4.2The Schuppen belt is bounded in the south by the Naga Thrust. There are some interior thrusts also. In its easternmost part it is represented by pre-Tertiary/Cretaceous serpentinzed ophiolite rocks up to and across Indo-Myanmar boundary. This synclinal belt is referred to as Manabhum-Patkoi, Saramati-Arakan syncline (B. Biswas, SVOC) or Axial belt. It is possible that the Assam Schuppen sequence is repeated in the Pegu system of Myanmar. Drilling in Geleki has revealed extension of platform sediments below the Naga Thrust.

5.1 It is the express purpose of this note to examine the stratigraphic status of the Tipams in the Assam platform. The Tipams of Tripura and Cachaar extend into the Schuppen belt of Assam and are exposed over the Naga Thrust. The Surma is a very thick sandstone. Upwards, there is no clear-cut contact with the Tipam sandstone and in the Assam exposures this is totally lost. In the electrologs of Assam wells (Nahorkatia-Moran-Lakwa-Rudrasagar structures) the Surmas are hardly identifiable and the entire post-Barail sandstone sequence can be considered as one unit. AOC Geologists based their stratigraphic grouping on the basis of Heavy Mineral (HM) differences. Outside of Cachaar and Tripura, the Surmas have been distinguished as Laisong-Jenam-Renji units, possibly on fossil evidence. The post-Barail sandstone units (Tipams) are devoid of any marine charactenistic fossils. Palynology cannot also be a safe basis since salting is a distinct possibility (AOC had no palyological lab or specialists to undertake palynological studies). They were for the first time established in ONGC by Messrs. A.K. Ghosh and R.K. Verma (the latter from the B.S. Institute, Lucknow)

5.2 As for HM evidence, question arises whether HM assemblages reflect their provenances. The minor mineral constituents of Shillong gneiss or Mikir granite are biotite and other accessories. These Arcahean rocks have been subjected to at least four periods of emplacement and diastrophism that any assumption as to their specific erosion levels contributing HM assemblages will be far fetched and unrealistic. A way out could be radiometric correlations of the provenance and RM assemblages; this could perhaps be considered by geoscience bodies/researchers.

5.3 On the basis of these considerations, the author argues that Surma-Tipam sedimentation was an isochronal process under same paleogeographic setup. As for their volumetric content, Shillong gneiss and Mikir granite, under the devastating flood conditions and meteorological location of the region, can account for the material balance (sediment budget) of the fill.

6.1 Finally certain observations on the hydrogeology of Assam sedimentary formations' connate waters seem to be relevant. The connate waters of the Barail sediments have salinity of about 5 g/litre, waters of the Tipam sediments have a salinity of less than 3 g/litre. Also pressures in the Assam platform formations are hydrostatics (1 kg cm^{-2}/ 10 m (1 x 10^4 pascals) approximately save for some over-pressured Barail strata in the Lakwa field. Artesian heads, due to inflow from the Schuppen belt are not evident. Oil-water contents are horizontal and no hydrodynamic tilts are noticeable.

7.1 In this article stratigraphic terms such as strata, member, series, group etc. are loosely used in violation of stratigraphic definitions set by Krumbein and Sloss' "Stratigraphy and Sedimentation" or AGI dictionary. The author craves the indulgence of stratigraphic purists.

8.1 The ideas and viewpoints put forward herein need deeper study by specialists in GSI, ONGC and OIL.

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INTERNATIONAL SEMINAR ON COAL SCIENCE AND TECHNOLOGY EMERGING GLOBAL DIMENSIONS (GLOBAL COAL–2005)

Coal, the dominant energy resource presently, will continue to reign as the primary energy resource in the foreseeable future. Global head coal consumption in 2003 was 4,058 million tons against production of 4,037.5 million tons. Coal demand grew about 1 billion tons between 1980 and 2004. Increased demand for energy attracted the attention of coal scientists to develop newer techniques of coal exploration and utilization to fulfill the demand. Fast depletion and acute scarcity of coking/ low-ash coals, needed for steel industries, compelled the scientists/ technologists to use non-coking low rank coals for coke formation and to explore more utilizational prospects of these coals and any other carbonaceous matter that otherwise cannot be used in coking industries.

Switch over from coking to noncoking coals lead to the scientific/technological innovations in various spheres of

coal, viz. beneficiation, carbonization, clean coal technology, mine safety, eco-friendly utilization and many more related issues. Mitigation of environmental damage caused by coal combustion is also of great concern to geoscientists.

Keeping in view the gaps and problems in coal S&T in current scenario, a two-day International Seminar on *Coal Science and Technology– Emerging Global Dimensions (Global Coal-2005)* was jointly organized by Central Fuel Research Institute (CFRI) and Central Mining Research Institute (CMRI), Dhanbad, at New Delhi on April 12-13, 2005.

The seminar was inaugurated by Hon'ble Union Minister of State for Coal and Mines, Dr. Dasari Narayana Rao, in the forenoon of Tuesday, 12th April. He focused the attention of coal scientists and technologists to take up the challenge of developing eco-friendly coal mining and utilization techniques and to fulfill the shortage of good quality coal globally. He also emphasized on training more and more R&D personnel on coal and developing infrastructure in several Institutes of India. Dr. Kalyan Sen, Chairman, Organizing Committee and Director, CFRI, while delivering the Welcome Address, emphasized that in the present international scenario there is an urgent need to develop efficient techniques for coal exploration, mining, characterization, beneficiation, combustion, carbonization and other environmentally friendly utilization techniques.

The inauguration was followed by keynote addresses and scientific paper presentations distributed in six technical sessions, to cover a vide variety of themes on coals— (1) Policy and exploration, (2) Mining and allied technologies, (3) Combustion and gasification, (4) Carbonization and related technologies, (5) Coal beneficiation and characterization, and (6) Environmental issues and others. Around 75 invited and contributed research papers were selected (abstract volume) for oral presentation covering almost entirely the coal S&T in Indian context, and one each from Japan and Poland. Two parallel sessions for oral presentation were organized, with each having invited lectures in the beginning delivered by the eminent speakers. Leading experts and researchers in the respective fields shared their experiences and discussed recent trends and developments. A pre-printed comprehensive 675-page proceedings volume (Singh et al. 2005) containing 60 papers contributed by scientists, technologists and policy makers, was also brought out on this global platform.

Policy and Exploration

Major part of coal (about 80% of coal produced) has a share in power generation and also in environmental pollution. While dealing with the clean coal technology (CCT) as a policy option for energy security, Malati Goel from DST in her address narrated the importance of utilization of CCT, which actually is a generic name used for technology of coal utilization in an environment friendly manner. She also informed about the changing scenario from CCT to zero emission technology (ZET).

Attempting on prospects and perspective of Indian coal industry, Singh VK of Northern Coalfields Ltd. concluded that indigenous coal would be the most stable and economic option for the bulk of Indian energy needs in the foreseeable future. However, the success of indigenous coal industry and its ability to hold the commitment of national energy needs will largely depend on how quickly the government and domestic coal industries respond to the current issues like and above all in evolving national policies for sustainable development. He added that future of domestic coal appears bright and India could poise itself to become a leader in coal based energy production by 2025.

India is a global player in mining and ranks 3rd largest producer of coal and 4th largest producer of iron ore in the world. Role of coal in the country's economy will continue to be vital, as it is the main pillar of energy security. Paper by Trehan (Monnet Ispat Ltd.) synthesized the information on combustion technique and requirements of coal characteristics for manufacture of sponge iron. He elaborated the parameters for selection of proper type of non-coking coals to be considered for sponge making. Subramanyam et al. (CFRI, Bilaspur) presented the geology and seam disposition of Sendurgarh Coalfield highlighting coal resources (of varied quality) and their possible utilization.

Coal is a source as well as reservoir rocks for coal bed methane. While presenting the results of sorption capacity of several Indian coal samples, Singh AK *et al.* (CMRI) observed that methane sorption capacity is highly influenced by the coal type and rank. Based on the study they concluded that some virgin blocks of Jharia, Raniganj and East Bokaro coalfields might be suitable for future production of this alternative clean source of energy. Studied lignites are highly under saturation, which suggest that CBM production from lignite-bearing areas may require an alternative technology.

Mining and Allied Technologies

Ghose (ISM, Dhanbad) while addressing on global coal industry– issues, opportunities and challenges, elaborated on various issues of coal, viz. carbon sequestration, coal liquefaction and challenges for coal industries. The most formidable challenge that controls the global coal industry was said to be the environmental management, including the control and abatement of residuals, which has a price.

Majority of papers contributed in this theme were from CMRI Based on the studies and experiments made in the mining field, Bandyopadhyay et al stressed on the importance of wireless communication system for underground (UG) mines especially for safety purposes He and his associates in another paper provided information on a two-way communication system for enhancing underground mine safety They said that for continuous monitoring of vital parameters—methane, carbon monoxide, air velocity, temperature, etc , environmental monitoring system should be applied Singh R elaborated on the geotechnical problems encountered during the UG extraction of thick and contiguous coal seams and some special mining methods developed at CMRI to overcome these problems Singh SK introduced the promising innovations in rock penetration and rock excavating equipments that have paved way for convenient UG mining even in difficult geo-mining locales

Ghosh and Chakraborty evaluated social externalities in Indian coal mining industry and opined that suitable contemporary theories on externalities and the state of the art techniques for their evaluation may be adopted as the basic principles with necessary alterations from case to case Pingua *et al* attempted studies on the safety characteristics of permitted explosives using high-speed video technique They described the nature of flame characteristics for better understanding of explosion behaviour towards firedamp and coal dust Antoni Kalukiewicz (AGH Univ of S&T, Krakow, Poland) elaborated briefly the course of the machining process using a sharp and blunted tool and the effect of a high-pressure jet support on the course of that process to establish the effectiveness of dust suppression

Combustion and Gasification

Increased environmental problems have led to demand for reduced emissions of CO_2, the main green house gas Reduction in CO_2 emissions form coal fired power plants can be achieved through increased efficiency Technologies used in Japan for high efficiency in power generation in order to reduce the CO_2 emission were shared by Michio Nakajima and Katsuhiro Ota (Mitsubishi Heavy Industries Ltd , Yokohama) Using this technology Japan commits to reduce annual CO_2 emission by 6% until 2010 according to Kyoto Protocol as per their information

The paper by Tokushi Maruta et al (MHIL) dealt with the latest technologies used in coal-fired boilers in Japan, with high reliability and efficiency and low emission and unburnt carbon in fly ash Biswas *et al* provided information about the infrastructure designed, fabricated and installed at CFRI (Dhanbad) for pulverized coal combustion that can provide information on combustion characteristics, carbon burnout, fly ash and bottom ash properties, etc

While discussing the improvement of coal quality by blending, Mandal and Nebhnani (NTPC) experimented blends of different Indian high ash coals and low ash indigenous and imported coals to see the possibility of blending to upgrade quality of Indian high ash non-coking coals Importance of compatibility of individual coal properties (hardness, reactivity and minerals present) in blending were also narrated by them, which otherwise may lead to several problems during coal utilization Studies and observations (at CFRI) on combustion behavior of some Indian power coals (by DSC-TG technique), and on lignite samples (by oxygen chemisorptions) for assessing active surface area and reactivity were discussed by Sarkar et al and Sharma and Saha, respectively

Carbonization and Related Technologies

Dealing with the role of coal in global energy scenario, Mitra (Dankuni Coal Complex) mentioned about of coal fuels and the role of energy after exhaustion of oil reserves He in his address stated that shift of focus from liquid fuel to solid fuel will enable energy scenario to maintain international peace and harmony between different countries He also mentioned that India holds highest per capita coal reserve and hence it is important that coal be developed by giving the highest national importance for its total growth as the major energy supply base in India Address of Das et al (SAIL) elaborated that Steel Authority of India Limited is utilizing low rank–low ash coals as blends to produce cheaper coke without effecting coal quality in view of the shortage and sustained rise in the price of high rank metallurgical coal needed to fulfill company's future plans

Highlighting the production of coke in non-recovery oven from high sulphur low ash– low rank NE coals, Baruah et al (RRL, Jorhat) stated that coke thus produced can be utilized in many industries other than steel sector Singh, P et al informed that successfully utilizing less expensive less or over matured coals for by-product type of oven, CFRI has developed a technique for commercialization of technology for non-recovery type of coke ovens Chakraborty (Durgapur Project Ltd) discussed information on different coals for their utilization in making metallurgical coke through eco-friendly non-recovery coke ovens Bharathi (CFRI) covered economic aspects in coal quality for its utilization in steel plants, and emphasized about the pulverized coal injection (PCI) method, a new approach to coal utilization in steel sector, where coals of all rank and variety can be used

Information on preparation of formed coke, i e tailor

made moulded fuel, with formed coke process from non-caking coals/ coke breeze/ char using a binder was provided by Sengupta et al (CFRI) He also stated that formed coke has all the properties to replace conventional low ash coke used for industrial and metallurgical purposes Gupta (Eco Coke Pvt Ltd , Bangalore) stressed the requirement of process control and automation in non-recovery coke ovens and discussed insight into how the control philosophy is getting evolved Choudhury et al (CFRI) presented the results on six blends made from different combinations of indigenous and imported coals and concluded that petrographic parameters (rank, reactive and V-step distribution) can be utilized to assess the coking propensity of a blend and also the coke quality

Coal Beneficiation and Characterization

Sen (CFRI), speaking on emerging dimensions for utilization of global coals stated that characteristics of Indian coals differ from that of imported, particularly in chemical and petrographic makeup, and hence there is a need for understanding the origin of their differences that helps to decide upon the judicious strategy for optimizing washing of indigenous component of the mixture Highlighting the well-defined steps Sen et al highlighted the significance of large diameter bore-hole samples over the small diameter samples They opined that washability studies carried out on large diameter samples are authentic and reliable in selective beneficiation circuits and mine plan strategy

Dhillon and Saxena introduced the technological innovations made in Jindal Steel and Power Limited to produce quality clean coal They were of opinion that global competition comel industries to come out of the conventional beliefs of the beneficiation practices adopted for washing high ash Indian coals Prakash et al provided information about the fine coal treatment pilot plant installed by CFRI for coal beneficiation studies Mitra et al (CFRI) presented the washability characteristics of non-coking coals from northern coalfields and indicated better scope of utilization of these coals, like in cement and sponge iron industries which require comparatively lower ash coals

In order to reduce SO_2 production during high ash/high sulphur coal combustion, a major air pollutant producing acid rain, information on desulphurization of these coals by biological methods was provided by Acharya et al (RRL, Bhubaneshwar) Considering the importance of biological desulphurization, an important method (cost-effective and eco-friendly) they described the role of micro-organisms in desulphurization of Indian coals Barnwal et al (RRL, Bhopal) while presenting a coal flotation model expressed that the performance of a new coal at any level of variables can be predicted by conducting a single test in a continuous cell and extensive tests in a batch cell

Jha and Nath (CMPDIL, Ranchi) shared constraints in characterization while evaluating the equitability of coals suitable for sponge iron industries Emphasizing the role of sponge iron in steel industries they stated that non-conventional route of steel making in secondary sector is advantageous over conventional primary route, in less capital investment, low project gestation period, non-dependence on coking coals/coke, energy efficiency and protection of environment Suitability of Singrauli field coals for liquefaction and CBM assessment on petrographic data was suggested by Mishra et al (CMPDIL) While evaluating the Turra seam coals of this field Singh BD and Singh A (BSIP) illustrated the existence of good quality coals in the western part of the sub-basin, may possibly be used for blending purpose On the basis of maceral data under fluorescence mode, they further concluded that these coals should be conserved for generation of by-products

Observations on transformations of minerals in Makum coals on heating, in the presence of air at 350°C and 850°C using X-Ray Diffraction (XRD) were shared by Mukherjee and Srivastava (CFRI) Nageswara Rao and Krishnamacharyulu (Hyderabad) threw light on minerals identified and characterized in Godavari valley coals through FTIR and XRD Mukherjee and Mukherjee (CFRI) stated that quantitative analysis using XRD technique (the most utilized and non-destructive method to evaluate proportional mineral phases in a coal) was found to be consistent with chemical analysis of corresponding ashes They used SIROQUANT[TM] software to determine mineral proportions in a mixture in Mahanadi coals Singh KN et al (Ujjain) provided a description of minerals in Korba coals, identified by Performance Scanning Electron Microscope and narrated the importance of mineral studies in lithotypes for characterizing coals for washing industries

Advantage and significance of application of petrographic image analyser (PIA) system in petrographic studies of coals was explained by Mishra et al (CMPDIL) They also informed that data obtained through PIA method and conventional methods were compared to assess efficacy of the former Delegates were informed about a novel technique developed by Bhatia et al (New Delhi) to remove fine quinoline insoluble (QI) particles from coal tar pitch, widely used as a binder They also informed that QI-free coals can be used as an excellent precursor for the production of many new carbon products An attempt to predict the characterization of macerals using artificial neural network techniques by incorporating the proximate and ultimate

analyses of Gondwana coals was made by Khandelwal and Singh (IIT, Bombay)

Environmental and Related Issues

In this session, delegates were benefited by the views presented by authors mainly on environment friendly solution to use fly ash, which creates problems as an air and water pollutant Information on extensive researches carried out by CMRI in association with Fly Ash Mission (New Delhi) to solve the environment friendly disposal of fly ash was provided by Ghosh et al They also informed about the technique developed by them to use fly ash as a filling material for UG mines, stating that ash can be successfully stowed in UG mines According to Kumar and Seetharamu (Bangalore) fly ash can be used as a new material for environment friendly value added products, viz building materials Tripathi *et al* and Srivastava et al of CFRI suggested the use of fly ash in agriculture, forestry and in wastelands, which benefits the crops in several ways They also intimated about the extensive research and development efforts of CFRI in order to tackle the problem of disposing fly ash and mining refuse form open cast mines Verma et al (CFRI) discussed the effect of dry compaction density on final property of fly ash bricks

Airborne atmospheric bio-particulates play a vital role in causing allergic disorders in human beings In information about study of type and population of bio-particulates in a particular industrial environment was provided by Bharati et al (CFRI), with a view that the study can be used as useful tool in treatment and/or preventing the effects of aeroallergens in different individuals While assessing the water quality of mining areas of Dhanbad district, Singh, A K et al (CMRI) emphasized that water is suitable for domestic use with few exceptions They further indicated that the water can be used in irrigation purpose without any hazard Pal et al (CMRI) stressed the need for formulation of re-vegetation strategies in coal mine wasteland areas for improvement in socio-economic conditions of the local people along with pollution attenuation Kumar and Gupta (CMRI) reported the results on the rate of nutrient release by some of planted species on coal overburden dump They found the study useful in understanding the plant establishment and change in the fertility status, which further sustain the other vegetation to come up

Carbon dioxide (CO_2), a well-known green house gas can be secured in natural reservoirs through carbon sequestration, which is an emerging technology to capture and store CO_2 Singh MP (Varanasi) suggested that an assessment of geological conditions in thermal power plant areas is essential for application of geological sequestration of CO_2 Spontaneous combustion in coal mines is a great problem Role of chemical inhibitors, which act as five inhibitors, in preventing and controlling the spontaneous ignition was dealt by Singh RVK et al (CFRI) Singh A K et al (CFRI) discussed abatement of mine fire in the UG coal mines of India, using the existing successful techniques for monitoring the mine fire gases and different fire indices

Panel discussion and valedictory session was organized in the afternoon of 13th April'05 Prominent panelists included Dr Vimal Kumar (TIFAC, DST), Mr Michio Nakjima (MHI, Japan), Dr P G Rao (RRL, CSIR), Dr O P Agarwal (CSIR), Mr R K Sachdev (Former Advisor, Ministry of Coal), Dr Kalyan Sen and Dr A K Singh (CFRI) Speakers discussed the future strategies of the country in coal exploration, exploitation and utilization and emphasized on the need of the hour innovations in coal Science and Technology from a global perspective

The Seminar Global Coal–2005, fulfilled the need for an international platform to disseminate the scientific and technological researches/ innovations in various spheres of coal Seminar also provided a platform for a detailed discussion on global scenario of coal and future planning and challenges However, we still feel that to improve our understanding of the nature, formation (origin), quality (organic composition), grade (rank or maturity) and other physico-chemical properties for the judicious and sustainable utilization of this solid fossil fuel and its associated gas (CBM, CMM, AMM), long-term experimental, analytical and observational investigations (with multidisciplinary approach) using conventional and most modern techniques are imperative

Recommendations

Recommendation committee unanimously suggested the following

- To pay emphasis on developing innovative technologies for exploration and mining the coal including selective mining techniques
- To frame liberal, globally acceptable policy guidelines on coal exploration, import and export, keeping in view the global competition Also to develop joint partnership with global industries
- Establishing and setting up more and more R&D laboratories to impart training to more scientific and technical experts on coal in various coal/other sectors to ensure efficient characterization techniques for specific end uses through sophisticated instruments including coal petrographic set up and image analysis

- Emphasizing the need of beneficiation of non-coking coal through setting more and more number of coal washeries
- Using alternative steel making techniques to use low rank coals, such as ROMELT, HISMELT and COREX processes of steel making to overcome the shortage of coking coal For coke making, non-recovery technique to be popularized
- Innovative techniques as available internationally to be followed for combustion and gasification including underground coal gasification and coal bed methane (CBM) related studies
- To make environmental cautiousness compulsory to all coal handling and using industries and develop sense of using more and more fly ash generated through power plants. To popularize the use of e-business, e-governance and e-auction in coal industry

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THE CHANGING FACE OF MICROPALEONTOLOGY

[We reproduce below for the benefit of our readers the abstract of the special lecture delivered by Prof M S Srinivasan, Professor Emeritus, Banaras Hindu University on 'A Journey through Morphological Micropaleontology to Molecular Micropaleontology" at the XX Indian Colloquium on Micropaleontology and Stratigraphy at Andhra University, Visakahpatnam on 24 10 05 — Editor]

"Micropaleontology has undergone a remarkable change over the past 150 years, a trend that may be expected to continue in the near future The paper gives a brief overview of the changing face of micropaleontology highlighting how it attained a status of a very powerful discipline of Earth Sciences during the last few decades

With the recognition of biostratigraphic utility of microfossils in petroleum exploration, micropaleontology received a new impetus from the early descriptive stage to noticeable and exciting trend in the early part of the 20th century The changes have been primarily in the areas of systematics of smaller benthic foraminifera, biostratigraphy and precision in paleoecology mainly to cater the needs of oil companies This marks the first major milestone – the development of Industrial micropaleontology

A dazzling shift in research efforts in micropaleontology occurred in the seventies and eighties with the advent of intensive scientific ocean drilling programmes and availability of new instrumentation and analytical techniques to study microfossils In addition, efforts to evolve multiple microfossil biostratigraphies and their integration with other fields such as magnetostratigraphy, stable isotopic stratigraphy, carbonate stratigraphy, computer application and more recently with molecular biology opened up multifaceted approach to micropleontological research This was indeed another important milestone in the history of development of micropaleontology This led to a qualitative change in research emphasis in the areas of correlation, paleobiogeography, plankton evolution, paleoclimatology and paved way for new research areas like Paleoceanography and molecular micropaleontology

The present generation of micropleontologists in India, through their strenuous efforts, brought micropaleontology in our country to its present level of excellence It is not only one of the most actively pursued research subjects in the country but also one which has made significant contributions in recent years to the Earth Sciences Of late, microfossils have emerged as a very powerful and reliable tool to trace past variations in monsoon and to characterize Tsunamigenic sediments Thus, the subject of micropaleontology is becoming more and more important branch of Earth System Science for finding solutions to contemporary issues and that its future is indeed very bright"