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# Evaluation of Coalbed Methane potential of the Eastern part of North Karanpura CBM Block, Jharkhand, India

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***Summary***

*Selected Barakar coal samples collected from coreholes/wells of eastern part of North Karanpura CBM Block were analysed for integrated laboratory studies to find out coalbed methane prospectivity of the area. Five Barakar coal seams occur regionally with thickness in the range 1-22m with cumulative thickness up to 70m. The coals have low to moderate moisture and ash content. Volatile matter decreases with increasing depth, but there is no relationship between ash content and depth. The vitrinite reflectance (VRo) found in the range of 0.65-1.22% indicates high-volatile-C- bituminous to medium-volatile-bituminous rank coals.*

*Vitrinite is the dominant coal maceral 46-65% (vol. vmmf), with inertinite and liptinite in the range of 23-41% (vol. vmmf) and 2-33% (vol. vmmf) respectively. The gas content of the seams on daf basis range from 3-12cc/g. The shallow seams have relatively higher gas content than the deeper seams. Methane adsorption isotherms reveal gas saturation of 62-75%. Deeper coals have relatively low degree of gas saturation. Desorbed gas samples show the predominance of methane (56.9-91.4 vol %) with low concentration of ethane and propane and methan isotopic composition values of -40.8 to -51.0‰ indicate thermogenic gases. Present investigations reveal that coal seams of eastern part of the block are most prospective for commercial development of coalbed methane.*

***Keyword****: Gondwana, coalbed methane, gas content, volatile matter, maceral, vitrnite, adsorption isotherm, carbon isotope, dry, ash-free (daf)*

## Introduction

The North Karanpura Coalfield (Fig.-1) is the western-most member of the Damodar Valley Coalfields. Two CBM blocks viz., North Karanpura and North Karanpura (West) comprise North Karanpura coalfield. The horse-shoe shaped North Karanpura CBM Block falls in the district of Hazaribagh and Chatra of Jharkhand state. The North Karanpura block encompasses an area of 340 sq. km with envisaged CBM resources of ~62BCM (DGH Presentation).

## 2.0 General Geology and Stratigraphy

The North Karanpura basin is bounded by the Archean metamorphics of Ranchi plateau in the south and is delimited in the north by the shield of Hazaribagh plateau. The basin exhibits complete succession of Gondwana sediments starting from the Karharbari to Mahadeva formations, of which Raniganj, Barakar and Karharbari formations are coal bearing (Fig.-2). The Mahadeva Formation occurs in the isolated hillocks in the central, western and south-western part of the basin. Talchir formation is quite thin and occurs in a discontinuous manner mostly along the fringe of the coalfield. Barakar Fomation, which is the chief contributor of coal in the area, is exposed in about 45% of the basinal area. Five regional coal seams (Seam-I to -V) with a cumulative thickness in the range of 20-70m are reported from this formation. Maximum thickness of coal seams is developed in the eastern sector.

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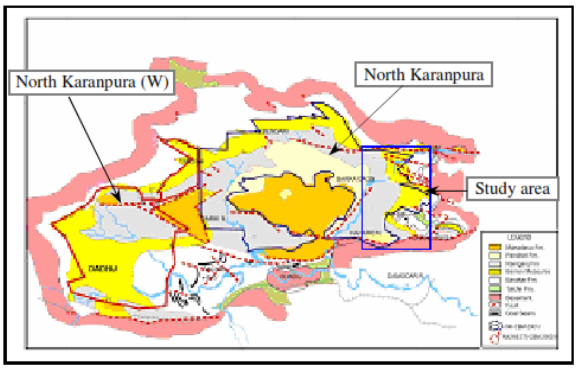


Fig.-1: Geological map of North Karanpura Coalfield showing North Karanpura and North Karanpura(W) CBM Blocks

## 3.0 Experimental

**3.1 Proximate analysis:** BIS Standard 1350 (Part-1), 1984 was followed for the determination of moisture, ash, volatile matter and fixed carbon present in the sample.

**3.2 Gas Content Measurement in fields:** Gas content measurements in the core hole / well sites were performed following modified USBM Direct Method. Gas content is reported at NTP conditions in units of cc/g.

**3.3 Adsorption Isotherm Measurement**: Adsorption isotherm test is used to determine the gas storage capacity of a coal at reservoir temperature and pressure. Adsorption isotherm measurements of the samples were carried in the CSIR laboratory of Central Institute of Mining and Fuel Research (CIMFR), Dhanbad.

**3.4 Petrography and Elemental Compositional analysis**: The results of petrographic and elemental compositional analysis of the coal samples were obtained from CSIR laboratory, Central Institute of Mining and Fuel Research, Dhanbad.

**3.5 Gas Composition Analysis**: Molecular gas compositional analysis was carried out following Standards ASTM D 1945. The gas samples thus collected at different time intervals were analyzed for molecular compositions on Chemito GC, Model 8610 by using modified Fisher Thermal Conductivity Detector at 400C. The molecular concentrations are reported as percentages on air free basis.

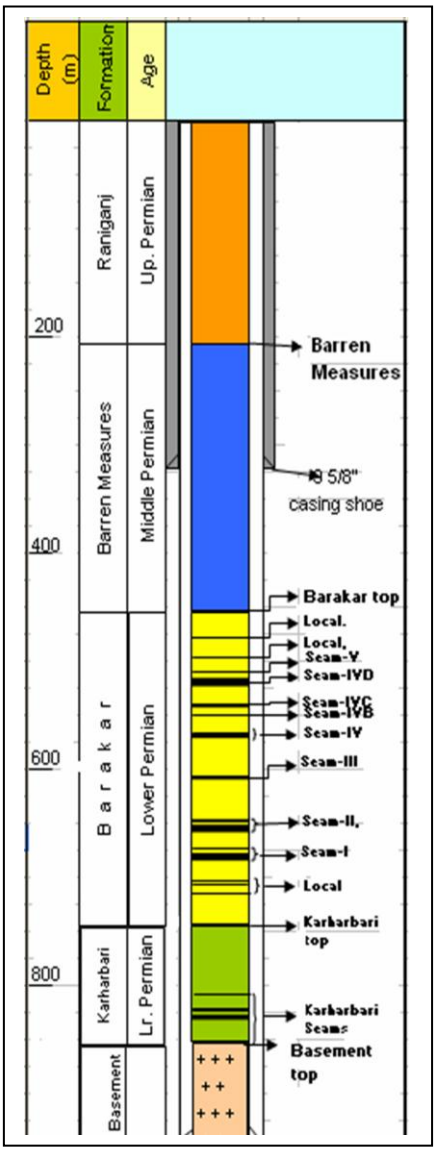


Fig.-2: Lithostratigraphic column of a Pilot well of North Karanpura

## 4.0 Results and Discussion

One exploratory well and five pilot wells have been drilled in the eastern part of the block to explore the CBM potential of Barakar (Lower Permian) coals. Laboratory investigations on recovered coal cores of North Karanpura were carried out to assess the coalbed methane potential of coal seams.

## Proximate data

Proximate analysis data are shown in (Table-1). The results of standard ASTM quality analyses of the Barakar Formation coals indicate wide range in variation (Table-1). Moisture content values determined on air-dried basis are in the range of 0.4-4.4 wt.%, decreasing with depth of seam burial. Volatile matter on dry, ash-free basis varies from 27.9-49.8 wt.%. Ash content varies from a low of 14.0 wt.% to high of 43.9 wt.% and there is no relationship with ash content and depth. The wide range of ash content indicate the variability of mineral matter content and this could be the result of intense organic matter degradation which would concentrate the inorganic fraction (Davis et al, 2007).

## Coal Petrography

The macearal composition of coal seams studied reveal vitrinite, inertinite and liptinite group of macerals in the range of 32.0-88.2% vol., 7.0-60.9% vol. and 0.3-27.1% vol. respectively on visible mineral matter-free basis. The coal samples at shallow depth are rich in vitrinite but with increasing burial depth, the vitrinite maceral group decreases with increase in inertinite content. The wide range of variation of maceral compositions from top to bottom seams indicates oxidation, subsidence and biological, chemical and mechanical disaggration of original vegetation in the depositional environment. The measured vitrinite reflectance (%VRo) values, which is more reliable maturity indicator, has been found in the range of 0.68-1.22% (Fig.-3), and as inferred from dry ash-free volatile matter values, indicate high-volatile-B-bituminous to medium-volatile- bituminous rank coals. Based on Hydrogen and Oxygen indices the organic matter of studied samples is inferred to be dominantly Type-III, which is expected to generate gaseous hydrocarbons only.

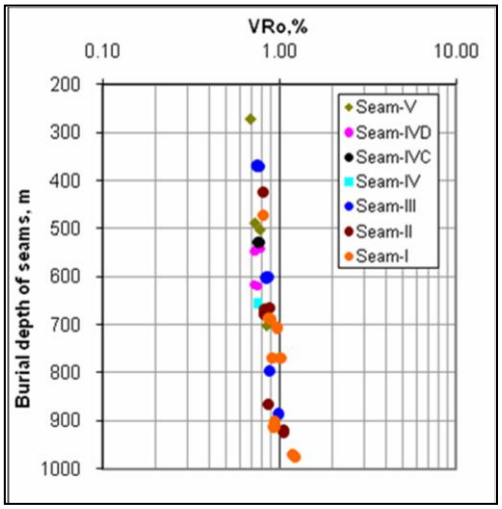


Fig.-3: Variation of vitrinite reflectance with burial depth

## Gas content of coal seams

The coalbed gas content is influenced by rank dependent properties such as moisture content, permeability and porosity and also by geology and hydrology property such as mineral matter content, reservoir temperature and in situ stress (Laxminarayana and Crossdale, 2002). The subsurface coal samples of North Karanpura Block have relatively high vitrinite at shallow depths. Liptinite and inertinite relatively increases with depth and the maturity of coal is in the range of 0.68-1.22% (%VRo). Gas content on dry, ash free basis of shallow seams (seam-V to -IV including intermediate minor seams) varies from 1.3-11.9 cc/gm, in which the vitrinite content is more than 50% by volume. In the deeper seams (seam-II & -I) inertinite content is higher with decrease in vitrinite content and dry, ash free gas content varies from 3.2 -8.8 cc/gm (Fig.-4). Vitrinite reflectance values are relatively more in deeper seams. The gas content in deeper seams is relatively low due to causes of various possibilities of gas leakage from reservoir, generation of non hydrocarbons during maturation and increase in the temperature of the reservoir.

## Adsorption Isotherm data

The adsorption capacity is estimated from the isotherm at the appropriate hydrostatic pressure to the reservoir depths. The coals from the shallow depths are on an average 46-75% saturated with gas with respect to adsorption isotherm

(Fig.-5), whereas coals from deeper seams are comparatively less saturated. These indicate that the gases from the seams at deeper depths have migrated through faults/fractures.

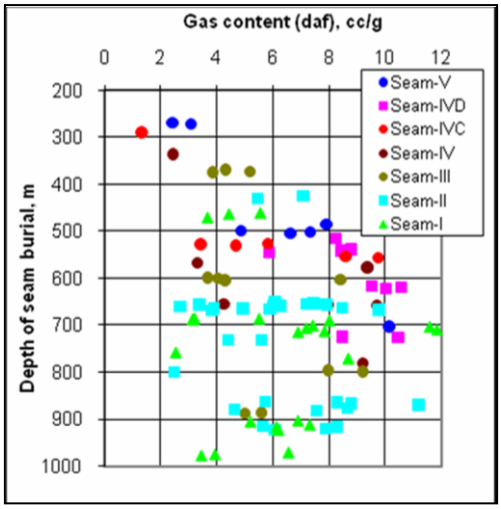


Fig.-4: Variation of gas content with depth of burial

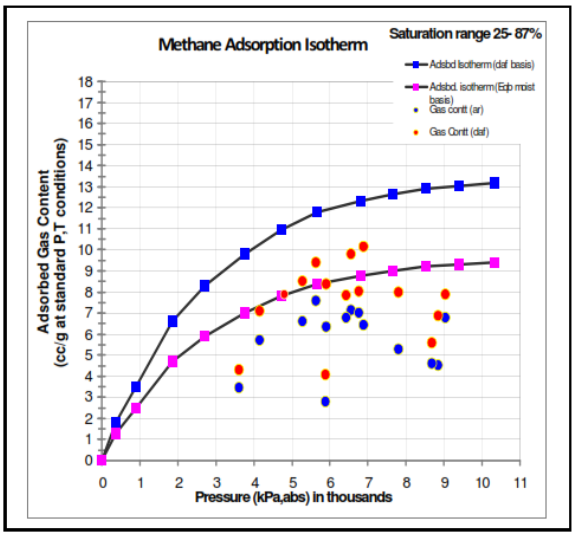


Fig.-5: Methane Adsorption Isotherm of samples from wells of eastern part of North Karanpura CBM Block

## Gas Compositional & Methane Isotopic data

The composition of desorbed gas samples indicate that the methane concentration is as high as 91.4% (air-free basis) with higher hydrocarbon components ($C_2$+) constituting up to 27%. Average concentrations of carbon dioxide and nitrogen are in the range of 11.5% and 14.8% respectively.

Carbon isotopic analyses of $\delta^{13}C_1$ vary from -48.8 to -51.0‰ indicate that the desorbed gases are thermogenic in nature. Based on the above observations it can be inferred that the coal seams in the eastern part of North Karanpura Block at shallow depths are more prospective as compared to deeper seams.

## 5.0 Conclusions

The coals of North Karanpura CBM Block have generally low to moderate moisture content which decreases with burial depth. Ash yield and volatile matter content have no relationship with depth. The shallow seams are generally rich in vitrinite content which decreases with depth with vice- versa in inertinite content. The vitrinite reflectance (VRo%) values of these seams vary from 0.68-1.22% which indicate that the rank of coals are in the range of high-volatile bituminous-B to medium-volatile-bituminous. The desorbed gas contents of shallow depth coals are relatively higher than those of deeper depths. The shallow depth coals are also relatively more saturated with gas as compared to deeper coals. The desorbed gas is rich in methane and Carbon isotopic values indicate that these gases are thermogenic in origin. Based on the above geochemical analyses, the shallow seams (Seam-V and -IV) of the eastern part of North Karanpura Block are inferred to be most prospective for coalbed methane.

## 6.0 Acknowledgements

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Table-1: Geochemical parameters of coal samples of wells of the studied area North Karanpura

| Sl. No. | Seam | Gas cont. daf | | Moisture | | Ash | | Volatile matter, daf | | Maceral composition, vmmf, %vol. | | | | | | VRo | | Saturation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (cc/g) | | % wt. | | % wt. | | % wt. | | Vitrinite | | Inertinite | | Liptinite | | % vol. | | % | |
| | | min. | max. | min. | max. | min. | max. | min. | max. | min. | max. | min. | max. | min. | max. | min. | max. | min. | max. |
| 1 | V | 2.8 | 11.9 | 1.6 | 4.4 | 26.1 | 40.8 | 34.6 | 46.8 | 57.7 | 83.8 | 9.8 | 29.4 | 4.3 | 16.9 | 0.68 | 0.84 | 34 | 79 |
| 2 | IVD | 7.7 | 10.0 | 1.1 | 3.1 | 14.0 | 40.8 | 35.4 | 39.0 | 51.9 | 88.2 | 7.0 | 42.1 | 1.8 | 7.5 | 0.72 | 0.78 | 64 | 84 |
| 3 | IVC | 1.3 | 9.2 | 1.4 | 2.3 | 15.9 | 34.5 | 32.9 | 38.9 | 44.6 | 83.1 | 11.7 | 36.4 | 4.7 | 18.0 | 0.76 | 0.76 | 26 | 51 |
| 4 | IV | 2.4 | 9.4 | 1.1 | 3.2 | 22.0 | 43.9 | 28.7 | 40.4 | 32.0 | 80.0 | 15.2 | 59.9 | 3.0 | 8.2 | 0.76 | 0.76 | 58 | 87 |
| 5 | III | 3.9 | 8.6 | 0.9 | 1.7 | 22.7 | 32 | 31.3 | 37.7 | 46.6 | 75.6 | 18.9 | 43.8 | 4.6 | 11.5 | 0.75 | 0.99 | 33 | 65 |
| 6 | II | 3.8 | 7.8 | 0.4 | 1.4 | 17.0 | 34 | 27.9 | 44.5 | 40.6 | 81.1 | 13.6 | 49.1 | 0.3 | 15.2 | 0.81 | 1.06 | 41 | 71 |
| 7 | I | 3.2 | 8.8 | 0.4 | 1.6 | 20.8 | 42.2 | 29.5 | 49.8 | 35.0 | 77.4 | 15.5 | 60.9 | 0.3 | 27.1 | 0.81 | 1.22 | 25 | 65 |

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