE

- For the first hundred of thousands of years of life on the earth, man depended on muscle power to gather food mainly from hunting and collecting from the forests. Discovery of fire helped to improve the living conditions but its true potential could be utilised much later. Water is utilized as the most important

resource for survival since the dawn of civilization but as a source of energy it was utilized much later. The major transition in energy use came with acquiring knowledge of Agriculture and animal husbandry. But man started to interfere with nature's functioning as he cleared forests in favour of agricultural land and creating crop storage facility by constructing store houses using wood. Water use was intensified due to irrigation. The fuelwood base metal working technology helped man to develop tools to use animals to plough the land and to develop axes, saws, swords and so on for other uses. The next energy use transition came after learning the use of coal and other fossil fuels leading to establishment of industrial revolution in Europe. The pressure on the natural resources of the planet increased many fold and with population growth and technological revolution, man interfered with nature's functioning very significantly and bringing changes on the planet. Taking the late 17<sup>th</sup> century as base

year, scientists tell us that the carbon dioxide level was around 280ppm and during the last 100 years or so, it has increased to 383ppm and at this rate of increase it will reach about 550ppm by 2050 and 700 ppm by 2100AD. Besides, the concentration of other green house gases like methane, chlorofluorocarbons, perfluorocarbons, oxides of nitrogen and some other gases, whose resident time in the atmosphere is very long. Unless to stop the increasing concentration of these gases, action is taken urgently, dooms day will be nearer. Besides, the automobiles consume huge amount of Oxygen to convert the fuel into energy and gases. Thus the CO<sub>2</sub> and O<sub>2</sub> balance is seriously disturbed.

- **Earth's Signals:** The following tables (Table 3 b) show the signals that earth has given to man world wide and the signals in Indian context.

### THE POSITION OF GLACIERS AND ICE-SHEETS

In 40 to 50 years in perennial mountains streams, river, water flow will be drastically reduced if the glaciers continue to sink. It is estimated that the following effects may also be found:

- 1) Worldwide flooding
- 2) Desertification of Africa and some other parts
- 3) Food crisis
- 4) Monsoon season will be affected
- 5) Drastic climate change
- 6) Hydro energy crisis
- 7) Island nations will submerge and some other nations like

Bangladesh, Coastal areas, Maldives etc. will be seriously affected. Diseases like Dengue, Chikngunya etc. will occur.

India is witnessing soaring temperature, especially during summer months, & shorter winters. Nicholas Stern, Chief Economist of World Bank – studied climate change from an angle of Economic perspective. Stern review was released on October 30, 2006, just before the 12th conference of parties to the UN convention on climate change.

The scientific evidence is now overwhelming that climate change presents serious global effects & demands urgent global response.

### SITUATION IN INDIAN SUBCONTINENT

“Down to Earth” – December, 2006 issue of the magazine based on ISRO data report that “Rain is a stranger in a cold desert spread across spiti in Himanchal Pradesh and Ladakh in Jammu & Kashmir”. The Tibetan plateau, however, falls in rain shadow area beyond the Himalaya range. The Tibetan plateau does not receive the monsoon. The annual precipitation is about 100 mm, mostly snow. However, in 2006 monsoon season, this region witnessed heavy rains and floods in August. However, Kashmir valley witnessed severe summer in the past 30 years during this period. At the same time part of Bihar was under flood and another part suffered from drought. Assam witnessed drought and Barmer district of the Thar desert in Rajsthan was flooded.

Monsoon often exhibits fickle behaviour. In the 1990s, India used to receive 12 monsoon depression but it dropped to four in 2000. However in 2006, the monsoon depressions were

many in coastal provinces, especially in Orissa, which also witnessed a super cyclone in 1999.

All these climate flip-flop may be the consequences of global warming. The Indian National Climate Centre in Pune are of the opinion that one of the most significant consequences of

global warming would be increase in frequency of extreme precipitation, which would largely be due to increased evaporation for warmer temperatures. . The climate changes are happening more frequently in some states ,especially coastal states and hence many are inclined to believe that this is effect of global warming .

**Table-3(b): River Basins, glaciers, area loss in India due to Global Warming**

RIVER BASIN	NO. OF GLACIERS	AREA LOSS %
CHENAB	359	21
PARBATI	88	22
BASPA	19	19
<b>TOTAL</b>	<b>466</b>	<b>21% (AVERAGE</b>

SL. NO.	GLACIER	BASIN	GLACIER AREA SQKM	RETREAT TOTAL	IN METRES RATE / YR.
1	MIYAR	CHENAB	87.8	757	16.43
2	SHAUNE BANGE	SATLUJ	8.8	923	26.4
3	BILARE BANGE	SATLUJ	2.8	90	2.6
4	PARBATI	BEAS	48.44	6569	214
5	SAMUDRA TAPU	CHENAB	77.67	802	21
6	CHIPA	DHAULIGANGA	5.0	1050	26.92
7	MEOLA	- DO -	14.0	1350	34.62
8	JHULANG	- DO -	3.3	400	10.53
9	GANGOTRI	GANGA	143	535	28.1
10	DOKARIANA BAMA	- DO -	5.8	585	16.7
11	MERU BAMA	- DO -	4.7	395	17.2

**Table-3: An estimate of Green House Gas (CO<sub>2</sub>) generation from major industries in India**

Industry	GHG Potential	India's and CO <sub>2</sub> Emission industry production / year.
I. Thermal Power (2005-2006) (≤ 20MW plants not taken into account)	<ul style="list-style-type: none"> <li>• 1MWH generation of Electricity = 15 tonnes of Indian Coal per day with 32% C coal</li> <li>• 1MWH = 17.57 tonnes of CO<sub>2</sub></li> </ul>	<ul style="list-style-type: none"> <li>• 0.5 Billion MWH X 17.57 = 8.79 Billion Tonnes CO<sub>2</sub>/Year</li> <li>• (SPAN-2006, 2007)(Economic Survet,2006-07)</li> </ul>
II. Iron & Steel (2005-2006)	<ul style="list-style-type: none"> <li>• 1 tonne C-Steel Production generate ~ 3.5 tonne CO<sub>2</sub></li> </ul>	<ul style="list-style-type: none"> <li>• 44.54 + 41.68 pig iron = 86.22 Million tonne</li> <li>• 301.77 million tonne CO<sub>2</sub> per year</li> </ul>
III. Cement (2006-2007)	<ul style="list-style-type: none"> <li>• 1 tonne cement production generate ~ 1 tonne CO<sub>2</sub></li> </ul>	<ul style="list-style-type: none"> <li>• &gt;150 million tonnes of cement per year</li> <li>• 150 million tonne CO<sub>2</sub> per year</li> </ul>
IV. Aluminium (2006-2007)	<ul style="list-style-type: none"> <li>• 1 tonne aluminium production requires 1.85 MWH Electricity including auxillary mount.</li> <li>• 21.66 tonne CO<sub>2</sub> emission</li> </ul>	<ul style="list-style-type: none"> <li>• ~ 2 million tonnes of aluminium production</li> <li>• 40.07 million tonne CO<sub>2</sub> emission</li> </ul>
	<b>Total</b>	<b>~ 9.28 Billion tonnes CO<sub>2</sub> (2.5 Billion tonnes of C)</b>
V. Transport ( 4.5 Million automobiles in the world)	many times higher than industrial sources.	

### IMPACT OF GLOBAL WARMING AROUND THE WORLD

In the winter of 1997, Japan experienced a high erratic snowfall and eight tropical cyclones ripped through the islands of central pacific. In 1998 New York was 4.4°C lower than usual temperature in January. Guadala Jara in Mexico experienced snowfall for the first time since 1881. Indonesia experienced worst drought in 150 years and forest fire destroyed 4 lakh hectares of forest. India, abnormally high rains swept over Tamilnadu & Orissa experienced a supercyclone in

1999. These impacts may be due to phenomenon called El-Nino & global warming.

### WHAT IS EL-NINO ?

It is periodic warming of the pacific ocean waters that bring extremes in weather. Meteorological scientist are of the opinion high pressure in the eastern pacific sends trade winds blowing to the west. These winds push ocean water before them and the surface water level in and around of Australia and Indonesia rise about a

half metre than it does off the coast of Peru. The trade winds slacken after pressure drops & then the sea water pushes back down hill to the east and this eastward flow key to understanding the phenomenon called **El-Nino**. The backward flow of sea water causes high waves. These waves push down the thermocline layer in ocean. Thermocline is a layer of cooler water that normally mingles with the warmer water at sea surface.

As the thermocline sinks down to greater depths, the mixing of cool and warm water stops and thus the sea surface water temperature rises and this onsets the phenomenon called El-Nino, warming of the pacific ocean. This phenomenon occurs in a cycle of 4-7 years. There waves can be thousands of kilometers long and travel some 30 metre below the sea surface. Satellites pick up the subtle undulations in sea level as ripples pass through. The waves first hit the south American Coast and some reflect back. These reflected waves reach Asia & rebound again. This double bouncing waves lift up cool water and cool the surface water bringing a sea temperature drop in eastern pacific and this decrease is called **La Nina**. These phenomenon was discovered by Peruvian fishermen about a century ago.

In 1982-83 El-Nino caused world wide destruction and the Food and Agriculture Organisation (FAO) has observed these weather charging patterns in Asia. El-Nino may affect Monsoon season in South East Asia, especially India. But it is still scientifically not determined the linking of El-Nino with monsoon. .

However, data available from other many sources indicate that the number of rainy days are decreasing in some

regions but the intensity is increasing. The monsoon is shifting westwards and north-westwards. Month wise distribution of rain fall indicates that the rainfall is decreasing in the month of July where as if shows increasing trend in august and June shows wide fluctuations from year to year. (Down to Earth, December, 2006).

## THE INTERNATIONAL RESPONSE

- Realising the urgent need, The World Climate Conference was held in 1979 under auspicious of UNO and the conference led to develop United Nations Framework Convention on climate change (UNFCCC) in 1992 followed by Kyoto Protocol in 1997. The International Panel for Climate Change was formed in 1992 and on the basis of scientific facts, they have been able to develop series of reports in 1992, 1995, 2001 establishing the green house gas increasing causes and their effects and brought world wide awareness. The following tables (Tables 4 & 5) give data on Kyoto protocol and CDM (clean development mechanism). Since reduction of green house gases affect industrial development in developed and developing countries, the world is divided on phasing out the source of reduction. The senate of USA has not yet ratified the declaration and are of the opinion that the ratification will come after the key developing countries like Argentina, Brazil, China, India and some other large countries adopt meaningful actions on this matter.

- The Kyoto Protocol includes explicit targets or 'assigned amounts' for developed countries which are expected jointly to reduce their emissions of six green house gases (among them hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride) by at least 5 percent below 1990 levels (and in some cases 1995 levels) in the period 2008-12. Individually, these countries have separate commitments. The European Union countries are expected to reduce their emissions by 8 per cent, the USA by 7 per cent and Japan by 6 per cent. Australia, Iceland, and Norway are allowed to increase their emissions. The remaining countries are allowed varying levels of reduction.
- The North-North differences refer to the internal problems that the developed countries were themselves experiencing in articulating definitions, targets, measures, and co-operative mechanisms. For example, while the EU pushed for a 15 per cent reduction target, the USA was only willing to go as far as stabilization of emissions in 2008-12. Despite the divergence of starting points and the inflexibility of negotiating positions, an agreement was reached with legally binding targets. The serious North-South conflict in relation to the so-called voluntary commitments of developing countries was partially resolved through the inclusion of the CDM (Table-5 and 6).

*TABLE : 4*

**Kyoto Protocol : Carbon Trading (2008 – 2012):**

- The International Protocol which regulates GHG emissions – Carbon Trading – Essentially means exchanging points earned by the reduction of GHG for money. This has emerged as a huge opportunity for Developing countries where GHG emissions are much below the quota fixed. Developing Economics are not expected to meet emission targets. Companies in Developing Countries can earn carbon credits by investing in Clean Technology.
- Global cooperation on technology:
- Climate change is a global problem that requires a global solution.
- Developing countries will need access to climate-friendly technologies if they are to limit emissions from their growing economies.
- Technology can be transferred through several different channels.
- The GEF has a critical role to play in the co-development and transfer of advanced technologies.
- Activities Implemented Jointly has been conceived as one way of channeling private-sector money into climate change activities.
- Technology transfer must be accompanied by capacity building.

**TABLE – 5**

**Eligible Climate Change Mitigation Activities :**

- Fuel system Actions
- Conventional Power Generation system actions.
- Transmission system actions.
- Distribution system action.
- End Use Energy Efficiency & demand side management actions. \
- Renewable Energy actions. (Reforestation, Solar Energy, Wind Energy, Nuclear energy, Bio-Gas Energy etc.
- Offset Actions and Emissions Trading Actions (Carbon Treading)

**IPCC(International Panel of Climate Change )(An International Body of > 100 Govts.)**

First Assessment Report 1992 (1-3.5C Rise) (FAR)

Second Assessment Report 1995 (Increased Tend in Temp.) (SAR)

Third Assessment Report 2001 (TAR)

- More than 100 Scientists were involved in the analysis of data and modeling: Developed 8 climate models & arrived at conclusions – TAR : Temperature rise will be 1.4 to 5.8oC (2.5 – 10.5oF) in 21st century depending upon location & situations.
- Clarification and growing scientific acceptance of the view that modest temperature increases would likely produce a mix of beneficial and detrimental changes. Harmful effects would be concentrated in the already warm tropics and subtropics, but warming beyond a few degrees would likely produce negative impacts across the board. It may be some positive effects on Agriculture Productivity in higher latitudes. But occurrence of new diseases is expected.
- Ecosystems, with their specific flora and fauna, are especially

vulnerable to negative impact from *global warming*. Already, human interventions have imposed such extensive disruptions and fragmentations on them that they have lost many of their original adaptive mechanisms, such as long-term, large-scale migration of animal and plant species, or local shifting of the species balance.

**STERN'S REPORT:  
SUMMARY (2006)**

- Climate change could shrink global economies by 20 per cent.
- World temperatures are likely to rise by atleast 2°C by 2050, or sooner, and could rise by 5°C.
- Upto 200 million people could become refugees through flooding or drought.
- Rich nations have caused global warming, but the main suffers will be poor nations.
- Remedial action will cost 1 per cent of global GDP, but will save £1.32 trillion.
- Governments must use tax and regulation to reduce carbon

emissions, and double research into low – carbon technology.

- The worst impacts of climate change can still be avoided – but delay would be costly.

**Table-6: The Global Market in CDM**  
(Suppliers of Carbon-Credit by volume, 2006)

China	India	Brazil	Rest of Latin America	Rest of Asia	Rest of other countries	Africa
61%	12-15% (increased to ~20% in 2007)	4%	6%	7%	7%	3%

(Present Market in 2006 about 30 Billion US dollars)  
(Rs.1,20,000/- crore)

### CDM PROJECTS

Note:

- 1) In 2007, 282 CDM Projects from India have been registered. Chinese Projects are less in number but earn money more 4 to 5 times more than Indian Projects.

### INDIAN EXAMPLES

INDIA : Companies that have been benefited under C-Trading.

- GFL (Gujarat Fluorochemicals Ltd., Bus Rapid Transport System, Indore): During the last 18 months, the company has sold (by decomposing HFC-23) 9 million CER (Carbon Emission Reduction units) for Rs.667 crores.
- GMR (Group (Sugar Division): Andhra Pradesh has earned Rs.3.0 crore from CER and has saved Rs.2.5 crore in the annual power bill by transforming its sugar mill effluents to biogas → energy and by calculating the GHG reductions. They

supplement biogas with Rice-husk to conserve fossil fuel. Besides the company has set up a methane recovery project in their Distillery (Resource use molasses) and CH<sub>4</sub> is used to generate electricity.

- (i) DMRC (Delhi Metro Railway Corporation) has earned Carbon Credits from shifting from Buses (1650 buses stopped plying) and cars to trains by reducing pollution levels by 30%.  
(ii) In developing regenerative braking system that reduces electricity consumption by using the braking energy of trains to generate electricity for reuse. They are expecting to earn Rs.74 crore from CERs sale.
- Indian Railways: Expecting to earn 1.1 million CERs from using light weight coaches, solar lighting at crossings & use of bio-diesel.
- GRASIM Cement: The company blends fly ash with cement, uses alternative fuel & conserves energy. They plan to

reduce 30 million tonne of CO<sub>2</sub> per year (CER credit Rs.1000 crore).

- ITC has saved half a million tonne of coal and reduced emissions of GHG, invests in afforestation & use of alternative fuels (paper business).

## GLOBAL CO-OPERATION ON TECHNOLOGY

After Kyoto protocol Global Co operation on technology specially technology transfer are encouraged and the main issues are as follows :

- Climate change is a global problem requiring Global solutions.
- Developing economies will need access to climate friendly technology to limit their emissions.
- Technology can be transferred through several channels including Global Environment facility (GEF) sources.
- The GEF plays important role in co development and transfer of advance technologies.
- Joint activities – Private & Public sector and between developed countries can play important role in climate change activities.
- Technology transfer shall be accompanied by capacity building.

## SINK FACTOR

- The green house gases especially, CO<sub>2</sub> are usually absorbed by plants and phytoplankton but because of disappearing forest and water pollution, the CO<sub>2</sub> sink potential has been reduced.

Since the land has been denuded with forest cover the sun rays directly hit the soil and land which retain more heat and radiate at night and trapped in troposphere causing warming. The recent forest policy of Govt. of India envisages to achieve forest cover of 33% of the total land area. This will increase the green house sink potential of the country.

## ROLE OF FORESTS (SEQUESTRATION)

- Forest play an important role in Global C-Cycle because they store about 830pgC (10<sup>15</sup>g or 1 billion metric tonnes) in their vegetation. (Brown et al 1996, IPCC SAR). Soils store 1245pgC (1.5 times over the contents in vegetation).
- Forest exchange C with the atmosphere through photosynthesis and respiration.
- Seral stages accumulate C. Climax forest do not account for much storing of C. Climax forest are however important for Eco system services.
- Forest fire create catastrophes disturbing the C-balance. Deforestation causes c-imbalance.
- We have the potential through forest management to alter forest C-pools and fluxes affecting climate change and also Albedo (Reflectivity).
- Biomass burning contributes about 10% of total CH<sub>4</sub> emission, 15% of total N<sub>2</sub>O emission, 50% of CO emission and has a

significant influence on atmospheric troposphere – chemistry (Houghton et al 1992). Biomass burning transfers upto 10% of the C to Charcoal can inter form) with an infinite time of turnover.

- These estimates by scientists do not take peat or organic soils, which contain huge amount of C. Anaerobic Peatlards are since of CO<sub>2</sub> but source of CH<sub>4</sub>. Conversion of peatlards to forest does not help much as CH<sub>4</sub> production is reduced but CO<sub>2</sub> emission happen. (Cannell et al 1993).

- 52% of Forests are in low latitudes (0-25° N&S – Tropical Zone). High latitude forest (Boreal : 50-75° N&S) account for 30%, and mid latitudes (Temperate zones) account for 18% of forests of the Globe. The total forest area is 3.4 Billion ha. Besides there are additional 1.7 Billion ha of open woodland, scrub, shrub etc. lands (degraded forests). Besides about 69 Million ha of plantations (31 million ha in tropics & 37.6 million ha in mid latitude mainly in China) exist. (FAO, 1995).

**Table - 7 :** Shows the estimated C-pools and flux in forest vegetation (above & below ground living and dead mass) and soils upto 1m depth in forests of the world (Brown et al 1996). The error factor is high (about 30%).

Region country	C pools (Pg)		C flux (Pg yr <sup>-1</sup> ) (1Pg = one billion tonne = 10 <sup>15</sup> gram)
	Vegetation	Soils	
High Latitude or Boreal Zone			
FSU <sup>1</sup>	72	106	+0.36
Canada <sup>2</sup>	15	76	+0.08
Alaska	2	11	*
Subtotal (25%)	89	198 (41%)	+0.44± 0.2
Mild Latitude or Temperate Zone			
USA	15	21	+0.08 to +0.25
Europe <sup>3</sup>	10	18	+0.09 to 0.12
China	17	16	-0.02
Australia	9	14	Trace
Subtotal (14.48%)	51	69(14%)	+0.26± 0.1
Low latitude or tropical zone			
Asia	41.54	43	-0.50 to -0.09
Africa	52	63	-0.25 to -0.45
America	119	110	-0.50 to -0.70
Subtotal (60%)	212	216 (45%)	-1.65 ± 0.40
428 (51%)			
Total	353	478	-0.95±0.5
830			

\* Includes with USA

<sup>1</sup>Soil pool excuse peat ; all data for FSU are from Karnkina et al. 1996.

<sup>2</sup>Vegetation includes estimates for roots (Kurz et al. 1996) ; soil pool excludes co – located peat.

<sup>3</sup>Includes Nordic countries. Total live biomass carbon was assumed to be the product of growing stock in 1990, converted to carbon units, and the mid-point of the expansion factors given in Kauppi et. al. (1992) ; an additional 40% of live biomass was added to account for litter and dead wood. Soil

pool is the product of forest area and soil C density of 9kg m<sup>2</sup>(Dixon et al. 1994)

### 1. FSU – RUSSIAN (FORMER USSR)

The estimate C flux is about 16% of the amount produced by burning of fossil fuels and cement industries.

**Table -8:** Shows the average annual C-budget for the 1980s (Schimel et al 1995)

	Pg C yr <sup>-1</sup>
Emission from fossil fuel and cement production	5.5 ± 0.5
Emission from change in tropical land use	1.6 ± 1.0
<b>Total emission</b>	<b>7.1 ± 1.1</b>
Increase in storage in atmosphere	3.3 ± 0.2
Ocean uptake	2.0 ± 0.8
Uptake by non-tropical forest growth	0.5 ± 0.5
<b>Total sinks</b>	<b>5.8 ± 1.0</b>
<b>Different (emissions – sinks)</b>	<b>1.3 ± 1.5</b>

**Table -8(b) :** Global estimates of the potential amount of C that could be sequestered and conserved by forest management practices between 1995 and 2050 (from Brown et al. 1996)

Latitudinal belt	Practice	Area (Mha)	C sequestered & conserved (Pg)
High	Forestation	95.2 <sup>1</sup>	2.4
Mid	Forestation	113	11.8
	Agroforestry	6.5	0.7
Low	Forestation	66.9	16.4
	Agroforestry	63.2	6.3
	Regeneration <sup>2</sup>	217	11.5-28.7
	Slow deforestation <sup>2</sup>	138	10.8-20.8
Total		700	60-87

<sup>1</sup>Includes not satisfactorily restocked forest lands in Canadas.

<sup>2</sup>Includes an additional 25% of aboveground C to account for C belowground in roots, litter and soil (based on data in Nilsson and Schopfhusser, 1995 and Brown et. Al 1993b) ; the range in values is based on the use of low and high estimates of biomass C density resulting from the uncertainty in these estimates.

### Note :

1. The Estimated imbalance between emission and sinks is 1.3 billion tonnes per year.
  2. The emissions from tropical plantations reduce the quantity of emission data by 0.6 Pg yr<sup>1</sup>.
- Thus forests developed in non forested lands or plantations for fuel wood or energy source will increase C-storage and even if the wood is burned, there will be less consumption of fossil fuels decreasing CO<sub>2</sub> emission.

Forest management to conserve forests and sequesters C are necessary for sustainable development and to prevent forests becoming a significant source of CO<sub>2</sub> emissions. Large scale plantations and harvesting scientifically, legislation to limit automobile use, using modern technology to cap CO<sub>2</sub> and other GHG under ground etc are to be explored on priority basis. Besides the alternate source of energy are to be used.

### SUMMARY

- The Oceans (Planktons, sea grasses and water) and the land vegetation especially the forests are the chief resources for Carbon sequestration. Their role in the process and the dimensions of the problem are discussed. An estimate has been made on carbon emissions and absorption and the annual Increase in the atmosphere.
- The developed countries are still divided in the mechanism of operation of Kyoto protocol, CDM, and the key developing countries are looking for industrial growth to provide employment to their growing youth, linking to livelihood options of their poverty stricken population in the context of carbon emission to the atmosphere. The academicians,

environmentalists, NGOs, Business NGOs and educated public are concerned and want tangible results. The carbon credit business is around 30 billion dollars per year and India has been able to capture only five billion dollars and China has been able to capture three times more of the carbon credit market than India. Since our energy source is largely thermal power and will continue to depend on fossil fuels for atleast another two to three decades, wide scale plantations and efficient management measures and use of ecofriendly technology and alternate energy sources are to be adopted. Many of these aspects can be included under carbon credit system.

- I close this paper quoting W.H.Auden on global warming: !Those who will not reason perish in the act, Those who will not act perish for that reason !.

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## HISTORY OF GEOLOGY

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### INTRODUCTION

The history of geology is concerned with the development of the natural science of geology. Geology is the scientific study of the origin, history, and structure of the Earth. Throughout the ages geology provides essential theories and data that shape how society conceptualizes the Earth. Ancient Greece developed the primary geological concepts concerning the origin of the Earth. Additionally, in the 4th century BC Aristotle made critical observations of the slow rate of geological change. During the 17th century the heated debate between religion and science over the Earth's origin further propelled interest in the Earth and brought about more systematic identification techniques of the Earth's strata. The Earth's strata can be defined as horizontal layers of rock having approximately the same composition throughout. The popular mining industry during the 18th century both increased social interest and drove scientists to form more systematic and detailed studies of the composition of the Earth's strata. From the increased societal interest of geology, in 1741 it became a specific field of study to be taught at the National Museum of Natural History in France. The controversial topic of the Earth's origin continued to circulate between religious and scientific circles. Two feuding theories developed to explain the Earth's origin with designated followers: the Neptunists whose

theory supported that of the Bible's Great Flood and the Plutonists who believed the Earth gradually formed over an immeasurable amount of time. The dialogue about the creation of the Earth occurring within the scientific community and the evidence being uncovered in Civil Engineering works during the 19th century drove the development of the stratigraphical column; many of the concepts behind this invention can be attributed to William Smith, Georges Cuvier and Alexander Broignart. Also in this period, imperialism motivated countries to sponsor voyages of exploration to distant lands. Charles Darwin made geological observations on such a voyage, providing evidential support of his revolutionary theory of evolution. Again a religious debate ensued; two conflicting groups, uniformitarians and catastrophists, argued over the age of the Earth. Charles Lyell, an influential uniformitarian, published his book in 1830 the "Principles of Geology" which proposed that the Earth changes very gradually and is immeasurably old. The theory of Continental Drift was proposed in 1912 by Alfred Wegener. This idea, unaccepted at the time, suggested a method of continental movement that occurred throughout history. Supporting evidence of Continental Drift, including seafloor spreading and paleomagnetism, justified the theory of Continental Drift, which in the late 1960s was replaced and encompassed by Plate

Tectonics. In the latter half of the 20th century the approach to the study of geology changed to evaluating the Earth in a broader perspective. To coincide with this perspective, satellites were first used in the 1970s and are still currently in use by the Landsat Program to produce images of the Earth that can be geologically studied.

### ORIGINS OF GEOLOGY

The foundations of geology trace back to that of the Ancient Greeks. Some of the first geological thoughts were about the origin of the Earth. With a lack of knowledge and technology, ancient philosophers created mythical stories and proposed theories to explain how the Earth came to be. One of the philosophers who observed the composition of the land and formulated a theory with some supporting evidence was Aristotle in the 4th Century BC. From his observations he determined that the Earth changes, and that it does so at such a slow rate that these changes can not be observed during one person's lifetime. Aristotle developed one of the first evidentially based concepts connected to the geological realm regarding the rate at which the Earth physically changes. Unfortunately, this concept of change was too unbelievable for the public to embrace and Aristotle's theories on the Earth were dismissed.

Some modern scholars, such as Fielding H. Garrison, are of the opinion that modern geology began in the Muslim world. Abu al-Rayhan al-Biruni (973-1048 AD) was one of the earliest Muslim geologists. He wrote the following on the geology of India:

"But if you see the soil of India with your own eyes and meditate on its nature, if you consider the rounded stones found in earth however deeply you dig, stones that are

huge near the mountains and where the rivers have a violent current: stones that are of smaller size at a greater distance from the mountains and where the streams flow more slowly: stones that appear pulverised in the shape of sand where the streams begin to stagnate near their mouths and near the sea - if you consider all this you can scarcely help thinking that India was once a sea, which by degrees has been filled up by the alluvium of the streams."

In medieval China, one of the most intriguing scientists was Shen Kuo (1031-1095 AD), a polymath personality who dabbled in many scientific fields of study in his age. In terms of geology, Shen Kuo is one of the first scientists to have formulated a theory of geomorphology. This was based on his observations of sedimentary uplift, soil erosion, deposition of silt, and marine fossils found in the Taihang Mountains, located hundreds of miles from the Pacific Ocean. He also formulated a theory of gradual climate change, after his observation of ancient petrified bamboos found in a preserved state underground near Yanzhou (modern Yan'an), in the dry northern climate of Shaanxi province.

### 17<sup>th</sup> CENTURY

A portrait of Whiston with a diagram demonstrating his theories of cometary catastrophism best described in *A New Theory of the Earth*.

It was not until the 17th century that geology made great strides in its development. At this time, geology became its own entity in the world of natural science. It was discovered by the Christian world that different translations of the Bible contained different versions of the biblical text. The one entity that remained consistent through all of the interpretations

was that the Deluge had formed the world's geology and geography. To prove the Bible's authenticity, individuals felt the need to demonstrate with scientific evidence that the Great Flood had in fact occurred. With this enhanced desire for data came an increase in observations of the Earth's composition, which in turn led to the discovery of fossils. Although theories that resulted from the heightened interest in the Earth's composition were often manipulated to support the concept of the Deluge, a genuine outcome was a greater interest in the makeup of the Earth. Due to the strength of Christian beliefs during the 17th century, the theory of the origin of the Earth that was most widely accepted was *A New Theory of the Earth* published in 1696, by William Whiston. Whiston used Christian reasoning to "prove" that the Great Flood had occurred and that the flood had formed the rock strata of the Earth.

## 18<sup>th</sup> CENTURY

From this increased interest in the nature of the Earth and its origin, came a rise in the interest of minerals and other components of the Earth's crust. Moreover, the increasing commercial importance of mining in Europe during the mid to late 18th century made the possession of accurate knowledge about ores and their natural distribution essential. Scholars began to study the makeup of the Earth in a systematic manner, with detailed comparisons and descriptions not only of the land itself, but of the semi-precious metals that had such great value. For example, in 1774 Abraham Gottlob Werner published the book "*Von den äusserlichen Kennzeichen der Fossilien*" (*On the External Characters of Minerals*), which brought him widespread recognition because he presented a detailed system for

identifying specific minerals based on external characteristics. The more efficiently that productive land for mining could be found and that the semi-precious metals could be identified, the more money that could be made. This drive for economic success fueled geology into the limelight and made it a popular subject to pursue. With an increased number of people studying it, came more detailed observations and more information about the Earth.

During the eighteenth century, the story of the history of the Earth; namely the religious concept versus factual evidence once again became a popular discussion in society. In 1749 the French naturalist Georges-Louis Leclerc, Comte de Buffon published his "*Histoire Naturelle*" in which he attacked the popular Christian concepts of Whiston and other Christian theorists on the topic of the history of Earth. From experimentation with cooling globes, he found that the age of the Earth was not 6,000 years as stated in the Bible, but rather 75,000 years. Another individual who attributed the history of the Earth to neither God nor the Bible was the philosopher Immanuel Kant who published this concept in 1755 in his "*Allgemeine Naturgeschichte und Theories des Himmels.*" From the works of these educated men, as well as others, it became acceptable by the mid eighteenth century to question the age of the Earth. This questioning represented a turning point in the study of the Earth. It was now possible to study the history of the Earth from a scientific perspective rather than a religious one.

With science as a driving force behind the investigation of the Earth's history, the study of geology could now become a distinct field of science. First, the terminology and definition of what

geological study consisted of had to be determined. The term geology was first used professionally in publications by two Genevian naturalists, Jean-Andre Deluc and Horace-Benedict de Saussure. Geology was not well received as a term until it was used in the very popular encyclopedia, the "Encyclopedie," published in 1751 by Denis Diderot. Once the term was coined as the study of the Earth and its history, geology slowly became a more prevalent and recognized science of its own standing that could be taught as a field of study at educational institutions. In 1741 the most well-known institution in the field of natural history, the National Museum of Natural History in France designated the first teaching position specifically for geology. This was an important step in the further development of geology as a science and in the recognition of the importance of widely distributing this knowledge.

After the designation of geology as a specific field of study in an institution, this subject flourished in educated society. By the 1770s two feuding theories with designated followers were established. These contrasting theories explained how the rock layers of the Earth's surface had formed. The German geologist, Abraham Werner proposed the theory that the Earth's layers, including basalt and granite, had formed as a precipitate from an ocean that covered the entire Earth, referring to the Deluge. Werner's system was influential and those that believed his theory were known as Neptunists. The Scottish naturalist, James Hutton, argued against the theory of Neptunism. Hutton proposed the theory of Plutonism; the Earth formed through the gradual solidification of a molten mass at a slow rate by the same processes that occurred throughout history and continues in present day. This led him

to the conclusion that the Earth was immeasurably old and could not possibly fit within the limits of the Bible's 6,000 years. Plutonists believed that volcanic processes were the chief agent in rock formation, not water from a Great Flood.

## 19<sup>th</sup> CENTURY

Engraving from William Smith's 1815 monograph on identifying strata by fossils  
The Neptunists and Plutonists supplied necessary data to help complete the stratigraphical column in the early 19th century. The stratigraphical column can be defined as "the sequence of rock formations arranged according to their order of formation in time." William Smith, Georges Cuvier and Alexander Brogniart can all be recognized for their roles during this century in furthering the concept of fossil-based stratigraphy. The English mineral surveyor William Smith found empirically that fossils were a highly effective means of distinguishing between otherwise similar formations of the landscape. At about the same time, the French comparative anatomist Georges Cuvier realized that the relative ages of fossils could be determined from a geological standpoint; in terms of what layer of rock the fossils are located and the distance these layers of rock are from the surface of the Earth. Cuvier's mineralogist colleague Alexandre Brogniart augmented Cuvier's practices. Through the synthesis of these findings, Brogniart and Cuvier realized that different strata could be identified by fossil contents and thus each stratum could be assigned to a unique position in a sequence. After the publication of Cuvier and Brogniart's book, "Description Geologiques des Environs de Paris" in 1811, which outlined the concept of stratigraphy, came a great interest in this new method. Stratigraphy became very

popular amongst geologists; many hoped to apply this concept to all the rocks of the Earth. During this century various geologists further refined the stratigraphical column to completion. For instance, in 1833 while Adam Sedgwick was mapping rocks that he had established were from the Cambrian Period, Charles Lyell was elsewhere suggesting a subdivision of the Tertiary Period; whilst Roderick Murchison, mapping into Wales from a different direction, was assigning the upper parts of Sedgwick's Cambrian to the lower parts of his own Silurian Period[38]. The stratigraphical column was significant because it now supplied a method to assign a relative age of these rocks by slotting them into different positions in their stratigraphical sequence. This created a global approach to dating the age of the Earth and allowed for further correlations to be drawn from similarities found in the makeup of the Earth's crust in various countries.

During the same time that the stratigraphical column was being completed, imperialism drove several countries in the early to mid 19th century to explore distant lands to expand their empires. This gave naturalists the opportunity to collect data on these voyages. One British naturalist, Charles Darwin (who had accompanied Sedgwick on some of his Welsh mapping expeditions), had great influence on society from the data he collected and observations he made during his voyage. Darwin read on his voyage Lyell's book the "Principles of Geology" and was converted to a uniformitarian. With this idea in mind, he made geological observations that supported the concept of Uniformitarianism; that throughout history the world changed at a very gradual rate, through processes that could be observed

today. From such geological observations Darwin was able to deduce the revolutionary theory of evolution with the publication of his book "The Origin of Species" in 1859.

The Uniformitarian-Catastrophist debate formed the centerpiece of the geological religion versus science discussion during the nineteenth-century. Catastrophists defended the concept of the biblical Great Flood and is the axiom that certain vast geological changes in the Earth's history were caused by catastrophes rather than gradual processes. Charles Lyell challenged this approach in the publication of his book in 1802, "Principles of Geology," which presented a variety of geological evidence from England, France, Italy and Spain to prove Hutton's ideas of gradualism correct. He argued that most geological change had been very gradual in human history. Lyell provided evidence for Uniformitarianism; a geological doctrine that processes occur at the same rates in the present as they did in the past and account for all of the Earth's geological features. Lyell's works were popular and widely read, the concept of Uniformitarianism had taken a strong hold in geological society.

Economic motivations for the practical use of geological data caused governments to support geological research. During the 19th century the governments of several countries including Canada, Australia, Great Britain and the United States funded geological surveying that would produce geological maps of vast areas of the countries. Geological surveying provides the location of useful minerals and such information could be used to benefit the country's mining industry. With the government funding of geological research, more individuals could study geology with

better technology and techniques, leading to the expansion of the field of geology.

In the 19th century, scientific realms established the age of the Earth in terms of millions of years. By the early 20th century the Earth's estimated age was 2 billion years. Radiometric dating determined the age of minerals and rocks, which provided necessary data to help determine the Earth's age. With this new discovery based on verifiable scientific data and the possible age of the Earth extending billions of years, the dates of the geological time scale could now be refined. Theories that did not comply with the scientific evidence that established the age of the Earth could no longer be accepted.

## 20<sup>th</sup> CENTURY

The determined age of the Earth as 2 billion years opened doors for theories of continental movement during this vast amount of time. In 1912 Alfred Wegener proposed the theory of Continental Drift. This theory suggests that the continents were joined together at a certain time in the past and formed a single landmass known as Pangea; thereafter they drifted like rafts over the ocean floor, finally reaching their present position. The shapes of continents and matching coastline geology between some continents indicated they were once attached together as Pangea. Additionally, the theory of continental drift offered a possible explanation as to the formation of mountains. From this, different theories developed as to how mountains were built. Unfortunately, Wegener's ideas were not accepted during his lifetime and his theory of Continental Drift was not accepted until the 1960s.

In the 1960s new found evidence supported the theory of Continental Drift. The term

Continental Drift was no longer used but was replaced by the concept of Plate Tectonics that was well supported and accepted by almost all geologists by the end of the decade. Geophysical evidence suggested lateral motion of continents and that oceanic crust is younger than continental crust. This geophysical evidence also spurred the hypotheses of seafloor spreading and paleomagnetism. The hypothesis of seafloor spreading, proposed by Robert S. Dietz and Harry H. Hess, holds that the oceanic crust forms as the seafloor spreads apart along mid-ocean ridges. Paleomagnetism is the record of the orientation of the Earth's magnetic field recorded in magnetic minerals. British geophysicist S. Runcorn suggested the concept of paleomagnetism from his finding that the continents had moved relative to the Earth's magnetic poles.

## MODERN GEOLOGY

By applying sound stratigraphic principles to the distribution of craters on the Moon, it can be argued that almost overnight, Gene Shoemaker took the study of the Moon away from Lunar astronomers and gave it to Lunar geologists.

In recent years, geology has continued its tradition as the study of the character and origin of the Earth, its surface features and internal structure. What changed in the later 20th century is the perspective of geological study. Geology was now studied using a more integrative approach, considering the Earth in a broader context encompassing the atmosphere, biosphere and hydrosphere. Satellites located in space that take wide scope photographs of the Earth provide such a perspective. In 1972, The Landsat Program, a series of satellite missions jointly managed by NASA and the U.S. Geological Survey, began supplying

satellite images that can be geologically analyzed. These images can be used to map major geological units, recognize and correlate rock types for vast regions and track the movements of Plate Tectonics. A few applications of this data include the ability to produce geologically detailed maps, locate sources of natural energy and predict possible natural disasters caused by plate shifts.

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 "The Saracens themselves were the originators not only of algebra, chemistry, and geology, but of many of the so-called improvements or refinements of civilization, such as street lamps, window-panes, firework, stringed instruments, cultivated fruits, perfumes, spices, etc."  
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### Salient Facts on History of Coal Mining in India

1774	Warren Hasting initiates commercial coal mining at Raniganj (West Bengal).
1815 – 1820	First Shaft Mine opened at Raniganj.
1835	Carr, Tagore & Company takes over Raniganj Mines.
1843	Bengal Coal Company takes over Raniganj Coal Mines and others. First joint stock company in India.
1925	First Nationalisation of coal mining by Railway Board.
1944	Railway collieries transferred to Coal Board under Coal Commissioner.
1956	Formation of Public Sector company National Coal Development Corporation Ltd. with II stage owned collieries, Production 3.11 MT.
1959	First Washery of NCDC – Kargali.
1971	Nationalisation of Coking Coal Mines.
1973	Nationalisation of Non Coking Coal Mines.
1975	Central Coalfields Limited recognized in November under Coal India Limited – Holding company.
1986	Truncation of CCL – formation of NCL (Singrauli) and MCL (Talcher).
2004	II areas 65 Mines Presently CCL has 63 Mines (26 underground and 37 opencast) 7 Washeries; 4 Medium Coking Coal, 3 Non-Coking Coal .

#### ➤ History of Mining at Kolar Goldfield, India

- An English Mining Firm John Taylor & Sons in 1880 started the systematic mining for gold.
- The first hydroelectric project in South India was built in 1902 to provide electricity for the gold fields.
- In the year 1902 the suburb of Robertsonpet was established.
- The mines were taken over by the Govt. of Mysore in 1956.
- The mines were taken over by Govt. of India in 1962.
- The tradition of mining gold started at least as early as first millennium B.C. The Champion reef at ICGF was mined to a depth of 50 mtrs. during Gupta period in fifth century A.D. The metal was continued to be mined by eleventh century, kings of South India, the Vijayanagar Empire from 1336 to 1560 and later by Tipu Sultan.

## News about member

- On invitation from the Indian Institute of Management, Calcutta **Sri S.N. Padhi**, Director General of Mines Safety (Rtd.), attended the Workshop on "Use of Information and Communication Technology for Disaster Management in Underground Mines" on 20.06.2007 as an Honourable speaker and delivered a talk on **Mines Safety: Trends and Practices.**
- **Dr. B.M. Faruque**, laid down the office of Director (Coordination Technical), Marine Wing, GSI, Kolkata on 31.07.2007, on superannuation.
- **Dr. B.M. Faruque**, Director (Retd.) participated the International Workshop (IGCP-514) on FLUVIAL AND MARINE PROCESSES OR CENOZOIC AND FORMATION OF PLACERS as member of

National Advisory Board for the Workshop.

- **Dr. Faruque**, also chaired the Technical Session – IV of the International Workshop, held at Trivansrum-Goa during 1-10 November 2007 organised by Centre for Earth Science Studies, Trivandrum, Kerala.
- **Shri B.B. Sarangi** laid down the office of GSI on superannuation.
- SGAT deeply mourns the sad demises of the following members:
  - i) Shri R.N. Patnaik, Mine Owner, Joda, Keonjhar
  - ii) Shri B.P. Patnaik, Mine Owner, Bhubaneswar
  - iii) Shri Bijoy Lenka, Dy. Director of Geology (Retd.), Govt. of Orissa
  - iv) Shri K.S. Das, DGM (Geology), OMC, Bhubaneswar.

May their souls rest in eternal peace.

➤ **New Members**

- |          |  |          |   |
|----------|--|----------|---|
| <b>1</b> | <b>Mr. Drupada Chandra Dagara</b><br>Mine Owner<br>Plot No. 1289, Sriram Nagar<br>Old Town<br>Bhubaneswar – 751 002  | <b>2</b> | <b>Er. Umesh Chandra Jena</b><br>Mining Officer<br>O/o Dy. Director of Mines<br>Sambalpur Circle<br>Kacheri Road<br>Sambalpur                             |
| <b>3</b> | <b>Dr. Kulamani Parida</b><br>Scientist – F<br>Qrs. – 505<br>Institute of Minerals and Materials<br>Technology<br>Bhubaneswar – 751 013  | <b>4</b> | <b>Mr. Upendra Kumar Sutar</b><br>Sr. Manager Planning<br>C/o Sri S.K. Sethy<br>Qr. No.: W/236<br>At/PO.: Bolani<br>P.S. Barril<br>Dist: Keonjhar-758 037 |
| <b>5</b> | <b>Mr. Nilamadhab Swain</b><br>Asst. Manager (Geology)<br>POSCO-India Pvt. Ltd.<br>5 <sup>th</sup> Floor, Fortune Tower<br>Chandrasekharpur<br>Bhubaneswar – 751023<br>Tel: 9437637031 |          |   |

## Submission of Papers For SGAT Bulletin

### (Guidelines to Prospective Authors)

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

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

**Journal Format:** A-4 size

**Language:** English

### Manuscripts

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

## Headings

Different headings should be in the following format.

- (a) Title: Centrally aligned, bold, capital
- (b) Author(s): Centrally aligned, short name, bold, first letter of all words capital followed by communication address (Not Bold)
- (c) Abstract: Left aligned, bold
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- (h) Acknowledgements: Left aligned, bold, first letter capital
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## Illustrations

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

## Tables

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

Time New Roman/Arial Font for table is recommended.

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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)
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- (c) Articles from the books should follow the format given below: Windley, B.F. and Razakamanana, T. (1996) The Madagascar – India connection in a Gondwana

framework. In: Santosh, M. and Yoshida, M. Eds.) *The Archaean and Proterozoic terrains of South India within East Gondwana*. Gond. Res. Group Mem. No.3, Field Sci. Publ., OSAKA, pp. 25-37

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

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

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

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