RESEARCH PAPER | Geophysics | Volume : 5 | Issue : 8 | August 2015 | ISSN - 2249-555X

Correlation Analysis of Well Logs for Coal Seams Delineation in Mahuagrahi Coalfield, Jarkhand, India

KEYWORDS: Well logs, Correlationof Coal seams, Gondwana formation,Mahuagrahi Coalfield.

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ABSTRACT *India well-endowed with coal reserves in the lower Gondwana and Tertiary formations. Exploration and exploitation of coal at an enhanced activity confronted with several geological and mining problems. Many of these problems can solve effectively with geological approaches supported by geophysical investigations on the surface,in boreholes and inside the mines. The developments taking place in geophysical instrumentation, field methodology and digital data processing all had established the utility of geophysical technology in coal prospecting and mining.Thus the authors are experimented the applicability of different techniques of logging in solving various coal investigation related problems. In view of the above the authors has undertaken research studies based on the application of multi-parametric geophysical well logging methods for coal exploration in sedimentary areas of Kayada Block, Dumka District of Jharkhand state, India and some of the interested results are presented in this paper.*

Introduction:
Coal, as energy resource, will assume even greater significance in future because of the depleting and relatively meager petroleum resources. The oil crises of the early nineteen seventies to present, in the backdrop of limited crude reserves and the need for huge imports, highlight the importance of coal with vast reserves as dependable source of energy in the case of India. Coal has been the dominant player in the Indian energy scenario and accounts for bulk of the energy growth. The main consumer of coal is the power sector, as coal-based electricity constitutes the major component with a contribution of around 65% to all India electric power generation capacity this signifies the importance of coal as energy resource in India and clearly points to the continuous increase in the demand for coal from power sector in future. India well-endowed with coal reserves in the lower Gondwana and Tertiary formations (Dutt, and Datta 2000).

Exploration and exploitation of coal at an enhanced activity confronted with several geological and mining problems. Many of these problems can solve by geological approaches supported by geophysical investigations on the surface, in boreholes and also inside the mines. The developments taking place in geophysical instrumentation, field methodology and digital data processing all have established the utility of geophysical technology in coal prospecting and mining.

The geophysical logs provide detailed records of lithological units encountered in the boreholes, thus identifying the coal seams and thickness of each horizon. Correlation is useful in coal exploration or related formation, which continues to be present in section separated by large horizontal distance (Doll, 1948). In coal seams especially for the small depth, which are of interest from the coal seam point of view, such continuous structures are rarely available (Uday Bhaskar, 2006). Geophysical borehole logging is routinely conducted at coal mines for various applications such as strata correlation from borehole to borehole. Geophysical well logs respond to variations in petrophyscial factors, the quality, temperature and pressure of interstitial fluids and ground water flow. The information obtained from a well log can be extrapolated vertically within a well and laterally to other wells for a better understanding of subsurface geology (Fox, 1934). Geophysical logs can be used to identify coal beds and to quantify their resources because coal has several unique physical properties including low natural radioactivity, low density, and high resistance to electrical currents; these properties contrast with those of most other rocks in the coal-bearing sequence. Thus, geophysical logs can provide information on the existence, continuity, thickness, and correlation of shallow to deep buried coal beds unknown coal-bearing areas that have not yet been fully explored and in the future may provide information in areas not previously thought to contain coal.

The important basic concepts that are to be understood are the volume of investigation, calibration and extraneous problems (V.V.L.N.Swamy, 1988). The logs normally run to evaluate a coal bed includes resistivity, lithology and auxiliary data. The density data under the lithology are used to determine the coal quality. The resistivity log is used for coal bed thickness measurements and coal bed correlation. The spontaneous potential (SP) under ancillary data is used for indication of permeable zones. Coal seams are relatively easy to identify and correlate on well logs.

Regional geology of the area:
The Rajmahal coalfield forms an integral part of a Purnea-Malda-Rajmahal-Birbhum Master Basin (Krishnan, 1982). The Rajmahal group of coalfields is North-South trending linear chain of coal basins (Jodha, et al 2000). Mahuagarhi basin occupies the south-central part of Rajmahal group of coalfields.

The Mahuagrahi basin is sandwiched between the Brahm-

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ani coalfield in the south and the Pachwara basin in the north. The basement rocks in the north around villages Kathaldih and Nicha-Pujadih demarcate the Mahuagrahi basin from Pachwara basin. Its southern margin with the Brahmani basin is concealed by younger units comprising of Dubrajpur formation and Rajmahal volcanic (Bose, 1968).

The western boundary of basin delineated by a prominent NNW-SSE trending boundary fault along which Precambrian basement on the west juxtaposed against the Lower Gondwanas. The central part of the basin covered by younger formations like Dubrajpur and Rajmahal volcanic occurring as plateau type hills. The coal bearing Barakar Formation occurs in low grounds in northeast and southeast part.

The Kayada-Chaudhar-Gariapani block lies in the eastern slope of NW-SE trending central hill ranges. General geology shown in figure 1. The Kayada block covers an area of 18 Sq. Km and forms integral part of Mahuagrahi basin. The Mahuagrahi basin occupies south central Part of Rajmahal Group of coalfields. The Kayada block is bounded by Latitudes 24^0 24′ 47.8″, 24^0 25′ 0.2″and Longitudes 87^0 28′ 12.5″, 87^0 28′ 44.10, extending over a strike length of 5.07 km & dip length of 2.68 km. Geological plan shown in Figure -1 and Regional geology of map of study area is shown in Figure -2.

Characteristics of Geophysical Responses:
Based on the study of several geophysical log responses for certain important geological formations and under varying geological condition have identified from the present work. For the purpose of study, formation are conveniently divided into two coal occurring i.e., in Rajmahal formation and Barakar formation (Pant and Bose; 1989). The well logs recorded with Resistivity log, Natural log, Sp log. Caliper log and formation Density log. The resistivity log shows in coal seams very high value and Rajmahal formation shows medium values. Natural Gamma curve shows in coal seams very low value and Rajmahal formation shows medium and against shale formation shows very high value observed. Formation density log plays very import role in coal seams and accurate lithology thickness identification (Rabe, 1957). The formation density log shows very low value in coal seams and in sandstone shale response, density is 2.2 gm/cc to 2.8 gm/cc. caliper log is shows borehole diameter. In this all boreholes diameter is 80 mm to 120 mm. The SP curve is a recording versus depth of the difference between the potential of a movable electrode in the borehole and fixed potential of a surface electrode (Saha, et al 1992). Geophysical logs response shown in Figure - 3.

Identification of Coal seams:
Kayada block, Mahuagrahi coalfield in coal seams has encountered in the boreholes drilled in this area. Most of the coal seams are inter-banded in nature and exhibit split section development pattern both along strike and dip direction. Moreover, coal seams show considerable variation in thickness and lithological characters of inter-seam parting sediments. In view of such variability in fancies characteristics of the coal seam sections, zone wise grouping and their correlation has made where each zone comprises a number of coal seam sections having identifiable fancies development cycle. The incrops of coal seams projected from interpolation and extrapolation of subsurface data generated from boreholes, which are sometimes widely spaced, are somewhat tentative. Exploration in this block reveals occurrence of nine regional coal seam zones and these have numbered I to IX in ascending order. Each coal seam zone barring Seam Zone- IX is composite one comprising more than one coal seam sections with shaly and sandy inter-bands.

The physical continuity, development pattern and chemical profiles of all the coal seam zones occurring in Kayada Block, Mahuagarhi basin are described in Table-1 & 2.

Quality of Coal:
It is well known that quality grade of coal is evaluated from the parameter, comprising ash and moisture content determined from proximate 2 core boreholes (SKDA-1, 2) analysis of coal in laboratory at CFRI Ranchi. Illustrate and support correlation deduced theoretically explained by taking into account the physico-chemical properties responsible for the log responses and sudden variation at increasing density.

The Natural gamma and Density logs are used for identification of coal seams and its quality evolution. Ash or dirt/shale content is denser than coal and naturally exhibits greater gamma ray activity. Therefore, ash content (%) has positive correlation with density as well as gamma ray responses. This is true for Mahaugrahi coalfield, Kayada block. The density and natural gamma are increases with increased of percentage ash content, whereas moisture increase density decreased.

Available chemical data reflects wide variation of coal quality in different sections of the same seam zone. Coal is highly inter-banded with mostly dull bands alternating with bright bands or streaks. Coals from all the nine seam zones contain high moisture (1.80%-9.44%), moderate to high ash (18.50%-52.80%), and are non-coking in character. Coals from these seam zones vary in grade from ‘C’ to ‘G’. The calorific values vary generally from 1314 K. Cal/Kg to 5450 K. Cal/Kg. Seam wise coal properties based on analytical data given in Table-1 and 2.

Conclusions:
Geophysical log run in boreholes can used to provide excellent data for coal prospect evaluation. Multiparameter logs are useful to make accurate coal thickness determinations and to study coal quality estimation.

The problem has a large scope for further studies. The usefulness of the geophysical logging methods like sonic log and neutron logs needs to be established. Detailed theoretical and modeling studies, and interrelationship between various geophysical parameters logged is an important point to study.

Acknowledgements:
The authors gratefully acknowledge the financial support extended by the UGC, New Delhi for granting Emeritus professor.

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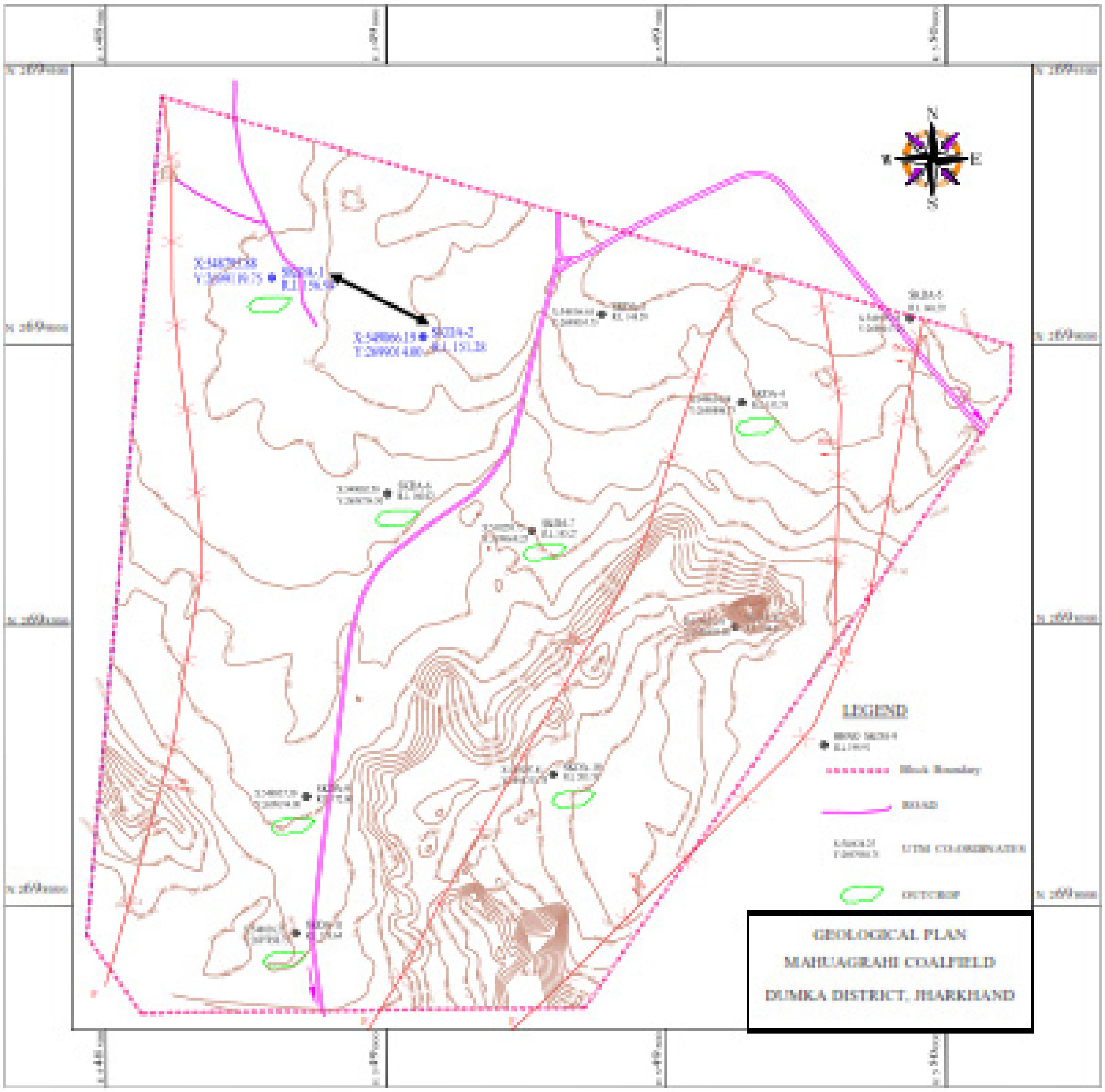

Figure-1: Geological plan of Mahuagrahi Coal field, Dumka District, Jharkand

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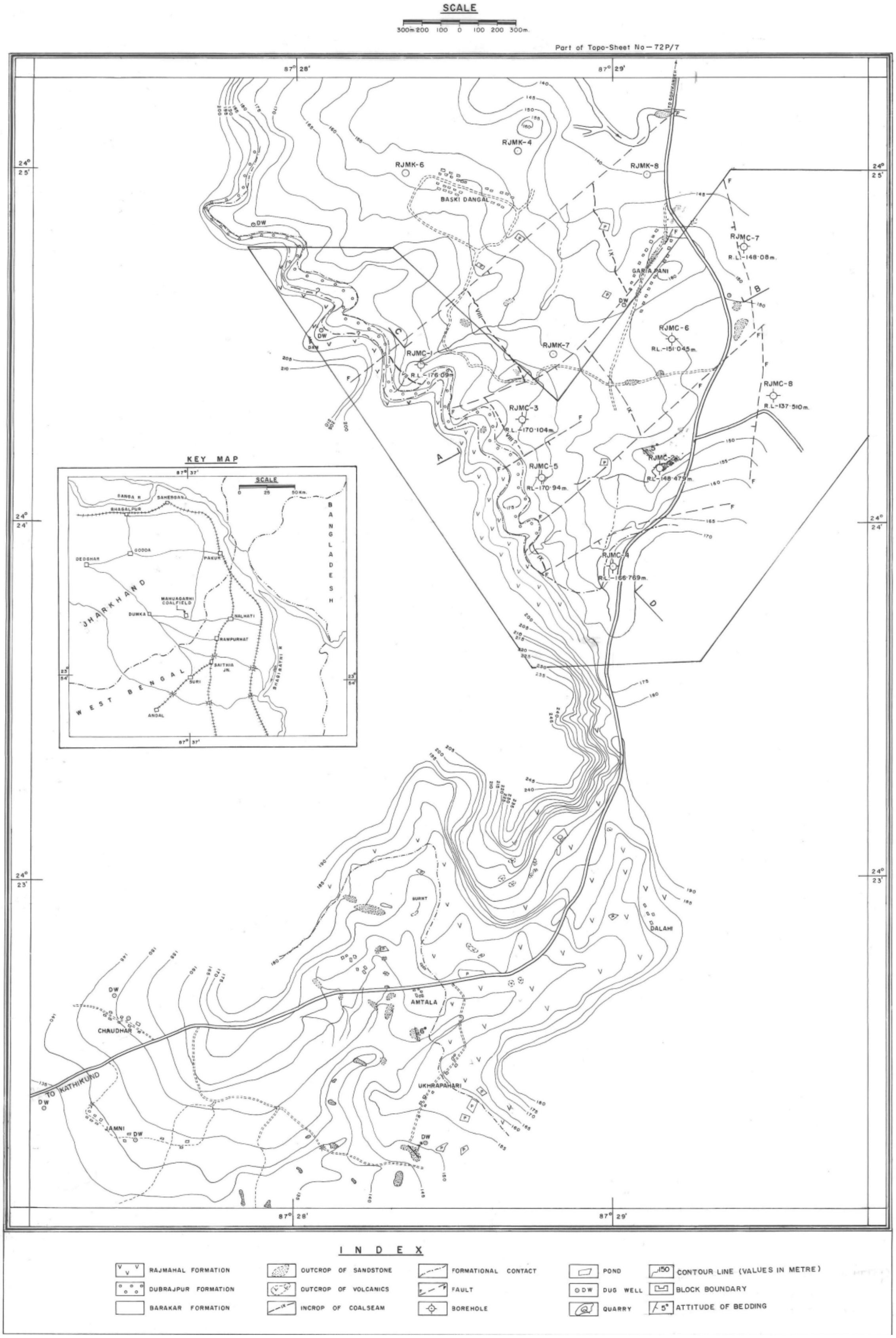

Figure- 2: Regional geology map of Kayada block, Dumka Dist, Jharkhand state, India

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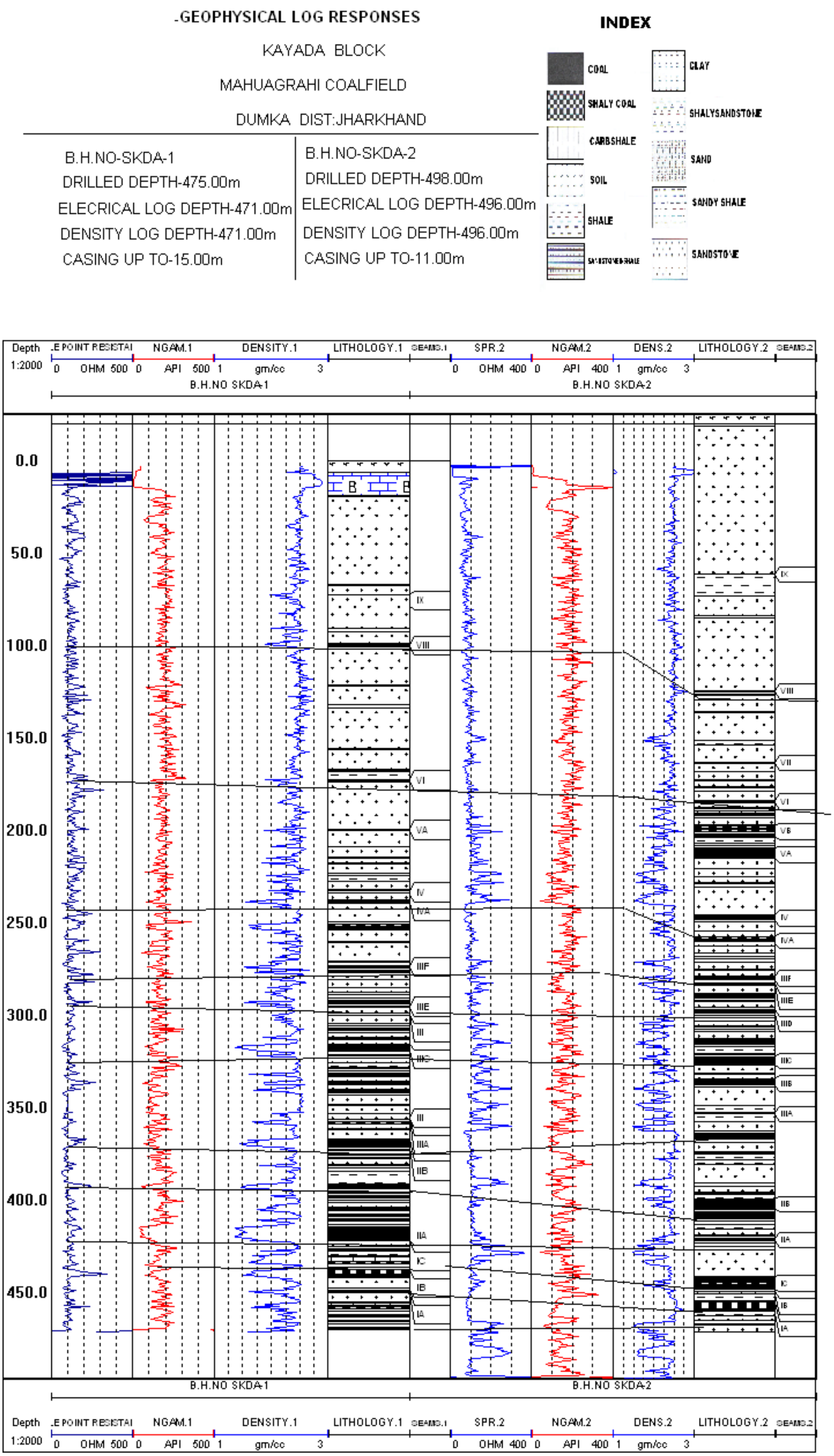

Figure-3: Geophysical log Responses

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Table-1: B.H.No. SKDA-1 Ash%, Moisture%, UHV and Grade values

BH.No.	From	To	Thickness	Seam No.	Moisture%	Ash%	UHV K.cal/kg	Grade
SKDA-1	72.48	72.65	0.17	IX	Carb shale	Carb shale		
SKDA-1	99.87	99.97	0.1	VIII	Carb shale	Carb shale		
SKDA-1	172.61	172.98	0.37	VI	Carb shale	Carb shale		
SKDA-1	199.36	199.85	0.49	VA	Carb shale	Carb shale		
SKDA-1	232.08	232.34	0.26	IV B	Carb shale	Carb shale		
SKDA-1	237.71	239.32	1.61	IV A	Carb shale	Carb shale		
SKDA-1	273.08	274.46	1.38	IIIF	Carb shale	Carb shale		
SKDA-1	292.58	295.30	2.72	IIIE	7.10	31.30	3600.80	E
SKDA-1	299.73	299.95	0.22	IIID	Carb shale	Carb shale		
SKDA-1	315.79	319.20	3.41	IIIC	5.63	34.24	3432.34	E
SKDA-1	335.64	337.18	1.54	IIIB	7.30	27.20	4139.00	E
SKDA-1	340.05	340.95	0.9	IIIA	7.46	24.82	4445.36	D
SKDA-1	366.85	371.24	4.39	IIB	8.20	19.60	5063.60	C
SKDA-1	391.05	393.82	2.77	IIA	7.72	19.45	5150.54	C
SKDA-1	414.27	422.05	7.78	IC	7.80	23.20	4622.00	D
SKDA-1	437.68	441.71	4.03	IB	5.83	35.24	3232.34	F
SKDA-1	448.86	450.16	1.30	IA	4.99	40.99	2554.76	F

Table-2: B.H.No. SKDA-2 Ash%, Moisture%, UHV and Grade values

BH.No.	From	To	Thickness	Seam No.	Moisture%	Ash%	UHV K.cal/kg	Grade
SKDA-2	64.24	64.51	0.27	IX	Carb shale	Carb shale		
SKDA-2	124.77	125.46	0.69	VIII	6.42	36.75	2942.54	F
SKDA-2	173.64	174.38	0.74	VII	6.00	39.08	2678.96	F
SKDA-2	193.3	193.79	0.49	VI	7.32	28.44	3965.12	E
SKDA-2	199.12	202.77	3.65	VB	8.87	32.54	3185.42	F
SKDA-2	215.89	219.35	3.46	V A	6.44	37.75	2801.78	F
SKDA-2	251.29	253.7	2.41	IVB	6.90	35.83	3003.26	F
SKDA-2	263.40	264.93	1.53	IV A	7.34	32.03	3466.94	E
SKDA-2	286.08	287.82	1.74	IIIF	6.18	37.30	2899.76	F
SKDA-2	289.03	290.25	1.22	IIIE	9.59	27.57	3771.92	E
SKDA-2	305.94	306.97	1.03	IIID	6.27	33.58	3400.70	E
SKDA-2	326.4	329.4	3	IIIC	6.61	29.62	3900.26	E
SKDA-2	340.24	343.31	3.07	IIIB	5.40	42.12	2342.24	G
SKDA-2	355.38	358.72	3.34	III A	6.68	31.44	3639.44	E
SKDA-2	385.44	395.16	9.72	IIB	6.04	32.51	3580.10	E
SKDA-2	410.12	417.12	7	IIA	6.46	30.89	3745.70	E
SKDA-2	430.6	434	3.4	IC	5.46	38.06	2894.24	F
SKDA-2	440.75	442.35	1.60	IB	6.11	32.41	3584.24	E
SKDA-2	454.05	459.65	5.60	IA	5.61	34.78	3326.18	F

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REFERENCE

Doll, H.G., 1948, The SP log Theoretical analysis and principles of interpretation: Society of Petroleum Engineers of the American Institute of Mining, Metallurgical and Petroleum Engineers Technical publication,2463,pp.40. | Dutt, A.B and Datta, R. K(2000) Indian coal resources spectrum, Proc. Sem on New Challenges for Indian Coal, Coal resources of India. Mem. Geol. Survey of India,pp10-13. | FOX, C.S. (1934) The Lower Gondwana coal field of India, Mem,Geo.Surv.of India. Vol.LIXpp.1- 386. | Rabe, C.L.1957, A relation between Gamma radiation and permeability, Denver-Julesberge basin: Transaction of the Society of Petroleum Engineers of theAmerican Inst. Of Mining Metallurgical and petroleum Engineers. Vol.210.pp.358-360. | Robertson Geologging 2009: Win logger software version 6.3. Robertson Geologging 2009: Well cad software version 6.3. | SAHA, S. N., Roy, A.K., BRAHMAN, C.V., SASTRY, C.B.K. and M.K. (1992) Geophysical Exploration for Coal-bearing Gondwana basin in the state of West Bengal and Bihar in Northeast India.Tectonophysics, v.212, pp.173- 192. | UdayBhaskar, G., 2006: Electro lithofacies analysis for depositional history and Stratigraphy of Manuguru coalfield using geophysical well logs, Jour.of Ind. Geophys.Union (July 2006) Vol.10, pp.241-254. | V.V.L.N.Swamy, 1988 Computer interpretation of well –logging data. | Bose, J. 1968. Geological investigation by drilling in the Chuperbhita and Mahuagarhi Coalfields, Rajmahal Hills, Santhan Parganas district, Bihar. Goel. Surv.Ind., Unpublished progress Rep. for 1964-65. | Buchanan, D.J and Jackson, L.J 1986c. Boreholes logging of coal deposits: Editor's commentsIn: Coal Geophysics, Geophysics Reprint Series No: 6, SEG Publn, pp 25-27. | Jodha, B. S.,Sen K. K.,Ray, Atanu 2000. Final Report on Regional Exploration for coal in the Dumaria-Gandharap-Keyada Sector, Mahuagarhi coalfield, Dumka District, Bihar. Progress Report, Geol. Surv. Ind. (unpublished) | Kayal, J.R.and Das Christoffel, D.A 1989. Coal quality from geophysical logs;Sounth land lignite region, NewZealand. The log analysist, v30.pp343-352. | Krishnan,M.S. 1982. Geology of India and Burma, CBSpublishers Distributors(India). | Mitra, N. D. 1965. Geology and coal resources of Rajmahal Coalfield, Santhal Parganas district, Bihar, Progress Report,Geol. Surv. Ind. (unpublished). | Pant, P.R. and Bose, R.N. 1989. Geophysical exploration strategy for lower Gondwana coal: some case studies. In: R.K. Verma (Ed), Advances in Coal Geophysics. Assn. Expln . geoph. (India) Publn. Pp.139 -156. |