

ISSN 0972-2173



SGAT bulletin

Journal of the Society of Geoscientists and Allied Technologists

Volume 12 • June 2011 • No. 1



**SGAT Executive Council Meeting at Tribal Development Centre,
Jamshedpur of TISCO**



**SGAT Executive Council Meeting
at Tribal Development Centre Jamshedpur of TISCO**

SGAT **bulletin** **Bi-annual**

Vol.12•June 2011•No.1

EDITORIAL BOARD

EDITOR

Dr. S.K. Sarangi
267, Kharavela Nagar
Bhubaneswar – 751 001
Phone: 0674-2390516
Fax: 0674-2390687
E-mail: info@sgat.in
geomin@satyam.net.in

ADVISORS

Prof. Dr. S. Acharya
Chairman
155, VIP Colony
Bhubaneswar – 751 015

Prof. Dr. Madhab Ch. Dash
45 VIP Area, Flat-101,
Ananda Villa, Nayapalli
Bhubaneswar 751015

Shri S.N. Padhi
A/8, Palaspalli
B.D.A. Complex
Bhubaneswar – 751 020

MEMBERS

Dr. G.V. Rao
Scientist – G
Institute of Minerals and
Materials Technology
Bhubaneswar – 751 013

Prof. Dr. R.N. Hota
P.G. Dept. of Geology
Utkal University
Vani Vihar, Bhubaneswar

Dr. B.K. Mohapatra
Scientist
Institute of Minerals and
Materials Technology
Bhubaneswar – 751 013

EXECUTIVE COUNCIL MEMBERS (2009-2011 term)

President

Dr. R.C. Mohanty

Vice Presidents

Dr. S.K. Sarangi
Prof. G. B. Mishra

General Secretary

Shri B.C. Patnaik

Joint Secretaries

Shri S. Mishra
Shri G.C. Das

Treasurer

Shri K.C. Pradhan

Members

Shri R.L. Mohanty
Shri M.V. Rao
Shri N.R. Pattanaik
Dr. V.P. Upadhyay
Mr. Singa Tiu
Shri P.K. Bose
Shri J. Mohapatra
Dr. B. K. Mishra
Shri J.K. Hota
Prof. Dr. Mrs. M. Das
Shri R. Chintak
Shri U.K. Mohanty
Dr. S.C. Mahala
Shri T. Mohanta
Shri B.P. Mishra
Shri G. B. Mohapatra
Prof. N. K. Mahalik
Shri R.C. Samal
Shri G.S. Khuntia
Prof. G.C. Mitra
Shri P.K. Panda
Shri A. Mohapatra
Shri N.R. Sahoo

Publication of the Society of Geoscientists and Allied Technologists

Complementary for Members of the Society

The statements made or views expressed in articles in this
publication do not necessarily reflect the opinion of SGAT



SGAT Bulletin

Vol.12

June 2011

No.1

CONTENTS

President's Column

Editorial Remarks

Risk Management Techniques for the Assessment of Rock Slope Engineering Problems	A. SANTHARAM	1-10
Theoretical Prediction of Permeability of Clastic Reservoirs and Aquifers	B.K. Sahu	11-19
Investment Opportunities in Indian Mining Sector	A. Sengupta	20-25
Mean Sea Level (MSL) - As a Tectonic Interface	M. R. Mahapatra	26-27
New Developments in Cement Making - Experience of OCL India OCL Cement Division At A Glance	D.D. Atal	28-37
Multi-faceted approach to improve Iron Ore Industry	T. Treadgold	38 - 41
Prospect of Vanadium Recovery Unit with mini Steel Plant in Orissa	H.P. Mishra	42 - 45
SGAT News		46- 53
News About Members		
Other News		

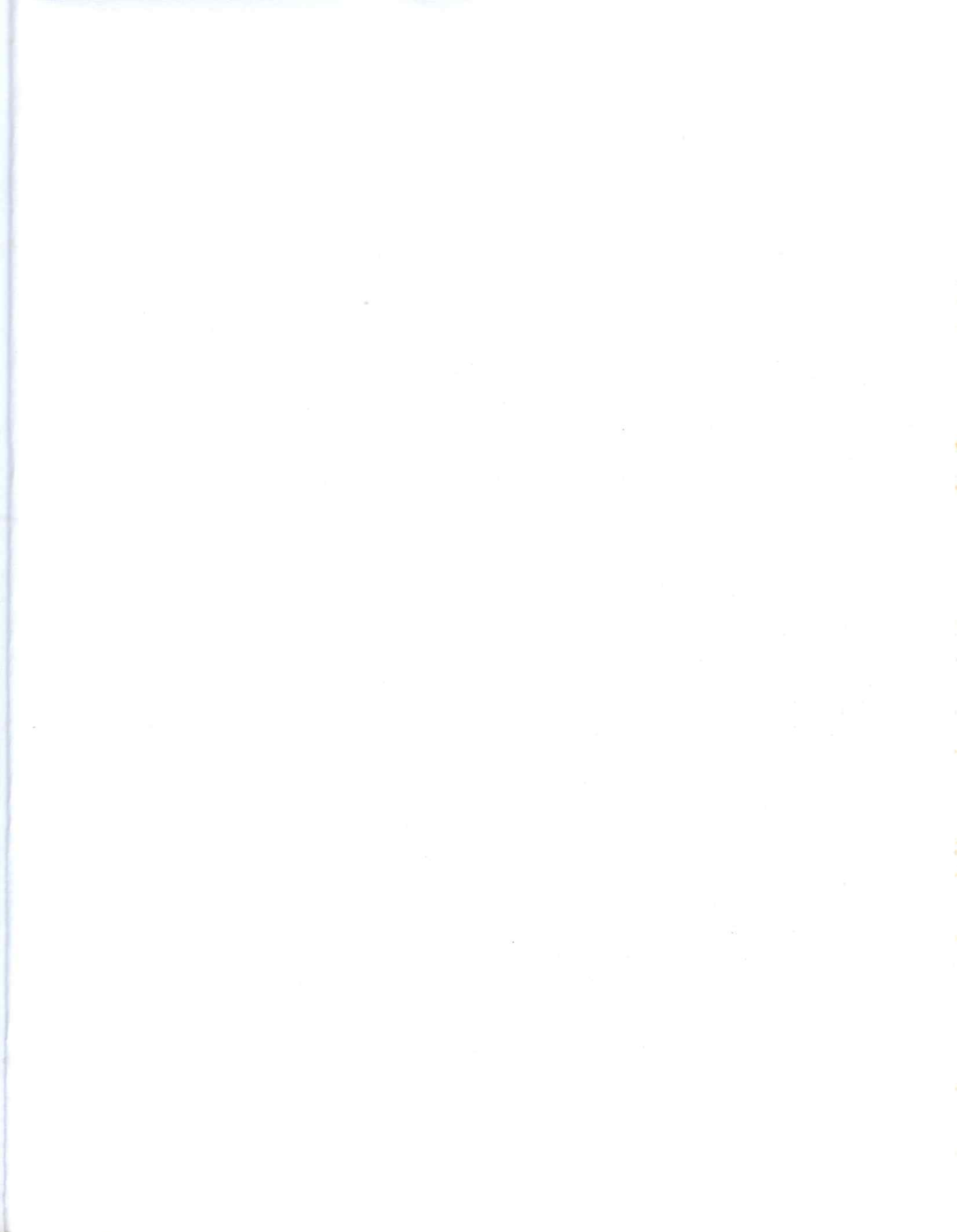
PRESIDENT'S COLUMN

Mining is considered as one of the oldest professions practised since Stone Age. Civilisations and progress of mankind have been greatly influenced by mining profession which helped in production of minerals and metals essential for human usages. With the advent of newer technology mining profession adopting scientific and sustainable development has played a vital role in ushering economic growth and development of many nations in the world. In spite of this, mining and mineral based industries are opposed recently from various quarters. This warrants a proper scientific and judicious analysis by the professionals in order to take corrective measures as well as highlight the importance of this sector for the society.

The recent mining scam and subsequent actions by Govt. have revealed many irregularities. Though steps have been taken, much improvement is not visible. Operations of some mines have been stopped. Grant of new leases and renewals pending for a long time are yet to be approved. Much expected amendments to MMDR Act are yet to come. Suggestions given in the "Vision Document on Mineral Development - 2020 for Orissa" prepared by SGAT, followed by series of discussions for preparation of action plans are yet to be seen in action. Awareness is to be created emphasising the need of enhancement of mining activities and all stake holders have to join hands to achieve overall growth of mineral sector.

SGAT has been organising various seminars and symposia on various issues relevant to mineral development. During 23-24 September, 2011, a Seminar on "Approach and Strategy for integrated Development of Joda - Barbil - Koiria Mining Area, Odisha" is scheduled to be held at Barbil with the objective of promoting sustainable development programmes for this mineral rich belt. Contributions of mining for community welfare would be highlighted in the Seminar. Another international seminar on "Mining Legislations" scheduled to be held on 2-3 December, 2011 at Bhubaneswar would aim for suggesting suitable changes in mining and related laws to promote mineral development. Hope the above two Seminars would bring out suitable ideas and practical suggestions which would help in development of mining activities and create a better image of mining sector.

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



EDITORIAL REMARKS

It is needless to say that the sphere of the activities of SGAT is increasing manifold and it is achievable through whole hearted supports of his members, patrons and sincere supporters. Though SGAT has become more than 30 years old still it is more or less confined to Odisha State only. Time has come to expand its activities in other parts of the country through conduct of various activities as Seminar, Symposia, Workshop, and Environment Awareness Programme etc. in collaboration with other associations. This is only achievable through the sincere efforts and supports from young members of SGAT. There is no harm in expanding the activities of SGAT in the country. To start with Geological Society of India is entrusting SGAT to organize a Seminar during 2012. A commendable achievement indeed.

Appeal to all members to spare some of your busiest time and think for the three dimensional growth of SGAT. Your positive suggestions shall be highly appreciated.

Love SGAT to achieve –

Scientific growth
Generosity
Academic Excellence
Technological strength

Dr. S.K. Sarangi
Editor, SGAT Bulletin

RISK MANAGEMENT TECHNIQUES FOR THE ASSESSMENT OF ROCK SLOPE ENGINEERING PROBLEMS

A. SANTHARAM

Regional Mining Geologist (Retd)
Indian Bureau of Mines, Nagpur

Abstract

Geotechnical designs usually run the risk of encountering unexpected surprises while working with natural materials. To predict in advance the behavior of engineering properties these material to a reasonable degree demands the site characterization studies followed by ground instrumentation and monitoring.

Risk evaluation and risk management is an growing area of priority in assessing the problems of rock engineering to evaluate the risks associated with design and implementation practices. These include pit slope design, design of tailings dams and impoundments, design of large waste dumps, underground excavation and design and stoping layouts.

Considerable work has been done on the risk associated with environmental projects for evolving proper mitigation measures. Whereas, in the case of geotechnical projects, these concepts were relatively new and deserves much attention. Risk assessments are to be performed on a periodic basis for the identification the likelihood of failure and its possible consequences. The potential for failure together with the severity of the consequences determine the risk for such type of failure. Therefore, for sustained risk management, a program of risk assessment and risk mitigation is required under the management structure to perform the program effectively. Neglect in the initial stages may likely to lead towards disaster management, if the inputs are not properly addressed or ignored during process evaluation.

The paper describes the methodology of failure modes and its effects and analysis and its application to geo-technical projects. Case studies of geotechnical structures from Goa region, India were discussed.

Key words: Risk evaluation, Risk management, Mitigation measures, Geotechnical structures.

1.0. INTRODUCTION

Geotechnical investigations form one of the essential ingredients in mine planning, design of tailings impoundment facilities, stability analysis of waste dumps, Design and management of civil engineering construction projects. In the early days, mine designs are solely based on historical and professional experience followed by engineering judgment. Now a days, due to the advantage of high speed computing numerical software, the task has become relatively easier to evaluate the designs based on cost-effectiveness, high productivity by maintaining best practices

in environmental management and safety standards.

Any performance of a geotechnical structure that is outside the expected and design intent for that structure, which results in consequences that are undesirable to the mine management, is considered to be a failure. The potential for failure together with the severity of the consequences determine the risk of such failure. Risk management for major geotechnical structures is a process which involves the following aspects:

- a) Assessments of the risk of failure, and
- b) Implementation of a program of risk mitigation and risk control.

Failure may occur in many forms, ranging from physical failure resulting in collapse of pit slopes, underground, tailings dam failures, waste dump failures, displacement or erosion. Chemical failures resulting in contaminant generation and migration, biological failures, resulting in poor vegetation growth or impacts on fauna, or social failures resulting in dissatisfied public or regulatory agencies.

Risk assessments are done on a periodic basis, involving processes for the identification of the likelihood of a failure and of the consequences of failure in a process often termed a Failure Modes and Effects Analysis (FMEA) originally developed by (Robertson & Shaw et al). The output from an FMEA can be used to

prioritize and manage the implementation of risk reduction measures. For sustained risk management a program of risk assessment and risk mitigation is required under a management structure to perform the program effectively.

The paper describes both an FMEA methodology and a risk management program and structure applicable to Indian mining situations.

2.0. MINE DESIGN PROCESS (OPENCAST/UNDERGROUND)

The main function of mine design or mine planning in the broadest sense is financially evaluate and optimize the mining project or operation. The three main stages of characterizing the mine design process comprise of the following components (Table.1).

Table 1: Components of Mine Design Process

Conceptual Modeling	Phasing Base	Detailed Designs
<ul style="list-style-type: none"> • Minerals and Rock mass data input 	<ul style="list-style-type: none"> • Grade constraints 	<ul style="list-style-type: none"> • General mine layout
<ul style="list-style-type: none"> • Geological, geotechnical interpretation 	<ul style="list-style-type: none"> • Geological reserves 	<ul style="list-style-type: none"> • Mine-extraction sequence
<ul style="list-style-type: none"> • Geological and geotechnical volume models 	<ul style="list-style-type: none"> • Mining constraints 	<ul style="list-style-type: none"> • Slope/Bench design or stope design layout
	<ul style="list-style-type: none"> • Mining Reserves 	<ul style="list-style-type: none"> • Schedules and evaluation
	<ul style="list-style-type: none"> • Selection of Mining Methods 	<ul style="list-style-type: none"> • Risk evaluation and Management
	<ul style="list-style-type: none"> • Production reserves 	

A description of the mine environment is essentially the foundation upon which an assessment is built and should include geological, hydrological and historical mining data on failures, if available. Pertinent details of the regional and mine geology are required to cover the general characteristics of the rock types, structures, mineralization and geological history.

It is also important to record details of ground water, surface water and precipitation given the effect of water on strength of intact rock and geological discontinuities and thus overall stability of rock masses. Thus, analysis of the behavior of rock mass during past and present mining operations form a valuable input for the risk analysis.

3.0. REVIEW OF ROCK MASS CLASSIFICATION AND CHARACTERIZATION SYSTEMS

Rock mass classification is a means of evaluating the quality and expected behavior of rock masses based on the most important parameters that influence the rock mass quality. Numerous researchers have developed rock mass classification systems and each may be more appropriate than others to use in different circumstances. One of the first such systems to be developed is the Rock Quality Designation (RQD) system (Deere, 1988). This system only accounts for the frequency of jointing within a rock

mass as a measure of its quality. Later systems which have been developed such as the RMR and NGI Rock Tunneling Quality Index use the RQD as one of their measurable parameters, but also include factors such as intact rock strength, joint spacing, joint condition, field stress, and groundwater effects.

The other classification systems include Mining Rock Mechanics Rating (MRMR), Rock Mechanics Index (RMI), Basic Geological Index (BGI) and Slope Mass Rating (SMR). Some classifications are used for opencast mines and some are used for underground mines. The basic rock mass rating systems and adjustments were summarised in Table.2.

Table 2: Basic Rock Mass Rating System and Adjustments

Method	RMR ₇₆	RMR ₈₉	MRMR	RMS	SMR	CSMR	M-MR	SRMR	GSI
Intact strength	0-15	0-15	0-20	5-20	0-15	0-15	0-15	0-30	0-15
Block size	8-50	8-40	0-40	8-30	8-40	8-40	0-40	8-40	8-50
- Spacing	*	*	*	*	*	*	*	*	*
- KOD	*	*	*	*	*	*	*	*	*
Defect condition	0-25	0-30	0-40	3-14	0-30	0-30	0-30	0-30	0-25
- Persistence							*		
- Aperture	*	*	*	*	*	*	*	*	*
- Roughness	*	*	*	*	*	*	*	*	*
- Infilling	*	*	*	*	*	*	*	*	*
- Weathering	*	*	*	*	*	*	*	*	*
Ground water	0-10	0-15	*	1-6	0-15	0-15	0-15	-	10
Defect orientation	(60)-0	(60)-0	63-100%	5-20	(60)-0	(60)-0	(12)-(5)		
- Strike	*	*	*	*	*	*			
- Dip	*	*	*	*	*	*			
- Slope dip -					*	*			
Excavation	-	-	80-100%	-	(8)-15	(8)-15	80-100%	-	-
Weathering	-	-	30-100%	3-10	-	-	60-115%	-	-
Induced stresses	-	-	60-120%	-	-	-	-	-	-
Major plane of weakness	-	-	-	-	-	-	70-100%	-	-
Total Range	52-100	52-100	0-120	25-100	60-115	63-141	7-105	8-100	18-100

Some of these empirical design systems include:

- Open stope span and support design
- Man-entry stope span design
- Tunneling support design, Pillar design
- Road header cuttability assessment
- Rock slope design
- Underground excavation stand-up time
- Suitability for block caving
- Drilling and Blasting

4.0. SLOPE STABILITY

The most important use of slope stability analysis is in the optimization pit slopes and the effect of on this on stripping ratio. Slope design must encompass many other factors such as access roads, drainage and others. The planning of slope stability programme is very important. Two forms of rock mass models are available namely "continuous or discontinuous". The choice is specific to the slope/rock mass configuration involved. Discontinuities can be defined as real or potential planes of preferential fractures within the rock mass. The potential classification covers such as cleavage, bedding and schistosity.

Maximizing the angle of open pit mine slopes while managing the risk to workers and equipment is the goal of most open pit mine operators. Often, a small increase in the pit slope angle can significantly reduce the amount of waste rock stripping that is required and can save a mining operation considerable amount..

The design of rock slopes in open pit mines involves first gaining an understanding of the pit slope geology and geotechnical inputs. During the feasibility stage, this information will be gathered through a geotechnical data collection program that includes mapping of outcrops, diamond drilling, and laboratory testing. The orientation and frequency of geologic structure is the most important control on slope stability.

At the design phase, there is a need to collect reliable and detailed information on geo-mechanical properties of various slope forming materials to establish the probability of risks associated in case of failure and to evaluate the consequent mitigation measures to avoid costly mistakes

Goals and Philosophy of Practical Slope Design and Analysis

- Assessment of the stability of slopes under specified conditions
- Evaluation of the possibilities of the failure of slopes.
- Determination of the influence of proposed changes on a slope
- Comparisons of the effectiveness of alternative remedial or preventive measures
- Sensitivity analyses for evaluating the influence of variations in critical parameters such as geometry, material properties and groundwater conditions on the stability of slopes
- Analysis of failures that have already occurred. This helps understand failure mechanisms and obtain in-situ material properties.
- Design of remedial or preventive measures for slopes, and
- Assessment of the effects of exceptional loadings such as earthquakes on mine structures

5.0. RISK ANALYSIS AND SLOPE STABILITY: EXAMPLES FROM GOA

The problem of pit slope stability is a matter of concern when the mines operations go deeper followed by weak and friable strata conditions. Most of the mines are operating below water table and in highly saturated strata conditions. A review of failure analysis of several pit slope failures in Goan Iron ore mines demonstrates that there are two scales of slope stability namely Gross instability and local instability. As indicated that the mechanism of slope failures could be complex and dependent on failure pathways, where certain units fail first and it is followed by subsequent failures due to redistribution of stresses from the proceeding zone.

Gross in stability refers to large volumes of material failure which is observed in case of deeply weathered rocks and soil (Mn clay, weathered dykes) resulting in rotational shear failure. Local Instability to

smaller volumes the corresponding failure can effect one or two benches. Usually, problems of local instability can be serious and can lead to gross instability.

The results of several observations, laboratory studies and monitoring of the slopes have lead to an awareness of various mechanisms of failure and the conditions under which they occur. On a laboratory or bench scale, the structurally controlled failure mechanisms such as Circular, planar, shear, wedge are well understood whereas in real world situations, the failure mechanisms are much more complex involving a many other variables due to complexity in geological materials

It is necessary in any slope stability program to understand the failure mechanisms and

the possible conditions under which they may occur. However, our ability to assess different failure types or its combination or dynamic process is limited with the present methodologies adopted.

The problem for designers of slope is how to cope up with complexity and variability. The process of design must consider observations on rock behavior and fracture mechanics, monitoring of rock movements and stresses together with an assessment of the simplified mechanisms of failure to obtain an understanding of ground behavior. Computer methods can assess the interaction of ground interacting rock failure mechanisms in complex geological conditions. Physical rock testing program is essential in any design process. Depending upon the site characterization studies, the testing program need to documented.



Fig 1. Pit slope failures in iron ore mines, Goa, India



Fig 2.Pits flooded with water: Cause of pit slope problems, Goa

6.0. DESIGN OF PIT SLOPES

Various reviews of slope design methodologies reveal that strength of the weak rock mass determination is very difficult and there are few classification systems available. For rock masses in a particular region, back analysis of previous failure proves to be the only practical approach for obtaining relevant strength parameters. However, interpretation and translation of such data from one geological environment to another is lined with problems.

Design method for rock slopes can be divided into mainly four categories, namely

1. Limit Equilibrium Methods (LEM)
2. Numerical modeling (BEM, Hybrid)
3. Empirical methods
4. Probabilistic methods.

There are advantages and disadvantages of all these methods. However, in the present context, the choice of design methods is less important than the choice of input parameters to the design, in particular rock mass strength parameters.

Over the past 15 years, probability concepts have been applied to

geotechnical problems to try and overcome the difficulties of using engineering judgment and to take some of the guesswork out of the natural variability geological material. However, difficulties arise with probability analyses if there is limited input data available. For example, it should not be assumed that input parameters have a simple normal distribution about some mean value.

In most instances the shape of the distribution function for input parameters is unknown and even so with probability analysis, engineering judgment is often used to assume the shape of the distribution function. Probability analysis are useful way of analyzing slope stability problems providing assumptions on which on which they are fully recognized. Other debating issue in geotechnical literature, is which slope stability method is correct?

- Does it cover force equilibrium?
- Does it consider moment equilibrium?
- Does it have local or global factor of safety?
- Does it consider inter-slice shear strength?
- Does it allow non-vertical slices?
- Does it allow progressive failure?
- Is it kinematically admissible?

Different values of Factor of Safety are often compared by quoting factor of safety values. Finite Element Analysis using most modeling techniques does not necessarily produce the "right" answer. And for slope stability analysis in complex geology, could in fact produce misleading results. Secondly, factor of safety values should not be quoted to high level of accuracy since the input parameters will rarely be known with sufficient accuracy to warrant this level of definition for the factor of safety.

In summary, the stability of any slope is dependent of the choice and engineering judgment of the method of analysis. No one method is ideally suited to all problems and users should be aware of the advantages and limitations of different methods. However, for complex slope stability problems where in-suit stresses are significant, it may be more appropriate to use a stress analysis method such as finite element or finite difference etc.

Failure Mode

A failure mode can be naturally initiated (e.g. an 'act of God' such as an earthquake which is greater than the design event) or it can be initiated by the failure of one of the engineered subsystems (e.g. instability of pit or result from operational failure (e.g. failure to control the envisaged strata conditions). Because of the large number of potential failure modes that could be included in an FMEA, it is often necessary to confine evaluations to those that represent a significant risk. Failure modes can also be combinations of events where a small trigger event sets off a chain of events resulting in substantial or large consequences.

The examples provided in the worksheet (Table No.4.) relate to the stability of opencast mine but later parts of the same FMEA relate to other failure modes, the tailings dam as well as facilities such as

open pit mine walls and mine waste dumps. Some of the failure modes are simply acts of nature (e.g. acidity generated from a pit wall) whereas others may be failure modes related to ineffective or inadequate control measures (e.g. inadequate control of erosion or change in strata conditions).

Slope performance" curves provide a valuable tool in the design process where rock mass failure plays a strong control in the stability of slopes. The curves are derived from the performance of stable and unstable slopes plotted on a slope angle versus slope height plot. The curves are often site specific and take into account the impact of existing failures, the remaining time frame for mining and the acceptable risks to the mining operation

In order to gain an understanding of the long- term stability of slopes, it is necessary to have a good slope monitoring program to provide a forewarning of instability so that remedial measure can be implemented before critical situation arise and stabilizing the slope by monitoring program to verify whether the desired safety has been achieved.

7.0. RISK ANALYSIS AND MANAGEMENT

The objective of an FMEA is to identify and quantify these risks in order to either avoid, or mitigate them. FMEA is an acronym for **F**ailure **M**odes and **E**ffects Analysis, and is a methodology for the assessment of 'risk', which is a combination of likelihood and consequences of failure. The goal is to provide a useful analysis technique that can be used to assess the potential for, or likelihood of, failure of structures, equipment or processes and the effects of such failures on the larger systems, of which they form a part, and on the surrounding ecosystem, including human health and safety.

The environmental community often uses this type of process for conducting environmental risk assessments and engineers use this type of method to assess the risk of engineered systems. Mining companies can use this assessment method to evaluate the risk that their Closure Plans impose on the surrounding environment, workers and the public. This analysis methodology has been adapted for many applications over numerous industries including 'systems' approach and 'criticality' analysis.

For ease of communication, the alphanumeric codes (ID) of the various failure modes can be plotted within the risk matrix easily flagging those ID codes with their associated risk ratings. The resulting plots are called 'Risk Matrices'. These risk matrices (the risk profile) is an excellent tool for illustration to management, regulators and the public the risk profile for a project or its alternatives, as well as for planning risk management programs.

Risk Management through Audit and Review

Technical Audits and Reviews are completed in order to review the safety, stability and environmental liability of mine facilities such as tailings systems, sediment dams and waste dumps; to identify the safety, stability and environmental liability risks of each structure; and, to provide recommendations for the improvement of safety measures and procedures to enable appropriate international standards to be achieved. These Audits and Reviews are typically completed by professional specialists and consist of:

- Information collection, review and analysis of all site investigation (geotechnical, hydrology, hydrogeology, geochemistry,

- environmental and socio-economic), design and 'as-built' plans and reports;
- Field inspection of the sites and structures;
- Review of the operating history and compliance of the structure/facility, operating plans, management systems, emergency response plans and closure plans;
 - Identification of the relevant risks for each of the structures;
- Completion of an FMEA for the structure/facility;
- Development of recommendations to mitigate the risks and address issues identified;
- Prioritization of the mitigation measure into a 'Risk Management Plan'; and
- Preparation of a report summarizing the work.

Mine closure plans include complex natural and engineered systems involving geology, geotechnics, hydrogeology, hydrology, geochemistry, biology, ecology and social systems. Failure modes exist for each of these systems and as a result of interaction between these systems.

Methods for failure risk analyses for geotechnical/geochemical/hydrogeological / biological engineered systems are in the early stages of development in comparison to failure risk analyses used in some other fields of engineering where the potential for failures have been more precisely determined from statistics of equivalent system performance or from probability analyses of deterministic systems.

This lack is partly due to the heterogeneous nature of natural geological/geochemical/biological systems and partly due to the lack of any established databases for failures of components of such engineered/natural systems. Often the 'best' estimate of the likelihood of failure of such complex systems is made based on the opinion of

suitably qualified and experienced professionals. In essence, such estimates are empirical values based on experience and informed judgment of the appropriate 'expert' familiar with the design, operations and site conditions. The reliability of the estimate is substantially dependent on the available information, expertise, skill, and experience and good judgment of the experts. The scope of the FMEA should be broad to cover the effects of relevant modes of failure,

including engineered system failures and natural failures (avalanches, floods, droughts etc.). Factors, to account for the confidence in estimates of the likelihood and consequence, should be included to provide readers with an understanding of the analyst's opinion of the reliability of the estimate.

The weighting factors associated with the risk analysis for Goan Iron ore mines are shown in the Table.3.

Table 3. Weighting factors for Risk Analysis: Goan Mines

Sl. No.	Parameter	Weightage Factor (%)
1	Change in Slope Angles	45
2	Laterite Cover and Structural Conditions	25
3	Influence of Ground Water Pressure	15
4	Surface erosion of benches	10
5	Irregular pit design	5

8.0 CONCLUSIONS

The paper addressed the basic areas of geotechnical investigations and its potential areas of risk management techniques. An attempt has been made to understand the different geotechnical parameters associated with risk. Once the failure modes and measures with the highest risk have been identified, it is possible to consider mitigation or alternative designs to reduce risks.

There is a growing need of these investigations for establishing safe design practices and safety considerations both in opencast and underground mining projects. Support designs for slopes and underground stopes, fill mechanics and systems are solely based on rock mass characterization techniques. Most of the mines in our country are adopting these new philosophies for mine design. Some Tailing dam designs in Goa are based on geotechnical approach. There is a need to develop proper slope design guidelines for friable ore bodies with weak wall rocks. Standardization of geotechnical data,

development of databases for rock characterization is very important for the development of proper design guidelines. As most of the opencast mines become deeper, slope steepening is of concern due to limitation of space available for dumping purposes, which demands such type of investigations.

REFERENCES

1. *Geotechnical investigations for the assessment of stability of slopes: Jaquela-Pale iron Ore Mine, Goa*
2. *Slope stability investigations at Saniem Iron Ore Mine, Goa*
3. *Robertson AMG and Shaw.S. Risk Management for Major Geotechnical structures in Mines (2005), Robertson Geoconsultants inc, Canada*
4. *Galena, Version 5.2, User Guide, Clover Technologies, Australia*
5. *Flacslope: Ithasca Consulting, Minneapolis, MN, USA.*

Table No.4.Failure Modes and Effects Analysis (FEMA) Worksheet-Sample Mine

ID	Physical Instability	Failure Mode	Effects	Project stage	Likelihood	Consequences			Confidence Level	High concern Issue	Mitigation Measures
						Regulatory Impact	Public concern	Safety Consideration			
A1	Tension crack development	Initiation of failure Mechanism	O	L	L	L	L	H		Geotechnical instrumentation and monitoring	
A2	Tension crack propagation	Initiation of failure Mechanism	O	L	L	L	L	M		Geotechnical instrumentation and monitoring	
A3	Seepage of rain water into the cracks	Initiation of failure Mechanism	O	M	M	L	M	M		Geotechnical instrumentation and monitoring	
A4	Face erosion, gully formation in benches	Possibility of effect of slope equilibrium	O	M	M	L	M	M		Construction of drainage ditches, diversion pathways	
A5	Draining the pit by pumping	Possibility of effect on slope equilibrium	O	M	M	L	M	M		Monitoring, change is slope design, support measures	
A6	Local Instability	Small scale bench failures	O	M	H	M	M	M	H	Monitoring, change is slope design, support measures	
A7	Gross instability	Large scale bench failures	O PC	H	H	H	H	L	‡ H	Development of proper safety precautions measures, Disaster Management Plan	
A8	Depth of workings 0-30m, 30-60m, 60m and above	Pits more than 60m depth May likely to cause instability	O PC	H	H	H	H	L	H	Routine pit slope monitoring, periodic inspections, Disaster Management Plan	
A9	Pit Slope Angle 20°, 30°, 40°	Steeper angles may cause slope problems	O PC	H	M	L	M	M	M	Routine pit slope monitoring, periodic inspections, Disaster Management Plan	

THEORETICAL PREDICTION OF PERMEABILITY OF CLASTIC RESERVOIRS AND AQUIFERS

B.K. Sahu

Dept. Earth Sciences, IIT BOMBAY, Powai, MUMBAI- 400076, India

ABSTRACT

Permeability controls the formation of hydrocarbon pools, location of groundwater aquifers, and depositional sites of ore minerals in clastic sediments and sedimentary rocks as well as the production rates of different fluids from these reservoirs. Theoretical prediction of permeability of clastic reservoirs becomes essential if insitu drilled core samples are not available or are very expensive to procure especially for groundwater explorations.

Measured grain size statistics of clastic rocks/ sediments are usually on a weight(volume) frequency basis(not on number basis as needed for statistical analysis) and hence these must be converted to their equivalent phi size statistics on surface area and or specific surface basis as is required for prediction of permeability. Here we use unimodal phi- Normal size distribution model as given in Sahu(1965a,b) for each of the five phi-normal size modes of clastics (boulders , pebbles, medium sands, fine sands, clays) as has been deciphered in Sahu (2009a,b). Theoretical prediction of permeability of hard indurated clastic rocks (granular porous media) can also be done through thin section size analysis with proper probabilistic corrections to obtain phi size statistics on surface area basis in 3D space (Sahu,1974c) but this method is rather complex and time-consuming and hence, cannot be used routinely.

Permeability can be predicted through use of a linearized Kozeny-Carman(non-linear) equation by taking a logarithmic(phi) transform of both sides of the equation (Sahu,2005), where each variable has been phi-transformed to a Gaussian(Normal) variable, so that the predicted phi-permeability remain Gaussian , using a empirical constant C in Kozeny-Carman relation as 760×10^{-4} . Better prediction accuracy for phi-permeability can be obtained through linear regression of theoretically computed permeability against the measured permeability for a large number of clastic reservoir samples which can give a more accurate universally applicable value of constant C in Kozeny-Carman equation (rather than 760×10^{-4}) as has been used in this paper.

1. INTRODUCTION

Permeability is bulk property of granular sediments or fractured rocks, and it is the most important property for trapping and production of hydrocarbons and/or groundwater as well as for deposition of valuable ore deposits. Permeability is a positive real static random variable in open interval (0, infinity) and possesses a unimodal log-Normal (phi-Normal) distribution for a large enough sample (more than the REV) that induces homogeneity and hence, continuity in an otherwise molecularly and microscopically heterogeneous medium. It can also vary dynamically through time and/or space if the rates of production of fluids from the reservoir are kept very high (Reynolds

Numbers more than 100) as a consequence of consolidation, compaction, deformation of pore structures in the clastic reservoirs. Permeability depends on grain surface area statistics with phi-normal density for grains, porosity with phi (n/ (1 -n)) having phi-normal density (Sahu and Patro,1970)and on an empirical constant C.

Permeability (k) is an intrinsic property of the porous medium only and is independent of the fluid or fluid properties passing through it. But it cannot be directly measured in the laboratory and is indirectly calculated using an exact deterministic relation between measured hydraulic conductivity (K) and permeability (k). Hydraulic conductivity

can be measured easily in the laboratory using standard permeameters, and gas absorption apparatus, provided undisturbed large cylindrical core samples are available with cylinder length (l) much greater than the cylinder diameter and cylinder diameter much greater than the grain/pore diameters. This ensures that the cylinder sample is greater than the representative elementary volume (REV) of the porous media, so that homogeneity and continuum theories are applicable to the results of the experiments.

However, un-fractured and undisturbed large diameter cylindrical core samples are very expensive to procure routinely, although diamond drilling or double barrel core drilling are available to use. Often, much cheaper percussion drilling or air drilling methods are used which provide disaggregated particles from which the size distribution statistics of clastic reservoirs (aquifers) can be obtained but cannot give insitu samples for measurement of hydraulic conductivity (K) from which permeability (k) is calculated. In such cases, it will be prudent and necessary to predict the permeability of reservoir rocks theoretically using the results already available for hydraulic conductivity by applying laminar flow of fluids through the cylindrical core samples (REV) from the clastic reservoirs (aquifers).

Clastic rocks belong to granular porous media and comprise intertwined grains (close convex sets that are measurable) and pores (union of open sets that are not measurable) and these two components of porous media are complementary phases giving the total volume of reservoir set equal to 1.0. Therefore, characterization of only one phase (say of grains that is measurable) is sufficient for characterization of the whole porous media and then the characteristics of pores can be obtained as its complement. Since pores are open sets with high connectivities and its sizes and size distribution required for

calculation of permeability (k) of the reservoir rock cannot be measured directly, the grain sizes and its size distribution statistics are measured easily in laboratory and used to compute the permeability of reservoirs and also using the laminar fluid flow theory through the cylindrical samples (REVs). The prediction of permeability using linearized Kozeny(1927)-Carman(1937) non-linear relation between permeability and porosity and specific surface of the porous medium is slightly modified from the method given in Sahu (2005, p.153), by using the Gaussian(ϕ -normal) transformation of specific surface of grains(pores) and ϕ -normal porosity as independent input variables on its RHS and ϕ -normal ($k/C \cdot n(A)$) as the dependent Gaussian variable on its LHS; where $n(A)$ is the porosity of cross-section of cylindrical test sample. Since, porosity, $n(A)$, measured on area basis need not be equal to porosity, $n(V)$, measured on volume basis in finite samples of the porous media, these two quantities must be clearly distinguished theoretically, although these are equal in the limit asymptotically if volume and cross-sectional area of sample tends to be infinite (as given in Stereological Theory).

Clastic reservoirs are often easily disaggregated in the laboratory and the size statistics of grain size distributions obtained by measuring the cumulative weight frequencies against grain diameters by sieving (very inaccurate and imprecise) or settling (very accurate) methods or with much difficulty by loose grain counting on number frequency basis for gravels and coarse sands. However, for permeability predictions, we need grain size statistics on surface area basis (s.a specific surface) and not the statistics on number or weight frequency basis. For hard rocks that cannot be disaggregated, usually thin section size analysis is followed where grain sizes are measured as circle diameters (2D) or as semi-intercepts (1D) and frequency as numbers. Complex probabilistic corrections are necessary for obtaining the

true 3D sphere diameter distributions and on weight frequency, surface area frequency as needed and these theories are given in Sahu (1974 a,b). Application of this method to theoretically calculate permeability in granular porous media (clastic rocks) is given in Sahu (1974c). However, thin section method for predicting the permeability of reservoir rocks, although very accurate, is rather complex and time-consuming for any routine application, especially for groundwater exploration, and hence this method is not recommended. In this paper, we give a simpler and better theoretical prediction method for permeability of clastic reservoirs (aquifers) which can be applied routinely.

The main defects of sieving and settling methods of size analyses for permeability prediction are listed:

- (i) These do not yield surface areas of grains which are very difficult to measure because of small sizes, irregular grain shapes, and interconnectivities in pores/grains in 3D space.
- (ii) Size distribution is measured on weight(volume) frequency basis but permeability prediction requires size statistics on surface area basis (specific surface of grains) as laminar flow through the porous media encounters frictional forces at the grain surfaces.
- (iii) Size distributions of clastic reservoirs can have five phi-normal modes and not necessarily unimodal phi-normal (Sahu,2009a,b) which must be accounted for in any theory. To keep the prediction theory simple, we have computed theoretical permeability for each of these five phi-normal size distributions separately.
- (iv) Therefore, in this paper we calculate theoretical permeability for each of these five phi-normal modes (boulders,pebbles, medium sands,

fine sands, and clays) separated based on surface area statistics(specific surface) of each mode. In case, the reservoir is bimodal, trimodal or polymodal, the method can be easily extended by taking the weighted predicted permeability of these modes on basis of their individual weight frequency weighting factor.

These defects can be easily remedied through some simplifying assumptions that do not seriously affect the accuracy of predicted permeability as follows:

- (i) All grains are assumed spherical which is not a serious error (Sahu, 1971) and if any bias is there it is incorporated in the empirically computed value of C in Kozeny-Carman equation.

Since, sphere is a smooth convex body, it can only have point contacts with other neighbouring spheres and do not reduce the surface area of grains (hence of pores) affecting the laminar flows through the porous media.

- (ii) Size statistics on weight frequency basis, as measured in the laboratory, can be easily converted to equivalent size statistics on surface area basis, as required for prediction of permeability, using the unimodal phi-normal size distribution results given in Sahu (1965a,b).

We define phi-size as the negative logarithm grain diameter in mm (i.e. 1 mm diameter becomes the zero phi in phi scale) (see, Krumbein,1934,1938). Phi is a non-dimensional real variable with a ratio scale and belong to Normal (Gaussian) distribution (i.e. diameter distribution belong to log-normal type). Hence, phi-size statistics can be easily computed on surface area basis (Sahu, 1974c) if we know the phi statistics in any other basis

(number, length, volume(weight)) using theory of unimodal phi-normal density given in Sahu (1965a,b).

- (iii) But many clastic reservoirs are not unimodal phi-normal type but are polymodal with a maximum of five phi-modes at boulder, pebble, medium sand, fine sand, and clay sizes as has been given in Sahu (2009a,b). In such cases, theoretical permeability can be predicted by appropriately weight each of the phi-modes present in the clastic reservoir (aquifer) with weighting factors of weight frequency of each phi-mode. The average phi-statistics of polymodal phi-size distributions and their dissection to each phi-normal components are given in Sahu(2009a).

2. BRIEF REVIEW OF PERMEABILITY OF CLASTIC RESERVOIRS:

This review is primarily based on the book of Bear (1972). Clastic Sediments/Rocks belong to granular porous media which are molecularly and microscopically very heterogeneous but can be sampled over a minimum representative element value (REV) to make any property to measure any porous medium homogenous so that continuous theories can be applied. Porosities can be measured in 3D, 2D, 1D, 0D spaces and these are asymptotically equal in the limits only but not necessarily in finite sample spaces. For permeability, the effective porosity or corrected porosity are important (not the total porosity which may have closed unconnected porosities). However in Clastic Reservoirs, since it is a granular porous media, most of the pores are connected to one another and total porosity may be the same as effective porosity. Porosities and sedimentary

materials (Clastic Reservoirs) range in porosity values from 30-35% in fine to medium sands, 30-40% in gravels, 30-33% in gravelly sands and 1-10% in shales with respect to size sorting, porosity varies in 32% for well sorted, 17% for poorly sorted and a combination of two sized spheres forming a closed compact cubic cell, porosity reduces to 12.5%. Specific surface (M) for sphere distribution is $\frac{3(1-n)}{avg(r)}$; where avg(r) is the harmonic mean on number frequency basis and hence, surface area for unit volume $M_s = \frac{M}{(1-n)}$ with $M_s = \frac{3}{r}$ for a sphere.

Kozeny (1927) and Carman (1937) used specific surface fluid flow through porous media. Darcy laminar flow ($Re < 10$) is given by $q = -K \frac{\partial \phi}{\partial l}$ and using potential $\phi' = \left(\frac{p}{\rho}\right) + gz$ we obtain $q = (k\rho/\mu) \cdot \text{grad}(\phi')$ (Hubbert 1940). Hydraulic Conductivity (K) jointly depends on properties of porous media and properties of the passing fluids through it and has a dimension of L/T whereas permeability (k) is the property of porous media only and has a dimension of L^2 . Thus $k = \frac{K\mu}{\gamma} = \frac{Kg}{\nu}$

Permeability (k, cm^2) ranges from 10^{-8} to 10^{-4} and is approximately equal to $(0.617 \cdot 10^{-11} \cdot d^2)$ where d is the effective grain diameter in microns ranging from 10 to 10^4 . This can be converted as $(k, cm^2) = 0.617 \cdot 10^{-5} \cdot d^2$ where d is in millimeters ranging in Clastic Sediments from 1028mm to less than 1 micron. Permeability can be theoretically predicted using the Kozeny Carman Relation as $k = C \cdot d^2 (cm^2)$ where the empirical constant $C = 6.54 \cdot 10^{-4}$. Which can

be modified as $C=654 \cdot 10^{-4}$ when d is expressed as millimeters on the basis of specific surface. We get

$$k = C_0 * \left(\frac{\left(\frac{n^3}{(1-n^2)} \right)}{n_s^2} \right) \quad \text{with } C_0$$

ranging from $\frac{1}{2}$ to $\frac{1}{6}$ (Bear 1972, page 166).

Gravels can be classified on file size basis as Boulders (-17 to -8), Cobbles (-8 to -6), Pebbles (-6 to -1), very Coarse Sand (-1 to 0), Coarse Sand (0 to 1), Medium Sand (1 to 2), Fine Sand (2 to 3), Very Fine Sand (3 to 4), Silt (4 to 9), Clay (9 to 21). The corresponding phi means are -12.5, 7, -3.5, 2.5, 6.5 and 15.5 with phi variances for each of these five modes as 4 for Boulders and Cobbles, 1 for Pebbles, $\frac{1}{4}$ for Fine Sands, 1 for Silts and 4 for Clays. (See, Sahu 2009 a, b). The observed values of permeability is (md) for clastic materials are as follows: (Fetter 1990);

Well sorted gravel (10^{-2} to 0), well sorted glacial outwash (10^{-3} to 10), silts and fine sands (10^{-5} to 10^{-3}), silty clayey sands (10^{-6} to 10^{-4}) and clays (shales) (10^{-9} to 10^{-6}). The theoretically predicted permeability values would be related to observed values through an empirical constant 'C' which must be uniformly constant over all phi means and phi variances in the clastic reservoirs. (granular porous media).

3. MATHEMATICAL THEORY FOR PREDICTION OF PERMEABILITY(k)

Hydraulic conductivity (K) dimension L/T can easily be measured in the laboratory using a large cylindrical core sample to obtain Darcy's Law for laminar flow through i

$$K = (Q/A) (dh/dl), \dots \dots \dots (1)$$

Hydraulic conductivity (K) is directly proportional to specific weight, $Y (= \rho \cdot g)$, of the fluid and inversely to the dynamic viscosity, μ , of the fluid measuring the frictional resistance of fluid to shear that is necessary for the fluid to flow. Thus, we get :

$$K = k (Y/ \mu) = (\rho \cdot g) / \mu. \dots \dots (2)$$

Permeability controls the laminar ($Re < 10$) fluid flow across the sectional area of pores ($n(A)$) of cylindrical sample parallel to its length, l . However, since pore space is more difficult to measure we can measure the grain area and its complement gives the pore area, assuming that the convex grains have only point contacts having contact area close to zero, and matrix and/or cement proportions are negligible. Further, assume that the convex grains are spheres, we get theoretical permeability (k) as below:

$$K = C(\text{sphere}) \cdot (\text{aver. } ds)^2, \dots \dots (3)$$

with dimension ($L^2; \text{cm}^2$). The unit of permeability, Darcy = $9.87 \times 10^{-9} \text{ cm}^2$, which is too large to be of any practical use. Therefore, we use millidarcy (md), ($1 \text{ md} = 10^{-3} \text{ darcy}$), or $1 \text{ md} = 9.87 \times 10^{-12} \text{ cm}^2$. The permeability, k , of a granular porous medium having a unimodal phi-normal grain size (pore size) distribution can be predicted theoretically as mentioned in ~Introduction~ by slightly modifying the nonlinear Kozeny-Carman formulation as:

$$k = C \{ n(a) \cdot [(n(v) ^2) / (1 - n(v) ^2)] \} (ds)^2, \dots \dots \dots (4)$$

where C is an empirical constant of calibration to reconcile the observed

and theoretically predicted permeabilities with minimum square errors. The structural factor of the granular porous media is represented as $n(a) \{ n(v) / (1 - n(v)) \}^2$ because $n(a)$ measured in cross-section of sample may not equal to $n(v)$ measured over the whole volume of sample as the sample is of finite volume/cross-sectional area. Stereological theory gives that $n(a) = n(v)$ in the limit which is true only if the volumes / areas are infinity. However, if the length, l , is about 2 to 3 times the cross-sectional diameter of the cylindrical sample, then the equality of $n(a)$ and $n(v)$ may be approximately valid and used in calculations.

Equation 4 is a non-linear equation, hence permeability prediction would not have same prediction error variance over the whole range of its variation. To avoid this problem, we linearise Eqn. 4 by taking phi transformation (log transformation) to both sides of the equation (Sahu, 2005) and get:

$$\Phi(k/n(a)) = \Phi(C) + 2 \Phi(n(v)/(1-n(v))) + 2 \Phi(\text{aver. ds}), \dots\dots\dots (5)$$

Where, $\Phi(C)$ is the new fixed constant intercept of Eqn.5, and Φ is defined as the negative logarithm to base 2 of the argument ,(ds in mm or any other dimensionless argument) (Krumbein, 1934, 1938). Since $n(v)$ or $n(a)$ lies within the open interval (0,1), we get $\Phi(n(v)/(1-n(v)))$ is Gaussian/Normal (see, Sahu and Patro,1970 and Sahu,2005). $\Phi(\text{aver. ds})$ is also Gaussian/Normal and can be calculated from measured phi-mean (u) and phi-variance (σ^2) on weight frequency basis of the clastic reservoir grain size distribution (assumed unimodal phi-normal, Sahu, 1965a,b)or polymodal phi-normal

(Sahu, 2009a,b)). For unimodal phi-normal size distribution, we get:

$$\Phi(\text{aver. ds}) = (u(s)) - (1/2) (\ln 2) (\sigma(s)^2), \dots\dots\dots(6)$$

$$\text{or, } \Phi(\text{aver. ds}) = (u(w)) - (3/2) (\ln 2) (\sigma(w)^2) \dots\dots\dots (7)$$

Thus, $\Phi(\text{aver. ds}^2) = 2(u(w)) - 3(\ln 2) (\sigma(w)^2)$ which yields,

$$\Phi(k/n(a) \cdot C) = 2 \Phi(n(v)/(1-n(v))) + 2 \{ (u(w)) - 3(\ln 2) (\sigma(w)^2) \}, \dots\dots\dots(8)$$

which shows that this Eqn(8) is a linear regression equation as terms of each of the variable on RHS is Gaussian(phi-normal), the LHS is also Gaussian, i.e., k is phi-normal as desired (see,Sahu,2005, p.153).

Krumbein and Monk (1943) simulated a few limited number of phi-normal sands with different phi-means and phi-standard deviations by mixing sieved sands in appropriate phi-normal proportions and tried to correlate these phi statistics with measured permeabilities of these phi-normal sands . However, they could not find any equations to predict permeability values from the phi-mean and phi-standard deviations of corresponding samples and gave a very complex non-linear surface for prediction of permeability. This surface was complex and could not be usable to predict permeability (k) routinely from input values of phi-mean and phi-standard deviation. Their approach had several defects:

- (i) Did not Gaussiannise porosity distribution, and did not use average specific surface area of grain size distribution and Gaussiannise that variable.
- (ii) Used phi-mean but phi-std. deviation on weight frequency

basis(not phi-variance which is required) to estimate average ds on surface area basis.

- (iii) Did not linearise the Kozeny-Carman equation (4) to globally reduce error variance in constant C, so the predicted permeability would be much more precise and the linearised equation say, Eqn. 8) would be globally applicable and easily used.

The present theory is more accurate as all these three defects have been eliminated in obtaining prediction permeability (k) through use of Equation 8. The only remaining problem is a good estimate of global calibration constant C. From literature survey, we get C to be approximately 760×10^{-4} (or 654×10^{-4} , as in Bear, 1972) and porosity values in clastic reservoirs (aquifers) with different phi-means and phi-variances over the whole range of grain sizes from gravels through clays. The values of the five unimodal phi-normal size distributions in this range of grain sizes are taken from the papers in Sahu (2009a,b).

4. THEORETICAL PERMEABILITY OF EACH UNIMODAL PHI-NORMAL CLASTIC RESERVOIR ROCKS AND AQUIFERS

We can predict the permeability (k) of clastic rocks having five unimodal phi-normal size distributions (Sahu, 2009a,b) using Equation 8 and taking the phi size weight frequency phi-mean and phi-variance values as in Sahu (2009a,b). The five phi-modes lie within boulders, pebbles, medium sands, fine sands, clays (shales). We are using the calibration constant value as $C = 760 \times 10^{-4}$ and the detailed calculations are given in Table 1 for easier comprehension of this theoretical procedure. In real reservoirs and aquifers the number of size modes are seldom one but two, three, four or five modes. So, the permeability of these multi-modal reservoirs and aquifers can be estimated with proper weighting factor (on volume (weight) frequency basis for each size mode) averaging of permeability for the clastic reservoir (aquifer).

TABLE 1: Theoretically predicted permeability (k) for clastic reservoirs (aquifers) with phi-modes located at boulder, pebbles, medium sands, fine sands, and clays. Phi-size statistics are taken from Sahu (2009a,b) and average specific surface, ds, computed using equations in Sahu (1965a,b).

Modes >	Boulders	Pebbles	Medium Sands	Fine sands	Clays(Shales)
Phi mean, u(w)	- 6	-2.8	1.5	3.0	8
Phi-variance, $\sigma^2(w)$	4	1	1/4	1	4
Sp.surface, ds	-4	-3.6	2.5	4	0.5
Porosity, n(v)	0.1	0.2	0.25	0.4	0.5
Phi(n/(1-n))	.1525	.2333	1.74	2.746	0
Phi(k/ nC); R3 + R5	-3.85	-3.367	4.24	6.746	8
k/nC	7.00	12.89	18.75	100.54	251.2
nC x 10 ⁻⁴	76	152	190	304	380
k, (md)	532	1959	3543	30565	9545

A better estimate of global constant C would be giving more precise estimate of permeability (k) for the clastic reservoirs/aquifers.

5. CONCLUSIONS

- a. Permeability is an intrinsic property of clastic reservoirs which greatly influences not only formation of hydrocarbon pools, groundwater aquifers, and zones for concentration of ore minerals but also the rates of withdrawal of fluids from these granular porous media.
- b. Permeability of reservoir rocks can be predicted theoretically by using a linearized theory of Kozeny-Carman non-linear relation, with inputs of Gaussianised phi (Specific Surface values) and Gaussianised phi($n(v)/(1 - n(v))$) (see, Sahu and Patro, 1970 for Gaussian Transformation) values as independent variables and Gaussianised phi (permeability (md)/C. n(A)) as the dependent/ predicted variable (Sahu,2005). Estimating the Constant C and assuming areal porosity n(A) equal to volume porosity n(v) in the limit for large (cylindrical) test samples, the permeability can be calculated using five poly(modal) phi-size distributions in clastic sediments as given in Sahu (2009a,b). The observed weight
- c. frequency phi-size parameters are theoretically converted to phi-size parameters on surface area basis from which specific surface is easily computed (see, Sahu, 1965a,b). Example of predicted permeability for each unimodal phi-normal distributions for boulders, pebbles, medium sands, fine sands, and shales (clays)) are computed here ,for reference(see, Table 1). The method is easily extended to bimodal, trimodal and polymodal phi-normal size distributions, as required.
- c. The empirical constant C used here is 760×106^{-4} which can be further improved by linear regression of phi(k/C n(A)) versus $2\phi(n(v)/(1 - n(v)))$ and $2\phi(ds)$, where ds is the specific surface of grains on surface area basis when a large set of data on permeability against different types of clastic reservoirs become available through laboratory experiments. Using this revised/corrected value of constant C, the theoretical permeabilities for each sample of clastic aquifer and reservoirs can be computed much more accurately.

REFERENCES

- Bear, J., 1972, *Dynamics of fluids in porous media*. Am. Elsevier, New York, 764p.
- Carman, P.C., 1937, *Fluid flow through granular bed*. Trans, Chem Engr., London, 15: 150-156.
- Fetter, C.W., 1990, *Applied Hydrogeology*, (2nd En), CBS Publ., New Delhi, 592p.
- Hubbert, M.K., 1940, *Theory of groundwater motion*. Jour. Geol., 48, 785-944.
- Kozeny, J., 1927, *Über Kaitlage Leitung des Wassers im Boden*. Seit. Akad. Wiss. Wein, 136: 271-306.
- Krumbein, W.C., 1934, *Size frequency distribution of sediments*, Jour. Sed. Petrol., 4: 65-77.
- Krumbein, W.C., 1938, *Size frequency distribution of sediments and the natural phi scale*. Jour. Sed. Petrol., 8: 89-98.
- Krumbein, W.C., and Monk, G.D., 1943, *Permeability as a function of size parameters of unconsolidated sands*. Trans, AIME, 151, 153-163.
- Sahu, 1965a, *Transformation of arithmetic and phi normal size distributions*. Jour. Sed. Petrol. 35: 969-972.
- Sahu, B.K., *Transformation of weight- and number-frequency for phi- normal size distributions*. Jour. Sed. Petrol., 35: 973-976.
- Sahu, B.K. and Patro, B.C., 1970, *Treatment of roundness and sphericity data of quartz grains of clastic sediments*. Sedimentology, 14: 51-66.
- Sahu, B.K. 1971, *Relationship between 2D shape and elongation indices*. Q. Jour. Geol. Min. Metall. Soc. India. 43: 237-240.
- Sahu, B.K., 1974a. *Probabilistic solution to thin section size measures*. Ind. Jour. Earth Sciences, 1(1): 22-36.
- Sahu, B.K., 1974b, *Probabilistic solution to thin section size measures expressing size as intercepts and frequency as number or any measure*. Ind. Jour. Earth Sci., 1(2): 168-176.
- Sahu, B.K., 1974c, *Determination average grain sphericity in granular porous media*. Jour. Sed. Petrol., 44(2): 578-582.
- Sahu, B.K., 2005, *Statistical Models in Earth Sciences*, B.S. Publics, Hyderabad, 211p.
- Sahu, B.K., 2009a, *Inference on Polymodal phi-size moments of clastic rocks*. Jour. Ind. Asson. Sedimentologists, 28(1): 1-7.
- Sahu, B.K., 2009b. *Physic and Mathematics of Transportation and Deposition of clastic sediments*. Jour. Ind. Asso. Sedimentologists, 28(2): 1-6.

INVESTMENT OPPORTUNITIES IN INDIAN MINING SECTOR

Abhinav Sengupta

Tata Consulting Engineers, Kolkata

ABSTRACT

India is bestowed with huge mineral deposit of 86 minerals, which include 4 fuels, 10 metallic, 46 non-metallic, 3 atomic and 23 minor minerals (including building and other materials). After liberalization of the Indian Economy, 100% FDI has been allowed in Mining Sector, which encourages huge appetite for Mining investments. India's growth story to become a developed nation by 2020 caused the huge surge in development of infrastructure and power generation. To achieve this high demand for raw materials, the mining activity will witness a growth of major minerals. Beside this India has the largest domestic consumer base. This paper discusses the four sectors steel, aluminium, coal and cement industry with their growth trajectory, industrial demand and scope for future investment.

INVESTMENT IN MINING INDUSTRY

Investment decisions in the mining industry, as in any other, normally focus on numerical methods comparing alternative investments. While these methods are important, the process of investment strategy, making the investment, and operating a project during its economic life, involves much more. Many key people in various disciplines provide varying degrees of input over the life of the project, and their input can play a major role in the investment strategy process. Investments in the mining industry have many characteristics, which are not found in most other industries. These include the following:

1. Finding or Exploration: Either generative or opportunistic exploration must be funded for a company to get/renew investments that will be profitable in the future. These programs, which may be structured as individual efforts, partnerships, or joint ventures, take time to develop good prospects/projects.
2. Size: Mining projects involved large scale mining operation, involvement of heavy machineries, high

technology for processing and a huge infrastructure to make it feasible. Hence projects involving thousands of million dollars makes it highly capital intensive industry.

3. Life: Projects generally have very long lives. Many years pass between first finding ore-grade material, proving up the reserves, planning the project, and construction. Additional years must pass before capital costs are recouped, and thereafter even more years are needed for equity investors to make an adequate return.
4. Product: By their nature, mining projects produce a major product, although byproduct or co products are often produced. In general, the product produced in the mining process is not sold to the final customer. Rather, this raw product is often sold to others who, after adding value to it, may sell to the final customer. As a result, demand for "raw" mining products is "derived" and therefore subject to price and volume swings in addition to those generated by the final customer.

5. **Profile:** Projects are usually “high” profile wherever they are located because they are “natural resources.” In some countries, they often get much more media and political coverage than they might

elsewhere. If this situation exists, or may come to exist, attitudes and business ground rules can change very quickly; what appears to be a good investment one day can quickly become less attractive.

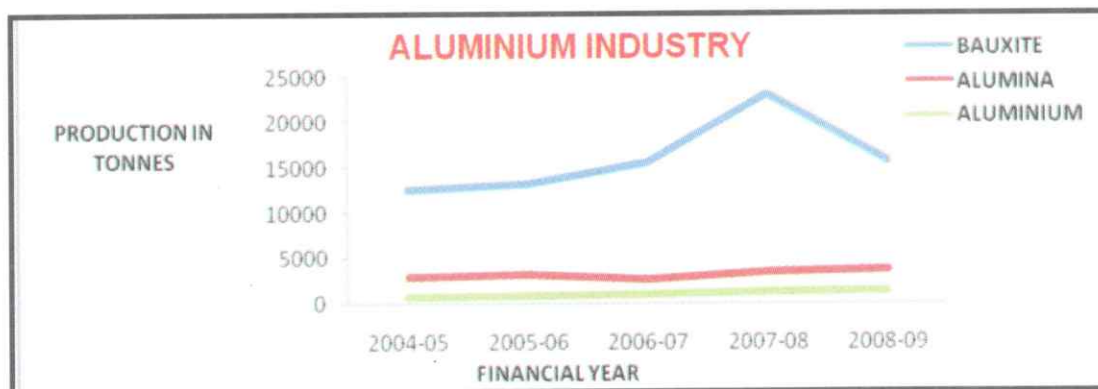
STATUS OF MINERAL RESERVES IN INDIA				
GROUPING	ABUNDANT	ADEQUATE	DEFICIT	SCARCE
Fuel Minerals	Non-Coking Coal	Lignite	Coking Coal	Petroleum Crude
Metallic (Ferrous Minerals)	Iron Ore	Chromites (Metallic Grade), Manganese	Chromites (Refractory Grade)	Nickel, Tungsten, Cobalt, Molybdenum, Vanadium
Metallic (Non Ferrous Minerals)	Bauxite (Metallurgical Grade)	Zinc	Bauxite (Chemical Grade), Copper, Lead	Antimony, Gold, Platinum Group of Minerals, Tin
Industrial Minerals	Limestone (Cement Grade) Mica, Dolomite, Gypsum	Graphite	Limestone (Metallurgical Grade) Apatite, Rock Phosphate, Kyanite	Sulphur, Potash
Precious Stones	-	-	-	Diamond, Emerald, Sapphire, Ruby

ALUMINIUM INDUSTRY

India has total Bauxite reserve of 3290 MT while proved reserve is 899 MT. India stand 6th in the world with bauxite reserve, while 5th largest producer of bauxite. The 86% of bauxite in India is of metallurgical grade & aluminum industry requires bauxite containing min. 58% of Al₂O₃. With the abundance of bauxite resource, eastern ghat region of Orissa & AP will be the hub for the bauxite mining activities. The 87% of Indian bauxite get consumed by Aluminum industry, 9.5% by cement industry & 3% by chemical & refractory. Aluminium gets consumed

mainly in electrical sector, packaging, transportation, building materials, consumer durables, machinery etc.

1 tonne of Alumina requires 3 tonne of bauxite, while 1 tonne of Aluminum requires 2 tonne of Alumina. Therefore 1 tonne production of Aluminium requires 6 tonne of bauxite. 27% of Aluminum production comes from public sector and remaining from joint & private sector. Per capita Aluminum consumption is 0.7 kg, while the world average is 12-15 kg. India is the 8th largest aluminum producer in the world.



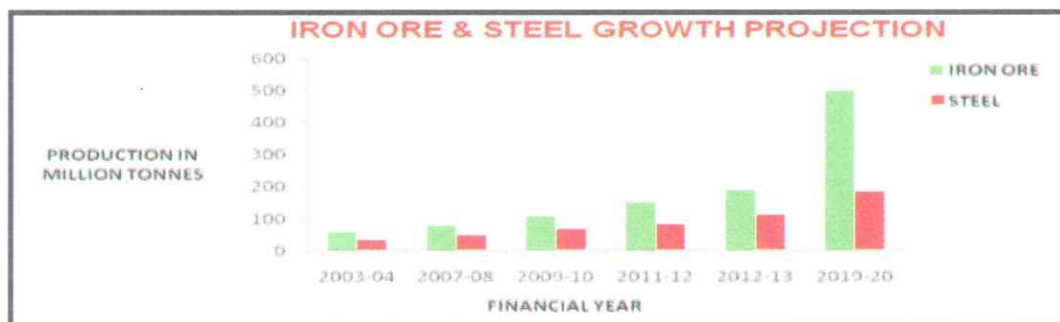
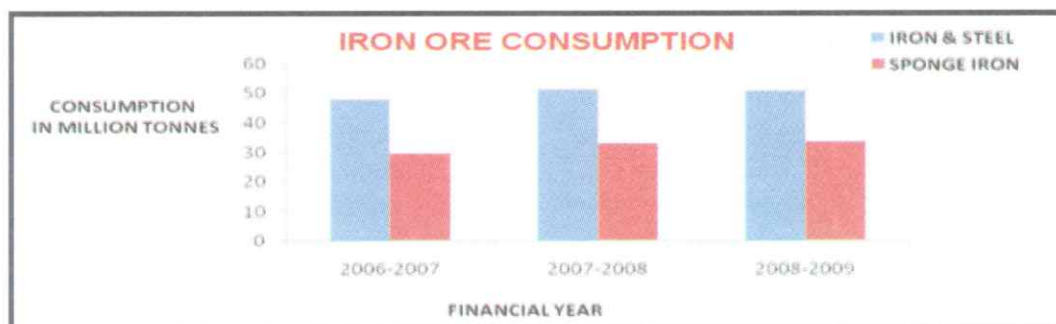
India, backed by its six decades of collective experience in the industry, is suitably positioned with regard to skilled manpower at reasonable cost within the country. While gibbsitic bauxite resources in the world are depleting, vast gibbsitic deposits in India assume particular interest because of its ease in processing. Since gibbsitic bauxite processing has specific advantage of low energy consumption, the alumina refineries enjoy sustainable comparative cost advantage. As per the industry sources, the present domestic consumption is estimated at around 7 to 8 lakh tonne and is expected to grow further. The main segments driving Aluminium demand in the country are construction, consumer goods and power & electrical segments. In order to increase its payload capacity & save fuel, aluminium wagons are likely to be inducted in Indian Railways by 2012-2013. The Planning Commission of India has projected production of aluminium at 1.28 MT by 2012 (8% growth rate) & 1.5 MT by 2017.

STEEL INDUSTRY

India with the total resources of over 25 billion tonne of Iron ore is one of the leading producers as well as exporters of iron ore in the world. Iron ore is the basic raw material used for making pig iron, sponge iron and finished steel. The iron ore is used mainly in blast furnaces, mini-blast furnaces (MBF), DRI and sintering and pelletisation plants. India is the largest producer of sponge iron in the world with

production over 20 million tonne. 2.5 tonne of ROM iron ore required to produce 1 tonne of steel, while 1.8 - 2.0 tonne of iron concentrate of high form is required to produce 1 tonne of steel. In India 70% of iron ore is having Fe% of +62 to +65 grades. India ranked fifth among the major crude steel producing countries in the world. Iron & steel including sponge iron is the major consumer of iron ore and accounts for 98% consumption. India's per capita steel consumption is 49 kg in 2008. The world average of per capita steel consumption stands at 150 kg and that of developed country stands at 400 kg. Only 30% of iron ore production comes from public sector and remaining 70% is from private sector.

Hematite (Fe ₂ O ₃)	Magnetite (Fe ₃ O ₄)
Total resources is 14,630 MT, 60% found in eastern sector, By grade 45% of resources are lumps, 33% are fines, remaining are mix & unclassified. Located mainly in Orissa (33%), Jharkhand (28%), Chhattisgarh (19%), Karnataka (11%) and Goa (5%).	Total resources is 10,619 MT, 87% found in southern sector, 20% resources are of metallurgical grade while 79% resources are of unclassified, not known and other grades. Located in Karnataka (74%), Andhra Pradesh (14%), Rajasthan (5%) and Tamil Nadu (4%).



The country has rich potential of iron ore, both in terms of quantity and quality to meet both the domestic demand and the export market. There is a tremendous scope for using the mined ore within the country for augmenting steel production and export steel in lieu of iron ore on a large roller, forward integration of DRI or pig iron producers and emergence of a few green field projects. With necessary measures, this sector would gear up to provide employment and boost the economic development of the country.

The National Steel Policy (NSP), 2008 revised has set a target of 180 million tonne of domestic steel production by 2019-20. This would entail requirement of about 500 million tonne of iron ore. The cut off grade of iron ore mining has been lowered down by IBM to 45% from 55% earlier to augment the production. Besides, there are targets set for export purpose as well. Therefore, in order to meet the total demand of iron ore, the Government plans to initiate steps including creation of additional mining capacity; encourage investment; issue environmental and forest clearances within specified time frame; propose

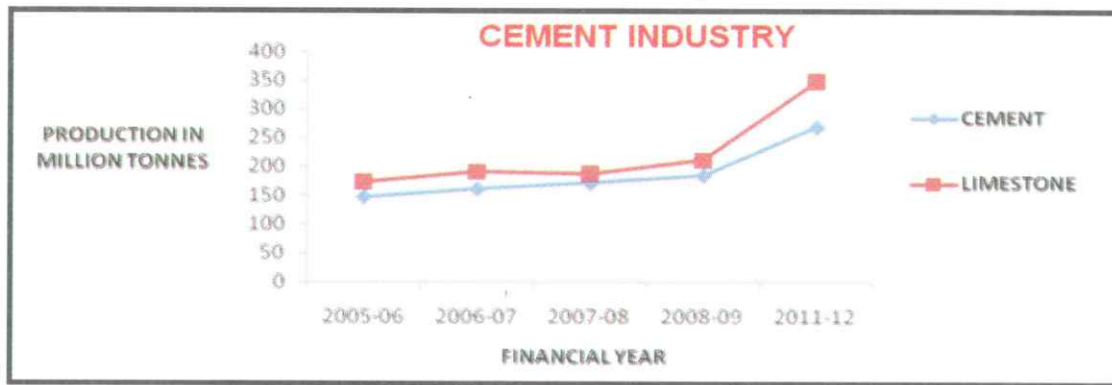
investment plans for large number of idle mining leases; grant and renew leases against credible mining plans; and grant of fresh leases only against new norms that are in place for assessment of technical and financial capabilities of applicants; restrict long term export contracts to maximum five years; and encourage use of fines as sinters/pellets scale.

CEMENT INDUSTRY

India has emerged as the 2nd largest country in the world in the production of cement. Cement is a basic construction material in housing, infrastructure and large projects for social development like irrigation dams, hospitals, roads, etc. It has become synonymous with construction and per capita consumption of cement is accepted as an important index of the country's economic growth. The Infrastructure and industrial activity, real estate business and investment in core sectors mainly drive the demand for cement. Some emerging markets for cement demand are concrete roads, concrete canal lining and rural construction (housing). Over 65% demand for cement arises from construction sector.

Limestone containing 45% (min.) CaO and above is usually preferred in the manufacture of cement. The total resources of limestone of all categories and grades are estimated at 175,345 million tonne, of which 12,715 million tonne (7%) are under reserves category. Grade wise, cement grade has leading share of about 59% followed by

SMS & BF grades (18%) and chemical grade (3%). Remaining 20% are others, not known and unclassified grades. Cement the major consuming industry accounting for 93% consumption, followed by iron and steel industry (4%) and chemicals (1%). The remaining consumption was reported by sugar, paper, fertilizer, glass, metallurgy, foundry, etc.



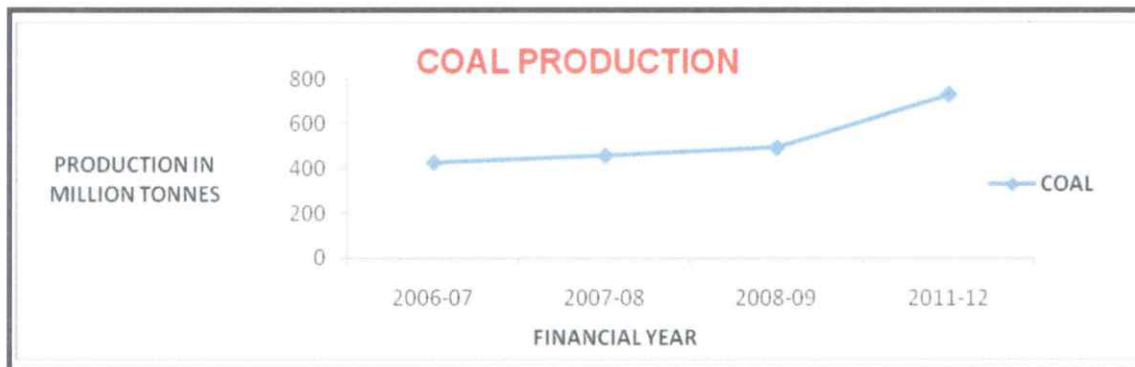
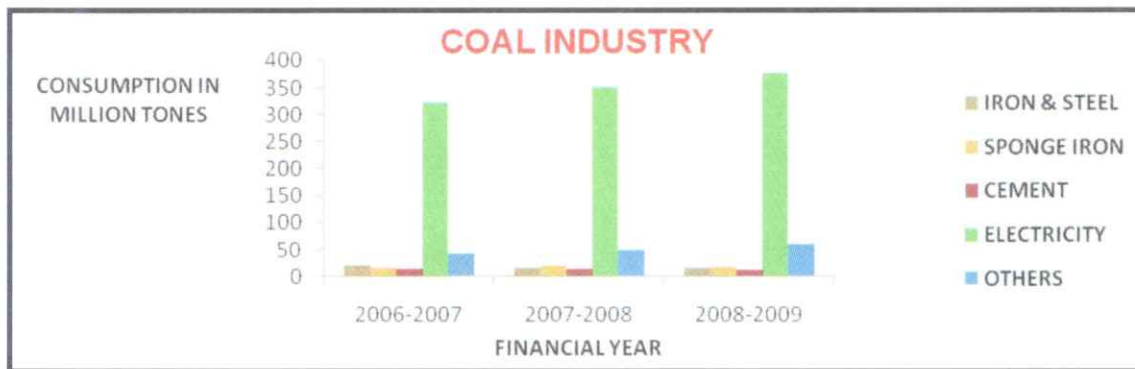
Cement-grade limestone occurs in all the limestone-bearing areas, while SMS, BF and chemical- grade limestone occur in selective areas. Increase in steel production in the country has escalated the demand for SMS and BF grade limestone. Concerted efforts to locate SMS and BF grade limestone along with cement- grade limestone are imperative to meet the growing demand. The Working Group on Cement Industry constituted by the Planning Commission for the 11th Five-Year Plan period has projected a demand growth at the rate of 11.5% per annum during the plan period at an expected 9% GDP growth rate. Access to potential limestone deposits of hill States and north-eastern States for exploitation on selective basis needs to be pursued for the industrial development of the region.

COAL INDUSTRY

India ranks 3rd in world coal production. The country has surplus resources of coal & lignite but the availability of good coking coal is limited. Quality wise the resource is 83% non coking coal & 17% coking coal. With 82% of coal production comes from

public sector & remaining from private sector. Per capita energy consumption in India is 285 kg oil per annum against 1,454 kg in the world. The Indian demand for energy will remain high. XIth Plan Working Group for Coal & Lignite has assessed a coal demand of 731.10 million tonne by terminal year i.e. 2011-12. The indigenous coal supply projection in the terminal year is projected to be 680 million tonne. As per National Steel Policy, 2008 (NSP) (revised) the requirement of coking coal for Iron & Steel industry will be 110 million tonne and non coking coal will be 50 million tonne by 2019-20. With huge demand of power about 78000 MW envisage in XIth Planning commission report creates tremendous demand for coal as a raw material for power industry.

Liberalization of policy regime includes: Captive mining by power, steel & cement industry allowed, with 100% FDI allowed in Power & Coal mining, by creating a competitive market for sale of coal, introduction of contract mining in coal cause the thrust in liberalization of regulatory & statutory regime and promotes investment in coal sector.



CONCLUSION

The 2020 vision of India to become a developed nation has augmented the high demand for infrastructure and self sufficient in power sector. Strong long term demand from steel industry is expected to boost iron ore industry while positive trend in power sector will catapult demand for coal. The construction industry will witness multifold increase in its growth rate; will augur growth for cement industry. Boom in automobiles and manufacturing of new Aluminium Indian railway wagons are expected to lend support to the aluminium industry. In India, availability of skilled mining personnel and low cost of production attracts huge potential for investment in mining sector. The As per

business Monitor International, the overall mining industry is expected to grow at a CAGR of 9% during 2008-12 to reach INR 1.9 trillion by 2012. The industry is expected to form 5.0% of GDP by 2015.

REFERENCES

1. *Indian Mineral Year Book, 2009, Published by IBM*
2. *A Guide to Investment in India's Mineral Industry, Published by FIMI*
3. *National Mineral Policy, 2008*
4. *National Steel Policy, 2008 (Revised)*
5. *XIth Five Year Plan. Govt. of India*
6. *Ministry of Mines, India (Annexures)*

MEAN SEA LEVEL (MSL) - AS A TECTONIC INTERFACE

Manoranjan Mahapatra
Geologist O/O J.D.G, Keonjhar

ABSTRACT

Mean sea level (MSL) is the surface of the sea water between the low tides and high tide. This surface has never been proved as a tectonic interface influencing tectonic movement in the planet Earth. Since the time of Earth's formation this surface is seem to be fixed for determination the mean radius of the Earth. When Earth's size & shape ever influence the tectonic activities, so as this MSL interface proves to influence the tectonics. The phenomena like transgression & regression of sea, emergence & submergence of land mass, sedimentation & upliftment of land mass, peniplaination & rejuvenation of Earth's surface directly relate to the development of land mass on this planet. The proportion of land mass & oceanic water surface seems to remain same throughout the Earth's history which otherwise confirms the presence of a tectonic interface at the line of MSL which influence global tectonics.

Key words- Tectonics, interface, upliftment.

1. INTRODUCTION

Mean sea level (MSL) is considered as the surface of sea water in between high tide & low tide. Again it determines the mean radius of the Earth. Its conceptual acceptance for the calculation of mean radius of the Earth is also conveying its connection with the earth's tectonics along with the theories of surface tension that gives earth a spherical shape from the hot molten material to a solid sphere during the time of its origin.

When the oceanic water mass is considered as one of the ingredient of the earth crust which surrounds 70.9% of the Earth surface area, the MSL would have there been fixed to a definite plain for a considerable span of time which would have not been changing so much since the earth's formation.

2. TRANSGRESSION & REGRESSION

3800 mts below the MSL is the average depth of the ocean floor and 840 mts above the MSL is the average height of continental mass seems to be well balanced in

congruence with the Earth's tectonics. Sea transgression with 10mts rise in MSL would have deluded more than 30% of the coastal areas which constitute 30% of the total land mass. Sea regression with decrease of MSL of 10 mts again exposes another 10% of the total land area from the continental shelf thereby reducing the oceanic area upto 65% and increase in land area by 35%. So total 20 mts difference level in the Mean Sea Level would have ultimately changed the oceanic surface & land surface ratio to 65% is to 35% which seems impractical considering recent manifestation of Earth topography which otherwise confirms the presence of MSL interface in tectonic sphere.

3. PENIPLAINATION & REJUVANATION OF EARTH SURFACE

A thickness of average 1 mm sediments degraded from the land mass every year in the process of weathering & erosion which in turn became 1 cm in 10 years & 1mt in 1000 years. So the total thickness of average height of 840mts would have been worn out in 840,000 years in which a complete cycle

of peneplanation occur. So it can be calculated that as more as at least 50 complete cycles of peneplanation would have occurred in Earth from the time of it's formation but the level above the MSL is still maintaining with the same average height of landmass above it which confirms the bearing of this plain upon the tectonic activity .

4. EMERGENCE & SUBMERGENCE OF LAND MASS

Transition from land mass to ocean and ocean to landmass along with the movement of sea are proved by typical sea beaches which have been raised above the sea level but pertains the wave activities on it at Isley & Jura beach ,Argyll manifests the sign of emergence of land mass. Relative movement between land & sea may also bring about submergence of land mass like that in Netherland coast & in Dwaraka in Gujrat coast in India. When the land surface & oceanic surface have developed proportionately ,the factors responsible for these submergence & emergence confirms its tectonic connection with the 0 mt RL i.e. Mean Sea Level .

5. SEDIMENTATION VS UPLIFTMENT

Tectonic Contradictions can't be ignored as 8000 million tons of sediments is annually transported & deposited in the sea floor every year. Is it always necessary to have those materials be always uplifted above the Mean sea Level to maintain the average height of the land mass rather than levelling the sea floor below the MSL which should have been the case in normal case of gradation . Except few occasions, degradation process can not go below the mean sea level which worked as a plain of restriction & contradicts the natural process of upliftment unless the tectonic process prevails. Rejuvenation is also one of the tectonic process involved with the upliftment of landmass in a fresh way above the MSL along with isostatic readjustment . These contradictions prove the presence of

a tectonic surface at the plain of MSL which influences the tectonics of the Planet EARTH .

6. CONCLUSION

The development of land mass above the sea level and the shifting of land mass to thousands of kilometre since its formation on the Earth proved by the theories of plate tectonics and continental drift indicate strong relationship between the upliftment of the surface topography correlating with the submergence & emergence, transgression & regression phenomena influenced by the tectonics of Earth.. So the mean sea level (MSL) i:e 0 mt RL is definitely coinciding with a **TECTONIC INTERFACE** in the same surface surrounding the geode both in the land mass & sea portion which controls and influence a part of tectonic activity on this PLANET. This interface also coincides with the imaginary spherical surface that surrounds the Earth which would have been developed if Earth were a complete sphere with the mean radius would have the actual radius of the Earth.

REFERENCES

- Homes,A. (1964)Principles of physical geology (reprint1972) PP14-35, 845-858
- Mahapatra, M. Evolution of continental crust & oceanic crust, The hydropressure theory of crustal evolution & tectonic plate movement. SGAT Bulletin vol. II No-2, December-2010 pp30-34

**NEW DEVELOPMENTS IN CEMENT MAKING-- EXPERIENCE OF OCL INDIA
OCL CEMENT DIVISION AT A GLANCE**

D.D. Atal
Orissa Cement Ltd., India

ABSTRACT

Syt. Jaidayalji Dalmia has set up a cement plant in Rajgangpur in 1951 to manufacture super grade cement for use in the construction of Hirakud dam. Initiating with a production of 500 TPD capacity of cement in 1957, OCL has installed the 2nd plan to enhance the rate of production as 600 TPD. With the progress of time adopting newer technology, OCL has modernised over 3 decades their plant and machineries to have quality product. The paper highlights on different aspects of the adoption of newer technology by OCL.

The origin of OCL was seeded in the time that signaled India's independence. A dream unleashed. A blue print of growth was drawn. Endeavours to reconstruct economy set in. Indian industry woke up to the key challenge of self-reliance. Agriculture took a turn to modernity with construction of dams across the country.

Against such a bubbling background Syt. Jaidayalji Dalmia, an industrialist of farsighted vision set up a cement plant at Rajgangpur during 1950 - 51 at the request of government of Orissa to manufacture super grade cement for use in the construction of Hirakud dam. The plant that went on steam as Orissa cement limited during 1952 transformed itself into OCL India Limited during 1996 to better reflect its multifarious activities.

From a modest 500 TPD capacity imported single wet process Kiln of FL Smidth make of Denmark, the house of 'Konark' brand cement has journeyed a long way. To cater the growing demand the company enhanced its installed capacity with addition of its second wet process 600 TPD kiln in 1957.

Keeping a steady progress with time and technology, OCL has produced the first clinker through modernized and fully Automated dry process plant in 1988 and further enhanced its installed

capacity by adding its 2nd clinkerization unit in 2009.

In the early fifties OCL has installed four numbers of Ball mills of FL Smidth for cement grinding purpose. Later on, to keep pace with the technological advancement and facilitating manufacture of blended cement, three giant Vertical Roller Mills with combined and separate grinding systems were installed during the period of 1997 to 2005.

To ensure easy availability and timely supply of cement to the customers in the coastal area of Orissa, a split level cement grinding unit Kapilas Cement Works was set up near Cuttack in 2008.

The urge to modernize and continuously upgrade technology has gone beyond the plant and transformed OCL's limestone mines into one of totally mechanized operations from the earlier system of manual mining.

The drive for excellence through continuous technological up-gradation has resulted in many 'Firsts' for OCL. A few of them are, The first auto kiln control system based on fuzzy logic in India, The world's largest cement and slag grinding Vertical Roller Mill LM 46 during 1997, another largest Cement Vertical Roller Mill LM 56

again was first in the world market in 2005 at OCL only.

In 2003 OCL became the first Cement manufacturer in eastern India and one amongst the only four Indian Cement manufacturers who are accorded with the right to use American Petroleum Institutes (API) monogram for its Oil Well grade cement, approved for use in various Oil Well constructions.

The target centric investments in R&D and application specific product development have both enabled OCL to enlarge and include in its product range various grades of Ordinary Portland Cement(OPC) like 43 and 53 grades; 53S Grade cement for use in the manufacture of railway sleepers; Portland Slag Cement (PSC); Fly Ash based Portland Pozzolana Cement (PPC), Sulphate Resisting Portland Cement (SRPC); OIL Well Cement (Class G Type HSR/MSR) and the latest one for the first time in Indian cement market is Masonry Cement specially designed for plastering applications.

For a brief spell OCL also ventured into manufacture of a wide range of cement allied products including spun pipes etc., in early sixties of the last millennium and became a prime source of high strength reinforced spun pipes and pre-stressed concrete poles. It was the first manufacturer of pre-stressed concrete railway sleepers. Decades later, the company still reigns supreme as a supplier of railway sleeper grade cement in India. Industrial Research & Development had always been the backbone of OCL's product supremacy. Apart from harnessing the fruits of in-house research for direct application to product and process development related spheres, OCL regularly commissions the services of Dalmia Institute of Scientific and Industrial Research (DISIR) in carrying out application oriented specific research projects.. This immensely helps OCL to draw upon the knowledge of scientific community as well and use it for

the betterment of both the industry and the consumer to whom the benefits of such research ultimately reach.

A company is primarily known for the products it makes and the services it renders. In the ultimate count it is quality that holds the key.

'Konark' Brand cement of OCL has been extensively used in the construction of the prestigious Hirakud Dam in Orissa and in building some of India's largest roads, bridges and Industrial plants - including the Vidyasagar Setu in Kolkata ,the Gandhi Sagar Bridge in Patna , as well as in the construction of port facilities at Haldia and Paradip. OCL is proud that it was 'Konark' cement, which was exclusively used in essential restoration repairs by Archeological Survey of India in Lord Jagannath Temple at Puri.

To name a few remarkable Projects where Konark Cement has been recently used are Modernisation of TISCO/Jamshedpur plant , 2.2 Million ton Integrated Steel plant of Electro Steel Integrated in Bokaro, Jharkhand , A 3 Million ton Integrated Steel Plant of Jindal Steel and Power at Angul, Orissa.

An all weather new private Port at Dhamara near Bhadrak in Orissa built jointly by TISCO and L&T placed confidence on Konark in using its cement.

A first all concrete road connecting the busiest commercial town of Orissa with its only Port Paradip in underway with all its requirement met from Konark cement

A 3 Million ton integrated steel plant of Bhushan Steel and Power alongwith 500mw of power plant placed its confidence on Konark for its vital installations and used maximum quantity for installation of BF and other systems.

Vedanta Aluminium, Jharsuguda building a world class Aluminium Refinery and a

2400MW IPP is another testimony of the confidence placed in Konark.

Besides these, numerous Large and medium projects of Irrigation, Power, Sponge Iron and Steel have used Konark cement in shaping up their dream which shows the confidence the brand enjoys in the minds of its consumers.

As on date **Konark Brand Cement** enjoys rock solid customer satisfaction across the country and is very popular in the state of Orissa where for the last almost 60 years it is the most demanded premier lead brand. It is a name 'Cemented to Quality'.

People at all levels in OCL are encouraged to be knowledge driven to be at their individual best.

OCL is proud of its dedicated team of people-its employees, its ever-increasing list of satisfied customers, its dealers, its Bankers and Financial Institutions, its representatives and associates who have all immensely contributed to making what OCL is today.

Company maintains the harmonious relations with its approved suppliers & valued customers. A concerted work style is being maintained between the company and long listed customers & suppliers to meet the mutual business objective in pursuit of total quality.

NEW DEVELOPMENTS

Towards Quality

OCL has been modernized over the past three decades with state of art plants and machinery. Cement quality trends have undergone a significant change over this period in terms of the standard specifications, and market quality demand.

Simultaneously the quality has been driven by the consumer preferences, which largely center around high strength cements. The trends in cement quality over

the past decades or so indicate that the quality in terms of high early strength has considerably improved. The fineness of grinding has also increased primarily to improve early strength.

Durability considerations are today central issues with both the producers and consumers. The strength of blended cements has also shown upward trends and resulted in quality upgradation of clinker. There is an upward trend in the C3S contents of clinker in the past decade. Although strength grading has not been introduced in the blended cements, the market cement quality indicates quantitative improvement in terms of strength and other durability indicators.

Towards Energy conservation

Cement market have grown highly competitive over the past two decades. This has resulted OCL in modernization of its Cement plant particularly in terms of cost and quality of the product. Energy being major cost component of cement manufacture, sweeping changes have taken place in use of the energy efficient mills, fans, motors and low pressure drop cyclones. OCL has been continuously striving to adopt best practices for reducing energy consumption in cement manufacturing. The cost of energy input in cement manufacture is gradually increasing over the year which has resulted in a focused approach by the industry to maximize the operational efficiency and improving energy efficiency. Some of the best practice followed by the OCL are

Energy Conservation-Measures & Set up

- ❖ Regular energy audit by experienced engineer and consultants
- ❖ Daily monitoring of electrical & thermal energy through Energy Conservation Committee
- ❖ Use of AC/ D.C. drives for variable speed application

- ❖ Use of capacitor for improving power factor.
- ❖ Use of soft starter and energy efficient lighting.
- ❖ Use of waste heat of Pyro system and D.G. Set for drying and heating process.
- ❖ Leakages arrest at various levels
- ❖ Insulation of ducts to stop heat loss by radiation.
- ❖ Monitoring of idle running of equipments.
- ❖ Audit of Water and Compressed Air

Energy Conservation Projects Implemented in Last Few Years

- ❖ Commissioning three numbers of Cement grinding Vertical roller Mill (CVRM) utilising kiln & cooler waste gases
- ❖ Pyro Upgradation to increase output and reduce specific power consumption
- ❖ Raw Meal VRM Upgradation
- ❖ Use of industrial waste as alternate raw material and fuel
- ❖ Use of waste wood chips, bags, waste paper, waste oil as alternate fuel
- ❖ Improvement in HAG operation
- ❖ Replacement of CVRM-2 outlet duct to reduce pressure drop
- ❖ Retrofit of compressors
- ❖ Energy efficient street lighting system
- ❖ Conversion of analog cards to digital controller in Raw meal VRM ESP T/R set

Case 1- CVRM INSTALLATION FOR GRINDING CEMENT WITH FOLLOWING BENEFITS

- ❖ Higher output rate.
- ❖ Excellent ability to dry wet ingredients for making cement.
- ❖ Low specific wear.
- ❖ Low noise level.
- ❖ Reduction of Specific power consumption for grinding stage

Classifier Upgradation of existing Cement VRMs

- ❖ Classifiers of existing Cement Vertical Roller Mills have been upgraded by modifying louver rings and static flap etc.

Benefits: increase of mill output and reduction of sp power consumption of 1.5 kwh/tonne of grinding of cement.

Case2- PYRO UPGRADATION WITH FOLLOWING BENEFITS

- ❖ Conversion of high pressure cyclones into low pressure cyclones in Preheater.
- ❖ Addition of another string in Preheater with ILC, resulting increased kiln output and reduced sp fuel consumption by 50 kcal/kg of clkr.
- ❖ Use of latest design pyrojet burner for enhanced flame momentum.
- ❖ Cooler upgradation to IKN design as well as cooler plates changed from conventional to Omega plates for better heat recuperation.
- ❖ Upgradation of coal mill
- ❖ Removal of multiclone and installation of ESP at cooler

Coal Mill Upgradation

- ❖ The drying chamber in the coal mill was converted to a grinding chamber. The extra grinding path of 2 metres length could lead in increase in production
- ❖ Now the drying of coal is done outside mill by providing an external drying chamber connected to the mill.
- ❖ Static classifier was replaced with dynamic classifier for control of fineness and thereby improving energy efficiency.
- ❖ Above modifications increased coal mill output from 23 tph to 30 tph. Sp power consumption reduced 2 units/ton of coal.

Cooler ESP Installation

- ❖ Cooler ESP was installed and multiclones after cooler were removed.

Benefits

- ❖ Pressure drop reduction in tune of 40 mmwg.
- ❖ Reduced stack emission

Results of Pyro Upgradation

- ❖ Clinker production increased from 2300 to 2900 tpd on average
- ❖ Specific power consumption reduced by 7 units/ton of clinker
- ❖ Specific fuel consumption reduced from 810 to 760 kcal/kg of clkr.
- ❖ Increased heat availability for cement VRMs.

Case 3: Raw Meal VRM Upgradation

Requirement:

- ❖ To cater the raw meal requirement for pyro process upgradation from 2300 to 2900 tpd, without additional raw mill

Modifications done:

- ❖ Gearbox Upgradation
- ❖ Classifier Upgradation
- ❖ Conversion of 2 fan system into 3 fan system

RVRM-Gearbox Upgradation

- ❖ Changed input shaft with pinion & 1st stage bevel wheel gear.

❖ Benefit:

Increased table rpm from 29.2 to 34.4, which resulted increased production from 140 to 210 tph, without changing installed motor capacity.

RVRM Louver Ring & Integrated Armour Ring Modification

- ❖ Redesigned Louver ring and integrated Armour ring angle of inclination.

Advantages:

- ❖ Better bed formation.
- ❖ More efficient grinding of material.

RVRM- Classifier Upgradation

- ❖ Replaced existing LKS Classifier with a high efficiency cage rotor type classifier called LSKS classifier

Advantages:

- ❖ Increased Production due to less internal re-circulation within the mill.
- ❖ Reduced sp. Power consumption due to reduction in air flow rate and pressure drop.

2 Fan to 3 Fan system

Incorporated 3 fan system in place of 2 fan system

Advantages

- ❖ Only required quantity of gases pass through mill.
- ❖ Easy to control mill operation and to maintain constant under pressure at mill outlet.
- ❖ Lower static pressure at ESP fan inlet.
- ❖ Dust concentration at the ESP inlet reduced and therefore increased efficiency and better dust emission levels.

Case 4; USE OF INDUSTRIAL WASTES

Following are being used as substitute of natural raw material in raw meal for manufacturing clinker:

- ❖ Non Magnetic Char, a waste product of sponge iron
- ❖ Cinder, a waste product from producer gas plant
- ❖ Bottom ash ,a waste from power generation plant

Benefits:

- ❖ Saving precious natural raw material and input cost
- ❖ Waste utilisation to save environment and mother Earth.
- ❖ NMC having some carbon content helps in reduction of fuel consumption.

Case 5: USE OF WASTE MATERIAL

As Alternate Fuel

Waste wood chips, Polyethylene bags, waste paper & oil and cotton waste are being fired at kiln inlet,

Benefits:

- ❖ CV available in fuel helps in equivalent coal saving
- ❖ Reduced CO₂ emissions to save environment

Case 6: IMPROVEMENT IN HAG OPERATION

- ❖ HAG CA/DA fan were damper controlled, which was not much effective in maintaining air to fuel ratio
- ❖ Problem of FLAME OFF in HAG due to above, frequency 3 times a day. Each startup needs about 100 liter fuel

Changes Implemented:

- ❖ Installed AC drive for CA/DA fan motors for use of speed regulation instead of damper control
- ❖ Installed a venturi with DP transmitter after CA fan for online measurement of air flow

- ❖ Implemented auto logic for air to fuel ratio control, with help of AC drive & DP transmitter

Benefits of HAG improvement

- ❖ Air to fuel ratio maintained properly
- ❖ Reduced carbon emissions due to proper burning of coal
- ❖ Reduced interruptions in CVRM-3 operation
- ❖ Flame OFF problem due to improper air ratio solved, saving about 300 liters furnace oil per day
- ❖ Bag house DP range reduced, resulting reduction in Bag Filter fan power

ENERGY CONSERVATION COMMITMENT BY OCL

We strive to conserve energy

For Our Life

For Our Earth

For Our Future

Towards Environmental Protection and Go Green Activities

1. List of environmental safeguard activities taken in and around the surrounding:

- Control of Stack emission through installation of ESPS,BAG FILTERS, and ON LINE MONITORING and CONTROL etc
- Control Fugitive dust emission through COVERED SHEDS for raw materials and belts,DRY FOG and WATER SPRAY,use of VACUUME ROAD SWEEPING MACHINE and SILOS for storage etc
- Control of SO₂ and NO_x gas emission
- Control of noise level by COVERING MACHINERY BUILDINGS
- Management of solid & Hazardous waste
- Installation of ETP and STP
- 100% use of WASTE WATER by RECYCLING.
- Regular planting of TREES.

- Making of HAZARDOUS WASTE FILL-First of its kind in ORISSA by any industry.
- Installation of RAIN WATER HARVESTING systems in plant and colony.
- RECYCLE of colony waste for useful purposes.

2. Initiative to conserve natural resources

- Utilization of minimum quantity of clinker in PSC by maximizing slag consumption.
- Use of flyash from Sponge Iron plant as raw material
- Use of cinder from refractory plant as raw material
- Reduction in power consumption through various techniques
- Installation of rain water harvesting systems in the plant & colony
- Recycling of ETP/STP treated water for machinery cooling and dust suppression.

3. Initiative towards water conservation:

The Company has adopted 'zero' discharge concept. Waste water generated in the plant and colony is treated in the Effluent Treatment Plant (ETP) and Sewage treatment plant(STP) and used for make up water in the existing Cement plant. The quality of effluent water after treatment is being analyzed and reported to the required authorities.

4. Initiatives towards reduction of Green House Gases

Company has adopted various measures to maximize the replacement of clinker by slag without compromising quality to produce Portland Slag Cement thereby reducing the emission of green house gases.

The company is also registered for Carbon credit under CDM (Clean Development Mechanism) Project.

Company is also utilizing Waste hot gases for drying of raw material and slag. Company has designed its new housing complex which fulfils the GOLD RATING criterion

5. New initiatives to reduce GHG:

- Vehicle free day observed on every Saturday of the week in the factory
- Arresting false air leakages in process circuits to save fuel & power
- Insulation of hot air ducts to maintain maximum heat in process circuit for fuel & power reduction
- Installation of VFD drive to reduce power consumption.

6. New initiatives towards Environment:

- Certification of Environment , Occupational Health and safety Management system as per IS/ISO 14001:2004 & IS 18001:2007 by Bureau of Indian Standards
- Installation of Clinker silo for clinker storage.
- Covered shed for raw materials with Stacker & Reclaimer working inside.
- Covered conveyor belts for raw materials transportation.
- Installation of dry fog system.
- Installations of Bag house in Kiln & VRM.
- Installation of on- line Continuous particulate monitoring system in main stacks.
- Using flyash bricks in the construction of new project.
- Deployment of Vacuum Suction Road Sweeping Machine to control fugitive dust on the roads of plants and Colony.
- Celebration of 'World Environment Day' on 5th June by organizing various competitions and massive plantations to create awareness among the people of villages, employees, colony ladies & children

- Concreting the Municipality road just outside the factory to reduce fugitive dust.
- Installation of Weather monitoring system.
- Installation of STP to treat OCL Colony & part of Rajgangpur town sewerage for recovery and reuse of water.
- Water audit and compressed air audit for entire plant & colony by external agency

MILESTONES

- 1949 : Company got incorporated
- 1951 : Cement manufacturing started with a 500 TPD Wet process plant
- 1957 : Commissioning of 2nd 600TPD Wet process plant
- 1988 : Conversion from Wet to Dry process with capacity enhancement to 5.25 Lakh TPA
- 1990 : Cement manufacturing capacity enhanced to 7 Lakh TPA
- 1997 : First in India to install Vertical Roller Mill for cement grinding (CVRM) and enhancing the cement manufacturing capacity to 10 Lakh TPA
- 1998 : Obtained ISO 9002 Certification
- 2001 : Installed 2nd CVRM and enhanced cement manufacturing capacity to 12.75 Lakh TPA
- 2003 : The first Cement manufacturer in eastern India granted with the right to use American Petroleum Institutes (API) monogram for its OIL Well Cement
- 2004 : Expansion & modernization of Clinkerisation plant and enhancing the clinker manufacturing capacity to 12 Lakh TPA
- 2004 : Obtained ISO 9001-2000 Certification
- 2005 : 3rd CVRM installed and cement manufacturing capacity enhanced to 18 Lakh TPA
- 2006 : Cement Manufacturing Capacity enhanced to 20 Lakh TPA through de-bottlenecking
- 2008 : Kapilash Cement Works Commissioned with installed capacity of 9 LTPA

- 2009 : 2nd line Clinkerisation unit commissioned with installed capacity of 17 Lakh TPA
- 2009 : Project activities commenced for Captive Thermal Plant 2 X 27 MW capacity
- 2009 : Bagged National Award for Energy efficiency in Cement Industry from NCCBM
- 2010 : Obtained ISO 9001-2008 Certification
- 2010: Obtained Certification for Environment Management System as per IS/ISO 14001:2004 and Occupational Health and safety Management System as per IS/ISO 18001:2007 from BIS

Glimpses on the Scenario by 2010

- Clinker Manufacturing Capacity: 2.90 Million TPA
- Cement Manufacturing Capacity: 5.35 Million TPA
 - At Rajgangpur : 4.00 Million TPA
 - At Kapilash Cement Works : 1.35 Million TPA

Product Manufactured at OCL Cement and it's advantages

At Rajgangpur cement works we manufacture eight varieties of cement viz OPC 53 grade, OPC 53-S grade, OPC 43 Grade, PSC, PPC (Flyash Based), SRPC, OWC Class G Type HSR and Masonry Cement.

At Kapilash Cement works we manufacture PSC at present

53 & 53-S-grade OPC (IS:12269-1987):

53-grade OPC is a high strength cement. According to the BIS requirements, 53-grade OPC must have a 28-day compressive strength of no less than 53. For certain specialized products, such as pre-stressed concrete and certain pre-cast concrete items requiring high strength, 53-grade OPC is considered useful as it

can produce high- grade concrete at lower cement content levels. We produce 53-grade OPC by exposing the clinker to the grinding process for longer period of time, which results in a higher density and stronger cement.

53-grade OPC is a high strength OPC, and can be used for the following applications:

- Pre-cast concrete items such as paving blocks, tiles and building blocks;
- Pre-stressed concrete components; and Runways, concrete roads and bridges.
- High-rise buildings, Flyovers and Concrete structures where high grade concrete is normally required 53-S grade OPC can be used for the following application
- Manufacturing of Railway sleeper

43-grade OPC (IS-8112:1989): According to the BIS requirements, 43-grade OPC must have a 28-day compressive strength of no less than 43 MPa. 43-grade OPC is commonly used in the following applications:

- General civil engineering construction work including residential, commercial & Industrial buildings
- Roads, Bridges, Flyovers and Irrigation projects
- Pre-cast items such as blocks, tiles and pipes;
- Asbestos products such as sheets and pipes; and
- Non-structural works such as plastering and flooring.

Portland Slag Cement (IS-455:1989) : Portland slag cement is manufactured by intergrinding Portland cement clinker, gypsum and Blast furnace granulated slag. It is also manufactured by blending OPC with ground Granulated Blast furnace slag through mechanical blenders. Portland Slag Cement is commonly used for the following applications

- General civil engineering construction works but mainly preferred for

construction of marine structures and in coastal areas where excessive amount of chloride and sulphate are present. It can also be used for mass concrete works.

Features of Konark PSC

- It has high ultimate strength with higher rate of gain of strength than normal.

OPC available in market.

- Lower water demand
- Lower Shrinkage

With high compressive strength Konark PSC ensures substantial savings in cement consumption.

Portland Pozzolana Cement-Fly ash based (IS:1489 Part-1 – 1991): Portland Pozzolana cement is manufactured by intergrinding Portland cement clinker, gypsum and fly ash a by-product of thermal power plants.

Portland Pozzolana Cement is normally used for the following applications:

- Useful for general construction works and especially suitable for works in aggressive environmental conditions, employed for water retaining structures, marine works, mass concreting such as dams, retaining walls and sewage pipes.

Features of Konark PPC

- It is manufactured with carefully selected particle sizes of pozzolana (Flyash) ideal for denser and more durable concrete.
- It is having low heat of hydration and corresponding resistance to exposure in various environmental chemicals such as salt water. It is particularly suitable for marine and hydraulic construction and other mass concrete

structures. This cement has durability that is equivalent to OPC and can be used most of the application where OPC is used.

Sulphate Resisting Portland Cement (IS-12330:1988): Sulphate resisting portland cement is produced by inter-grinding special quality of cement clinker and gypsum. Sulphate Resisting Portland Cement is normally used for the following applications:

- Used for underground structures in sulphate-salts rich environment, effluent treatment plants, sugar and other chemical industries where civil works are likely to be subjected to sulphate attack which induces stresses in concrete, leading to cracks and disruption. Being a specially formulated cement with lower C3A content SRPC is free from these sulphate attack.

Features of Konark SRPC

- Konark SRPC with low C3A content and higher strength is an ideal cement for laying foundation of a building in any aggressive environment containing sulphate.

Oil Well Cement Class G Type HSR (IS-8229-1986): Oil well cement is produced by inter-grinding special quality of cement clinker with very low C3A prepared in a rotary cement kiln and gypsum. Class G Oil Well Cement is intended for use as a basic well cement for surface 2440m (8000ft.) depth as manufactured or can be used with accelerators and retarders to cover a wide range of well depths and temperature.

Oil Well Cement is used for the following application:

- This product is used by the petroleum industry for cementing the steel casing to the walls of the Oil Wells. The temperature of the wells range from

180° C to 250° C while the pressure varies from 1300 to 2000 kg/cm². This cement is specially formulated so that its slurry remain pumpable at this high temperature and pressure for a required length of time and then harden rapidly.

Masonry Cement (IS-3466-1988): Masonry cement is produced by intimately grinding a mixture of Portland cement clinker with pozzolanic materials or inert materials, and gypsum. It is a special cement for exclusive use in plastering and brick work.

Konark brand masonry cement gives:

- Very smooth and super surface finish of the plasters
- More plastic mortar mix
- Minimum fall of mortar while plastering walls or ceiling
- Least wastage of mortar mix hence cost saving
- Ease of work (trowelling and finishing)
- Leak proof plaster
- Less water consumption for making mix
- More coverage while plastering

MULTI-FACETED APPROACH TO IMPROVE IRON ORE INDUSTRY

Tim Treadgold

NO MINE lasts forever, but imagine you could add one year to the life of Australia's iron ore industry, earning the country a bonus \$56 billion.

No imagination is required with the dollar figure because that, according to the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), will be the value of iron ore exports this financial year, rising to \$63 billion next year.

Where imagination and knowledge become important is in the science of adding years to known ore resources and converting uneconomic deposits into viable mines.

That's the challenge facing a 30-member CSIRO team researching all faces of iron ore, from exploration to processing, at centres in Brisbane, Melbourne, Adelaide and Perth.

Led by CSIRO veteran Dr Ralph Holmes, the team is engaged in a series of projects that share the common aims of:

- making Australia's iron ore industry more competitive
- extending mine life
- converting uneconomic iron ore into commercially viable ore
- boosting Australia's market share in an increasingly competitive business.

In terms of potential 'bang for the buck', the team's current annual budget of \$B million ranks it as one of the most important research efforts in Australia. The fact that industry is providing 65 per cent of the budget underlines the importance placed on the work.

But knowing where to start, in an industry that is undergoing a significant growth

spurt thanks to strong Asian demand for iron ore, is the first challenge.

That is why the team is engaged in a series of projects that start at the exploration phase, incorporate methods of removing impurities from ore (such as phosphorus) and go all the way through no better understanding processing technologies used in making sinter (a blast furnace feedstock), and then to the final stage of accurately measuring the amount of iron in the ore that is shipped to overseas customers.

That final point touches on one of the most common misconceptions about iron ore: it is not uniform. Every mine contains ore of different chemical composition.

"Knowing precisely what you're mining and marketing is a critical step in knowing what's a fair price," Dr Holmes said in a wide-ranging talk with Process, which touched on some of the projects he is overseeing.

"But well before we get to that point we need to know a lot more about Australian iron ores, which have enormous physical and chemical differences.

Traditional high-grade Brockman ores at Mount Whaleback and Mount Tom Price provided the foundation for the Australian iron export industry, while Marra Mamba ores vary from 'curry powder' to high quality lumpy ore at the other end of the spectrum. Channel iron deposits and pisolitic ores provide even greater differences.

"Knowing more about the physical and chemical characteristics of the ores will become more important in the future because we are facing increased competition from the high-grade ores mined in Brazil, and from future developments in West Africa.

"We need to know how to deal with competition, which is why, in the longer term, we're looking at some beneficiation techniques, where we will have to do more processing to remove impurities such as alumina, silica and phosphorus from the ore.

"Right now, with demand strong, the question of impurities might not be a major issue, but in time the market will change and we need to look at ways of getting rid of those impurities to add to the life of working mines and enable new mines to be opened."

The growth spurt underway in iron ore can be seen in the latest numbers from ABARES, which estimate the Australian industry will export 425 million tonnes this year, rising to 599 million tonnes by 2016 - by which time Australia will account for 43 per cent of global iron ore exports, some 163 million tonnes more than our nearest rival, Brazil.

Exploration, however is where the industry starts and that's a good place to start looking at some of the iron ore research projects being undertaken by CSIRO's Minerals Down Under Flagship.

Key Points

- Research underway takes in all points of the value chain
- The aim is to extend the life of existing mine and make lower grade deposits more viable.
- Chemistry is providing important new insights to improve iron ore production.

HyLogging System

This is a scanning device used for rapid mineralogical and chemical analysis of drill core, to speed the exploration and mine development process. It uses continuous visible and infrared spectroscopy and digital imaging to examine drill cores without destroying the

core in the process. HyLogging System" is a laboratory-based tool that takes and stores images of core and scans them for a wide variety of minerals. It is a CSIRO invention and is being used in a number of laboratories.

A measure of the speed at which it works comes from the Western Australian Department of Mines and Petroleum, which used a Hylogging System" at its Joe Lord Core Library in Kalgoorlie to scan 33,000 metres of core in just nine weeks. The Hylogging System can replace time consuming, and subjective core examination, an important job often left to junior geological staff.

Removing Phosphorus

One of the greatest threats to the longevity of Australian iron-ore mining is the high level of phosphorus in some ores. Steel mills will not accept 'high-phos' ores or demand that they be blended with low-phos material as excess phosphorus can make steel brittle.

The CSIRO team is working on a heat treatment and leaching process to remove phosphorus. Earlier research used heat treatment at temperatures of up to 1000°C followed by acid leaching, which was effective but expensive and therefore not pursued. The iron ore ream is now looking at a variety of ways to lower the phosphorus content of ore, including one method that requires heat treatment at less than 300°C followed by an alkali or acid leach, which can also be useful in removing some of the alumina and other impurities. Scale up of the process is currently underway.

Locating phosphorus

A debate continues as to precisely where phosphorus occurs in iron ore. Pinpointing its location within the ore is a vital step in working out a process to remove it. One research project involves the use of electron microscopes to peer into the basic

molecular structure of iron ore. One theory is that the phosphorus occurs in the lattice framework of the ore, while an alternative view is that it might be bound more closely with the iron in some ores.

Differences between ores add to the complexity of the research effort, but success in economically lowering ore from around 0.15 per cent phosphorus to 0.06 per cent would be a major breakthrough.

Flotation

A number of flotation techniques are being used to remove impurities from iron ore, especially kaolinite and other alumina-bearing minerals. While some flotation techniques 'float off the valuable minerals, it is usually the reverse with iron ore, because the iron minerals are much larger in volume and mass than the waste. So-called' reverse flotation is designed to float off impurities that attach themselves to bubbles in the flotation cell.

CSIRO is undertaking a novel bioflotation research project using bacteria to extract impurities. Bacteria and their metabolic products may be able to be used as 'flotation collectors' to remove alumina, silica or even phosphorus.

Refined Sintering

The Australian Synchrotron provides tools that allow researchers to use advanced x-ray techniques for the rapid analysis of mineral samples. It is being used in a study of changes that occur during the production of iron ore sinter a blast furnace feedstock made by heating iron ore fines with coke and fluxes at around 1300°C to 'glue' the fine particles together and produce a strong, but porous lumpy product suitable for reduction to iron metal in the blast furnace.

The aim is to develop a fundamental understanding of what happens in the different phases of the sintering process, and to then move on to possible methods

of improving sinter production. Steel producers have invested heavily in systems to reduce carbon dioxide emissions iron sintering. The CSIRO team is looking at ways of reducing fuel use, and possible alternatives to coke used in the sintering process, such as biomass.

"Some of our research is what you might call 'blue sky'," Dr Holmes says. "The reward, however, for one of Australia's most important industries could be substantial. We're not focusing on one research project, which is often the preferred approach, because there is such a wide range of possible ways to add value to the iron ore industry.

"Work in areas such as bioflotation is quite speculative but the roasting and leaching process for removal of phosphorus is much more focused and advanced. In relation to alumina, physical and magnetic separation techniques can also be effective, but at the moment we're looking more closely at what we can do with flotation."

Dr Holmes says the multiple lines of research could produce benefits across the iron ore exploration and production Process.

"What we're doing is aimed at extending the life of existing mines and helping bring on new deposits that are marginal today," he says. 'As much of Australia's high-grade ore has already been mined, we need to add value to the vast amounts of lower grade material, which will help Australia grow its market share and be more competitive against some of the new, high-grade overseas projects."

Calculating the potential commercial benefit from the work of the iron ore research team is not easy, but even the smallest incremental gain in productivity could be spectacular because of the size of the industry.

A one-per-cent gain for the industry', for example, translates into an additional \$560

million in annual revenue, two per cent is over the \$ 1 billion mark, an eye catching number that says as much about the size of the iron ore industry as it does about the potential prize for the CSIRO research team.

SHIPPING iron ore is easy. Knowing how much iron you have actually shipped is another matter - one that keeps both the exporters and the buyers awake at night because it is the iron content, not the raw tonnage that determines the final price.

Tricky as that might sound, it all comes back to the fact that every iron ore mine is different and most mines also have different grades of iron in the same pit.

In one corner the ore might grade as high as 60 per cent iron, whereas another part of the same ore body might grade 5 per cent. This leads to that critical question: how much iron is actually being sold?

Welcome to the specialised world of measuring the iron content of iron ore. It is the starting point of a process that has been confusing outsiders for decades as they attempt to put a value on a tonne of iron ore.

The problem is that iron ore is sold in 'dry metric tonne units'. A DMTU is one per cent of the iron contained in a tonne of ore, excluding moisture.

Science enters the business in measuring how much iron is being shipped. The conventional measurement system is a messy, wet assay carried out at both the export port and the import port. The buyer and seller compare assays, haggle and finally agree on a price. Some countries prefer this tried-and-true route, and some accept the assay iron the port.

Australia has been leading an effort to modernise the process, opting for an x-ray fluorescence (XRF) measuring technique several years ago under the system of international standards (ISO 9516), which

rapidly measures 20 elements. It provides great accuracy for 19, but not always for the 20th element, the one that counts most - iron.

That's why for more than 20 years researchers at CSIRO have been looking for a better XRF method to accurately measure the iron and one that will eventually become a new internationally accepted standard under the ISO system.

"XRF is a very quick way of measuring ore," says Ms Sally Birch, who is leading the work for CSIRO's Minerals Down Under Flagship. "In a matter of minutes you can make up a sample (in the form of a glass-like bead) and get a very accurate XRF analysis report. The problem is that the iron measure is not regarded as good enough for a reference method (in pricing).

"The problem is caused by iron being the major element in iron ore, and iron being a heavy absorber of x-rays. It is also highly subject to curvature of the glass bead. If the bead is curved in the slightest way it massively affects the iron value."

The technique showing the most promise is to add terbium, a rare earth, to the glass bead as an internal reference to produce a sample that is unaffected by curvature. The original trials used 11 per cent terbium oxide in the sample disk, but that has now been cut to a two per cent mix, which is major cost saving.

The next big challenge is to achieve ISO acceptance, and that is a process which can take several years. "Ms Birch says. "If we can achieve international acceptance we will have made a major improvement in measuring the iron content of iron ore, and will have improved the process of determining how much iron is actually shipped." (Source: Mr. Mahendra Pal, Australia).

PROSPECT OF VANADIUM RECOVERY UNIT WITH MINI STEEL PLANT IN ORISSA

Dr. Ing H.P. Mishra
Ex-Chairman, IPICOL
222/Shastri Nagar, Bhubaneswar

ABSTRACT

Vanadium is proved to be a strategic alloying product. More than 80-85% of its total production is consumed in iron and steel industry. Vanadium bearing titanomagnetite are located in different states like Orissa, Jharkhand, Karnataka and Maharashtra. Having more than 25 million tonnes located in Orissa, the author is of the opinion that a plant can be implemented near Barbil to extract Vanadium and utilise in steel making process.

Key words: Vanadium, Titanomagnetite.

1. INTRODUCTION

Vanadium has proved to be a strategic alloying element in the manufacture of several ferrous and non-ferrous alloys. There has been a marked increase in utilisation of vanadium in recent years, thus providing an added impetus for exploration and mining of vanadium-bearing minerals as well as for the recovery of vanadium metal.

Almost 80-85 per cent of the total production of vanadium is consumed in the iron and steel industry. Therefore, the iron and steel industry is the predominant user of vanadium metal. Vanadium compounds are also used in the chemical industry as catalysts in the manufacture of acids and chemicals as well as for production of paints, varnishes etc. besides, vanadium-aluminium alloys and vanadium-titanium alloys find extensive application for aeronautical and defence use.

2. BACKGROUND

Bulk of the vanadium production is obtained from vanadium-bearing titanomagnetite ores. Vanadium-bearing titanomagnetite ore deposits are located in the state of Orissa, Jharkhand, Karnataka and Maharashtra. The overall potential

reserves such ores are projected to be more than 40 million tons. Of this, over 25 million tons are located in the Mayurbhanj district of Orissa and in the Singhbhum district of Bihar.

Vanadium-bearing titanomagnetite ores have been traditionally processed for extraction of vanadium by smelting in electric furnaces. In the contrast to the conventional practice of electric smelting of vanadium bearing titanomagnetite ores, smelting of such ores in blast furnaces is practiced in China & Russia.

3. TRENDS IN FERRO-VANADIUM PRODUCTION

Vanadium bearing titanomagnetite ores have emerged as the most important resource of vanadium metal. About 80 percent of the world production of vanadium is obtained from titanomagnetite ores.

4. WORLD VANADIUM RESOURCES

The world resources of vanadium metal occurring in association with titaniferous magnetite ores is estimated at around 47 million tons as indicated in Table - 1.

Table – 1: World Resources of Vanadium metal in Titanomagnetite ores

Country	Potential Resources 000 tons V metal
USA	: 20,535 (1)
Canada	: 6,610 (2)
Brazil	: 4,400
Sweden	: 900
Finland	: 90
Yugoslavia	: 28
South Africa	: 7,800
India	: 360
New Zealand	: 270
CIS	: 4080
China	: 1630

Note:

- (1) Includes vanadium present in Clays, shale and phosphate
- (2) Includes vanadium present in tar sands.

It will be seen from Table – 1 that South Africa holds the largest proportion of world resources of vanadium present in titanomagnetites, followed by Brazil, the commonwealth of Independent States – CIS (former Soviet Union) and China. However, the vanadium processing capacity (from titanomagnetites) is concentrated primarily in South Africa, CIS and China. For this Project, a technological offer is available from China.

5. PROJECT CONCEPT

The proposed plant is intended to be set up for utilisation of the vanadium bearing titanomagnetite ores available in the Mayurbhanj district of Orissa for ultimate production of ferro-vanadium and steel billets. The proposed plant is envisaged to be based on technology from China. Processing of vanadium-bearing

titanomagnetite ores for vanadium extraction has been extensively practiced on a commercial scale in China at the Panzhihua Iron and Steel Co. and at the Cherg De Iron & Steel works. At both these plants, smelting of the vanadium-bearing titanomagnetites is carried out in a blast furnace and the vanadium bearing blast furnace hot metal is subjected to various treatment process for recovery of vanadium.

Based on the technology package offered by CMiEC for installation of the proposed plant for production of ferro-vanadium based on utilisation of vanadium-bearing titanomagnetite ores of Orissa, the following major steps emerge:

- a) Smelting of the iron ore in a blast furnace for production of vanadium-bearing hot metal.
- b) Treatment of the vanadium-bearing hot metal in a LD converted for production of semi-steel and vanadium-bearing slag.
- c) Processing of the semi-steel in a second LD converter for production of liquid steel, followed by casting into billets.
- d) Preparation of the vanadium rich slag by grinding followed by magnetic separation.
- e) Roasting of the prepared vanadium rich slag with soda ash and sodium chloride.
- f) Leaching of the roasted product with water.
- g) Treatment of the Leach liquor by sulphuric acid followed by filtration to obtain vanadium pentoxide filters coke.
- h) Melting of vanadium pentoxide cake in a reverberatory furnace for production of vanadium pentoxide flakes.
- i) Production of ferro-vanadium by reduction of the vanadium pentoxide flakes with a mixture of ferro-silicon and aluminium in an electric arc furnace.

6. PLANT CAPACITY

It is proposed to set up a blast furnace of 350 Cu.m. useful volume for smelting of the vanadium bearing titanomagnetite ores. Therefore, the plant capacity based on the technology offered by CMiEC has been evolved taking into consideration installation of a blast furnace of 350 cu.m. useful volume. It is expected that the annual availability of vanadium bearing hot metal from the blast furnace would be about 161,000 tons.

The entire production of vanadium bearing hot metal will normally be subjected to vanadium recovery. However, in case the 2nd LD converter is not available for processing of the semi-steel obtained from 1st LD, the particular heat will be directly converted to liquid steel in the 1st LD converted itself without resorting to vanadium recovery. Treatment of the vanadium bearing hot metal will be carried out by the duplex LD converter process. It is expected that processing of the hot metal in the 1st LD converter will yield about 156,000 tons of semi-steel per year and about 8,300 tons of vanadium rich slag.

The semi steel obtained from the first LD converter will be further refined in the 2nd LD converter into liquid steel. The quality of liquid steel will be suitable for continuous casting into 130 mm sq. Billets. It is expected that the availability of liquid steel from the 2nd LD converter will be around 140,000 tons per year. The corresponding production of CC billets will be about 135,000 tons per year.

The vanadium rich slag will be roasted in the rotary klin. The roasted product will be leached with water. Vanadium in the leach liquor will be precipitated by means of sulphuric acid and recovered in the form of vanadium pentoxide filter cake.

The filter cake will be melted in a reverberatory furnace for production V₂O₅ flakes. The V₂O₅ flakes will be smelted in an electric arc furnace using ferro-silicon and aluminium. The resultant production of ferro-vanadium is expected to be around 830 per year.

The annual production of the major intermediate and final products are summarised in Table – 2.

Table – 2: Stagewise Production Capacities

Product	Annual Production (tons)
(A) Intermediate	
Vanadium bearing hot metal	: 161,000
Semi steel	: 156,000
Vanadium slag	: 8,300
Liquid steel	: 140,000
(B) Fuel Products	
CC billets	: 135,000
Ferro Vanadium	: 830

7. MAJOR RAW MATERIALS

The major raw materials required for operation for the proposed plant will comprise vanadium bearing titanomagnetite ore, hematite ore, metallurgical coke, fluxes and additives such as limestone, dolomite, manganese ore and quartzite, ferro alloys and additives such ferro manganese, ferro silicon, aluminium etc. The estimated annual requirements of major raw materials, their sizes and sources of supply for the proposed plant are given in Table –3.

Table – 3: Annual Requirement of Raw Materials

Raw Materials	Size	Quantity	Source of Supply
Iron Ore:	25 to 10	166,900	Kumarbhubi-Betjharan area in Mayurbhanj district.
Vanadium bearing titanomagnetite ore Hematite ore	25 to 10	199,700	Daitari, Banspani-Barbil area
Coke	40 to 15	116,500	Imported
Limestone			
Iron making grade	25 to 10	68,000	Birmitrapur
Steel making grade	80 to 40	6,400	Sana – Maihar
Dolomite for iron making	25 to 10	14,900	Birmitrapur
Manganese ore	40 to 10	4,200	Banspani-Barajamda area
Quartzite	25 to 10	9,400	Keonjhar Barbil area

8. CONCLUSION

The most suitable location of the unit may be considered at Barbil adjacent to Kalinga Iron Work or at Rairangpur near to vanadium ore deposit. I feel due to favourable market condition the project may be taken up immediately.

➤ **SGAT NEWS**

- **State Level ENVIRONMENT CUM MINERAL AWARENESS PROGRAMME (EMAP) – 2011 (For High School Students) Organised by Society of Geoscientists and Allied Technologists (SGAT), 29-30 January 2011**

RECORD OF PROCEEDINGS

Degradation of environment results from several causes. Mining and mineral based industries is one such. Mining which includes excavation, processing, haulage among others occupies less than 1% of the land area of Odisha. Degradation caused by mining affects:

Land, Forests, Wild Life, Water, Air and Human Settlements

Consequent to worldwide concern for environment, different countries have enacted legislations for protection of environment and sustainable development. In India, the main legislations which govern environment include:

Mines and Minerals (Development and Regulation) Act
Environment Protection Act
Forest Conservation Act

Every mine is required to comply with the provisions of these acts and rules made there under. There has been noticeable improvement in protection of environment by the mining community in recent years owing to pressure by environment activists and legislative compulsions. It is possible to minimize the adverse affects of mining on environment by taking several ameliorative measures and it is being practised.

Against the above background, **Society of Geoscientists and Allied Technologists (SGAT)** has been organising **Environment cum Mineral Awareness Programme**

(EMAP) in the major mining areas of the State for the last 20 years involving students of Higher Secondary Schools, their teachers and parents and through them the community with a view to inculcating a sense of awareness about the need to protect our environment and encourage them to take appropriate ameliorative measures. Another objective of the programme is to highlight the importance of minerals in economic development. As a part of this programme, the students and their teachers are taken round the various mines, processing plants, loading and transportation system and environment protection measures. The winning team from each of the 11 regions participate in the State Level EMAP which is held at Bhubaneswar every year. This year the programme was held on 29-30 January 2011 where 10 school teams took part. They included (1) D.A.V Public School, Pokhariput (2) Jawahar Navodyoya Vidyalay, Hadgarh (3) M.K.C High School, Baripada (4) Saraswati Sishu Vidya Mandir, Gopalpur (5) Daniel Public School, Brajarajnagar (6) Gopabandhu Uchha Vidyalaya Koira (7) Jindal School, Barbil (8) S.A.I.E.R.C, Rajgangpur (9) D.A.V Public School, Kalinga Area, Talcher and (10) V.S. Vidyalaya, Sunabeda.

The State Level EMAP included the following activities.

1. Visits to Plant Resources Centre, Regional Museum of Natural History, Meteorological Station, Pre-Historic Life and Science Park and State Museum
2. Identification of mineral and plant specimen, photographs of places, personalities and natural hazards
3. Written Test
4. Oral Quiz

The various activities were conducted and evaluated by Dr. R.C. Mohanty, Prof. N.K. Mahalik; Shri S.P. Mishra and Shri R.N. Mahapatra of Geomin; Shri T. Mahanta, Shri Kshitish Patnaik and Shri B. Sethi of

Directorate of Geology; Shri Subrat Mishra and Dr. T. Basa of OMC.

An important feature of this year's State Level EMAP was distribution of Mineral Set Boxes to the participating schools.

The Concluding Session of the programme was graced by Prof. M.C. Dash, former VC, Sambalpur University and Chairman, OSPCCB; Dr. V.P. Upadhyay, Director, Ministry of Environment & Forests; Dr. S.C. Sahu, Director, Bhubaneswar Meteorological Centre who along with Dr. R.C. Mohanty, President, SGAT addressed the students and the teachers.

This year's State Level EMAP was sponsored by Rungta Group of Mines.

The other organisations who contributed to the success of the State Level Programme include Rungta Group of Mines, Tata Steel, M/s M.G. Mohanty, M/s S.N. Mohanty, Shri Prabir Kumar Mohapatra, Shri K.C. Pradhan, Shri Srinibas Sahoo among others.

The State Level EMAP was quite a success considering the presence as many as 80 senior level executives representing SGAT Tata Steel, Directorate of Geology, OMC, IMFA Group, Geomin in the concluding session.

M.K.C. High School, Baripada represented by **Tinali Upadhyaya** and **Nilanjan Sahu** emerged the overall best team in the programme. All the participating schools were presented with Mineral Set Boxes and the students were awarded gifts, prizes and jerseys with the emblem "Go Green - SGAT".

The programme was designed and supervised by Shri B.K. Mohanty, Advisor, SGAT.

- **Film on Environment Management in different mines of Odisha**

SGAT in association with EZMA is producing a feature film highlighting the mining activities and the environmental management practice in different mining clusters of Odisha.

- **Visit to TISCO Plant at Jamshedpur and Noamundi Iron Ore Mines on 16-17 April 2011**

Many council members, being invited by TISCO visited TISCO Plant at Jamshedpur on 16 April 2011. Visit to various important places such as the modern Blast Furnace (H), Hot Rolling Mills, Tata Football Academy, Tata Sports Complex, Achieves and Tribal Culture Centre, was organized by TISCO authority.

Members also visited Noamundi Iron Ore Mines of TISCO on 17.04.2011. Mining authorities in the site arranged visit to the active mining sites, reclamation sites and water harvesting sites. Members of SGAT have planted trees in the mining sites. A warm welcome was accorded by the mining fraternity at Noamundi.

16th meeting of the Executive Council was held at Tribal Culture Centre at Jamshedpur on 16 April 2011.

- **Visit to Daitari Iron Ore Mines of OMC**

Members of Executive Council of SGAT have visited Daitari Mining Complex of Orissa Mining Corporation. Visit to the active mining sites, Mineral Processing Plant at hilltop and Ore Handling Plant was organized by the Regional Manager.

17th Council meeting was held at Daitari on 28 May 2011.

• **FORTHCOMING EVENTS OF SGAT**

- ❖ **International Seminar on Mining Legislations (ISML - 2011)**
2-3 December 2011,
Venue: Hotel Crown, Bhubaneswar

Society of Geoscientists and Allied Technologists (SGAT) in association with C-TEMPO; Ministry of Mines, Government of India; Department of Steel and Mines, Government of Odisha; Federation of Indian Mineral Industries; Eastern Zone Mining Association; Mining Engineers' Association of India, is organizing an International Seminar on Mining Legislations on 2-3 December 2011, Bhubaneswar, Odisha, India. The topics of the Seminar are:

- Mineral Concessions, Development and Conservation
- Safety, Health and Welfare
- Protection of Environment, Forest Conservation and Regulatory mechanism
- Impact of Mining Legislations on the growth of Mining industry and Remedial measures

Abstracts not exceeding 300 words shall be submitted on or before 15 July 2011. For details, please contact Dr. S.K. Sarangi, Vice President, SGAT & Convener, 267, Kharavela Nagar, Bhubaneswar – 751 001, Odisha, India, Ph: 91-674-2392080, 2390516, Fax: 91-674-2390687, E-mail: geomin@satyam.net.in, drsk62@yahoo.in, info@sgat.in.

- ❖ **Seminar on Approach and Strategy for Integrated Development of Joda-Barbil-Koira Mining Area, Odisha**
23-24 September 2011,
Venue: EZMA Hall, Barbil, Odisha

A Seminar on Approach and Strategy for Integrated Development of Joda-Barbil-Koira Mining Area, Odisha, sponsored by Essel Mining & Industries Ltd. & Eastern Zone Mining Association is going to be organised by Society of Geoscientists and Allied Technologists (SGAT) in collaboration with Department of Steel and Mines, Government of Odisha; Federation of Indian Mineral Industries; Tata Steel; Mining Engineers' Association of India on 23-24 September 2011 at Barbil, Odisha State, India. The Seminar shall focus on:

- Development Priorities of the region
- Mining Practices
- Infrastructure Development
- Development Priorities, Action Plan, Funding, Implementation Schedule, arrangements and constraints

Abstracts not exceeding 300 words shall be submitted on or before 31 August 2011. For details, please contact Mr. B.K. Mohanty, Advisor, SGAT & Coordinator, Tel: 09437355664, E-mail: bkmohanty@mail.com.

❖ **31st AGM**

Annual General Body Meeting shall be organized on 3 December 2011 at 6.00pm in SGAT Building at ND/12, VIP Area, Nayapalli, Bhubaneswar – 751 015. Members are requested to forward their suggestions/proposals if any to the General Secretary to reach him latest by 30th October 2011.

AWARDS 2011

• SGAT AWARD OF EXCELLENCE – 2011

Nominations are invited for SGAT Award of Excellence – 2011 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 2011.

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 2011.

Place:

Signature

Date:

Full name and address of the
Member/Institution proposing

• **H.H. READ MEMORIAL GOLD MEDAL AWARD – 2011**

Every second year this 'Society' awards a medal to the best worker on granites and granitic rocks on all India basis based on the papers published by him during the last two years.

The papers will be judged by a panelist of senior workers. Papers on granites published in last 2 years should reach to the General Secretary, **Society of Geoscientists and Allied Technologists (SGAT)** at 267, Kharavela Nagar, Bhubaneswar – 751 001 on or before **31st October 2011**.

All the awards shall be conferred during **A.G.M. to be held on 3rd December 2011 at 6.00pm in SGAT Hall.**

➤ **NEW MEMBERS**

1. **Mr. S. K. Pandey**
President (Mineral Resources),
M/s. Vandana Global Limited,
502, Block No. 13,
Ashoka Ratna.
Vidhan Sabha Road,
P.O.: Raipur – 492 007
(Chattisgarh)
3. **Dr. Adibhatla Santharam**
Regional Mining Geologist (Retd.)
307, Dutch House APTS,
Near Park Hotel
Kirlampudi Layout
Visakhapatnam – 530017 307,
Andhra Pradesh

➤ **NEWS ABOUT MEMBERS**

- **Dr. S.K. Sarangi**, Vice President, SGAT is also selected as President Mining Engineers' Association of India for the term 2011-13. During Annual General Body meet of MEAI held in Bhubaneswar on 12th May 2011, he has taken charge as President, MEAI. Hearty congratulations.
- **Dr. Umesh Chandra Jena**, Dy. Director of Mines, Joda has got his Ph.D. in Mining Engineering from CORLINS UNIVERSITY, USA online in the September 2009.

➤ **OTHER NEWS**

• **Turkey leads in Growth for First Quarter Steel Production**

Steel production increased 8.8% in the first quarter globally and by 31% in Turkey

In March, world production of raw steel rose by 7% from 120.9 million tons to 12.3 million tons. Turkey, which increased its production by 24.9% from 2.2 million tons to 2.7 million tons according to production figures for March, was among the top 10 largest producers of steel in the world, and the country to most increase its production among the 15 largest steel producers.

Production of steel in '000 tons.

Sl. No.	Country	2011	2010	% Change
1.	China	59,418	54,521	9.0
2.	Japan	9,092	9,341	-2.7
3.	USA	7,101	7,112	-0.2
4.	India	6,350	5,845	8.6
5.	Russia	6,160	5,735	7.4
6.	South Korea	5,762	5,037	14.4
7.	Germany	4,026	4,022	0.1
8.	Ukraine	3,050	3,057	-0.2
9.	Brazil	3,020	2,829	6.8
10.	Turkey	2,734	2,189	24.9
11.	Italy	2,575	2,371	8.6
12.	Taiwan	1,770	1,569	12.8
13.	Spain	1,621	1,616	0.3
14.	Mexico	1,550	1,479	4.8
15.	France	1,426	1,476	-3.4
	Total	129,343	120,897	7.0

- NASA have found a new mineral namely Wassonite in one of the significant mineral recovered in Antarctica in Dec'69. Wassonite is a mineral formed from only 2 elements i.e. sulphur and titanium possessing a unique crystal structure with has not been observed previously (Source: NASA).

• **China Imports 53.3 Million Tonnes of Iron Ore in MAY**

According to the latest data provided by the General Administration of Customs, China imported 53.3 million tonnes of iron ore in May, increasing 2.7% and 0.79% on a yearly and monthly basis respectively. "In fact, the rebounding has been happening with Indian iron ore fines (Fe63.5%) standing at US\$176/tonne which is already lower than the Q3 contract price." China's steel imports decreased 80,000 tonnes to 1.28 million tonnes and steel exports down 170,000 tonnes or 3.4% YoY to 4.76 million tonnes in May. (Source: Umetal)

• **Vedanta Aluminium To Increase Smelting Capacity At Jharsuguda Plant**

Vedanta Aluminium, a unit of Anil Agarwal led Vedanta Resources, has invested Rs 40,000 crore in its Orissa projects and aims to achieve 3,615 MW of generation capacity at its Jharsuguda power plants by the end of next year. At present, the company is supplying around 400-500 MW of power to the state grid and is using the rest for its own requirements, a senior VAL official said. (Source: Industry 2.0 Newsletter).

• **NMDC to buy 50% stake in Australian phosphate mine**

Indian state-owned mining company, National Minerals Development Corporation (NMDC), has inked an agreement with Minemakers Limited, an Australian-based mining company, to develop the latter's Wonarah Phosphate deposit in the Northern Territory. The Indian company has agreed to pay most of the development costs.

Wonarah is Australia's largest known phosphate deposit. The deal with NMDC is set to bring in the required financial and marketing push to allow the project to be developed to its full potential, an official privy to the discussion said.

Australia releases mine tax draft

AUSTRALIA'S government released draft legislation for its controversial mining profits tax on Friday, keeping the 30% rate.

"These reforms will ensure Australians receive a better return from their non-renewable resources and will help strengthen our economy through increased superannuation, new and better infrastructure, and business tax cuts," Treasurer Wayne Swan said in a statement.

Resource sector opposition over the tax and a A\$20m advertising campaign against it ahead of national elections led in great part to the ousting of former prime minister Kevin Rudd and a minority government for Rudd's successor Julia Gillard.

Private consultations with miners over the past few months helped iron out differences over the tax, which applies only to coal and iron ore, but some key sticking points remain before the bills go to parliament after a second drafting round.

The biggest open issue now involved the valuation of multiple tenements within an area, as their classification as a single or multiple projects will influence tax levels and the value of projects that can be shielded from the tax.

The tax point for underground coal mines is also a sticking point, as the government resisting concessions after Western Australia (WA) state raised royalties, threatening a A\$2bn national budget hole.

The draft said the legislation would account for different commodities by using appropriate pricing arrangements to ensure only the value of the resources extracted was taxed.

Resource Minister Martin Ferguson last month promised the national government would reimburse miners for future state royalties, in exchange for mining tax acceptance, after WA said it would lift gradually lift royalties on iron ore fines by 2014 to 7.5 % from 5.625%, raising A\$2bn.

But BHP and AngloCoal are arguing that mine sites straddling multiple exploration or production permits should be treated as a single project, helping them claim tax breaks.

BHP said in a statement it was committed to working with the government to implement the tax as agreed. (Source: DON).

Important Bird Areas (IBAs)

Important Bird Areas (IBAs) are sites of international significance for the conservation of birds and their habitats at the global, regional and sub-regional level. The selection of IBAs is a particularly effective way of identifying conservation priorities. IBAs are key sites for conservation - small enough to be conserved in their entirety and often already part of a protected area network.

A site is recognised as an IBA only if it meets certain criteria based on the occurrence of key bird species that are vulnerable to global extinction or whose populations are otherwise irreplaceable. An IBA must be amenable to conservation action and management. The IBA criteria which are applicable globally are as follows.

A1: Sites holding globally threatened bird species of global conservation concern.

A2: Sites having restricted range bird species, i.e. bird species with a historic breeding range up to 50,000 sq. km. in the world.

A3: Sites having biomerestricted bird species, i.e. bird species representing the distinct habitat types.

A4: Sites having large congregations of birds.

IBA programme in India

- The Bombay Natural History Society (BNHS) is the Bird Life Partner for India and is responsible for coordinating the IBA programme in the country.
- The programme was launched in 1999 by the BNHS, Bird Life International and is funded by the Royal Society for Protection of Birds (RSPB).
- A network of over 75 organisations and 1000 individuals constitute the Indian Bird Conservation Network (IBCN). The IBCN was a major contributor to the inventory process and helps meet the objectives of the IBA programme at the national, state and local level.
- Of the 466 IBAs identified so far, 191 are Wildlife Sanctuaries, 52 are National Parks, 23 are Tiger Reserves and one is a Conservation Reserve.
- India's IBAs host 75 species of globally threatened birds of which eight are Critically Endangered, 10 are Endangered and 57 are Vulnerable.
- A total of 199 IBAs (almost 43%) are located outside the Protected Area Network (PAN) and have no official protection.

Indian Bird Conservation Network (IBCN)

The IBCN is a network of organisations and individuals promoting conservation of birds and their habitats in India. It was established in 1998 by the BNHS in collaboration with Bird Life International and the RSPB (Bird Life Partner in the UK). Since its establishment in 1998, it has grown to nearly 1,000 members. The mission of the IBCN is

"To promote conservation of birds and their habitats through development of a national network of individuals, organisations and the government."

Aims of the IBCN

- Monitor IBAs and provide information to the IBCN Secretariat through standardised monitoring questionnaires.
- Encourage community involvement in IBA protection through raising conservation awareness among local communities; reporting threats to relevant authorities and implementing conservation actions to address urgent threats.
- Review the management plans of selected protected IBAs, and advise managers on how they can be strengthened with regard to conservation of globally threatened bird species.
- Utilize all available opportunities to participate in the environment decision making process and promote the cause of IBA protection.
- Identify gaps in protection and recommend the incorporation of IBAs into the Protected Area Network where appropriate.
- Promote an understanding of the IBA concept and an appreciation of bird diversity among local stakeholders.

Protection Status of IBAs

Sr. No.	State/U.Ts	IBAs	Wildlife sanctuaries	National Parks	Tiger Reserves	Not Officially Protected
1.	Andaman & Nicobar islands	19	6	4	0	9
2.	Andhra Pradesh	16	11	1	1	3
3.	Arunachal Pradesh	28	9	1	1	17
4.	Assam	46	13	4	1	28
5.	Bihar	11	3	0	1	7
6.	Chhattisgarh	4	3	0	1	0
7.	Delhi	1	1	0	0	0
8.	Goa	4	3	0	0	1
9.	Gujarat	17	6	3	0	8
10.	Haryana	5	2	1	0	2
11.	Himachal Pradesh	27	24	2	0	1
12.	Jammu & Kashmir	21	6	3	0	12
13.	Jharkhand	3	2	0	1	0
14.	Karnataka	37	15	4	2	16
15.	Kerala	24	11	2	1	10
16.	Lakshadweep	1	0	0	0	1
17.	Madhya Pradesh	17	5	1	4	7
18.	Maharashtra	20	8	2	2	8
19.	Manipur	9	5	1	0	3
20.	Meghalaya	8	1	2	0	5
21.	Mizoram	6	2	2	1	1
22.	Nagaland	9	3	1	0	5
23.	Orissa	7	3	2	1	1
24.	Pondicherry	2	0	0	0	2
25.	Punjab	3	1	0	0	2
26.	Rajasthan	24	8	2	2	12
27.	Sikkim	11	6	1	0	4
28.	Tamil Nadu	34	8	4	1	21
29.	Tripura	2	2	0	0	0
30.	Uttar Pradesh	25	16	1	0	8
31.	Uttaranchal	14	5	5	1	3
32.	West Bengal	10	3	3	2	2
33.	Total	466	191	52	23	199

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

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

Submission of manuscript implies that the same is original, unpublished and is not being considered for publication elsewhere. Two copies, complete in all respect (with copies of figures and tables) are required to be submitted. Originals of figures and tables should be enclosed separately. Each manuscript must accompany by a computer diskette (floppy) containing the electronic version of the text. Electronic files of figures, if available, should be submitted in a separate diskette. In each case, the details of software and type of equipment used should be clearly indicated. The copies of manuscripts, strictly in accordance with the instructions to authors given below may be sent to the editor of the bulletin.

Journal Format: A-4 size

Language: English

Manuscripts: Manuscripts should be typed in double spacing with wide margins in one side of A-4 size paper either by electronic typewriter or computer (size 12 point Times New Roman font). The title page should include the title of the paper, name(s) of author(s) and affiliation(s). The title should be as brief as possible. An informative abstract of not more than 500 words to be included in the beginning. Not more than 5 key words are to be listed at the end of the abstract. Text of research papers and review articles should not exceed 4000 words. The short communication is for quick publication and should not exceed 1200 words.

Headings: Different headings should be in the following format.

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

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

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

References :

- (a) References in the text should be with the name of the author(s) followed by the year of publication in parenthesis, i.e. Patnaik (1996); Patnaik & Mishra (2002); Nayak et al. (2001)
- (b) Reference list at the end of the manuscript should be in alphabetical order, in the following format: Sehgal, R.K. and Nanda, A.C.(2002) Palioenvironment and palioecology of the lower and middle Siwalik sub-groups of a part of North-western Himalayas. *Jr. Geol. Soc. Ind*, vol. 59, pp. 517-529
- (c) Articles from the books should follow the format given below: Windley, B.F. and Razakamanana, T. (1996) The Madagascar – India connection in a Gondwana framework. In: Santosh, M. and Yoshida, M. Eds.) *The Archaean and Proterozoic terrains of South India within East Gondwana. Gond. Res. Group Mem. No.3, Field Sci. Publ., OSAKA*, pp. 25-37

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

Submission of manuscript

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

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

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

Reprints: 10 free reprints of each published article will be supplied to the corresponding author. Additional reprints can be ordered through payment at the proof reading stage.



**Visit To Noamundi Iron Ore Mine of TISCO
by Executive Council Members, SGAT**



**Plantation by Executive Council Member of SGAT
at Noamundi Iron Ore Mine of TISCO**

