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# PRESIDENT'S COLUMN

Since the last issue of the Bulletin (December – 2009), there has been little change in the scenario of mining and mineral sector in India. Though after economic slowdown, this sector had revived in 2009, the expected growth has not been achieved there after. This is partly due to poor growth of metallurgical industries responsible for domestic demand and exports continuing to remain low compared to previous years. There are also other factors like no decision taken on pending cases of grant of new mineral concessions and renewal cases. Further, Forest & Environmental Clearances have also delayed development of new mines and expansion projects. It is apprehended that delays in opening of new coal mines would have serious impact on energy sector. This would not only slowdown the growth of metallurgical industries but due to increase in deficit of power availability when the public would suffer, there would be restrictions in power supply to industries.

There are also some good signs. As deliberated in the Seminar on "Strategy for Management of Economic Slowdown in Mineral Industry" held by SGAT in December, 2009, many industrial houses of the country have now moved abroad for acquiring and developing new mineral deposits of coal, base metals, chromite, iron and manganese ores. There are some new proposals for establishing beneficiation plants for upgradation of low grade iron ores which would help in utilisation of resources of marginal and sub-grade ores. The heat generated on illegal mining activities has cooled down. The one day Workshop organised by SGAT jointly with Mining Engineers Association of India (MEAI) on 14$^{th}$ April, 2010 at Bhubaneswar, discussed on the reasons of such illegal mining and opined that such cases are mostly due to failure in administration, delays in grant of mineral concessions and renewals. It recommended for streamlining the procedure for expeditious grant of mineral concessions and strengthening the Government organisation for monitoring and control of mining activities. Representatives of different States informed that such steps are being taken which is surely a welcome development. In this connection, there are many issues to be taken care expeditiously which have also been noted in the interim report of Central Empowered Committee (CEC). Pending leases which have been operating under deemed extensions having all required statutory clearances have to be regularised earliest. Similarly, the renewal cases pending for forest clearance of DLC category forest are to be considered separately as advised by CEC. Pending cases of new mineral concessions for developing captive mines for already planned value added industries need to be considered on priority basis. The cases of violations having produced more than the approved quantity of production where the Royalty has been paid need to be considered differently. These steps are essential to get back the mining and mineral sector into the right track for progressive development.

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

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# NEED TO REVIEW FOREST CONSERVATION ACT FOR SUSTAINABLE DEVELOPMENT

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

Minerals being located mostly in forest areas, their mining would obviously cause degradation of forests. Observing large scale deforestations taking place throughout the country, Govt. of India brought Forest Conservation Act, 1980. Since enforcement of this Act, mineral concessions and even renewal of old mining leases have become very difficult and have been delayed over the years. As a result, new major mines have not come up and due to restriction in exploration new deposits and additional resources also have not been established. At the same time production of minerals has significantly increased due to rise in demand. Compared to 2000, within a decade production of iron ore, coal, chromite, and bauxite in Orissa from 14, 45, 1.9 and 2.92 million tonnes has increased to 77, 100, 3.8 and 4.8 million tonnes respectively. This increase was achieved mostly by the existing mines through capacity expansions. Simultaneously, in order to avail the benefit of favourable market there have been reported instances of forest areas being unauthorisely encroached by illegal mining. These facts indicate that while the bureaucratic system at higher Govt. levels have restricted or prohibited authorized mining, administration at the ground level have failed to protect the existing forests in the mineral bearing areas

Sustainable development is the talk of the day. No doubt conservation of forest is quite essential for maintenance of eco-system. Exploration and exploitation of minerals are also equally required to meet the need of people and to achieve economic growth for development. While exploitation is increasing fast, much needed exploration for finding new resources for future is lagging behind. As such, we are failing in achieving Sustainable Development even within the mineral sector.

In spite of recent global recession the mining and mineral based industries have not been adversely affected not withstanding fall in margin of profit. In next decades demand is likely to increase at the rate of 8 to 10% due to growth in population and increase in per capita consumption. To meet this increasing demand in future growth of mineral sector is quite essential. It is now time to think how both mineral development and forest conservation would simultaneously be achieved. Not one at the cost of the other.

There is need to assess the results achieved in conservation and development of forest by enforcement of Forest Conservation Act. Against recorded forest land of 58136 Sq. km, the existing forest area in the State of Orissa is 48855 Sq. Km as per FSI Reports (2009). The loss over 9281 Sq. km. cannot be attributed to mining activities. Out of 596 mining leases in the State, 289 do not have any forest land (including DLC). Out of remaining 307 leases having forest area partly or fully, only 104 are being operated including 68 mines being worked within a part of forest area cleared for the purpose. As per Govt. record the total mining lease area does not exceed 1000 Sq. Km. having about 450 Sq. Km. of forest land. As actual mining is within a part of the lease area, mining being the cause of deforestation would be confined to maximum of 300 Sq. Km which is only 3% of total loss of forest. Never-the les almost all the mines have now contributed for compensatory afforestation

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against forest area acquired for Lease. Further, as per the directives and stipulated conditions of MoEF, these mines create green belts in the peripheries, take up additional plantation in the surrounding areas and are committed for plantation over mined out reclaimed areas and dumps. The mineral sector being controlled by various levels of Government departments and also being concerned about public opinion have to carry out above activities along with socio-economic development in the periphery areas. In case of their failures, mineral sector and mining should not be blamed alone. It is equally failure of Regulatory Authorities of both the State and Central Governments.

If FSI Reports based on last 4 surveys (2001, 2003, 2005 & 2007) are examined, it reveals that total forest area remaining more or less same, the dense forest coverage is reduced (Table-1). Simultaneously Open forests and Scrub areas (degraded forest) have been increasing. Even in thinly populated districts like Malkangiri, Nawarangpur, Nawapara, Boudh, Sonepur, etc where there are no mining and industrial activities, deforestations over large areas are observed (Table -2). This has been increasing even after enforcement of Forest Conservation Act. The aforesaid factors indicate that not mining but the other unorganised and uncontrollable reasons are responsible for loss of forest throughout the State. Reduction in density of tree and increasing trend of open forest and scrub areas is not a good sign for the objective of forest conservation. This suggests for more attention for conservation at field levels by effective control, monitoring and enforcement of laws.

**Forest Cover in Orissa**

**Table – 1**

| Year | Dense Forest | | | Open Forest*[4] | Total Forest | Scrub*[5] |
|---|---|---|---|---|---|---|
| | Very Dense*[1] | Moderately Dense*[2] | Total Dense*[3] | | | |
| 2001(Report – 2005) | Not assessed | Not assessed | 28178 | 20866 | 49044 | Not assessed |
| 2003(Report – 2005) | 487 | 27712 | 28199 | 20154 | 48353 | Not Assessed |
| 2005(Report- 2009) | 7077 | 21421 | 28498 | 20257 | 48755 | 4743 |
| 2007(Report – 2009) | 7033 | 21394 | 28467 | 20388 | 48885 | 4852 |

**Forest Cover in Non-Mining Districts of Orissa**

**Table -2**

| District | Very Dense & Moderately Dense Forest.*[3] | | Open Forest*[4] | | Scrubs *[5] | |
|---|---|---|---|---|---|---|
| Year | 2005 | 2007 | 2005 | 2007 | 2005 | 2007 |
| Malkangiri | 900 | 869 | 1302 | 1326 | 6 | 31 |
| Nawarangpur | 656 | 650 | 482 | 485 | 60 | 27 |
| Nawapara | 586 | 566 | 628 | 671 | 109 | 116 |
| Boudh | 809 | 807 | 443 | 448 | 71 | 77 |
| Sonepur | 200 | 203 | 108 | 121 | 52 | 69 |

**Changes in Forest cover in India**

**Table – 3**

| Year | Dense Forest: Very Dense*[1] | Dense Forest: Moderately Dense*[2] | Dense Forest: Total Dense*[3] | Open Forest*[4] | Total Forest | Scrub*[5] |
|---|---|---|---|---|---|---|
| 2005 | 83472 | 319948 | 403420 | 286751 | 690171 | 48475 |
| 2007 | 83510 | 319612 | 402522 | 288377 | 690899 | 41525 |
| Change | + 38 | - 936 | - 898 | + 1626 | + 728 | + 3050 |

All Figures for forest cover are in Sq. Km., *[1]- Tree Density (Canopy) more than 70%, *[2] from 40 to 70%, *[3] –more than 40%, *[4]- from 10 to 40% and *[5]- less than 10 %( degraded forest).

The figures of FSI Reports for 2005 and 2007 also indicate the same facts in the National scenario (Table-3). While by bureaucratic approach the forest land is being conserved, the density of tree in real dense forest is getting reduced in spite of all steps being taken. It also indicates that though the total forest area and the open forests are increasing due to new plantations but it is not able to increase dense forest. Due to deforestations open forest and degraded forest (scrub) is also simultaneously increasing in more areas. This trend is also prevailing in mineral rich States having mines and also in the States not having major mining or industrial activities.

Besides mines and mineral based industries, there are many other reasons for major loss of forest and reduction in tree density. There is urgent need to emphasize such activities for conservation of forest and restrict these activities. Hence, attention should not be towards restricting only the mining and mineral development activities.

For the country as a whole, the thrust area has to be first for preservation and conservation of existing dense forest coverage. Simultaneously poaching and loss of endangered species have also to be taken care seriously. Such dense forests which extended over large areas with connecting corridors have now been reduced to small disconnected pockets. These pockets of dense forest have to be laterally extended on priority basis along with development of corridors. Therefore, the open forest and scrub area (degraded forest) in between the dense forests have to be taken care immediately with massive plantations.

In the second priority, vast and extensive open forest and scrub areas at the proximities of habitational areas have to be improved to dense forest to preserve the ecosystem. The satellite imagery, field observations with photographs would confirm that around the organised mining and industrial activities, better forest with tree growth exist. Conservation of forest and new plantations have been invariably taken up in and around the mining areas while at a distance apart tree felling and deforestation continues unabated where the industry have no responsibility and control. Hence Govt. has to rely on this sector more than other unorganised sectors causing deforestation.

There are many other areas besides illegal mining which should draw attention under F.C. Act. Open forests and scrubs have to be improved quickly. It would require huge amount of fund, manpower and organisation which Government cannot provide immediately. Mining and Mineral Sector as an organised force can contribute and render support in achieving this objective in and around their areas of activities.

Minerals are required for meeting day to day requirement of man. Steps are to be taken for development of mineral sector i.e. exploration, exploitation, value addition and infrastructure to meet country's internal demand which is likely to increase. Nature has placed mineral deposits in forest areas and without affecting forest this development can not take place. The mineral bearing forest areas are to be suitably planned for mineral development. These areas are to be earmarked for separate consideration under F.C. Act taking into account the likely impact on forest. Mineral development permitting limited impact by temporary deforestations in phased manner can be promoted. At the same time, besides compensatory afforestation, the mines have to ensure reclamation of mined out areas in phased manner and help in the restoration of eco-system after closure as per the MMDR Act. Necessary provisions of F.C. Act also have to be enforced to ensure development of new forest areas and eco-friendly operations within the mines and in the surrounding areas.

At the same time due to growth in the population and extension of habitational areas, shortage of agricultural land is felt everywhere. Acquisition of such areas for compensatory afforestation and development of mineral based industries is being opposed throughout the country. If the country feels that industrial and economic growth is also important, small parts of extensive degraded forests close to habitational areas can be made available for the industries and with their support industrial growth and development of forest over larger areas can be achieved. This needs proper planning, enforcement, monitoring and control.

Hence, time has come after 30 years to review the Forest Conservation Act which would promote the mining and other socio-economic development activities and at the same time ensure conservation of forest particularly at ground level which would help in achieving desired Sustainable Development.

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# OPTIMAL LIBERATION OF ORE MINERALS FOR ORE BENEFICIATION

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*ABSTRACT*

*Ore minerals are normally complexly interlocked with adjacent gangue and/or ore minerals in most ores. Optimal liberation of ore minerals is essential for low-grade ores, so that maximal profits can be made by marketing such beneficiated ores by removing gangues after crushing these ores. Cost minimization for liberation is useful to achieve maximum profit for beneficiated ores through recovering as much ore minerals (in weight fraction) as feasible using statistical size distributions of ore minerals and gangue minerals, separately.*

*Ore and gangue minerals are usually having log-normal size distributions, in 3D space, on weight frequency basis which have different (size) means and (size) variances as well as different weight proportions (fractions) in the ores. However, since the price of marketable ores is often several times (or several tens/hundreds of times) that of the crushing cost for liberation, optimal crushing size is calculable from the actual size distributions of ore and gangue minerals in the ore. But, the measured sizes (circle radii or semi-intercepts) in 2D on thin/polished sections are not the true size distributions of ore and gangue minerals on weight basis in 3D space, and thus probabilistic corrections as proposed by author (Sahu,1974a,b,c) and transformation of corrected number frequency moments to equivalent 3D sphere size moments on weight frequency basis (Sahu,1974a,b) are essential to compute the true optimal libration size (on weight basis) for crushing the ores for ore beneficiation purposes.*

## I. INTRODUCTION

Ores containing ore minerals and gangue materials are often hard and cannot be easily disaggregated (without grain breakages) and separated to obtain their weight frequency size distributions separately in 3D space for purposes of liberation studies. Thin/polished section of ores is the only alternative to obtain these in situ size distributions but the method has several drawbacks. The size distributions can be measured as 2D circle diameters or as 1D intercepts on the section plane which are biased towards finer sizes (i.e. not true 3D spherical size distributions) and the frequency is recorded as numbers (not as weights needed for liberation purposes). It may be noted that weight frequency is more fundamental as it applies both to joint (open and continuous pores or matrix) as well as disjoint (grains assumed convex and closed) bodies. Most liberation studies can be characterized by mineralogy and texture of ore and gangue minerals and should be independent of grinding processes utilized for separating the valuable ore minerals or removing the deleterious gangue materials in order to efficiently beneficiate the ore and to maximize profits on marketing the beneficiated ores. We must not over-grind the bulk ores as finer grinding is very costly but also detrimental for subsequent ore mineral recovery. Hence, the choice of optimal grind-size or sequence of optimal grind-sizes is crucial for design and plant operation in mineral processing. However, much larger importance should be for better assay and grades of beneficiated products that yield better market price rather

than on maximal liberation of ore minerals interlocked with gangue minerals.

A liberation model is not yet well-defined and it links two better-defined models: (i) upstream communition model and (ii) downstream flotation/separation model. Hence, we develop here a more rational mathematical model for optimal liberation in beneficiation using weight-frequency sphere diameter distributions of ore and gangue minerals, separately, in 3D space as developed by author elsewhere (Sahu, 1974a,b,c, 1976, 2009a) where 3D weight-frequency of sphere diameters can be obtained, after suitable probabilistic corrections from counting(number-frequency) measurements of circle diameters (2D) or lineal intercepts (1D) on thin/polished sections of ores. Refinements of this optimal liberation model may be necessary if the proportions of exsolved and/ or complexly intertwined ore minerals become considerably large.

## II. BRIEF REVIEW FOR LIBERATION MODELS

Gaudin(1939) pioneered liberation models assuming, rather erroneously, that the grain structures and fracture patterns in ores were both cubic. Lineal intercepts were first introduced by Spektor (1950) and since then many workers have used them because of their simplicity and ease of measurements. These results have been well summarized by Underwood (1970, 126-133). Matheron (1967, 7-79) gave solution to second and higher sphere size moments in 3D space but could not solve the required and most crucial first moment (mean or average sphere diameter), which essential to liberation and other scientific studies. Wiegel and Li (1967) assumed grain structures to be random and described mineral content in composite particles. M.P.Jones (1972) effectively discussed many different aspects of mineralogy as applied to liberation and beneficiation of ores(refer Chaps. 3,6,7,8), although he did not specifically resolve the issue for reconstruction of 3D sphere diameter (size) distribution from measurements made on thin/polished sections of ores in the lower 2D or 1D space.

Significant conclusions made by Jones(1972) include: (i) number frequency and weight frequency distributions of a given mineral in ore are grossly much different and not at all correlatable (see,p.95, fig. 7.19), an earlier conclusion of Sahu (1965b), (ii) logarithm of intercepts is distributed approximately as a positively skewed distribution (see,fig.7.16,p.94 and hence, not exactly a negative exponential model as proposed by King(1975), and(iii) demonstrated the use of size distribution in liberation and beneficiation studies with several real life examples.

Andrews and Mika (1976) quantified liberation functions in batch grinding process. Sutherland,Wilkie, and Johnson(1989) correlated processing outputs to liberation parameters, such as phase specific surface area(PSSA), and effective mean sieve size(EMSS) measured by QEM*SEM microscopy. But their procedure does not predict effective liberation at different grind sizes nor produce optimal liberation of ore minerals. A cumulative liberation yield may be defined as the proportion of mineral carried by particles of a given beneficiated size grade.

Morrell, Dunne, and Finch (1993) quantified liberation using QEM*SEM analysis, assaying, and laboratory leach analysis of samples from a plant treating gold ores. They modeled passage of liberated, un-liberated and bulk ores passing through the plant circuit, separately. However, for flotation downstream the exposure of mineral surface area is more important than total mineral content composite particle but for gravity separation downstream the

mineral content (weight) of composite particle is more important. Hence, there is a need to find the relative weightages for liberated and un-liberated(composite) ore particles in communication incorporating the textural characteristics(especially the five parameters needed for defining the total weight frequency sphere diameter distributions of ore and gangue minerals, separately,(i.e. four for means and variances) and only ONE(not two) independent weight fraction, say of ore mineral, (or of gangue mineral) with the total weight being transformed to 1.0 as is required by probability theory).

King (1975) quantified ore texture through linear intercept distributions of ore mineral and gangue minerals in polished sections of ores. However, King`s (1975) liberation model is not rational and has following drawbacks:

(i) Since randomly placed lineal intercepts do not pass through all (assumed convex and closed) grain centres, the measured intercepts are highly biased towards finer sizes (intercepts) and hence, the highly biased finer intercept distributions need probabilistic corrections (Sahu,1974a,b,c; 1976, 2009a) for true size distributions in higher 2D and/or 3D space to be relevant for liberation, grinding and ore beneficiation. Also, intercepts are counting (number frequency) measures (not the needed weight frequency for ore beneficiation) and intercept distributions are conditionally dependent on existence of circles in the thin/polished section studied and cannot be directly converted to sphere diameter distributions (see, probabilistic correction solution in Sahu, 1974b).

(ii) King (1975) has not measured the finer (sub-micron) particles (clay and colloid sizes), so his intercept size data are censored at the lower end of one micron size. King (1975) fitted size distribution curve to plus one micron intercepts measured by him and found it to be negative exponential, a conclusion which is erroneous because of using censored data at one micron intercept. In petrology and ore petrology, it is well-established that spherical grain size distributions in 3D space follow the well-known log-normal (phi-normal with phi- size defined as the negative logarithm to the base 2 of grain diameters in mm.) distribution law (Krumbein,1934,Sahu,2009b, Stanton, 1972,Misra, 2000, Pirajno,2009). Therefore, each mineral size distributions are characterized for each group of homogeneous-sized minerals by the two size parameters of phi-normal distribution: mean phi-size and phi-size variance. So, for two groups we have four size parameters (mean and variance of each mineral types, i.e., ore mineral and gangue mineral), and one independent weight fraction where the two weight fractions are add (normalized) to unity. It is also well-known from unimodal phi-normal size distribution laws(Sahu,1965,a,b ) that phi-mean is really median(in mm) and phi-variance is equal to exp(1+ (CV)*2), where the coefficient of variation in arithmetic scale of grain diameters(mm) = (arith. standard devn.)/(arith.mean) and that arithmetic mean diameter(mm) = exp(phi-mean + ½ phi-variance). Also, number frequency phi-mean which is much smaller than weight frequency mean (in mm scale) is given by the weight frequency phi-mean minus half the phi-size variance which are equal for number and weight frequencies in case of unimodal phi-normal size distributions (see, Sahu,1965b).

Therefore, negative exponential distribution fitted by King (1975) is not acceptable for liberation studies.

However, grain (sphere diameter) size distributions in ores could be polymodal, and then the procedures given in Sahu (2009a) should be followed to get the required size parameters in order to decide the optimal grind-size for liberation/ beneficiation. Two important cases are obvious, (i) phi-mean for ore mineral is greater(i.e. less in mm scale) than that of gangue mineral and (ii) phi-mean for ore mineral is less(i.e. greater in mm scale). Similarly two important cases regarding weight fraction of ore mineral versus gangue mineral are: (i) mineral weight fraction very low necessitating mineral prices to be very high relative to grinding costs for marketing of ores and (ii) mineral weight fraction very high necessitating removal of deleterious gangues for marketing of ores but mineral prices could be low to intermediate value relative to cost of grinding. These two independent categories generate four different possibilities: (I)Mineral ,high value but low weight fraction such as uranium, diamond and gemstone, gold, platinum, vanadium, rare earths etc. ;(II) Mineral, intermediate value but intermediate weight fraction such as base metals, chromite, titanium minerals, nickel, bauxite etc., (III) Minerals intermediate to low value and high weight fraction such as iron ores, clays, limestones etc. needing removal of deleterious gangues, and lastly, (IV) Minerals of low value and high weight fraction which cannot be marketed at present prices and hence cannot be beneficiated include soils, sands, road metals, etc.. In all these cases, optimal grinding size for liberation can be found by simultaneous statistical analysis and profit analysis for a given ore and designed liberation/ beneficiation circuit using numerical calculations; and no general optimal solutions can be given.

More recently, ore genesis and ore mineral systems in geological contexts have been highlighted by Misra (2000) and Pirajno (2009) and applications of ore textures to liberation and beneficiation summarized by Craig and Vaughn (1994). The reader is referred to these latest books for further information.

## III. THEORY OF OPTIMAL LIBERATION:

Ore and gangue minerals in ores exist in different weight proportions which, in addition to their four phi-size parameters, also influence their liberation, grind-size, beneficiation and marketability. Whereas ore minerals have much market value and must be recovered from the gangues by ore-dressing techniques; gangue minerals could be highly deleterious to make the ore minerals unfit for marketing and these deleterious minerals must be removed by liberation and subsequent beneficiation in order to improve the market value of beneficiated products. It should be noted that although voids (pores) are present in ores, they do not add to the total weight of ores, unless pores are filled by fluids like water, hydrocarbons, and many other gases.

Optimal grind-size for good liberation of ore minerals from gangues must include four size statistics such as phi-mean and phi-variance of ore mineral as well as of gangue minerals as well as the weight fraction of ore mineral (weight fraction of gangue mineral is not an independent factor since the two weight fractions add to 1.0); (total of five independent factors) but also dependent on market values for different grades ore minerals, market trends of price stability (or, approximate constancy), price rise , or fall of price trends.

A few drawbacks for estimation of phi-size statistics in 3D space on weight frequency basis by circle radii or semi-intercept

measurements made on thin/polished sections of ores include the following:

(i) Size measurements made on ore minerals and gangue minerals on number basis must be treated separately to obtain their respective weight frequency sphere diameter distributions as given in Sahu (1974a,b).

(ii) A much larger counts of circle radii/intercepts are necessary to achieve equivalent precision in 3D space (sphere diameter) for the size distributions. The optimal number of counts in each lower space (2D, or 1D) is 14 times more counts compared to 3D space on number frequency basis (Sahu,1977,2009a). Thus, 700 circle radii (mm) or 9800 semi-intercepts (mm), yield the same precision as 50 sphere diameters (mm) in 3D space on number frequency basis.

(iii) The probilistically corrected observed size distributions in lower space using procedures and theory given in Sahu(1974a,b) must be transformed to weight frequency size distributions for ore minerals and gangue minerals, separately, using appropriate (average) densities for ore and gangue minerals(Sahu,1974b). Then, the weight fractions for ore minerals and gangue minerals can be calculated easily as the total weight of ore and gangue minerals is converted to unity, but only one of these two weight fractions is independent(say , weight fraction of ore mineral). Weight frequency sphere diameter parameters for ore and gangue minerals (FOUR factors) as well as the weight fraction of ore mineral (ONE factor). Thus, a total of FIVE factors are scientifically important to determine the optimal grind size for liberation and subsequent ore beneficiation/mineral separation studies.

(iv) Lastly, the corrected phi sphere diameter parameters and weight fraction for ore mineral and phi sphere diameter parameters and the compliment weight fraction for gangue minerals are utilised to obtain the cumulative weight frequency or weight frequency sphere diameter distributions using inversion of moments by Edgeworth`s expansion for unimodal phi-normal (Sahu, 1968) and for polymodal phi-normal (Sahu,2009a) sphere diameter distributions, if and when it is necessary.

In spite of above difficulties, a complete, unbiased, accurate and more(efficient) precise mathematical reconstruction of sphere diameter distributions of ore mineral and gangue mineral from size measurements made on lower space of 2D thin/polished sections of ores is feasible as given by Sahu(1974a,b,c, 2009a). Using these reconstructed sphere diameter distributions, on weight frequency basis, we can get optimal libration of ore minerals from gangues for maximal profits by marketing the beneficiated ores.

It is hoped that the methods and procedures proposed here, would be valuable and useful to metallurgists, ore dressing engineers, beneficiation plant designers, mine managers and others interested in liberation studies.

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# METALLOGENY IN THE INDIAN OCEAN : RETROSPECT AND PROSPECT

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*Abstract*

*As known and established mineral resources on Earth's surface are getting depleted at a faster rate, future of mineral based and metallurgical industries would depend upon mineral resources to be extracted from ocean beds. During last 4 to 4 decades, voyages for discovered of such resources have been attempted. This paper deals with few potential resources of this type in the Indian Ocean and analyses their distribution abundance, composition, origin, structural control, process of enrichment etc. It also gives results of DSDP hole in the floor of Indian Ocean which indicate likely occurrence of deposits identical to those found in the Pacific Ocean.*

## 1. INTRODUCTION

Seafloor minerals have become future resources for industry. As more and more reconnaissance and detailed surveys locate major tectonic, volcanic, and sedimentary features on the seafloor, we are able to identify a wide variety of mineral deposits with both scientific and economic interest.

We can also refine our concepts of the origin of mineral deposits on land by understanding the present seafloor processes and activity. So far direct observations seem to confirm our theoretical models.

It is clear that the knowledge of distribution of seafloor minerals resources in the Indian Ocean has increased substantially over the past few decades. Yet, there is scope for the systematic survey of mineral such as seafloor sulfides, and cobalt-rich crusts in the Indian Ocean.

There is also a considerable need for the systematic survey of both the Exclusive Economic Zone (EEZ) as well as the deeper parts of the ocean to make a realistic assessment of the mineral potential as well as the related technology for their eventual recovery.

## 2. TYPES OF DEPOSITS

Two types of seafloor metalliferrous deposits are known and have attracted attention in the past 3-4 decades. These two types of deposits have been formed under different processes though. These are listed below

The manganese nodules and crusts widely distributed on the floor of the major ocean basins are formed through sedimentary concretionary and biogenic processes. The metals they contain may be from hydrothermal or sedimentary sources, or be concentrated by the geochemical reaction of seawater and sediments. In the Indian ocean several areas have been demarcated where nodules occur in abundance (Fig.1). One may refer to several publication on this theme, but a good synthesis is available in Roonwal (1986) and Mukhopadhyay et al. (2002).

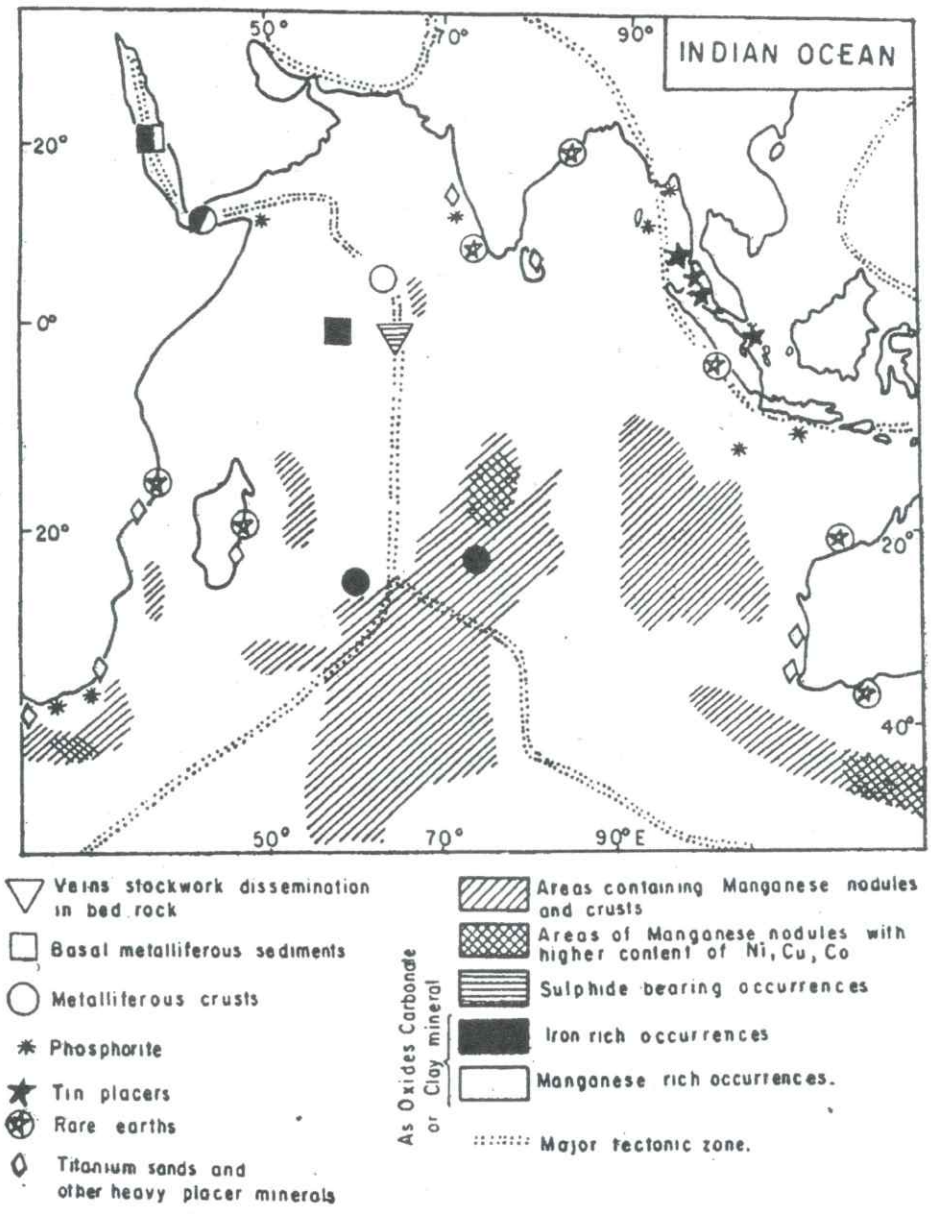


Fig.1 : Map of Indian Ocean showing major tectonic zone and mineral occurrences.

The other major metallogenetic type is even more exciting because we can see its creation. Along fracture zones, fault and the spreading ridges of the sea-floor, hydrothermal springs discharge solution containing iron, manganese, copper, zinc, lead, cobalt, silver, gold, platinum, and other metals. On a global map, these spreading centres and mid oceanic ridges are more than 60,000 km long and are generally indicated by the earthquakes and sometimes by volcanoes. They make the so called divergent boundaries of the rigid plates, some 100 km thick, and consisting of earth crust and upper part of the mantle. Some of the metals mentioned above may be precipitated as carbonate, oxide, sulfide, sulfate or silicate minerals in crust, chimneys, or stacks around the hydrothermal vents. Some are disseminated in the sediments and siliceous zones or muds on the seafloor forming metalliferrous sediments such as in the Red Sea, and some are deposited in

sub-surface fractures in the bedrock forming stockwork below the vent and effusive outlets.

**Nodules**

Manganese nodules would probably provide a commercial source of metals in the coming decades, because they contain metal of vital interest to modern industry. The richest and most valuable nodule field in the Indian Ocean located so far lies in the Central Indian Ocean Basin (CIOB). It is here that India has put claim for mining of nodules to the International Seabed Authority (ISA), a wing of the UN. One may say that vast area known to contain manganese nodules has not been closely explored.

Nodules were first discovered in the Pacific Ocean by the HMS Challenger expedition in 1872-1876. Since then they have been found widely distributed on the deeper part of the seafloor throughout the world where the rate of sediment accumulation is very low, and the biological productivity high. That is why in areas on both side of the equator, and away from the continents, occur the best grade nodules (Fig.1). The nodule are shaped like spheres, eggs or bunches or grapes, and have concentric layers of different mineral composition. They range in size from a few millimeters to tens of centimeters in diameter but are commonly 0.5 to 20 mm in their greatest dimension. They are principally manganese and iron oxides, ranging from 15% to 35% and 5% to 20% of these elements respectively. They also contain an average of 1% nickel, and 0.77% copper in larger areas south of equator in the Central Indian Ocean Basin (CIOB).

The cobalt percentage ranges from 1% to even more or some seamounts to a little as 0.01% on continental margins.

The distribution, abundance and composition of manganese nodules are indeed irregular, and we still do not clearly understand fundamental aspects of their origin and growth. Areas with concentration of manganese nodules are shown in Fig.1, with parts of these area where nodules have a higher content of nickel, copper and cobalt indicated.

In some places dense concentration of manganese nodules seem to give way to patches of thin beds of manganese and iron crusts. They may be related to hydrothermal activity more than the nodules. Manganese rich crusts have been found in deep seafloor and seamounts near ancient volcanoes, and even associated hydrothermal vent system which are of hydrothermal origin. Some of the manganese rich crusts such as those reported near the Hawaian islands in the Pacific Ocean contain more than 1% cobalt. They are being investigated as a source of cobalt and manganese. In the Indian Ocean, such deposits are likely to be met in areas of ancient seamount, where upwelling may be taking place (Roonwal, 1988), and some cobalt rich crust have been located in the Indian Ocean.

**Hydrothermal Deposits**

Hydrothermal systems producing metalliferous sediments and crusts and chimneys on the seafloor are located in three tectonic settings:

(a) On the spreading ridges which encircle the globe.
(b) Along volcanic areas and fracture systems and subduction zones and
(c) On seamounts or volcanic centres isolated from major fracture systems.

Active hydrothermal systems discharging metal bearing solutions have been investigated in the past in the Red Sea, and at present in the mid-Atlantic Ridge; along segments of the East Pacific Rise, and other parts of the Pacific Ocean, as well as in the Indian Ocean. Their occurrence in the Indian Ocean can be seen in Fig.1. In 1993, the German group discovered a

hydrothermal field north of the Triple Junction on the mid-Indian Ocean Ridge (Halbach et al. 1994). All these deposits are obviously bound to the recent tectonic faulting. In each of these cases, sulfides were the original phase precipitated, although they may have suffered later partial oxidation. All these deposits are found together with warm water which means they are hydrothermal in origin, in the true sense.

Such hydrothermal systems producing metalliferous sediments and crusts associated with active spreading centre can be divided into three types:

1. Sulfide deposits with silicates and oxides, as in the Red Sea.
2. Sharply fractioned – silicate and oxide deposits of very localized extent, as on some mid-oceanic ridges in the open seas, and
3. Widely dispersed predominant oxide deposits of iron and manganese, which comprise the bulk of metalliferous sediments on mid-oceanic ridges.

These different deposits could all be formed as a result of fractional precipitation of metals from hydrothermal solution derived from sea water leaching of hot newly formed oceanic crust. Sulfide deposits represent the early formed precipitations followed by silicates and oxide. Widely dispersed predominantly oxide bearing metalliferous sediments deposits on mid oceanic ridges, have been formed as a result of precipitation of iron and manganese bearing solutions. They represent residual liquid of sub-sea floor hydrothermal fractionation processes. Thus, their metal source is discharged from hydrothermal vents, together with some iron and manganese oxides. They become well mixed with bottom waters and precipitate their constituents relatively uniformly over a wide area.

In some places dense concentration of manganese seem to give way to patches or thin beds of manganese and iron crusts. These appear to be related to hydrothermal activity and some of them contain higher percentage of cobalt. Such crusts are known from submarine ridges such as the Carlsberg Ridge and seamount regions.

Hydrothermal mineralization on slow spreading oceanic ridge, such as the Mid Indian Ocean Ridge, is considered as a product of multi-stage episodic high and low temperature hydrothermal activity controlled by intrusive-extrusive volcanic cycle. Evidence of this can be found in the Carlsberg Ridge crust between latitude 5°21′S and 10°N in the northwest Indian Ocean (Fig.1).

On the floor of the Red Sea, metalliferous muds are being formed in trough or grabens about 2000m deep. Here thermal springs with temperature of about 65° discharge along fault of the rift zone on spreading ridge. The metalliferous mud consists of banded iron oxides and silicates interlayered with siliceous mud or ooze bearing iron and manganese. It closely resemble some types of banded iron formation in composition and general appearance. Prominent facies in these chemically precipitated sediments are oxides, sulfide, sulphate, carbonate and silicates, along with fine clastic muds, and siliceous oozes. Blanketing the metalliferous muds are hot dense layers of brine derived from evaporite beds in the bed rock of graben structure. The Atlantics II graben basin or deep is one of several in the Red Sea, with metalliferous muds, estimated to contain 1.7 million tons (mt) of zinc, 0.4 mt of copper, and 5000 tons of silver. The Atlantis II mud may be mined in the future. When dried they would probably average about 3 to 6% zinc, 1% copper, and 50 grams per ton of silver.

Table 1 gives the result of DSDP hole in the floor of the Indian Ocean, which is sufficient to indicate the likely occurrence of more such deposits in this Ocean as well as in the Pacific. The location of DSDP holes have been given in Table - 1.

**Table-1: Characteristics of basal metalliferous and hydro thermally altered sediment occurrence in the Indian Ocean (Data based on DSDP reports).**

| DSDP site | Unit thickness (cm) | Sub-seafloor depth | Age | Lithology |
|---|---|---|---|---|
| 211 | 66.5 | About 335-401,5 | Tertiary | Includes (I) moderate brown homogeneous amorphous iron oxide, (2) moderately indurated dark gray, pyrite almost totally replaced by iron oxides, and (3) moderately indurated red iron oxides |
| 213 | 5 | About 147-152 | Late Palaeocene | Grayish brown clay bearing to clay rich iron oxide sediment, contain oolitic like crystals (goethite ?) associated with red scales of haematite and less crystalline masses of limonitic material. Unit overlain and partly interbedded with calcareous nanofossil ooze. |
| 215 | 2 | About 149-151 | Palaeocene | Brown to dark brown iron oxide rich nanofossil ooze grading down to dark grayish – brown iron oxide rich clay nanofossils zone. |
| 236 | 4.1 | 301.0 – 305.1 | Late Palaeocene | Pale green, moderate yellowish brown and dusky brown clayey – nanofossil chalk, contains a thin layer of yellowish – green ferrugenous clay with about 23% , iron, 400 mm above basalt |
| 238 | 34.5 | 471-5-506 | Early to late Oligocene | Semi lithified variegated (mostly shades of orange, or brown, also pinks, green and yellow) nanofossil chalk with intercalated horizons of volcanic ash and zeolite. Sands, Iron oxide stained globules mixed with calcareous material. |
| 245 | 21 | 368-389 | Late Palaeocene | Moderate yellow brown dusky yellow brown grading down ward to brownish black or olive black ferrugenous clay in nanofossil chalk. |
| 45A | 18-3 | 468.2-486.5 | Early Miocene | Very pale yellowish brown to white garnet rich calcite (micarla) chalk, with faint limonitic mottling. Contain about 20% authigenic garnet and traces of iron oxides, garnet grain 2-3 μ in size. |
| 256 | 0.05 | About 251 | Early Cretaceous | Brown ferrugenous coccolith detrital clay. Contain 25-30% translucent and opaque ferrugenous material |
| 260 | 2 | 321-323 | Early Cretaceous | Semi lithified moderate brown to dark red brown calcareous radiolarian clay. |
| 261 | 5 | 527.5 – 537.5 | Late Jurassic | Semi lithified dark moderate brown nanofossils claystone |

## MECHANISM OF FORMATION

Cold sea water seeps through the ocean floor as much as 5 km deep to local hot spots. It heats, expands, and rises, leaching metals, from the lavas and sediments comprising the ocean floor. The mixture, now more than 350°C, bursts out of vents into cold ocean water, In the turbulent mixing, the metals become heavy, dark sulfide minerals. They build chimneys upto to 30 meters high, ejecting plumes known as "black smokers" or "white smokers", depending on the contents of hot metal laden water. Blankets of bacteria and exotic animals including giant claws and blood-red tube worms thrive around the vents. This process explains the mysteries about the composition of seawater. We once assumed its minerals came from river runoff. Yet the elements in the ocean were out of balance – not enough magnesium and too much manganese. Direct sampling of seawater gushing out of the vents shows that during circulation deep in the oceanic, crust, it had dropped off magnesium and picked up manganese. Geochemists calculate all the world ocean circulate through the curst once every ten million years.

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# GOLD IN TIEN SHAN

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*ABSTRACT*

*Tien shan belt of Central Asia is known for its gold occurrences for time immemorial. After breaking up from USSR and with opening up of central Asian economies like Kyrgyzstan, the gold prospects of this belt have drawn the attention of investors. Gold mineralization in this belt occurs as porphyry and epithermal systems within magmatic arc and as structurally controlled orogenic type gold deposits. In broad terms, this belt represents a Palaeozoic subduction-accretion complex on the Palaeo-Tethys Ocean margin of the proto-Eurasian continent that was active from the Neoproterozoic to the end of the Permian. These deposits are associated with Permian magmatism emplaced during the final- to early post-collisional stages of orogenesis, within a sutured back-arc setting containing carbon-rich sedimentary sequences.*

## INTRODUCTION

The Tien Shan Belt extends for over 2500 km, from western Uzbekistan, through Tajikistan, Kyrgyzstan and southern Kazakhstan to western China, and represents the central part of the Altaid Orogenic Belt (Sengör et al., 1993; Sengör and Natalin,1996; Yakubchuk, 2004) .of central Eurasia (Fig. 1).

Gold mineralization occurs in two principal settings within the Tien Shan Mineral Belt, namely as i) *porphyry and epithermal* systems developed within magmatic arcs, and ii) *orogenic-type* gold deposits that are structurally controlled, and temporally and spatially associated with late Palaeozoic, syntectonic to early postcollisional, highly evolved, I-type granodioritic to monzonitic intrusive in fore- and back-arc terrains (Cole and Seltmann, 2000; Yakubchuk et al., 2002; Mao et al., 2004).

The *porphyry and epithermal* systems include the vast Almalyk Complex of porphyry Cu-Au deposits (>5 Gt @ 0.5% Cu, 0.4 g/t Au) comprising the connected Kal'makyr and Dalnee deposits to the south-east of Tashkent, Uzbekistan, and meso- to epithermal deposits such as Kochbulak (which contained around 135 tonnes of Au at grades averaging 12 g/t Au, 120 g/t Ag) some 30 km northeast of Kal'makyr-Dalnee.

The *orogenic-type* gold deposits include the incomparable Muruntau (originally containing 5400 tonnes, or 175 Moz, of gold at an open pit recovered grade of 3.4 g/t Au), the nearby Amantaitau (primary and oxide resources of 700 tonnes, or 22.5 Moz, of Au at grades of 7.5 g/t Au), Daugyztau (180 tonnes of Au), Zarmitan (340 tonnes Au), Jilau (90 tonnes of Au), Kumtor (550 tonnes, or 17.5 Moz, of Au at grades of 2 to 6 g/t Au) and others (see Fig. 1).

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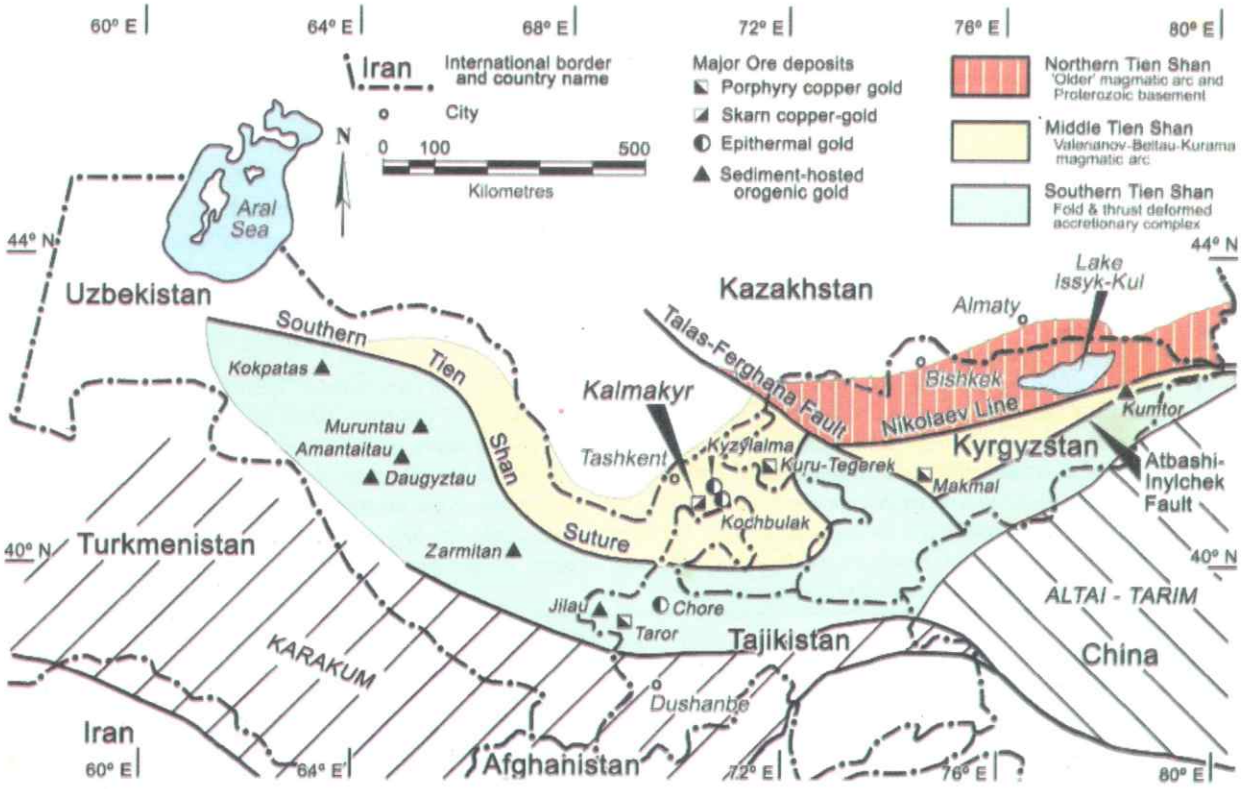


## TECTONIC SETTING

The contiguous Altaid and Trans-Baikal-Mongolian Orogenic Collages, of which the Tien Shan Belt is part, are made up of fragments of Neoproterozoic to Mesozoic sedimentary basins, island arcs, accretionary wedges and tectonically bounded terranes, and are the product of a complex sequence of processes resulting from subduction, collision, transcurrent movement and continuing tectonism. In broad terms, these collages represent a Palaeozoic subduction-accretion complex on the Palaeo-Tethys Ocean margin of the proto-Eurasian continent that was active from the Neoproterozoic to the end of the Permian. Over much of this period, the proto- Eurasian continent was separated from the Palaeo-Tethys Ocean by the broad Khanty-Mansi back-arc basin, and by Palaeozoic magmatic arcs and micro-continental slivers of Precambrian rocks between the back-arc basin and the ocean.

The Tien Shan Belt is composed of three main elements, the North, Central and South Tien Shan, each separated by a major suture/structural zone (Fig. 1). The North Tien Shan is composed of Proterozoic basement and Neoproterozoic to early Palaeozoic magmatic arc rocks of the Baikalides and pre-Uralides developed on the margin of the proto-Eurasian continent. To the south of the Nikolaev Line, the Central Tien Shan comprises remnants of the Late Devonian to Carboniferous Valerian-Beltau-Kurama magmatic arc, formed by subduction of oceanic crust of the Khanty-Mansi back-arc basin below the earlier arcs and micro-continental slivers separating the back-arc basin from the Palaeo-Tethys Ocean.

The South Tien Shan represents the south-western limb of the giant Kazakh Orocline and is found to the south of the Southern Tien Shan Suture. It was formed by compression related to the closure of the Khanty-Mansi back-arc basin during the Permian and collision between the contiguous Karakum and Altai-Tarim micro-continents to the south with the main proto-Eurasian mass to the north. This led to intense deformation of the sedimentary pile within the

Khanty-Mansi back-arc basin, development of nappe structures, and north-verging under-thrusting of the Karakum and Altai-Tarim micro-continents below the Valerian-Beltau-Kurama arc (Yakubchuk et al., 2002).

## GOLD-BEARING DEPOSITS OF THE TIEN SHAN BELT

While the orogenic-type gold deposits of the Tien Shan are not directly related to porphyry systems, they are a product of the same larger scale metallogenic evolution and set of tectonic processes as the gold-rich porphyry and epithermal deposits of the Tien Shan Belt.

Moreover, although belonging to two different terrain settings, the giant Cu-Au porphyries of the Almalyk district in the Valerianov-Beltau-Kurama magmatic arc of the Middle Tien Shan, and the giant orogenic Au deposits hosted by the black-shale series of the Central Kyzylkum slate belt of the South Tien Shan Khanty-Mansi accretionary complex, have some striking similarities. These hint at crust-mantle interaction and dominance of a deep-seated regime during emplacement, referred to as the "Chatkal-Kurama hot spot" (Dalimov et al., 2003). They are temporally close (315 to 285 Ma, Seltmann et al., 2004), their isotope signatures reveal the incorporation of a moderate mantle component (Chiaradia et al., 2005), and geophysical patterns from the middle crust in the region exhibit zones of low reflection indicating the existence of extended mafic bodies just beneath both giant ore-magma systems.

The orogenic gold deposits of the Tien Shan Mineral Belt, as listed above, include some of the largest economic gold accumulations in the world, and span the time scale from Lower to Late Palaeozoic. The greatest concentration of significant orogenic gold deposits however, is in the southwestern part of the belt, in the South and Middle Tien Shan of Uzbekistan and Kyrgyzstan. These deposits are associated with Permian magmatism emplaced during the final- to early post-collisional stages of orogenesis, within a sutured back-arc setting containing carbon-rich sedimentary sequences (Cole and Seltmann, 2000; Yakubchuk et al., 2002; Mao et al., 2004).

The orogenic gold deposits of the South Tien Shan are controlled by structures related to the Southern Tien Shan Suture Zone that separates the Middle and South Tien Shan terranes. They are hosted by the back arc accretionary complex deposited in the basin that had separated the Valerianov-Beltau-Kurama magmatic arc and the Karakum and Altai-Tarim micro-continents (Fig. 1). The suture zone is defined by ophiolites and borders the strongly deformed fold and thrust belt of the South Tien Shan that has been extensively intruded by Permian granitoids and hosts most of the significant orogenic-style gold deposits (Mao et al., 2004).

Most of the orogenic-gold deposits within the Tien Shan are located at mesozonal crustal levels, within Late Palaeozoic granitoid intrusives or their contact metamorphic aureoles, and yield radiometric dates of mineralization coincident with the magmatism. However, few can be shown to have a direct genetic link with the associated intrusives. Never-the-less, geochemical, isotope and fluid-structural models have implicated highly evolved Late Palaeozoic, syntectonic I-type granitoids as the source of metals and/or fluids for spatially associated orogenic gold deposits within the belt. The gold-quartz vein systems produced appear to represent only part of a larger magmatic hydrothermal system that often includes earlier scheelite (±Au) skarn mineralization (e.g., Zharmitan in Uzbekistan and Jilau in Tajikistan, while Muruntau, also in Uzbekistan, exhibits some similarities). In these examples, Au and W occur together with characteristic enrichments of As, Bi, Mo and Te deposited from CO2-rich fluids at temperatures of up to 400°C and pressures of approximately 2 Kbar (Cole and Seltmann, 2000).

The distribution of the granitoids and the associated gold deposits are both controlled by the same regional deep seated faults and shear zones that were the primary focus of regional fluid flow and of deformation. Mineralization appears to have been formed by CO2-rich fluids of deep crustal origin that episodically escaped

from geopressured reservoirs along major high angle reverse faults and deposited gold in zones of local structurally enhanced permeability (Cole, 1998; 2002).

Cole and Seltmann (2000) note that a general trend can be recognised in these granitoid related systems, where W, in the form of scheelite, dominates in mesozonal, more reduced settings, whereas Cu substitutes for W in the paragenesis of epizonal, more oxidized systems. They also observe that these same Late Palaeozoic (Variscan-Hercynian) granitoids are temporally, mineralogically, compositionally and isotopically similar, whether related to orogenic-style Au-W veins and associated skarn systems in the South Tien Shan fore-arc accretionary complex, or related to shallower porphyry Cu-Au systems in the magmatic arc of the Middle Tien Shan. They suggest a continuum, which would encompass classic Cu-Mo-Au porphyry, Cu-Au skarn and Au-Ag epithermal deposits in epizonal crustal environments / levels, passing down into W-Mo-Au with associated Bi-As-Te associations in skarn, lode and stockwork deposits (i.e., orogenic-style Au) at mesozonal depths.

- The major gold deposits of Tien Shan belt are Muruntau (175 Moz), Amantaitau (22.5 Moz), Daigyztau (6 Moz), Zarmintan (11 Moz), all in Uzbekistan, Jilau (3 Moz) in Tajikstan, Kumtor (18 Moz) and Makmal (1.5 Moz) in Kyrgyzstan. All these deposits are in production.

Over the last 6-7 years, particularly after opening up the economy by Kyrgyzstan, several occurrences/deposits are being explored and are in different stages of exploration. The deposits, in advanced stage of exploration, are Makmal (part under production), Kumtor (part under production), Jeroy, Andash, Taldybulak and Chaarat. The other occurrence / deposit which are under exploration are Kuranjaylu, Dolpran, Solton-Sary, Jamgyr, Kuru-Tegerek, Terek, Terekkan, Perevalnoe, Ishtamberdy, Bozymchak, Karabulak, Togolok, Tadybulak, Mironovskoe. Kumtor is being mined by Canadian company Centerra Gold. Chinese investors have shown keen interest in developing the gold mining industry in Kyrgyzstan followed by companies from Kazakstan, Canada, Europe and Australia. With many deposits in advanced stage of exploration and with investor friendly mining and taxation law in force, many of these deposits will go into production in near future. Even exploration activities both in green field and brown field targets are getting a boost with more and more investment pouring in. However, the recent political turmoil has acted as a dampener but the new Government's assurance that Kyrgyzstan will continue to have investor friendly policies has instilled confidence in the investors.

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# ELECTROMAGNETIC RADIATION POLLUTION- THE TYPE MAN NEVER KNEW

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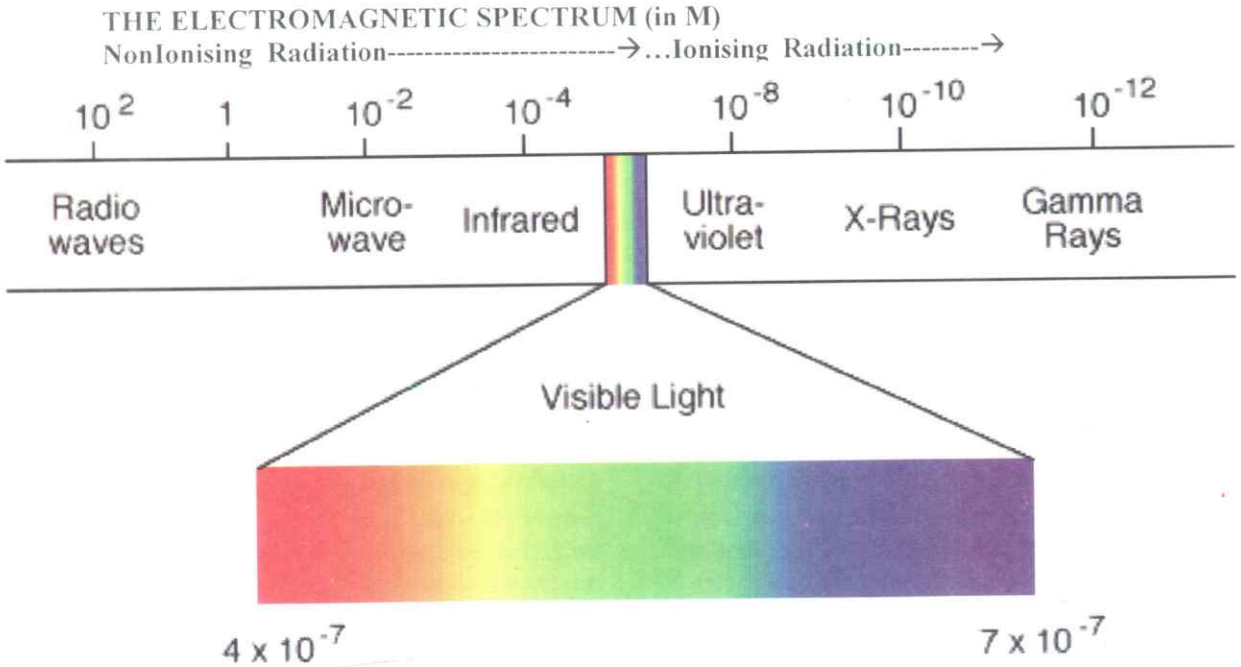
Celebration of "World Days" for various environmental issues has been established by UNDP to bring awareness among people. For example, "Ozone Day" celebrated on the 16th.Sept. every year is a reminder that in our enthusiasm for AC-comfort, fast automotive mobility and indiscriminate use of aerosol cans and bottles, we have punctured the stratospheric ozone shield that once protected earth from deadly ultra violet radiation coming out of sun. The result is our health and environment faces threat from UV-radiation pollution. UV-radiation is only a minuscule of a gamut of Electromagnetic Radiation (EMR) around us and that too is created by our enthusiasm for use of a variety of gadgets and appliances at homes and office. The environment conscious world is seized with pollution threats from pesticides and heavy metals in food and water; automotive exhausts, acid rains and global warming; waste disposals; nuclear waste, leakages and accidents, but barely aware of this new form of pollution "***Radiation Pollution, precisely the EMR- pollution***" which pervades everywhere, 24 hours a day- unless one lives in some remote corner of the planet. EMR is a radiant energy of accelerated electrons or photons, travelling as waves or particles and commonly known as gamma rays, X-Rays, UV and visible light rays, Laser, Infra-red, Radar or microwaves or those under various frequencies of Radio-TV propagation and high voltage transmission. Unlike the conventional pollution which takes place due to pollutants, which are substances or organic materials like metals, plastics, gases, salts, chemicals and bacteria, Radiation Pollution takes place through energy radiation that soaks us but can not be filtered and felt, seen or smelt or even mapped and measured through PUC tests and equipments. Radiation Pollution is a passive form of pollution that has both chronic and explosive impacts on health and environment in a modern progressive society.

Depending on wavelength and frequency, the EMR can be grouped into two types:

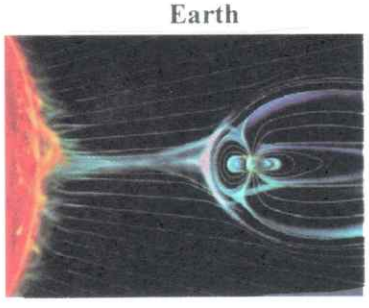
1. The **Ionizing Radiation**, coming out of cosmic rays, nuclear fission and fusion, mining and processing and use of radioactive minerals, radioisotopes use, x-rays and to some extent the short wave UV-rays, all of which are harmful to health and environment. When exposed, Ionising Radiation can induce burn, cancer, tumour, leukaemia, fatal foetal damage, defective births, chromosome aberration, DNA damage, mutation and other abnormalities till recently unknown to us.

2. The **Nonionizing Radiation**, covers a large range of wave length and lower frequency from UV to visible lights, Infrareds, Microwaves, and Radio-TV transmission, all of which are passive pollutants in the environment.

Either of the radiation types can be natural or artificial, but it is the artificial radiations which now threat the global ecology and the environment.




**Ionization Radiation:** ***Cosmic radiation*** originating from outer space and modulated by solar winds continuously impinges earth's atmosphere. These radiations are charged particles, 90 % proton, 9 % Helium nuclei (Alpha particle) and 1 % electrons (Beta particles) and having energy level in the order of $10^{20}$ eV when man could artificially generate a maximum of $10^{12}$ or $10^{13}$ eV. But for the protection of mother earth through an umbrella of magnetic field which makes our atmosphere opaque to these high energy cosmic bullets, life on earth would have been totally ionised and blown out into the abysmal space. Earth's magnetic field is weaker at the poles where the ionization produces the spectacular glows of aurora. While the threat from exposure to cosmic radiation to astronauts during their space flight is taken care of, the common man now travelling in high altitude commercial flight faces similar threats, although in a lesser degree.




**EARTH's MAGNETIC UMBRELLA PROTRCTS us FROM COSMIC RADIATION**

Earth has a small amount of radioactive materials evenly dispersed in crust. The spontaneous reaction (fission) of these produces enough heat to compensate heat loss by radiation and has prevented a frozen death for our planet. However, mining, concentration and production of enriched stocks of these materials generates ***radioactive pollution*** and background radiation in the environment and consequently, rightly resented by local residents. Man made radioactive emission has increased since 1950 and 60 because of nuclear weapon tests, various accidents, leakages and disposals of radioactive wastes world over.

Coal used for power generation also carries small concentration of uranium and other radioactive nuclides. A Canadian Scientist has estimated that annual mining and burning of coal world over brings out to the surface about 200,000 tons of uranium which freely moves in the biosphere and whose impact on background radiation is little understood. Similarly, according to the calculation of a Project at Bombay IIT, a 2000 MW coal fired power plant using 8 million tons of coal per year (with 5 ppm Uranium) would spread about 40 tons of uranium around the plant. The apex radiation research laboratory (ORNL) in USA reports that a normal size coal fired thermal plant disperse to the environment an amount of U-235 equivalent to a dozen feeds of a nuclear reactor. Since the radionuclides accumulate year after year, a century of coal combustion in thermal power plants world over would elevate the global anthropogenic radiation to a level of "Subdued Nuclear Evening" without going into large scale nuclear warfare. No wonder, a coal based thermal plant is considered more vulnerable than a nuclear power plant when it comes to hidden fall outs. However few will like to have a nuclear power plants at their back yard (**NIMBY-Not In My Backyard**) but fail to realise the radionuclide pollution arising out of a coal based power plant.

Another common source of radiation pollution is release of radon gas and fission products from construction materials like sandstone, granites and fly ash that go into building of our homes and offices. Many developed countries have laid down radiation limits for construction materials, especially for homes where people spend a greater part of their life time.

Medical practices including x-rays, radio-isotope therapy, disinfection, food irradiation and disposal of radioactive products cause radiation pollution of the environment.

**NonIonizing Radiation**: The UV and visible lights make up an insignificant range in EMR but have significant ecological impact on life of plants, insects and animals including humans. ***UV radiation*** is known to damage chlorophyll in plants, kills microbes and bacteria in water purification and medical sterilization, but when it comes to humans produces skin burn, melanoma (a type of skin cancer) and cataract. In US, Canada and Australia where UV-rays entry to atmosphere is high the media publishes daily UV-Index , warning sunbathers and people working on open ground of excessive exposure to UV-radiation. The bright white light of fluorescent tubes, CFL and mercury vapour lamps carry a high level of UV component and is known to damage vision especially in growing children. Welding torch emits large amount of UV radiation and is blinding and painful to eyes. Many developed countries have changed their street lights to sodium vapour lamps to avoid UV radiation pollution.

**Photons of light** at various wavelengths across the visible spectrum imbibe different quality of stimuli to life. The **blue** end of the spectrum is cool- so are the colour of the ocean and our blue planet, because polarisation of light through water cuts out a large amount of energy of photonic vibration. The median of the visible spectrum is **green** and represents colour of the natural world and means growth from the word "Growan". The **saffron** tinge at the orange-red end represents dawn, purity, truth and renunciation in several religions.

Irrespective of socioecological stimulus at various wave lengths, the planetary life is greatly conditioned by the circadian cycle of day and night. Plants lose their chlorophyll, turn pale, growth and productivity retarded, so is the human pigmentation lost and production of vitamin D ceases in absence of light. Biological clock of insects, birds, animals

and man are jeopardised when natural light cycle is disturbed. At least 300 insect species are known to use natural polarised light as primary source of navigation, baby sea turtles are guided to nearest water body soon after hatching. Damage of navigational instinct of nocturnal insects under artificial light pollution effects pollination of night blooms. Consistent studies have shown that under urban glows of Europe, Robins are chirping at night, where as at our door step at Hiranandani Gardens, Bombay, cuckoos can be heard singing well before dawn (for feeding and breeding). Excess, deficiency and unnatural light exposures have adverse health effects- people in night shift duty have psychological problems, sleep disorder, excess light induces loss of visual acuity, hypertension, headache, effects growth, maturity, confidence, hunger, sexual habits and increased incidence of carcinoma. Suppression of nocturnal production of melatonin hormone in body leads to added risk of breast cancer in women. Stubborn criminals are made to submit to confession under strong light beam; rapid flashes can induce epilepsy, trance and neurosis as in Javes and Discos. Scramble of insects even to the point of death around fires or lamp-post in the darkness of night is an intoxication of light pollution. The morning grave yard under the lamp post is in no way different to some of world's urban congregations, the pillar of attraction of material resources. **Like any other resources, excess of which sets in pollution, light too, which enables vision can be blinding**.

One of the serious impacts of light pollution is nocturnal urban haze which prevents millions of people from enjoying star studded beauty of night sky. Few urban children today behold a milky way or are capable of spotting the Pole Star in the northern horizon. Obviously, interest in Astronomy becomes the first victim, the grandeur and vastness of the universe in the growing minds is relegated to the background and replaced by a feeling of repealing darkness by artificial illumination- a sense of victory over the Nature. **We lay the seeds of subjugation of Nature at the very childhood.**

Urban haze not only effects astronomical observations, when considered from utilization of lighting energy, the financial implication is astronomical. The illumination lost into the atmosphere from street light alone is estimated to be about 300 MW in UK and astronomically large in some of the illuminated cities like Las Vegas and Chicago in US. **Obviously increased urban illumination has not been found to decrease urban crime, but has increased it**. Urban illumination not only diverts light energy to the sky where it is not needed, but in doing so add extra dose of carbon dioxide to the atmosphere and add fuel to Global Warming.

***EMR pollution*** in the range of microwave and Radio-TV propagation has become an issue of great controversy after the proliferation of the society with mobile phones and appearance of a large number of microwave towers over the horizon for reception and propagation. Amidst the controversy, WHO, in its preliminary report denied evidence of EMR pollution but surprisingly acknowledged "**its influence on environment but not on the people**" and kept the issue open for further investigation. However, large number of research and studies has concluded that Electromagnetic Radiation coming out of microwave and Radio-TV masts, cell-phones, micro ovens, NMR, MRI and high tension power lines have adverse effects on health and environment. Proven effects of the EM-radiation are: cognitive impairment, memory deficiency, EEG modification, DNA damage, chromosome aberration, micronucleus formation, and foetal malformation, increase permeability to blood - brain barrier, altered cellular calcium reflux and cell proliferation. At least 33 of 35 well known international studies have made a conclusive link between brain tumour, leukaemia and other forms of cancer, auditory damage,

and breast cancer in women and sperm count decrease in man. Eye strain, headache,, inability to concentrate, neck ache, irritability, depression, memory loss and weaken immune system are some of the common symptoms of Electromagnetic Field (EMF) stress.

The US Environmental Protection Agency has publicly acknowledged existence of serious threats from EMR pollution. Looking into the abuse of mobile phones, the Telecommunication Department, Govt. of India has warned young children and pregnant women to refrain from avoidable use of mobile phones. The manufacturers too have advised children with soft skull to refrain from keeping the phone close to the ear and adult to use speaking kits or radiation protection covers on the cell-phone. Many countries prohibit erection of mobile towers near school, hospitals and residential buildings. **In India, for a few bit of financial support from the mobile service provider, many housing societies invite installation of mobile mast over their building at an unknown risk to health of residents of their society and adjacent buildings**. A recent press report by Govt. of Maharastra says that, of the 510 mobile towers in Navi Mumbai and surrounding region, 118 are authorised and 332 are awaiting clearance, demolition or their case for demolition pending in the Supreme Court of India. Even the Government has constituted a scientific committee to go into the issue of health effects of use of mobile phones across the vast spectrum of the society. **With two billion people using cell-phones world over, we are under the largest clinical trial ever conducted on the human race.**

- **SGAT-NALCO State Level Environment cum Mineral Awareness Programme (EMAP-2010) (For High School Students)**

**Record of Proceedings**

The State level EMAP was held on 30 & 31 January 2010 at Bhubaneswar. SGAT considered it necessary to continue the programme considering its usefulness to the student community. The objective of the programme is to acquaint the students and through them their teachers, parents and the community at large about the dangerous consequences of degradation of our environment and urgent need to take appropriate ameliorative measures.

The participants in the State Level EMAP comprise students of schools who have won the zonal EMAP. This year altogether ten schools participated and they are:

1. Badampahar New Government High School
2. DAV Public School, Chandrasekharpur, Bhubaneswar
3. University Higher Secondary School, Bhanja Vihar
4. B.K. High School, Soso
5. Jagannath High School, Sukinda
6. DAV Public School, TEnsa
7. SAIERC, Rajgangpur
8. Kalinga DAV School, Talcher
9. Belpahar English Medium School
10. V.S. Vidyalaya, Sunabeda

The programme consisted of the following activities;

a. Visits to State Museum, Regional Museum of Natural History, Prehistoric Life and Science Park, Meteorological Centre and Regional Plant Resources Centre
b. Written Test
c. Identification of rock, ore and mineral samples
d. Identification of plant specimen
e. Oral Quiz

The activities were conducted and supervised by Dr. R.C. Mohanty, President, Sri B.C. Patnaik, General Secretary, Dr. T. Basa, Sri Jeevan Mohapatra, Sri P.K. Bose and Sri Rabi Mahapatra. A video film on Environment and Conservation was shown on the occasion.

Among the distinguished persons present in the concluding session were Dr. V.P. Upadhyay, Director, MOEF, Sri R.N. Praharaj, Senior GM (Mines) and Sri R.K. Mishra, General Manager (Mines), IMFA Group, members of the Executive Council of the Society. **Sri Bijoy Dash**, Executive Director, NALCO and Mr. Dinesh Shastri, EIA, FAMD, Tata Steel graced the occasion as the Chief Guest and Guest of Honour respectively.

Kalinga DAV School represented by Ms Samapada Nayak and sri Biswaranjan Si was adjudged the overall best team. Sri Bijoy Dash, Chief Guest, Mr. Dinesh Shastri, Dr. V.P. Upadhyay and Dr. R.C. Moahnty, President, SGAT addressed the students. Sri N.R. Patnaik offered format vote of thanks. The State Level Programme was sponsored by NALCO. Other organizations who extended support include Tata Steel and M/s M.G. Mohanty among others. All the participants and winners were presented gifts and prizes.

The State Level EMAP was designed by Sri B.K. Mohanty, Advisor, SGAT.

- **Proceedings of the Workshop on "Illegal Mining, Smuggling and Trading of Ores and Minerals" organised by Society of Geoscientists and Allied Technologists (SGAT) and Mining Engineers' Association of India (MEAI) on 14th April 2010 At Hotel Swosti, Bhubaneswar, Orissa.**

1. This Workshop was attended by members of SGAT, MEAI, invited guests of various Departments of Govt. of Orissa, Govt. of India, Mining Industries and representatives of Press & Media.Dr. Ashok Dalwai, IAS, Principal Secretary to Govt. of Orissa, Steel & Mines Department graced the occasion as the Chief Guest and Sri V.D. Rajagopal, President, MEIA presided over the meeting .

2. Dr. R.C.Mohanty, President, SGAT welcomed the dignitaries, guests, representatives of Press & Media. Introducing the topic of Workshop, its programme and objectives he stated that illegal mining issues have adverse impact on growth of mining industries. He informed that the "Vision Document for Mineral Development - 2020 for Orissa" prepared by SGAT has dealt the issue of illegal mining in detail and a brief note is prepared as the base paper for the Workshop. He invited the participants to discuss and suggest for remedial measures.

3. Shri B.K.Mohanty, Advisor, SGAT presented the Base Paper of the Workshop and at the outset introduced the Subject of Workshop, Legislations that govern, administer and regulate grant of mineral concessions, mining related activities, environment management and pollution control etc. He explained how the illegal activities take place and gave examples of areas vulnerable for illegal mining, mineral transport and trading. Further, he informed about recent developments and actions taken by State Govt. to control the illegal activities. He then discussed on the effectiveness of steps taken and suggested for efficient handling of such cases in future. Further, he gave examples of cases in Karnataka and Jharkhand. He expressed anxiety stating that the situation is complicated with the entry of naxals, gangsters demanding protection money and extortions. He expressed that such lawlessness, disruptive activities and adverse publicity will not attract investors, while companies having signed MoUs would have a second thought. He expressed that necessary steps need to be taken jointly by Police, Vigilance, Forest and Revenue Departments along with Steel & Mines Department. For effective control and monitoring these Department should have requisite manpower, logistics and adequate funds along with backup support of armed squad with modern ammunitions .

4. President invited speakers for discussion on the subject

   a) Shri M. Venkatiah briefly explained how illegal mining activities have developed in Bellary – Hospet area of Karnataka State and how mining activities of legitimate mines have been affected.

   b) Dr. T.Venugopal, former Addl. Director of Mines, Karnataka indicated various issues of illegal mining in Karnataka and how with the sudden rise in demand of iron ore and its high value, litigations amongst mine owners have encouraged illegal mining in different stages. He opined that any one reason is not responsible for the present situation. The situation can improve if Grant of Concessions, Mineral Administration and Regulations are streamlined and enforced effectively.

c) Shri T.V.Choudhury, former DM&G, Andhra Pradesh highlighted the importance of minerals in economic development, prevailing Acts and Rules, steps taken by Andhra Govt. for early disposal of mineral concession applications, simplification of procedures for grant of Surface Rights etc. In his opinion State has the right over the mineral and land belongs to land owner and hence conflict of interest starts for getting Surface Right. As such, the main issue is Surface Rights.

d) Shri K.C. Choudhury, former Director of Mines Safety indicated that control on explosives can help in controlling illegal mining as no mining activity can be there without explosives.

e) Shri S.N.Padhi, Former DGMS informed that Statutory Authorities are not able to effectively control illegal mining due to various litigations. He supported the investigations being conducted by vigilance Department.

f) Shri G.H.Khuntia dealt few specific issues of Orissa and emphasized on early disposal of applications for mineral concessions. He referred a report where such illegal cases are more in other States and it is prevailing throughout the country.

g) Shri Shantunu Mohapatra explained about vacuum created in Mining & Geology Directorates of Orissa after the actions taken by Vigilance Department. He advised for adequate funds and facilities for field level officials who are responsible for control of mines, mining activities and mineral transport.

5. Dr. Ashok Dalwai initiated his address stating that there have been instances of illegal mining. There were lapses in administration by the agencies responsible for regulation and monitoring of mining activities, collection of revenue, check gate and transit pass systems. These irregularities happened in many States and even in countries abroad. When this came to notice, Govt. of Orissa has taken steps to investigate for finding out lapses in mineral administration and control systems in order to take preventive measures for future. In fact Govt. of India has appreciated the steps taken by Orissa. The suggestions offered by SGAT and others have also been taken into consideration. Proper coordination and understanding between various Departments involved in the State as well as various Departments of Govt. of India particularly IBM, MoEF, Railways and Ports are quite essential. He informed about various new steps being planned.

He referred about the talks being held with Word Bank to sort out various issues and World Bank team would soon conduct diagnostic studies on procedural, organizational, legal and structural frame work of mineral development.

The State was contemplating to adopt new initiatives which would ensure transparency in high profile extractive industrial projects such as mining. This would help the State Government for better mineral development.

He said that the State Government plans to have a delivery mechanism, which would directly benefit people who are adversely hit by mineral development in their area. The mine operator should come forward voluntarily and contribute in lessening discontent among people. The State Govt. has already created a fund with 5% of royalty collected for

overall development of the Districts where mines exist. This amount which is Rupees 100 Crores in 2010 would increase in next ten years. One Committee has also been formed to prepare scheme for utilization of this fund in these affected Districts.

Admitting that mineral thefts were going on unabated in district like Keonhar, Dr. Dalwai mooted an idea of having a joint mineral management in place. He further said that the people should come forward and participate in prevention of mineral loot in their area.

6. Mr. Venugopal in his presidential address referred the cases of Andhra Pradesh and Katnataka border areas. He gave examples and offered suggestions for streamlining grant of mineral concession and faster disposal of cases. He suggested mining community to combinedly work for development of mining belts.

7. Dr. S.K.Sarangi, Vice President, MEAI & SGAT stated that during execution of any activity there can be certain deviations. These lapses, if any, should not be exaggerated defaming the industry and mining community. He concluded that mineral development is very much essential for the benefit of the people and hence it should be one of the priority areas.

Lastly Dr. S.K.Sarangi offered vote of thanks to President, Chief Guest, invited Guests, Press & Media for their active participation in this Workshop.

**Diary of Events**

- SGAT is organizing an International Seminar on **Development of Chromite, Nickel & PGM Resources** to be held on 27 & 28 Nov'2010 at Bhubaneswar. Details are appended in the volume.

- SGAT is organizing one Workshop on Geoscience Education to create awareness to facilitate introduction of Geoscience in the school syllabus as a separate subject highlighting importance of Geology on day today life. The Workshop shall be held on 24th July 2010 of Hotel Swosti, Bhubaneswar.

- Annual General Body meeting of SGAT shall be held on 28th November 2010 at 6.00pm. The venue shall be SGAT's Building near VIP Colony, Nayapalli.

- Griha Pravesh Puja for SGAT's Building shall be performed on 11th September 2010 (Ganesh Puja Day).

## ➢ NEWS ABOUT MEMBERS

- **Shri S.N. Padhi**, member, SGAT delivered a keynote address in the inaugural session of the 10th Annual Convention of the Mining Engineering Division and National Seminar on "Technological Advancement in Mining Industry" held at Udaipur, Rajasthan on 4th to 6th Dec'09. He was also the guest of honour in the valedictory session.

- **Dr. Ravi Bastia,** member, SGAT is awarded by Oklahoma University of USA and Albert University of Canada in the field of **Petroleum Research and Production.** He is the first Oriya and first Indian to get this special award.

- **Prof. Dr. S. Acharya,** member, SGAT & former Vice Chancellor, Utkal University, was awarded K.P. Rode Memorial Award for excellence in Earth Sciences in general and his contribution in the field of Exploration Geology with special reference to iron formations in the 97th Indian Science Congress Session held at Thiruvananthapuram on 4th January 2010. His contribution as an academician both in India and abroad, the large number of Ph.D. awarded under his supervision and scientific research projects completed during his academic career were reflected in the citation.

- **Sri B.C. Patnaik,** General Secretary of SGAT on his superannuation, he is retired as Director of Mining & Geology, Govt. of Orissa on 30th June 2010.

- **Sri S.K. Das,** member, SGAT, Director of Geology has taken over the official charge as Director of Mines, Govt. of Orissa from 5th July 2010.

**OBITUARY**

**Sri Raghunath Rath,** member, SGAT and former Director, Mining & Geology expired on 21.04.2010. Member of SGAT pray before 'GOD' to rest his soul in peace.

## • NEW MEMBERS

1. **Mr. Dipesh Dipu**
Principal Consultant – Mining
701, Canna Block
Garden Towers, Maasab Tank
Hyderabad – 500 028

2. **Mr. Dibya Jyoti Baral**
Consulting Geologist
1579, Behind Kalyani Plaza
Patrapada
Bhubaneswar – 19

3. **Prof. D.P. Tripathy**
Department of Mining Engineering
National Institute of Technology,
Rourkela – 769 008

4. **Mr. Sambhu Prasad Mishra**
267, Kharavela Nagar
Bhubaneswar – 751 001
Orissa

5. **Ms. Shibani Mahanta**
Executive Trainee (Geology)
Surpac Cell, Geology Section
Orissa Mining Corporation Ltd.
Bhubaneswar – 1

6. **Ms. Surabhi Mishra**
Sr. Geophysist in Cairn India Ltd.
34/9, Prim Rose, Vatika City
Sohna Road, Gurgaon
Haryana

7. **Mr. Satyabrata Mishra**
Sr. Geophysist in Cairn India Ltd.
34/9, Prim Rose, Vatika City
Sohna Road, Gurgaon
Haryana

8. **Mr. Bijaya B.K. Sahu**
Chief Engineer – Mining
ARCELORMITTAL India Ltd.
105/5, Club Town
PO: KIIT's Campus
Bhubaneswar – 751 024

9. **Mr. Siva Narayan Mohanty**
Retd. Ex. DGM (Geology), ONGC Ltd.
B/3, Swapnapuri Apartment
B/H Central School
Niladri Vihar, C.S. Pur
Bhubaneswar – 751 021

10. **Mr. Chul Kyoo Lee**
Team Leader – Exploration Team
POSCO-India Pvt. Ltd.
5th Floor, Fortune Tower
Chandrasekharpur
Bhubaneswar

11. **Mr. Krushna Ch. Sahu**
Geologist (Dy. Manager)
POSCO-India Pvt. Ltd.
5th Floor, Fortune Tower
Chandrasekharpur, Bhubaneswar

12. **Mr. Nishant Kumar Sharma**
Manager (Mines Development)
POSCO-India Pvt. Ltd.
5th Floor, Fortune Tower
Chandrasekharpur, Bhubaneswar

13. **Mr. Shivanand Gadag**
Associate Central Manager-Mining Dev.
F-3, B-32, Milroc Ribandar Retreat
Riabandar, Panaji
Goa – 403 006

14. **Ms. Rajashree Das**
Geologist.
C- 12, Utkal University Campus,
Bhubaneswar

15. **Mr. Jay Prakash Mohakul**
Geologist (SR) ,GSI,
Arunodaya Nagar,
Behind Market,
Cuttack – 753 012

16. **Mr. Mrutunjaya Panigrahi**
Geologist,
201, Moreshwara Complex
Plot – 35, Sector – 21
Kharghar, Navi Mumbai
Pin. 410 210

17. **Mr. Rabi Narayan Parida**
Director of Geology (Retd.),
P-10, Srikhetravihar ( Phase – II),
P.O. Aiginia, Bhubaneswar – 751 019

18. **Mr. D.N. Satyanarayana**
AGM (Corporate) Visa Steel Ltd.
C/o J. Venkenna Pantulu
Plot No-2, Street No. 4
Dixit Colony, Bhilai
Chhattisgarh

- **NEW INSTITUTIONAL LIFE MEMBERS**

1. **M/s Balasore Alloys Ltd.**
Balgopalpur – 756 020
Balasore
Orissa

2. **M/s. S.N.Mohanty**
At Weighbridge Road,
P.O.: Barbil
Dist.- Keonjhar

## AWARDS 2010

- **SGAT AWARD OF EXCELLENCE – 2010**

Nominations are invited for SGAT Award of Excellence – 2010 in the Proforma enclosed. Persons awarded in the past should not be re-nominated. The proforma (4 sets) completed in all respects and duly signed by the proposer should reach the General Secretary, SGAT at 267, Kharavela Nagar, Bhubaneswar – 751 001 on or before 31st October 2010.

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

Any person (member or non member) who has made outstanding contribution in the field of Geosciences, Mining, Metallurgical and Mineral Process Engineering, Mineral Beneficiation or whose work has led to significant development of mineral resources shall be eligible for the award. Self nomination is also accepted.

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

Signature

Place:

Date:

Full name and address of the
Member/Institution proposing

- **SITA RAM RUNGTA MEMORIAL AWARD**

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

**Proforma for Nomination**

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

The nomination (in 4 sets) in the prescribed proforma should reach the General Secretary, SGAT at 267, Kharavela Nagar, Bhubaneswar – 751 001 on or before 31st October 2010.

Signature

Place:

Date:

Full name and address of the
Member/Institution proposing

- **SMT. VEENA ROONWAL MEMORIAL AWARD - 2010**

Nominations are invited for Mrs. Veena Roonwal Memorial Award in the proforma given below. Any person (member or non-member) who would have made significant contribution in Environmental planning & management to achieve sustainable development of mining and mineral based industries will be eligible for the Award. The Award will be in the form of a citation and cash. Self nomination is also accepted. The work should be original, innovative and of applied nature.

Proforma for Nomination

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

The nomination (in 4 sets) in the prescribed proforma should reach the General Secretary, **Society of Geoscientists and Allied Technologists (SGAT)** at 267, Kharavela Nagar, Bhubaneswar – 751 001 on or before **31st October 2010.**

Signature

**Place:**

Date:

Full name and address of the
Member/Institution proposing

## ➢ OTHER NEWS

### Indian steam coal users hunting for South African junior coal mine

Indian steam coal end-users have stepped up their hunt for South African junior coal mines in a bid to secure supply from this year if possible but are finding attractive assets scarce, would-be buyers said on Monday. Indian companies including the Jindal Group (JIST.BO: Quote), Essar and a host of traders have looked at every junior coal producer with a view to buying during the past three years. They have also scoured Indonesia, Australia and the U.S. for likely coal assets. These end-users' desire to acquire mine assets has become more urgent because their coal demand is set to more than double in a few short years. The reliable delivery, relatively high energy-content and low ash content of South African coal have made it a preferred choice of many Indian end-users. "Our coal demand for power plants will be 10 million tonnes by the end of 2010 and double that again by 2014. We intend to be a coal producer," said one executive who asked to remain anonymous. Having become accustomed to the quality of South African coal but often squeezed by strong international prices, Indian end-users have decided to enter mining."South African cash costs are only $35 a tonne compared with market prices of $82-$85 a tonne FOB Richards Bay," another end-user said. "Obviously it makes sense, it is cheaper, to supply coal from your own mines," he said. But only one deal has been struck for a mine which was swiftly re-sold to an Australian consortium because there was no rail link to move the coal to port. "We are looking at every South African coal company of a small to medium size but we want mines with good rail logistics and costs," he said, in an office filled with maps and presentations on the South African coal industry.

### Rio Tinto Could Win India Diamond Mining Lease

Rio Tinto could be on course to get a mining lease for its $480m diamond mining project in the Indian state of Madhya Pradesh, a ministry official said. The state government has recommended the mining lease and an approval from the federal mines ministry is expected within two weeks. If the company obtains all the regulatory approvals in time, the project could start by 2016. Rio Tinto is targeting to mine about three to four million carats per annum. The company is planning to carry out a pre-feasibility study of the project in 2010.The Bunder diamond project in the Chhatarpur district of Madhya Pradesh has estimated reserves of 37 million tons and at 0.7 carat per ton, the project would give 27.4 million carats of diamond. The mine is located close to Panna, India's sole hardrock diamond mine, and may yield 30 times more because of greater reserves.

**NMDC is set to make first venture outside India**

State-owned National Mineral Development Corporation (NMDC), India's largest iron ore producer is set to make its first venture outside of the country, reportedly agreeing to pay US$2.5 billion to acquire a 50% stake in Ferrous Resources Brazilian iron ore operations. India's Economic Times reported that Ferrous will issues shares worth $2.5 billion over the next several years with the funds to be used for developing mines and building infrastructure according to an unidentified senior executive.After the acquisition is completed, the Times said the partners will list the joint venture on the LSE and sell a 20% stake to raise another $1 billion. Ferrous owns four mining development and two exploration-stage properties in Brazil. The Viga project in the State of Minas Gerais is expected to begin production in the second half of 2013 at a rate of 25 million tonnes per year of iron ore that could be converted into 10-million tonnes of high 67% Fe grade iron ore concentrate.

The total reserves of Ferrous's Brazilian properties are believed to be 3 billion tonnes of iron ore with a 35.6% grade (Fe) content. The company is also developing a new sea port to export its iron ore products. The mines are located within 300 kilometers from the sea and are close to Brasilia. The Press Trust of India quoted "an official in the know" who reportedly said the companies hope to mine 50 million tonnes of saleable ore from two Brazilian mining projects. NMDC has already announced it will divest an 8.38% stake through an IPO next month. The company also plans to introduce a new pricing mechanism when it re- negotiates iron ore supply contracts with Indian steel manufacturers next month. The new pricing mechanism will eliminate the existing system of fixing iron ore prices against an international price benchmark. London's CRU Consultants has been hired to work on the new pricing mechanism. NDMC produces about 28 million tonnes of iron ore annually with 85% sold to India's steel

**Biggest diamond found in Panna, India**

The pear-shaped white gem-quality diamond weighing 34.37 carat was recovered from a pit from Panna Mines in Madhya Pradesh by National Mineral Development Corporation's (NMDC).

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