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Classification and potential utilization of Eocene coals platform basins, Meghalaya, India: a petro-chemical evaluation

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Abstract

The present paper deals with the study of coal from Meghalayan with a view to characterize them in terms of their grade, rank, and type. In light of these parameters, a discussion has been made on their classification and potential utilization. The study reveals that these coals are vitric in type, meta-sub bituminous to hypo-bituminous in rank, and clean coal to ashy in grade. It is suggested that these coals are suitable for gasification and liquefaction.

Introduction

The coal deposits of the Meghalaya are quite far away from the main coal producing belt of the country and located in the state of Meghalaya which lies in the northeastern corner of the India. These coal deposits are described to have formed over platform basins under stable shelf conditions along the periphery of Shillong plateau. Among the several coal occurrences, major coal deposits occur in the Garo Hills and Khasi Hills districts. There are three major coalfields in Meghalaya viz.- Garo Hills (West Darangirri and Siju), Langrin and Mawlong-Shella coalfields (Khasi Hills). Besides, the major coalfields some minor coal deposits also occur in the Khasi and Jaintia Hills district named as Cherrapunji, Laitryngew and Bapung coalfields.

Geology of the area

The coal deposits of Meghalaya occur in the rocks of Jaintia Group (Lakadong sandstone) (Fig.1). The tertiary sedimentation conformably overlies the Cretaceous sequences which are represented by Mahadek and Longpar Formation. Sedimentation of Tertiary rock heralded with the deposition of Therria sandstone. Therria sandstone is overlain by the Sylhet limestone, which is subdivided in several calcareous and arenaceous members. The basal most member of this formation is Lakadong limestone while the top most member is Parang limestone. In the Garo and Khasi Hills, Lakadong sandstone, Umlatdoh limestone and Nurpuh sandstone are grouped together and referred to as Tura sandstone. Lakadong Limestone is grey to greyish brown in colour and contains foraminiferal remains. This is succeeded by Lakodong sandstone which is essentially an arenaceous in nature. This sandstone is overlain by Umlatdoh limestone, which consists of numerous Nummulites. On the basis of foraminifera assemblage Naggapa (1961) and Biswas (1962) assigned a Lower Eocene age to this member. Nurpuh sandstone unit conformably lies on Umlatdoh Limestone. Upper most member of Sylhet limestone is Parang limestone, which attains the thickness of 150m in the Khasi Hills. It also contains a very good amount of foraminiferal assemblages. On the basis of fossil assemblage the Parang Limestone of Khasi Hills is equivalent to Siju limestone of Western Khasi and Garo Hills. Sylhet limestone succeeded by Kopili Formation, which shows a variable thickness of splintery shale, fine grained sandstone, pyritous shale and ferruginous clay. In the Garo Hills, Simsong Formation conformably overlies the Kopili Formation and consist of current bedded sandstone intercalated with shale. This unit has been assigned an Oligocene age and is regarded to be the equivalent of Barail group of Assam (Acharya & Ghosh, 1968).

In the present study, an effort has been made to carry out a detailed petrographic and geochemical study of a large number of samples from all the coal seams measuring 1metre or more in thickness and exposed in major and minor coalfields of Meghalya and an attempt has been made to characterize these coals in terms of their grade, rank and type. In addition, the potential utilization of Meghalayan coals has been discussed based on the petrological and geochemical characteristics of these coals.

Method of Study

During the present investigation, pillar coal samples have been collected from working and exposed coal seam sections of Meghalaya. The analytical techniques comprise proximate and ultimate analysis, Rock-Eval pyrolysis, quantitative maceral analysis (both under white incident light, as well as under blue irradiation), and microlithotype analysis and vitrinite reflectance measurements. The proximate and ultimate analyses have been carried out according to ISI specifications (Indian Standard, 1970, 1974, 1975).The maceral analysis has been carried out by an advanced petrological microscope equipped with flurometry and reflectometry system. Microscopic studies of these coals have been done as per the recommendation of ICCP (1971, 1975, 1998 and 2001).

Results and Discussion

In general, the coals of Meghalaya are coarsely to the non-banded in nature. The occurrence of cleat is a common feature observed in these coals, especially in the coals of Siju Coalfield. Pyrite is a dominant mineral and occurs as blebs, nodules, veins and specks. For the Megascopic characterization of these coals, scheme of attrital coal has been used (Schopf, 1960)

The coals of Meghalaya constitute macerals of vitrinite, liptinite and inertinite groups. To bring precision to the quantitative evaluation of liptinite macerals, the examination was carried out in both incident white light as well as in blue irradiation. This made it possible to identify dark vitrinite and unstructured liptinite macerals such as bituminite, fluorinite, exsudatinite along with structured alginites. The petrographic study reveals that the coals of Meghalaya are exceedingly rich in vitrinite. All the subgroups and macerals of this group have been recorded in Meghalayan coals. Liptinite macerals occurs in significant amount and represented by sporinite, cutinite, resinite, suberinite, alginite and liptodetrinite, bituminite, fluorinite and exsudatinite. Bituminite occurs in amorphous as well as lamellar forms. It is considered to be the decompositional product of algae, animal plankton and bacteria. Fluorinite is rare in coals of Meghalaya. It occurs as thin to thick black coloured elongated or lensoid bodies. Exsudatinite occurs in very good concentration and produced by sweating of lipid rich liptinites and vitrinite during coalification at the sub-bituminous to bituminous coal rank boundary. It has been described to be a product indicating the onset of the bituminization process related closely to the genesis of liquid hydrocarbon. The good concentration of resinite and other liptinites maceral indicates that these coals can be act as a source of hydrocarbon. In the coals of Meghalaya, inertinites occur in very small concentrations. All the macerals of this group have been observed in the Megahalayan coals. Mean reflectance values of Meghalayan coal ranges between 0.37 and 0.69%. These reflectance values rank Meghalaya coals as sub-bituminous 'C' to high volatile bituminous 'C' (Fig. 2).

The Rock-Eval technique provide, vital information about the quantity, type and thermal maturity of organic Matter, source rock potential and degree of maturation based on the quantitative occurrence of various fractions of volatile and nonvolatile organic compounds. Elemental analysis has also been carried out for the characterization of kerogen type.

The study reveals that these coal as 'Sub-bituminous 'B' to 'C' in rank (as per ASTM classification), vitric in type and clean to ashy in grade as per the Alpern (1987) and Falcon (1989) classification schemes. However, 'some coal seam sections, due lo abnormal volatile content caused by liptinite enrichment show lignitous rank. The reflectance values of coals of Meghalaya indicate the onset of 'oil window' suggesting possibility of expulsion of oil and condensates. The H/C and O/C ratios are suggestive of these coals to be kerogen type III. However, the atomic H/C ratio and the results of Rock Evol pyrolysis (Hydrogen Index, HI) are the indicative of their suitability for the liquefaction and gasification process (Fig.3). Besides, most of the coal deposits being rich in vitrinite, low

in ash can produce good coke or at least it can be used as blend for the production of metallurgical coke. The high sulfur is the main hurdle for the utilization these coals in metallurgical and combustion processes.

Conclusions

On the basis of detailed organic petrological and chemical analysis, the following conclusions have been derived with regard to the classification and potential utilization of Meghalayan coals.

- The rank of Meghalayan coals, on the basis of volatile matter (d a f) and reflectance (Rom), according to the West German (DIN) and North American (ASTM) system of classification, ranges from sub-bituminous B to sub-bituminous C.

- The elemental composition and atomic H/C ratios suggest the suitability of these coals for liquefaction and gasification process.

- The highly reactive component and low ash constituent indicate that these coals can be used in the production of metallurgical coke but sulfur is a major restricting factor.

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