Coal Petrography of South Karanpura Coalfield with Special Reference to its Depositional Environment

Anubha Tigga[1], Uday Kumar[2]
[1,2]University Department of Geology, Ranchi University, Ranchi, Jharkhand, India

Abstract:- The coal samples of Run of mine (ROM) and washed coals were collected from the Gidi washery of South Karanpura coalfield for petrographic studies in order to observe variations, if any, in the maceral composition of raw and beneficiated coal fractions. Petrographically, coals of South Karanpura of Gidi 'C' block contains high percentage of vitrinite which is followed by inertinite and liptinite. Liptinite is present in low percentage as compared to vitrinite and inertinite. The ROM coals consists of higher percent of mineral matter and after beneficiation, there is a reduction of mineral matter. Basically coal of South Karanpura consists of minerals such as clay, carbonates, quartz, pyrite of which clay and carbonates are dominating. The facies model on the basis of petrographic constituents and mineral matter also suggests that they were mainly deposited under Alternate Oxic and Anoxic Mire condition.
Keywords: Coal petrography, Macerals, Run of Mine, Gidi 'C' block, South Karanpura coalfield, Environment

I. INTRODUCTION

Coal is the primary fossil fuel in which our country is highly dependent upon mainly for the power generation. The quality of the coal plays an important role in the environmental aspects of the power plant. The quality of Indian coal is mainly characterized by its origin. Due to drift origin of Indian coal, mineral matters were contributed at the time of transportation of vegetal matter from its original site to the site of deposition and are entered in the coal matrix and are dispersed in the coal [1]. Coal is composed of both organic and inorganic materials. Macerals are microscopically recognised phytogenic equivalent of minerals, composed of the organic remains of autochthonous or allochthonous plant material [2]. The coals of the study area are rich in inertinite with mineral matter in abundance like other Gondwana coals [3]. Coal petrography is broadly described as microscopic determination of organic and inorganic constituents of coal. Petrographic constituents are correlated with the property that affects the behaviour of coal combustion [4]. Coal with higher inertinite content, burns with longer flame at high temperature whereas vitrinite rich coal burns with shorter flames are burnt more quickly [5, 6]. The removal of potentially hazardous air pollutants prior to the coal's combustion at the mine site by coal cleaning process will reduce the ash content and consequently increases the heat values and hence it will reduce the coal consumption for thermal power generation. The heating value is the amount of heat evolved when unit weight of a fuel is burnt completely [7].

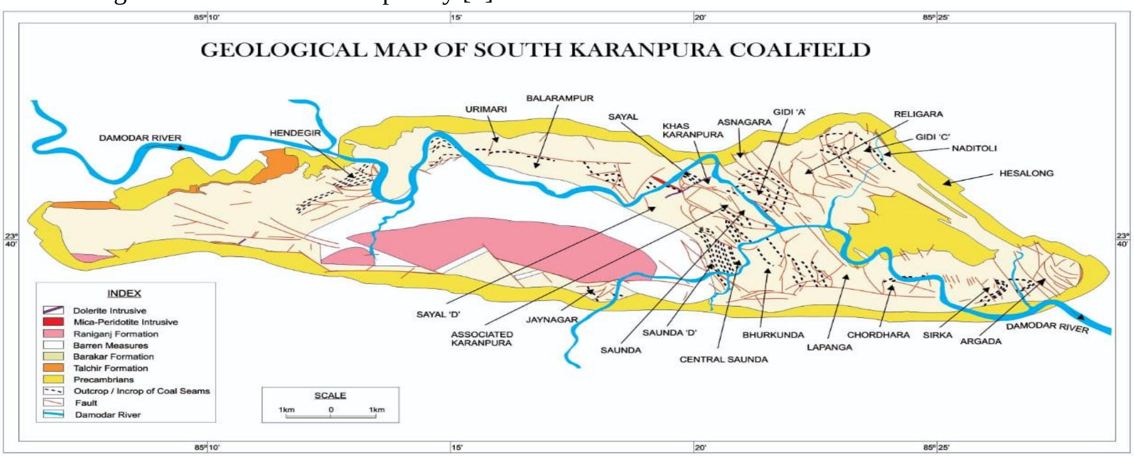

Figure1. Geological map of South Karanpura coalfield, Jharkhand (Modified after Raja Rao, 1987)

II. GEOLOGICAL SETTING

South Karanpura Coalfield in the western part of the Damodar valley is situated between latitudes 23º 38' to 23º 45' N and longitudes 85º 05' to 85º 28' E in the Ramgarh district of Jharkhand state. It covers an area of 194 square kilometers. This elongated coalfield which is trending east-west, occurring within Damodar-Koel River Valley Basins is bounded by metamorphic basement rocks to the north and south. The foliation is dominantly

WNW-ESE to East-West [8]. A continuous succession from Talchir to Raniganj formation is well preserved in this basin. The major parts of this basin are occupied by Barakar formation, which lies unconformable over the basement in large areas. Barakar formation, comprising mainly of coarse grained sandstone, shale and coal alternations. The outcrops of Barren Measures and Raniganj are well exposed at the central and south-central part of the coalfield [8]. Lamprophyre and dolerite dykes and sills occur at different stratigraphic levels within the Barakar, Barren Measures and Raniganj formations.

III. METHODOLOGY

The ROM and Washed coal samples for the present study were collected from Gidi washery of South Karanpura coalfield for various analyses by following IS: 436 (Part I, 1964) [9]. The channel sampling is also done as per Indian Standard- IS: 436 (Part I, 1976) [10] (sampling of coal and coke). The coal samples were reduced to 212 micron size for chemical analysis following IS: 436 (Part I, 1964) [9]. For the study of macerals, petrographic analysis was done according to the standard procedures IS: 9127 (Part III, 2002) [11]. The coal samples were mechanically crushed to obtain ± 18 mesh size which is less then 1mm (< 1mm) to prepare pellets for coal petrography and -72 mesh size for chemical analysis. The pellets were ground by different grades of carborundum powder to get smooth surfaces and were polished using various series of grit paper and then finally washed by water to remove the remaining dust particles. Microscopic observation has been done by Leica DM2700P microscope with 10×50μm and studied under both incident and fluorescent light.

IV. CHEMICAL ANALYSIS

Table -1 The ash content of raw and washed coals of Gidi ‘C’ block, South Karanpura coalfield

SAMPLE NAME	ASH %	SAMPLE NAME	ASH %
R1	44.9 %	W1	36.7 %
R2	45.3 %	W2	39.4 %
R3	45.2 %	W3	38.4 %
R4	44.4 %	W4	38.1 %

Explanations- R: Raw coal, W: Washed coal

V. MACERAL ANALYSIS

Petrographically, the coals of Gidi ‘C’ block of South Karanpura coalfield is of non coking type and is dominated mostly by vitrinite which is followed by inertinite and liptinite. The mineral matters present in these coals are present in abundance and hence increases the ash content which indicates long distance transportation of vegetal matter. In vitrinite macerals, collotelinites and telinites are more abundant whereas vitrodetrinite are present in lesser proportion. In the liptinite group of macerals, sporinites, megasporinites and megasporangium are present. Micrinites are also present in large amount in run of mine (ROM) coals. The mineral matter such as clay, quartz, carbonates, pyrites are observed in the coal samples of Gidi ‘C’ block of South Karanpura coalfield. Pyrites are present as fillings in cracks and also present in cell cavities of vitrinite. Among all the minerals clay and carbonates are most abundant. There is reduction in amount of mineral matter in washed coal with respect to their ROM samples.

Table -2 Maceral composition of coals of Gidi ‘C’ block, South Karanpura coalfield

SAMPLE NAME	VITRINITE	LIPTINITE	INERTINITE	MINERAL MATTER
R1	33.60	26.20	28.40	15.80
R2	47.20	9.20	26.00	16.80
R3	34.80	11.00	40.60	13.40
R4	38.80	9.00	37.60	14.40
W1	62.00	8.20	23.60	6.00
W2	45.60	20.40	29.40	9.40
W3	34.52	8.88	39.59	7.52
W4	22.89	10.80	46.22	15.59

Explanations- R: Raw coal, W: Washed coal

VI. DEPOSITIONAL ENVIRONMENT

Coal petrography is a basic tool to understand the palaeo environmental conditions and depositional environment of the coal basin [12]. The macerals provides the evidences for the nature and type of plant, duration of humification and the depositional environment [13]. The facies of coal in Gidi ‘C’ block of South Karanpura has been discussed on the basis of quantitative relationship among the macerals and mineral matter plotted on the ternary diagram. The depositional environmental model proposed by Singh & Singh (1996) is modified to interpret the Alternate Oxic to Anoxic Mire conditions. Mires are typically nutrient-poor and acidic as the depositional basin possesses very high cation exchange capacity due to its high organic matter e.g. Ca 2+ are preferentially adsorbed into the peat in exchange for H + ions causing water passing through peat to nutrient deprived leading to lowering of pH. The Petrographic constituents of Gidi 'C' block of South Karanpura in the model suggests that the vegetal matters were dominantly deposited under Alternate Oxic and Anoxic Mire conditions.

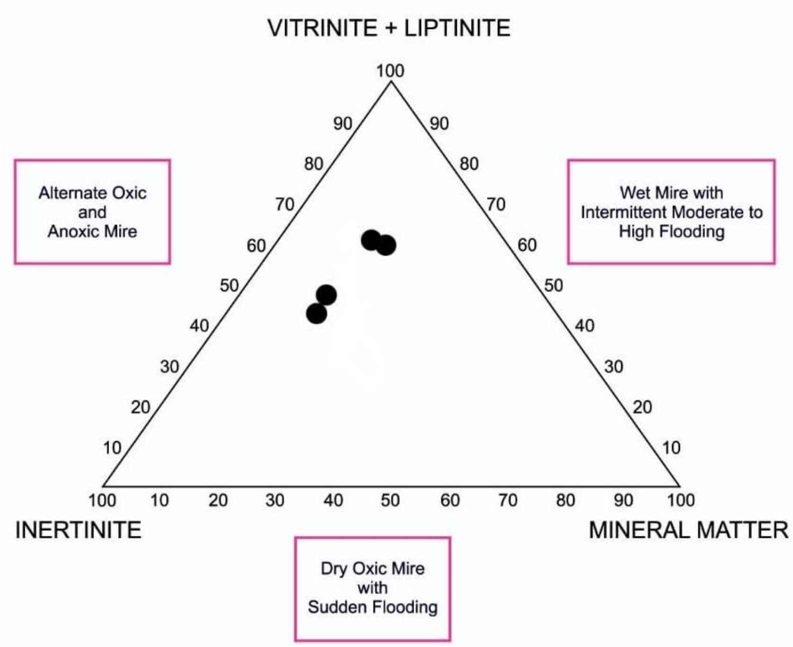

Figure2. Interpretation of Macerals for Depositional Environment showing Alternate Oxic to Anoxic Mire conditions of Gidi 'C' block of South Karanpura Coalfield

VII. CONCLUSION

In the chemical analysis data, ash % of raw and washed coals of the study area shows that there is a reduction of ash % of about 5% to 8% in washed coal. This reduction of ash % will result in the reduction of trace elements which are associated with the mineral present in coal. The reduction of ash % will therefore minimize the toxic trace element emission during combustion of coal in Thermal Power Plants (TPP). So by using washed coal products we can minimize the toxic elements entering into the atmosphere and will also improve the quality of coal. The petrographic study of Run of mine (ROM) coals of Gidi 'C' block shows variable characteristics. The coals are rich in vitrinite followed by inertinite and liptinite. Mineral matter is also present in high proportion of which clay and carbonates are dominating. The presence of mineral matter in abundance increases the ash content which indicates very slow burial and transportation of vegetal matter from its original site to another location. It is therefore very difficult to separate syngenetic minerals from coals but epigenetic minerals can be easily separated by coal washing in the washery which will reduce the amount of mineral matter from the coal thus helps in reducing the toxic elements present in coal and also helps in enhancing the quality of environment and human health.

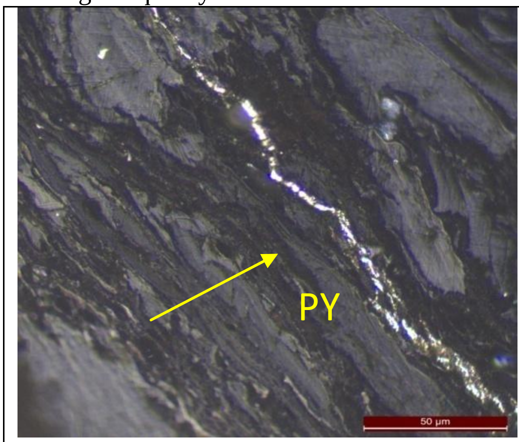

Fig.3: Photomicrograph showing Telinite, Collotelinite, Sporinite & Pyrites are present in the fillings in cracks of Vitrinite × 50µm

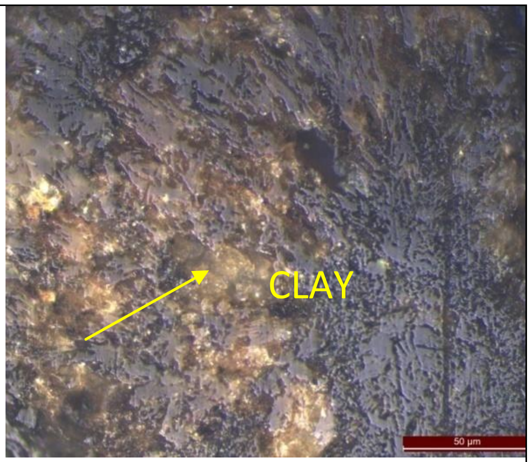

Fig.4: Photomicrograph showing Clay minerals present in Collotelinite × 50µm

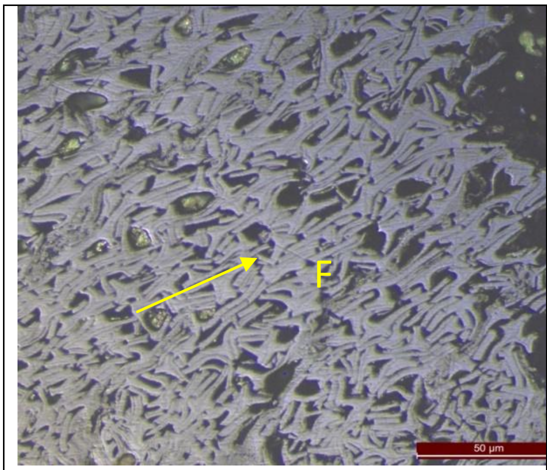

Fig.5: Photomicrograph showing Fusinite x 50µm

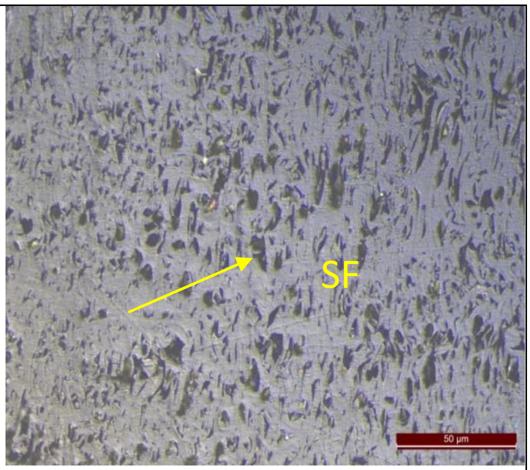

Fig.6: Photomicrograph showing Semi-Fusinite x 50µm

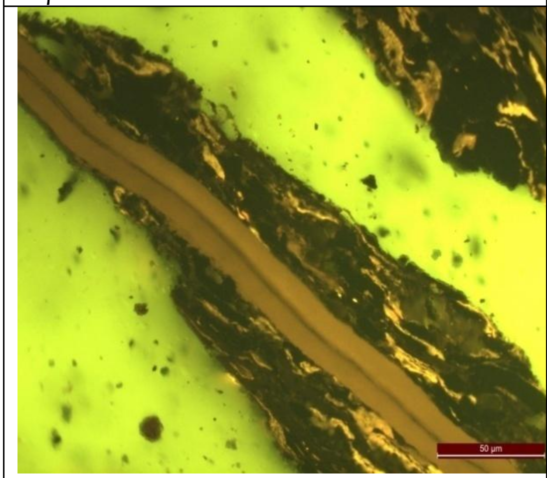

Fig.7: Photomicrograph showing Megasporinite under Fluorescent light x 50µm

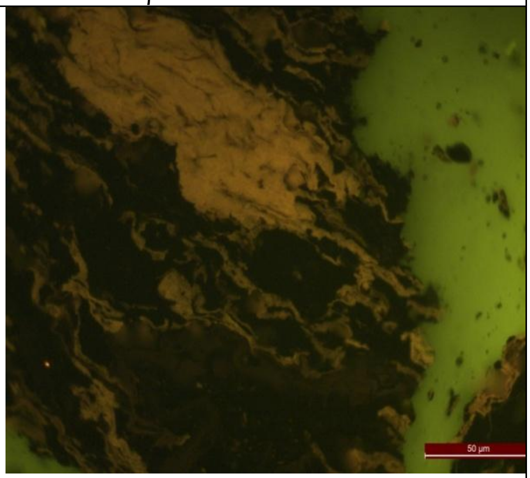

Fig.8: Photomicrograph showing Megasporangium under Fluorescent light x 50µm

VIII. ACKNOWLEDGEMENT

The authors are thankful to the Head of Department, University Department of Geology, Ranchi University, Ranchi for his support and encouragement. They are also thankful to CMPDI for providing necessary facilities and also extend their sincere thanks to Coal Geology and Organic Petrology Laboratory, Department of Applied Geology ISM (IIT), Dhanbad for the laboratory facilities.

IX. REFERENCES

[1] Berkowitz, N. (1994), An introduction to coal technology (2nd Ed.) Academic Press, California. 46p.
[2] Ting, T C F (1978), Petrographic techniques in coal analysis in Analytical Methods for Coal and Coal products. V-I, pp. 3-26.
[3] Stach, E., Mackowsky, M.T., Teichmuller, M., Taylor, G.H., Chandra, D., Teichmuller, R., 1982, Stach's Textbook of Coal Petrology, Gebruder Borntraeger, Berlin, Stuttgart, 3rd Edition.
[4] N. Rao, Cheepurupalli., G.V.S, Sharma., C.S. Singh and E.N. Dhanamaya, Rao., Petrographic Analysis and its Relationship with Calorific Values of Non-Coking Coals,Talcher Coalfield, Orissa. Volume 30 Number 1- December 2015.
[5] Sanyal, A. (1983), The role of coal macerals in combustion, Journal of the Institute of Energy, p 9.
[6] Yarkorskii. et.al. 1968, Influence of the petrographic composition of coal on the efficiency of fired furnaces Teploenergetika.
[7] Patel, S. U., Kumar, B. J., Badhe, Y. P., Sharma, B. K., Saha, S., Biswas, S., Chaudhury, A., Tambe, S. S., & Kulkarni, B. D. 2007, Estimation of gross calorific value of coals using artificial neural Fuel, 86(3), 334-344.
[8] Raja Rao, C.S. (1987), Coalfields of India, Bulletins of the Geological Survey of India, A, 45, 336 pp.
[9] IS: 436 (Part I) 1964, Methods of sampling of coal and coke, part I, Sampling of coal, Indian Standard Institution, New Delhi.
[10] IS: 436 (Part I) (1976), Indian Standard, Methods for Sampling of Coal and Coke, Part- I, Sampling of coal.
[11] IS: 9127 (Part III) (2002), Indian Standard, Methods for the Petrographic Analysis of Bituminous Coal and Anthracite, Part III (Methods of Determining Maceral Group Composition).
[12] Chaudhuri, S. N., Datta, D. R., Datta, A., 2006, Petrographic characteristics and depositional environment of early Permian coals of Ramkola-Tatapani Coalfield vis-à-vis coal bed methane, Journal of applied Geochemistry, Vol.8 No.2A (2006) pp 366-375.
[13] Singh, M. P., Singh, P. K., 1996, Petrographic characterization and evolution of the Permian coal deposits of the Rajmahal basin, Bihar, India, International Journal of Coal Geology, 29 (1996), 93-118.