Lignite Resources of Bikaner and Their Utilization

Pramod Kumar Rajak[1], Vijay Kumar Singh[2], and Dharmendra Kumar[3]

[1,2] Coal & Organic Petrology Laboratory, Department of Geology, B.H.U. Varanasi - 221005.(UP)

[3] Geological Survey of India, Dehradun (Uttarakhand)

ABSTRACT

Coal is the main source of energy and is considered as the backbone of industries as well as Indian economy. In India, about 99% of coal is from Gondwana and rest 1% is from Tertiary period. The major Gondwana coal deposits are located in the eastern and south eastern parts of India and the Tertiary coals are located in Assam and other north eastern states, as well as Tamil Nadu, Gujarat, Rajasthan and Jammu & Kashmir. In Rajasthan lignite producing basins are Jaisalmer basin, Barmer basin and Bikaner-Nagaur basin of Tertiary age. Lignite/Brown coals have very low calorific value, high moisture and high ash content. It is widely used as fuel for thermal power plants for electricity generation. Combustion process converts coal into useful heat energy, but it also pollutes the environment. Combustion of coal at thermal power plants emits mainly carbon dioxide, sulphur oxides, nitrogen oxides; CFCs, other traces gases and airborne inorganic particulates, such as fly ash and suspended particulate matter (SPM). CO_2, NOx and CFCs are green house gases (GHGs). High ash content in Indian coal and inefficient combustion technologies contribute to India's emission of air particulate matter and other trace gases, including gases that are responsible for the green house effects.

1. INTRODUCTION

Coal is the abundantb fossil present in India. It is widely used in thermal plants as thermal energy source for thermal power plants for producing electricity. Power generation in India has increased manifold in recent decades due to the demand of electricity based industries, house holds, etc. Its usage will be increased day by day.

In India, Gondwana and Tertiary coal is present in different geological horizon. The Gondwana coal is of semi-bituminous to bituminous and the tertiary coal is lignite. The geographical distribution of Gondwana coal is in Jharkhand, Orissa, West Bengal, Chhattisgarh, Maharashtra, etc. and the tertiary coal/lignite is in Tamilnadu, Gujarat, Rajasthan, Assam, Jammu & Kashmir, etc. The lignite deposits in India are of Eocene (Jammu & Kashmir, Gujarat and Rajasthan), Miocene (Neyveli, Tamil Nadu) and Plio-Pleistocene (Nichahom, Jammu & Kashmir) ages (Singh, P.K. et. al., 2010.). The Gondwana and Tertiary coals are of poor quality, with very high ash content and low calorific value. The coal supplied to power plants is of the worst quality. Some of the coal mines are owned by private companies, and they do not wish to invest on the quality improvement. Combustion process converts coal into useful heat energy and ash, but it is also a part of the process that produce the greatest environmental and health concerns.

Each segment of the coal system has some kind of environmental problem—from coal extraction, via preparation, to processing and utilization. Coal utilization processes in industry mainly include are greenhouse gases (GHGs) High ash content in Indian coal and inefficient combustion technologies contribute to India's emission of air particulate matter and other trace gases, including gases that are responsible for the greenhouse effect. The present coal consumption in thermal power station in India results in adding fly ash to air and the rest is dumped on land or water. In spite of various research results a consistent utilization is not evident, and it is expected that stock piles of fly ash will continue to grow with the increasing number of super thermal power stations in India. These large quantities of this material will be increasingly brought into contact with the water and soil environment.combustion and gasification for generating electricity, process heat and residential heat as well as carbonization for making metallurgical coke, and chemical materials. Of these, electricity generated by coal combustion is by far the largest consumer.

Combustion of coal at thermal power plants emits mainly carbon dioxide (CO2), sulphur oxides (SOx), nitrogen oxides (NOx); CFCs other trace gases and air borne inorganic particulates, such as fly ash and suspended particulate matter (SPM). CO2, NOx and CFCs

2. GEOLOGY

The Tertiary sediments in Bikaner basin are elongate in shape and occur in two distinctly separate areas in Bikaner districts and is separated by an aranaceous high represented by the Marwar Supergroup. The Tertiary sequence contains sediments of continental and marine origin deposited over the Neoproterozoic Nagaur Group (Marwar Supergroup) of rocks. It is represented by the Palana, Marh and Jogira Formations in ascending order having conformable contacts. It is bound on the north and south by E-W trending faults and marked by basement highs at Dulmera, Suratgarh and adjoining areas. Recent open cast lignite mining in the area exposed new geological sections at Matasukh and Barsingsar.

The Bikaner basin, better known as Palana – Ganganagar shelf, is an E-W trending elongated basin extending for about 200 km with a maximum width of about 50 km in north-south direction. The basin preserves Palana and Ganganagar embayments, closing eastwards, connecting with the Indus basin. The entire area is under alluvial cover. The Palana Shale is recorded subsurface and includes black shales, lignite, fuller's earth and fire clay all thinning towards the west.

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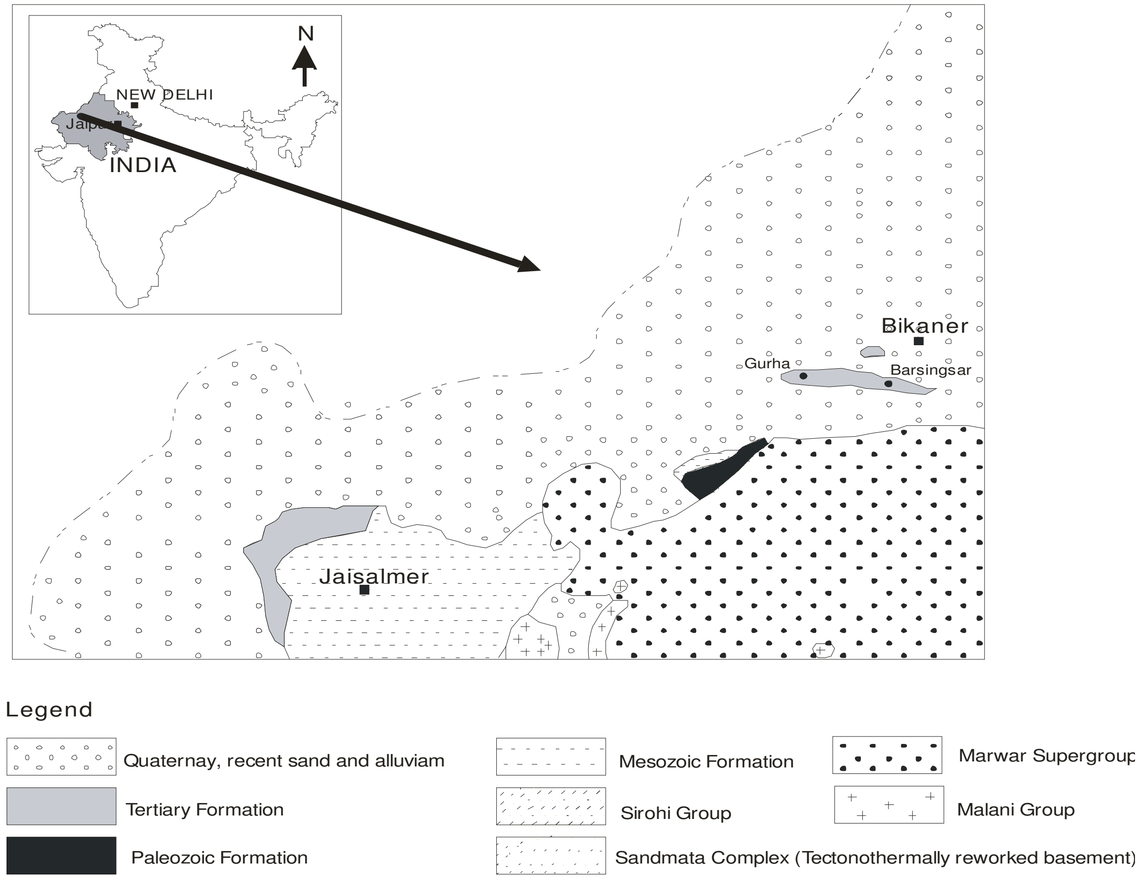

Fig.1 Geology of Bikaner basin, Rajasthan. (after Roy & Jakhar,2002)

3. GENERAL STRATIGRAPHY OF BIKANER BASIN

Age	Formation
Pleistocene to Recent	Kolayat Formation
~~ Unconformity ~~~~~~~	
Early to Middle Eocene	Jogaria Formation(Calcareous facies)
~~ Angular Unconformity ~~~~~~~	
*[2]Late Paleocene (?)	Marh Formation (Arenaceous facies)
~~ (?)Gradational Contact ~~~~~~~	
*[3] Early Paleocene (?)	Palana Formation (Carbonaceous facies)
~~ Base not encountered ~~~~~~~	

Table 1: Tertiary formation of Bikaner-Nagaur basin (After Ghose, 1983a)

*[2] *The formation has been described to be of Early Eocene (Bhandari, 1999).*

*[3] *The formation has been described to be of Eocene (La Touche, T. D. 1897; Rao and Vimal, 1952).*

4. LIGNITE/COAL OCCURRENCES IN BIKANER BASIN

Bikaner basin is a major repository of Tertiary coals in Rajasthan and is estimated to house substantial deposits of lignitic coal. The Basin has some high potential but lesser-known lignite fields e.g. Barsingasar. The lignite deposits of Eocene (Jammu & Kashmir, Gujarat and Rajasthan), Miocene (Neyveli, Tamil Nadu) and Plio-Pleistocene (Nichahom, Jammu & Kashmir) ages. These lignite mines are also a late comer in the Indian coal-mining scenario. The total lignite bearing area, though difficult to prognosticate owing to lignite occurrences as lensoid bodies, is not less than 3-4 thousand square kilometers. Coal industry over the years has generated limited geological and coal characteristic data for the Palana and Matasukh mines.

The data is specific to coal exploration and is confined predominantly to the working mines in the area. Further, data generated by the coal and power industry is usually confined to depths less than 100m and thus, major part of the coalfield, both in terms of area and depth is unexplored, primarily on account of less demand and discouraging results of initial exploration.

The lignite deposits of Bikaner district of Rajasthan are Palaeocene to Lower Eocene age (Ghose, 1983a) and are known to occur at several places in Bikaner district of Rajasthan. The desert sand of Rajasthan conceals all the outcrops of lignite and the associated formations. Out of all the deposits of lignite in this part of the Basin, the deposits of Palana – Barsingsar is the most important where workable mines exist. Lignite was proven and mined in Palana since 1898 through underground shaft but was stopped in 1967 following auto-combustion and was re-opened in early nineties. Here, a half-saucer shaped lignite seam occurs associated with Nummulitic limestone and Fuller's earth. The lignite body extends over 6 to 8 km's and has a NW-SE trend.

A large part of coal bearing Palana & Marh (?) Formations are devoid of lignite, but wherever so, it appears to have been replaced by carbonaceous shales. Lignite bearing Palana Formation is overlain by sequence of alternation of medium to coarse grained sandstone and clay belonging to Marh Formation with gradational contact. Marh Formation is completely covered by a thick pile of Quaternary sediments and the top part consists of blanket of desert sand. The lithological association of grey to black carbonaceous pyritic shale, fine to medium grained sandstone intercalation and presence of lignite, indicate deposition in reducing parallic / swampy environment.

Only one prominent regionally established unit, of thick lignite in the Palana Formation is identified in the area, wherein a cumulative coal thickness of about 30 - 40 m is expected.

5. METHODOLOGY

Twenty two pillar coal samples (Schopf, J.M., 1960.) were taken from Barsingsar lignite mine in such a way that the entire thickness of the seam was exposed. For the purpose the coal samples were crushed to -18 and -72 mesh size to make coal powder, to determine the constituents viz. Maceral analysis, proximate analysis, traces element analysis, etc.

6. TRACE ELEMENT ANALYSIS

Take 0.5 g (dry weight) of coal to a digestion vessel., Add 10 ml of digestion mixture (10 part conc. HNO_3 and 1 part $HClO_4$) and reflux for further 30 min. Repeat this step over and over until no brown fumes are given off by the sample. Filter through Whatman No. 41 filter paper. Rinse the digestate samples with 1% Conc. HNO_3 and transfer the sample in separate test tube and make the volume up to 20 ml. Digestated samples were analyzed by Atomic Absorption Spectrophotometer (AAS, Model Perkin Elmer Analyst 800).

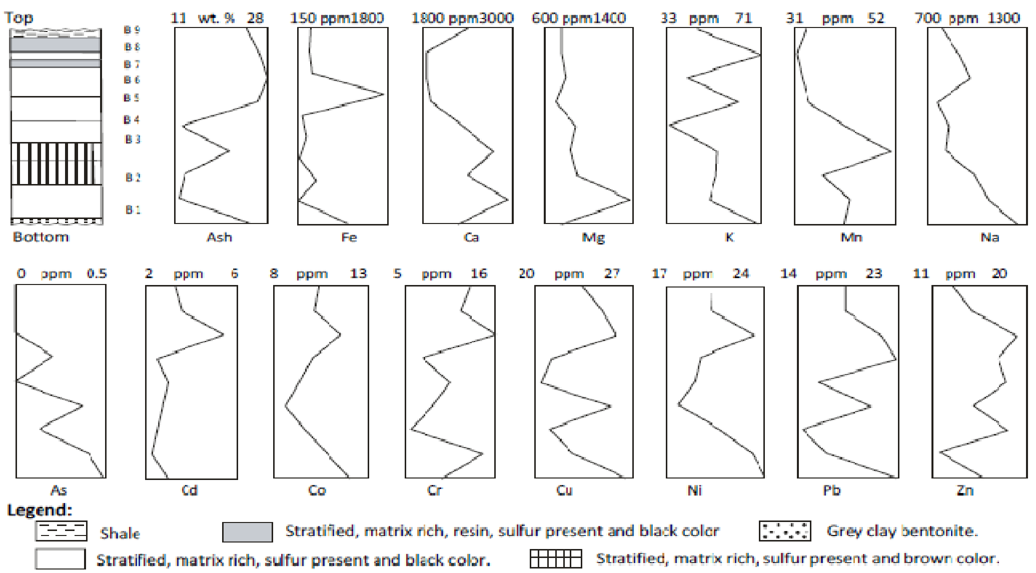

Fig.1a. Vertical variation of Ash and some elements in Barsingsar lignite seam.

7. DISCUSSION AND CONCLUSION

In recent years there has been increasing environmental concern related to the pollutant emissions from coal combustion. Not only are large amounts of pollutants discharged from coal combustion, but there are diverse pollutants produced, covering gaseous, liquid, and solid forms. It has increasingly been recognized that these pollutants pose various adverse impacts to the environment, harming public health and reducing the quality of life.

Sulfur:

During coal combustion, sulfur will produce SO_2 and H_2S, which will be emitted into atmosphere in the form of gases and aerosols. In atmosphere, they will react chemically with O_2 and vapor to form vitriol-vapor. Under suitable conditions, acid-rain will be formed and it will affect the atmosphere quality, reduce water quality, depress the function of soil, block the normal growth of plants, and finally influence the life and existing environment of human beings (Patra, J., 2010).

Arsenic:

Arsenic poisoning interferes with cellular longevity by allosteric inhibition of an essential metabolic enzyme pyruvate dehydrogenase (PDH) complex which catalyzes the reaction Pyruvate + CoA-SH + NAD+ PDH Acetyl-Co-A + NADH + CO_2. With the enzyme inhibited, the energy system of the cell is disrupted resulting in an apoptosis episode. Arsenic in cells clearly stimulates the production of hydrogen peroxide (H_2O_2).

When the H_2O_2 reacts with Fenton metals such as iron, it produces a highly reactive hydroxyl radical. Inorganic Arsenic trioxide found in ground water particularly affects Voltage-gated potassium channels , disrupting cellular electrolytic function resulting in neurological disturbances, cardiovascular episodes such as prolonged qt interval, high blood pressure central nervous system dysfunction and death (Patra, J.,2010).

Lead:

Lead poisoning (also known as plumbism, Colica pictonium, saturnism, Devon colic, or painter's colic) is a medical condition caused by increased levels of the heavy metal lead in the body. Lead interferes with a variety of body processes and is toxic to many organs and tissues including the heart, bones, intestines, kidneys and reproductive and nervous systems. It interferes with the development of the nervous system and is therefore particularly toxic to children, causing potentially permanent learning and behavior disorders. Symptoms include abdominal pain, headache, anemia, irritability, and in severe cases seizures, coma, and death (Patra, J., 2010).

Cadmium:

Cadmium is highly toxic and has been implicated in some cases of poisoning through food. Minute quantities of cadmium are suspected of being responsible for adverse changes in arteries of human kidneys. Cadmium also causes generalized cancers in laboratory animals and has been linked epidemiologically with certain human cancers. Cadmium may enter water as a result of industrialized discharges or the deterioration of galvanized pipe (Patra, J., 2010).

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Iron:

The excess iron affects organ function, presumably by direct toxic effect. Excessive iron stores exceed the body's capacity to chelate iron, and free iron accumulates. This unbound iron promotes free radical formation in cells, resulting in membrane lipid peroxidation and cellular injury (Patra, J.,2010).

Copper:

Continuous ingestion of copper from food or water supply at intakes is sufficient to induce chronic copper poisoning in man is extremely unlikely; judging by the amounts required for this purpose in other monogastric species. The accumulation sometimes results in chronic copper poisoning, followed by death (Gouch, L.P. et al.).

Magnese:

Underwood (1971, p. 202) reported, "Chronic manganese poisoning occurs in miners working with manganese ores. The manganese enters the lungs as oxide dust from the air and also enters the body via the gastrointestinal tract. The disease is characterized by a severe psychiatric disorder (Gouch, L.P. et al.).

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