

Ecological Marks for Coalbed Methane Gas (CBM) Reservoir at Damodar River Basin

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ABSTRACT: Coalbed methane is formed by geological or biological process in coal seams, which offers significant environmental benefits over other fossil fuel. Ecosystem/biological study is more susceptible to exploration for CBM/Natural gases reservoir but there are few studies that have been conducted on the environmental impacts of this type of resource extraction. The present paper discussed about the prospect of CBM reservoir on the basis of ecological marks. In this regard two distinguish field chosen are CBM producing area and non-mining/CBM area. Samples of Soil, Water and Coal have been collected for analysis and resulted parameters correlated with each other to understand coalification area and probability of existing CBM reservoir on the basis of ecological substances.

KEYWORDS: CBM, Environment, Energy, Soil, Water, Coal, Greenhouse gas.

I. INTRODUCTION

Coalbed methane is a type of coalbed natural gas (CBNG) because it is discovered in coal seams and having mainly composition of Methane (CH₄). It burns more cleanly than any other fossil fuel. This significant energy source has been converted from a centuries-old mining hazard into an environmentally friendly fuel extracted from coal seams and coals have been being characterized as lignite, sub bituminous, bituminous and anthracite [1]. The process of conversion of organic matter to coal generates methane. The amount of methane depends upon the quality and depth i.e. the higher the energy values of coal and deeper the coal beds the greater the volume of gas. Depletion of conventional resources and increasing demand for clean energy forces India to hunt for alternatives to conventional energy resources. Intense importance has been given for finding out more and more energy resources specifically non-conventional ones like CBM, shale gas & gas hydrates as gas is less polluting compared to oil or coal. CBM exposed to atmosphere adds greenhouse gas (GHG) causing global warming. India is one of the select countries which have undertaken steps through a transparent policy to harness domestic CBM resources. In Jharkhand CBM exploration is in high pick due to huge Coal reserve in Jharkhand especially in Jharia block. Ecosystem/biological study is more susceptible to exploration but there are few studies that have been conducted on the environmental impacts of this type of resource extraction. Coalbed methane (CBM) is a natural gas formed by geological or biological process in coal seams. The combined study of CBM reservoir and one control sites significantly analyze parameters of Soil, Water and native vegetation may marks to identify for Coalbed methane Reservoir. In order to meet the energy resources ecological study need to find out the natural gas reservoir which may facilitate the establishment of non-native plants. Future research and management decisions should consider the accumulative landscape-scale effects of CBM development on preserving native plant diversity.

1.1 Formation of CBM

Coalbed Methane is created during coalification the process which converts plant material into coal over millions of years by degradation of material thermally or biologically [5]. CBM is stored within the molecular structure of the

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Coal; some is stored in the fractures or cleats of the coal or dissolved in the water trapped in the fractures [6]. Methane attaches to the surface areas of coal and throughout fractures and is held in place by water pressure. Formation of sedimentary rock (coalbed) at high pressure and temperature 120 – 150° C. Biodegradation of Coal to Methane mechanism can be seen in figure 4. Within coal beds the organic compound degrading bacteria likely provide methanogens the necessary substrates, e.g., acetate, CO₂ and H₂, to produce methane (Strapoć et al., 2011).

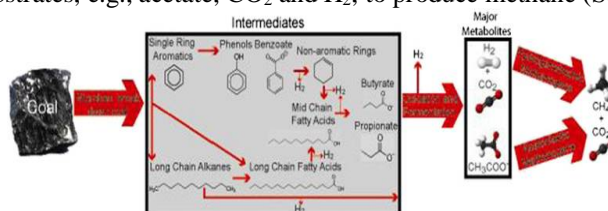


Fig.4 Step for biodegradation of Coal to Methane (Jones et al., 2010)

II. CBM SCENARIO

2.1 Global Activity

The Government of India has received overwhelming responses from prospective producers with several big players starting operations on exploration and development of CBM in India and set to become the fourth after US, Australia and China in terms of exploration and production of coalbed methane [3, 4]. CBM major activity worldwide enlisted in figure no.1. Major CBM reserves (dark grey) are found in Russia, the USA (Alaska alone has an estimated 1,037 Tcf), China, Australia, Canada, the UK, India, Ukraine and Kazakhstan of the 69 countries with the majority of coal reserves, 61% have recorded some form of CBM activity- investigation, testing or production. (US DOE, reference, and BP Statistical Review, [4])



Fig.1 CBM reservoir and global activity

2.2 Indian Activity

In India according to Geological Survey of India (GSI) for formulation of strategy for CBM search and production the first series of information docket and data packages in respect of certain selected coalfields like Raniganj, Jharia, East-Bokaro, West-Bokaro, Sohagpur, North-Karanpura and Birbhum were prepared during 1997-98. The total Gondwana basinal area as per Geological Survey of India (GSI) is 52246 sq. km. However the prognosticated potential coal bearing area is 19262 sq. km. out of which 13968 sq. km. Central Mine Planning and Design Institute (CMPDI) a subsidiary of Coal India Limited (CIL) has been engaged in the identification and subsequent preparation of data dossiers for most of the CBM blocks allotted to different operators. Besides this CMPDI is also generating CBM specific data from boreholes being drilled under Promotional Regional Exploration (PRE) scheme of Government of India period (2002-07).

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Fig.2 Coal and CBM reservoir in Indian state and working company

India having the fourth largest proven coal reserves in the world holds significant prospects for exploitation of CBM. However no assessment about total prognosticated CBM resources in the country including CIL mining lease areas is available. The MoPNG in consultation with Ministry of Coal and CMPDI has identified 26000 sq km of area for CBM operation. Total estimated CBM Resources in this identified area is about 2600 BCM (91.8 TCF). Jharkhand is one of the richest resources of CBM 722.08 BCM (25.5 TCF) [4]. In Jharkhand CBM exploration in high pick due to huge Coal reservoir especially in Jharia block of Dhanbad district.

III. MATERIALS AND METHODS

3.1 Study Area and Location

Dhanbad which is known as Coal city of India a huge reservoir of Coal have been found century ago. Bharat Coking Coal India limited (BCCL) is working and surveillance in this area. Currently working company in Jharkhand for Coalbed methane production is CMPDIL, BCCL, ONGC and etc. This has been clearly demonstrated by the strong support given to DGH in promoting and awarding some 16 CBM blocks for exploration and part of Jharia coalfields in Jharkhand. The highest value of 14.93 m³/ton methane content has been measured in Parbatpur block at a depth of 795 m from the surface. Figure 6, represents the location of sites in map of India.

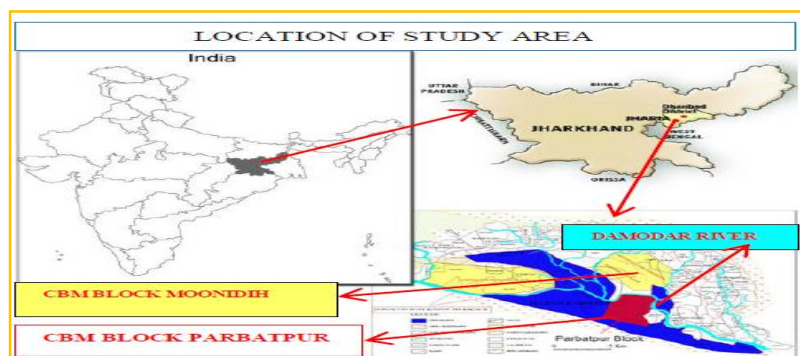


Fig.6, Study area and sampling point

Moonidih and Parbatpur are the two points where sample have been collected. Moonidih is located in the central part of the Jharia. Parbatpur is located south west from Moonidih colliery separated by Damodar River.

Soils: Samples are collected from the 0 to 15 cm and 15 to 30 cm depth during the summer session. Sampling follows standard method under the supervision of CSIR-CIMFR Digwadiah. Samples from CBMplot were air dried and biotic

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debris and particles greater than 2 mm were removed using a standard sieve. Prior to analyses soil samples were grind using a roller mill and oven-dried at 103-105°C till constant weight to determine moisture. Conductivity ($\mu\text{S}/\text{cm}$) was measured with an Orion Star A214 conductivity meter. Percent total carbon and nitrogen were analyzed CHNS Analyzer (Vario macro cube) or Kjeldhal Nitrogen estimation. Prior to any analyses for TOC, the soil sample must be collected and properly handled. During the collection and handling of the samples, losses of organic compounds may occur due to microbial degradation.

$$\text{Total Carbon} = \text{Inorganic Carbon} + \text{Organic Carbon}$$

TOC content can be measured directly or can be determined by difference, if the total carbon content and inorganic carbon contents are measured. For soils and sediments where no inorganic carbon forms are present, Equation becomes:

$$\text{Total carbon} = \text{Organic carbon}$$

Water: Water sample from CBM wellbore were taken in air tight bottle. Prior analyses was done temperature using glass thermometer, pH by pH meter, color with the help of spectrophotometer and DO (dissolve oxygen), TH(total hardness), TDS(total dissolve solid), TSS(total suspended solid), calcium, magnesium hardness. A number of parameters were examined during operation mention in Table 2.

IV. RESULTS AND DISCUSSIONS

Analysis of soil: soil samples taken from CBM or non CBM are mainly EC, PH, TOC, Nitrogen, MPN (most probable number) are shown in Table 1. Bacteria and fungi, the major types of microorganisms found in soil, Microorganisms in soil samples quantitatively using agar plate counts. Counts of microorganisms (Table 1) are expressed as log of CFU per 1 g dry soil and they correspond with usual counts of microbes in loamy soils (30 to 60% sand). There were marginal significant differences among tested localities in number of these bacteria. Correlations among the tested activities and counts of bacteria were mostly insignificant. It might indicate that some other factors (humidity, temperature, pH, aeration, composition of nutrient sources) could be of higher importance for the measured activities than the microorganism counts. Elements in soil samples examine for correlate with another site where CBM or Coal is not found which is mention in Table no. 1.

Table 1, Soil samples analysis

Sl. No.	Parameters	Unit	Soil Quality				
			Moonidih site1	Moonidih site2	Moonidih site (under processing)	Parbatpur	Mihijam (Non-CBM site)
1.	pH	-	8.59	7.99	6.95	9.21	6.76
2.	EC	$\square\text{S}$	213	215	224	209	305
3.	TOC	mg/l	0.36	0.38	0.34	0.35	0.30
4.	Nitrogen	mg/kg	74	69	81	86	76
5.	Microbial count	CFU/ml	1.80×10^8	1.83×10^8	1.90×10^8	1.60×10^8	1.22×10^8
6.	AMBC	mg/kg	36.5	24.4	31.13	46.5	23.35
7.	TOTAL BSR	mg/kg	1.6	2.1	1.7	2.7	1.9

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8.	BSR	mg/kg	469.5	564.2	369.5	751.3	206.6
Heavy Metals in Soil Samples (mg/kg)							
1.	As		0.93	1.09	2.72	1.25	0.89
3.	B		22.45	-	-	14.3	30
4.	Ba		19.12	22.13	51.41	55.32	19.11
5.	Be		0.39	0.25	0.99	0.38	0.35
6.	Cd		1.07	0.71	3.34	1.16	0.77
7.	Se		11.17	6.16	15.30	38.18	39.10
8.	Co		1.22	0.0103	0.1323	0.2700	0.0172
9.	Cr		1.82	11.92	44.00	20.59	10.07
10.	Cu		18.13	5.37	31.03	15.87	4.45
11.	Pb		10.85	7.01	35.56	1.27	3.58
12.	Mn		148.30	97.16	486.30	122.86	63.74
13.	Ni		325.60	301.20	332.10	374.10	299.10
14.	Zn		28.56	28.31	70.36	45.23	13.20
Major elements in Soil samples (mg/kg)							
1.	Na		75.6	51.12	82.1	124	46.7
2.	Mg		701.8	435.9	172.40	654.40	358.00
3.	Ca		67.02	37.45	65.77	66.95	29.72

AMBC = actively microbial biomass carbon, BSR= Basal substrate Respiration

Water analysis: The produced water from wellbore brought to the surface as a byproduct of gas extraction varies greatly in quality from area to area but may contain undesirable concentrations of dissolved substances such as salts naturally present chemicals and heavy metals. While working on water in laboratory some toxic heavy metal is noted for its potential toxicity especially in environmental contexts. The term has particular application to cadmium, arsenic, manganese, chromium, cobalt, nickel, copper, zinc, selenium antimony, etc. CBM Ground water quality assessment enlisted in Table 2.

Table 2, Analysis of water parameters

Sl. No.	Parameters	Abbreviations	Unit	Ground Water Quality		
				Moonidih	Parbatpur	Mihijam (Non-mining area), Jamtara District
1.	Temperature	T	°C	34.2	33.5	32
2.	pH			8.43	9.21	6.76
3.	Electrical conductivity	EC	□S/cm	843	859	907
4.	Color (at 620nm)	OD	°A	0.095	0.58	0.02
5.	Total solid	TS	mg/l	826	902	589
6.	Total dissolve solid	TDS	mg/l	801	872	575
7.	Total suspended solid	TSS	mg/l	25	30	14
8.	Dissolve oxygen	DO	mg/l	3.04	2.26	5.8
9.	Chemical oxygen demand	COD	mg/l	18	21	15
10.	Biological oxygen demand	BOD	mg/l	2.86	2.11	1.9
11.	Alkalinity		mg/l	26	21	20
12.	Total hardness	TH	mg/l	65	83	59
13.	Calcium hardness	CH	mg/l	15	21.5	13.2
14.	Magnesium hardness	MH	mg/l	40	51.5	45.8
15.	Nitrogen	N	mg/l	0.025	0.017	0.012

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16.	Water Acidity	WA	mg/l	24	19	17
17.	Bacteria count	BC	CFU/ml	1.50x10 ⁸	1.95x10 ⁸	1.45x10 ⁸
Heavy Metals in water samples (in mg/l)						
1.	As			0.31	0.54	0.05
2.	B			-	-	-
3.	Ba			7.4	17.6	9.5
4.	Be			0.005	0.006	.002
5.	Pb			0.15	0.28	0.09
6.	Cd			0.01	0.01	0.008
7.	Co			0.65	0.67	0.52
8.	Cr			0.06	0.08	0.04
9.	Se			0.16	0.28	0.12
10.	Cu			0.19	0.26	0.12
11.	Zn			0.43	0.45	0.23
12.	Mn			0.075	2.35	0.14
Major elements in water samples (mg/l)						
1.	Mg			36.5	84	45
2.	Ca			81.65	126.65	135

Climate and local vegetation around CBM: Tropical Deciduous forests (TDF) cover in most part of Jharkhand. It is also called the monsoon forests. Tropical Deciduous forests thrive where rainfall is between 70cm to 200cm. Trees in these forests shed their leaves for about six to eight weeks in summer. The deciduous forests are divided into:

- Most Deciduous forests
- Dry Deciduous forests

Most Deciduous forest found in areas where the rainfall is between 100cm to 200cm. where Dry Deciduous lies between 70cm to 80cm.

The average rainfall in Dhanbad has recorded 124.1cm [(1241mm) Ministry of water resources Govt. of India, 2013], hence in this region Most Deciduous forests thrives.

The coalfield lies in the sub humid belt of Jharkhand and the climate is extreme in this region. The maximum temperature during summer (April to middle of June) rises up to 46°C to 48°C while during winter (December to January) the mercury often drops to 5 °C to 7 °C. The eastern monsoon usually breaks out during the second fortnight of June with maximum precipitation in the months of June to September. The area is fairly vegetated with shrubs of *Lentana* and at places *Dhotras*. Trees like *Mahua*, *Palas*, *Bair*, *Pipal*, *Shishu*, *Karanj*, *Mango* and *Banyan* are common most abundant being *Palas*. Vegetation at CBM site, shown in figure, 7



Fig.7, Local vegetation around CBM site

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V. CONCLUSION

Study based on ecological/biological research, main focus to identify of CBM reservoir because it is sources of clean energy. Although global climate concerns have illustrated the need for the development of clean burning fossil fuels. Paper conclude that existing CBM reservoir area's samples resulted parameter and non-CBM reservoir/non-mining area's samples parameters differ in many aspect. And in this regards paper can be concluded that there is possibility of CBM, but this paper not make a strong comment onthe possibility of coalbed methane gas on the basis of calculated parameters of samples analysis. On the basis of result it may be existing probability. To fulfill this type of indication or ecological indicator more research required to make a strong comment. The project area consists of the Coalbed Natural Gas exploration area identified for development site selection will evaluate ecosystems with ecological mark.

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