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Application of Well Logging Techniques for Identification of Coal Seams: A Case Study of Auranga Coalfield, Latehar District, Jharkhand State, India

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Abstract

Application of well logging techniques comprising density, short normal resistivity, long normal resistivity, resistance, self-potential, natural gamma and calliper logs from five wells in Auranga coal field Jharkhand state India, were (The analysis was) carried out to evaluate the fields coal seams prospect i.e. identify lithology and study physical properties based on log data from the five boreholes. We have been identified from combined signatures of available physical properties logs against coal seams and non-coal litho units. Data was acquired and interpreted by software's Robertson geologging win logger and Well cad software (Version 6.3) respectively. The coal seams are in between shale or sandstone.

Keywords: Auranga coalfield; Well logging; Coal seams; Win logger; Well cad

Introduction

Coal is a vital component of the world's energy resources, and one that is expected to fill a significant role in meeting our energy needs well into the foreseeable future. Geological& Geophysical science and associated technology are used to evaluated the coal seams that will be used to meet these needs, a process referred to as coal exploration, and to assist in designing and operating effective systems for coal mining, preparation and utilization tasks. 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 of the India's 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 components with a contribution of around 65% to all India electric power generation capacity this signifies the importance of coal as energy resource. India's clearly points to the continuous increase in the demand of coal for power sector. India well-endowed with coal reserves in lower Gondwana and Tertiary formation [1].

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

The geophysical well logging techniques 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 [2]. Geophysical well logs can be used to identify coal beds unique physical properties including low density low natural radioactivity, high resistance and resistivity [3]. These physical properties contrast with those of most rocks in the coal bearing sequence. Thus, geophysical well logging can provide information on the existence, continuity, thickness, and correlation of shallow to deep buried coal seams and unknown coal seams areas that have not yet been fully explored.

Geology of the Study Area

Auranga coalfield is situated between the latitude 23°42' and 23°44'43" and longitude 84°30'45" and 85°35'46" in the district of Latehar, Jharkhand. The following are the geological formations of the area visited. Auranga coalfield is full development of lower Gondwana and the younger rocks [4]. There is good development of Talchir, Karhabari, Barakar, Raniganj formation. The most of the coals of this

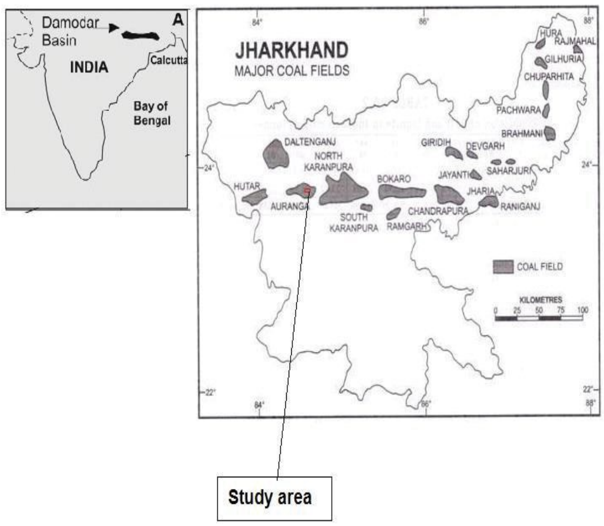

Figure 1: Jharkhand major coalfield map.

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area are non –coking. Figure 1 shown the Jharkhand major coalfield and Figure 2 shown the location of the study area.

Geophysical Well Logging Data Acquisition

Drilling for coal exploration programs may involve either core or non- core drilling. Core drilling is the only satisfactory means of obtaining reprehensive sample, either of coal seams for thickness and quality assessment or non-coal rocks for geotechnical tests. Non-core drilling, however, supported by geophysical well logging, can give useful information on thickness and depth of coal and beds for use in structural and Stratigraphy studies [5].

Figure 2: Location map of the wells study area.

Although regular grid patterns of boreholes are commonly employed, the location and depth of holes in the drilling programs should also be based, especially in the early stages of the program, on the result of surface studies such as field mapping and geophysical investigation [6].

The geophysical well logs data acquisition in the five borehole consist of qualitative analysis for identifying non coal and coal seams its thickness of lithology and compare with the available litho logs [7]. The result of five boreholes presented on scale of 1:2000 m individual logs in multiparameters logging are presented as parallel traces showing

Borehole No	Drilling depth(m)	Logging depth(m)	Casing depth(m)
BH-45	485.00m	483.00m	120.00m
BH-46	491.00m	489.00m	66.00m
BH-53	450.00m	448.00m	103.00m
BH-62	648.00m	641.00m	50.00m
BH-68	660.00m	655.00m	57.00m

Table 1: Well logging data acquisition, drilling and casing depth of boreholes.

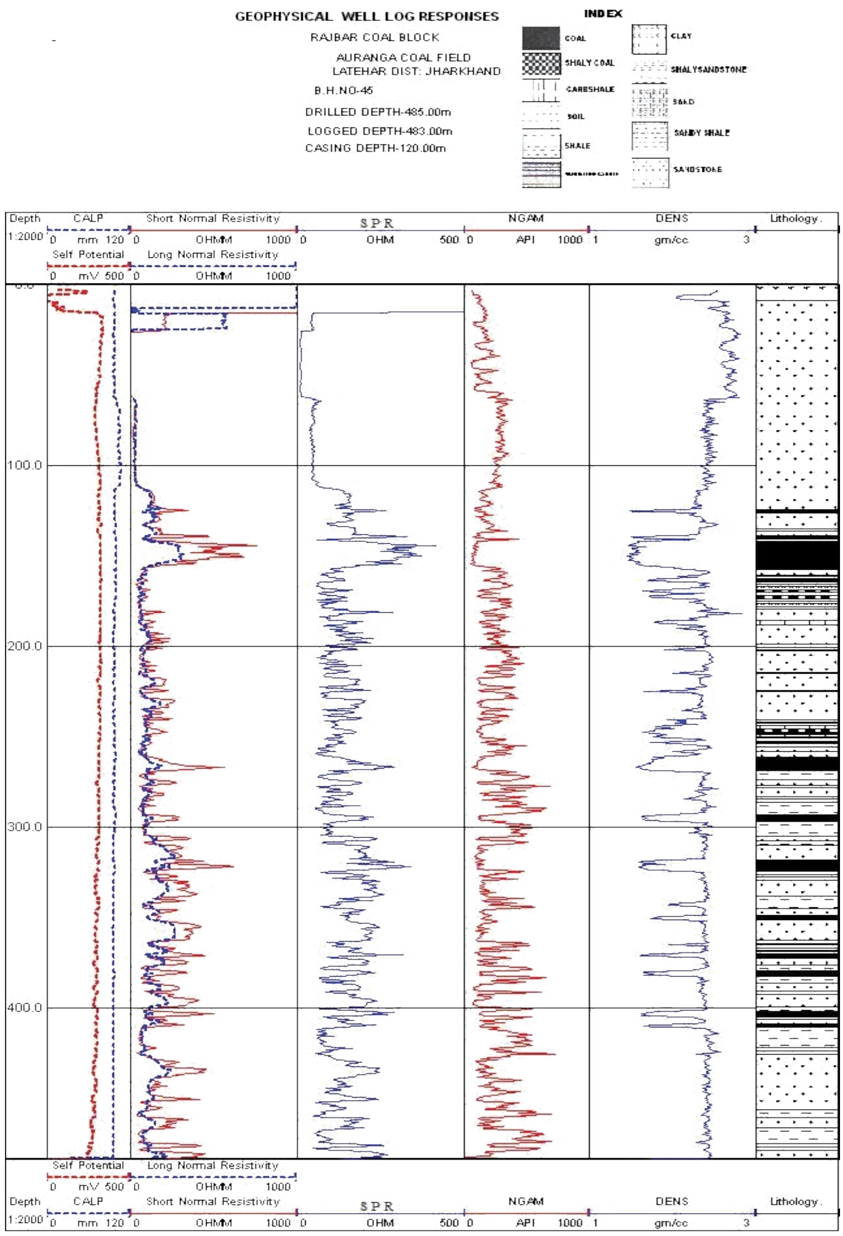

Figure-3 BH.No-45

Figure 3: Characteristic of Geophysical logs and response (BH No-45).

the variation with depth. This is helpful in the delineation of lithology penetrated by the boreholes [8]. The physical parameters logged are density, calliper, resistivity, resistance, natural gamma. Self-potential.

Delineation of well section consists in differentiating the sequence of formations with varying geophysical parameters [9]. From delineation we can establish the boundaries of different formation and their thickness and lithology. Table 1 has shown the well logging data acquisition, drilling and casing depth of boreholes 45,46,53,62, and 68 respectively.

Well Data Processing

As a means of illustrating typical logging responses in the coal seams, example is presented from the Auranga coalfield. Such logs were recorded with the present data resistivity log, natural gamma log, Self-potential log, calliper log density log. The resistivity log shows in Figure 3 coal seams very high value ranges 500-1000 ohm m. Natural gamma curve shows in Figure 4 coal seams low value range 10-100 API and against shale formation very high value range 500-600 API. Density

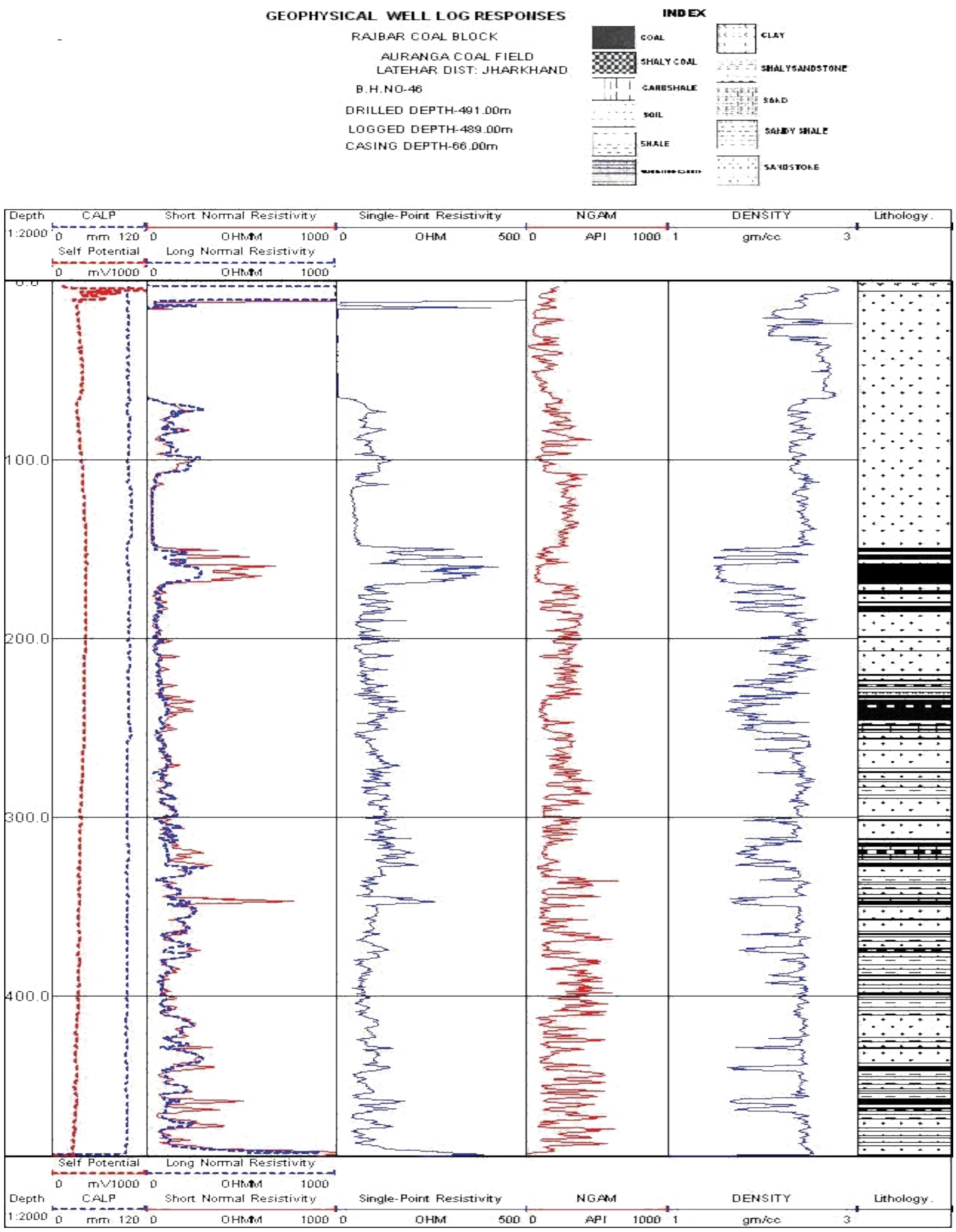

Figure 4: Characteristic of Geophysical logs and response (BH No- 46).

log very important role in coal seams and accurate lithology thickness identification [10]. The density log shows in Figure 5 very low value in coal seams (range 1.40-1.90 gm/cc) and sandstone shale responds density in 2.2 gm/cc to 2.8 gm/cc). The diameter of the boreholes is

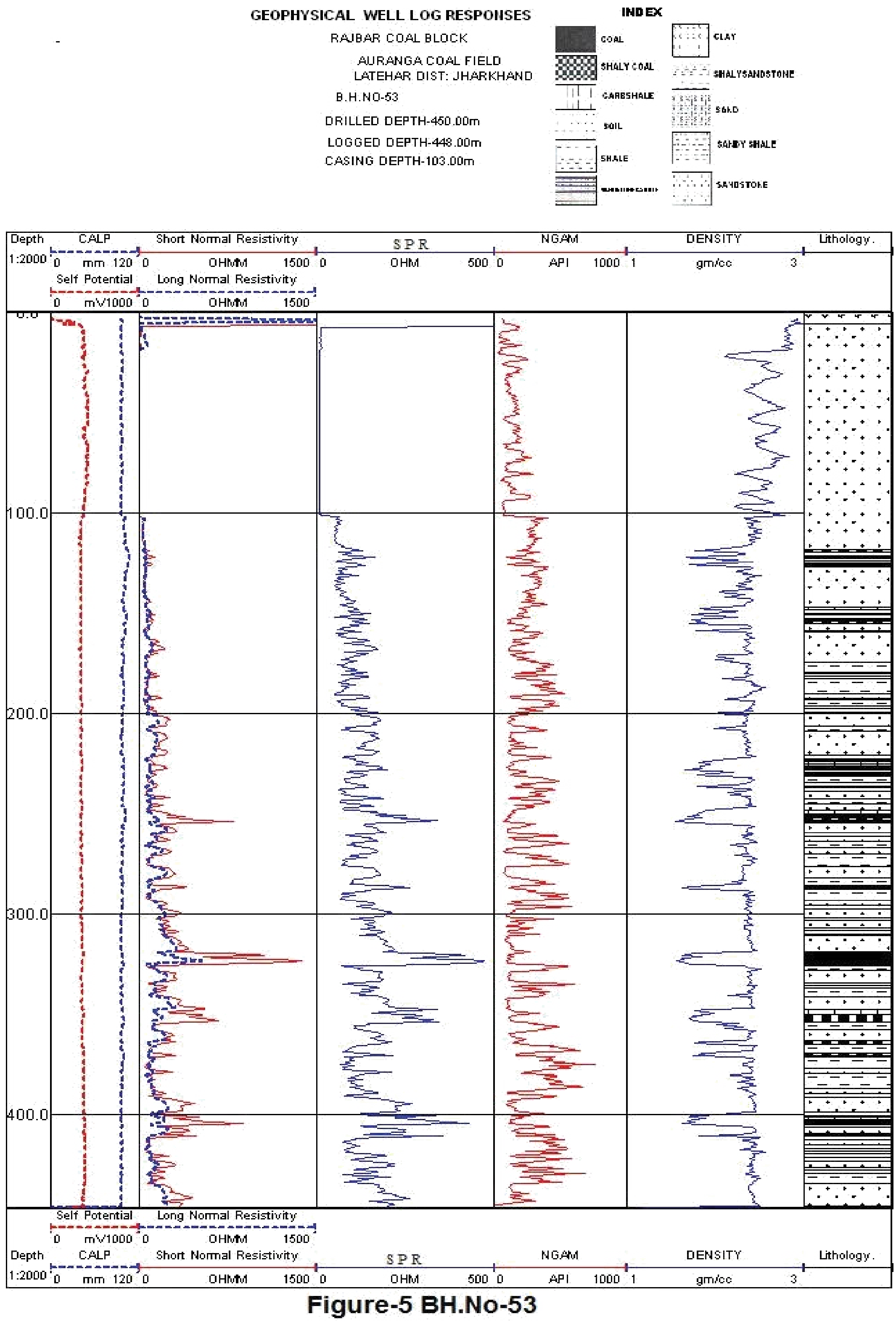

Figure 5: Characteristic of Geophysical logs and response (BH No- 53).

120.00 mm. Figures 3-7 showed the characteristic of geophysical logs and response of BH.No's- 45, 46, 53, 62 & 66 respectively.

Data Analysis and Interpretation

Auranga coalfield in coal seams has been encountered in the five

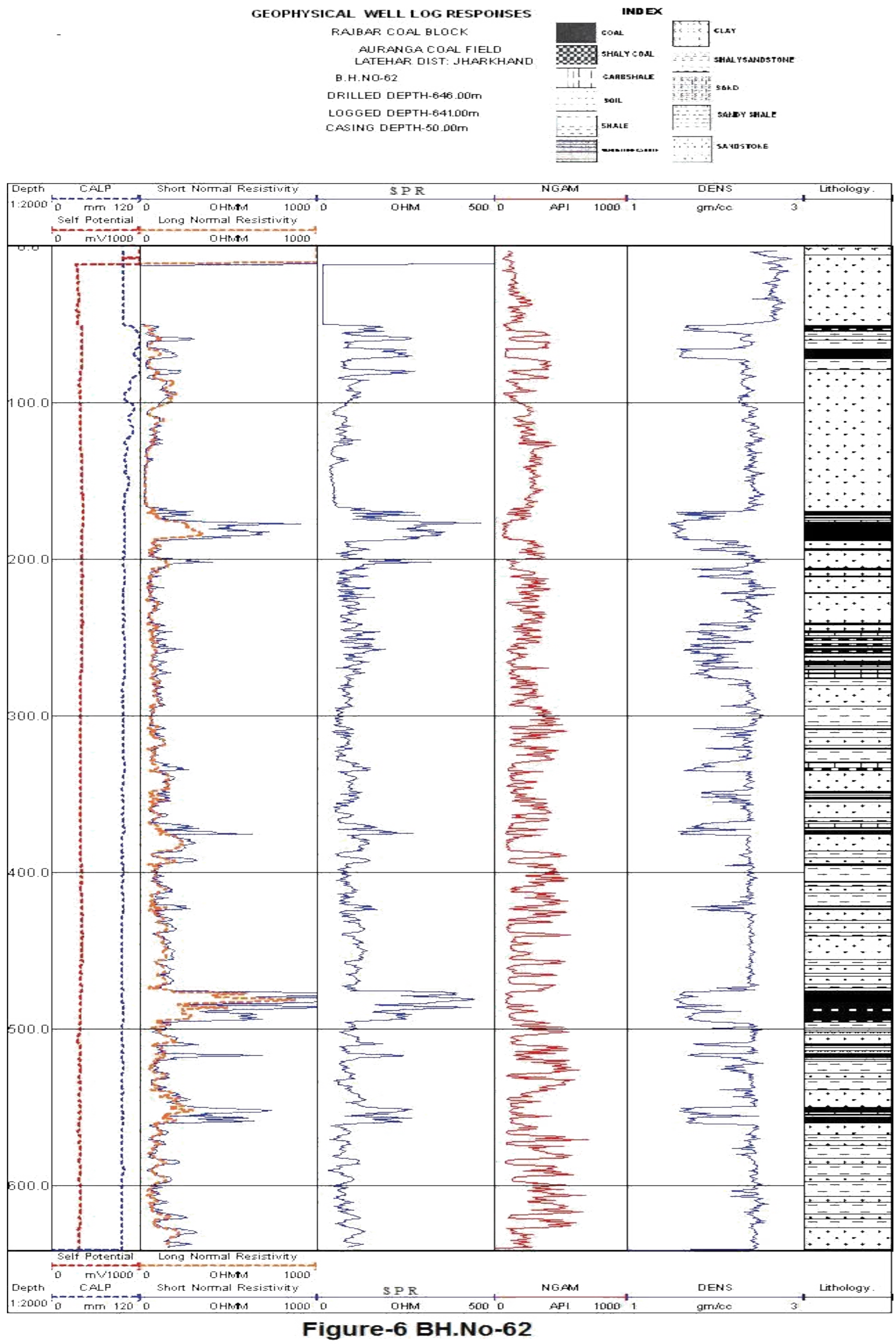

Figure 6: Characteristic of Geophysical logs and response (BH No- 62).

boreholes drilled in this area. Most of the coal seams are inter-banded in natural and exhibit split section development pattern both along strike and dip direction. Moreover, coal seams show considerable variation in thickness and litho logical characters of interseam parting sediments. In view of such variation in facies characteristics of the coal seams section, zone wise grouping and their correlation have been made where each

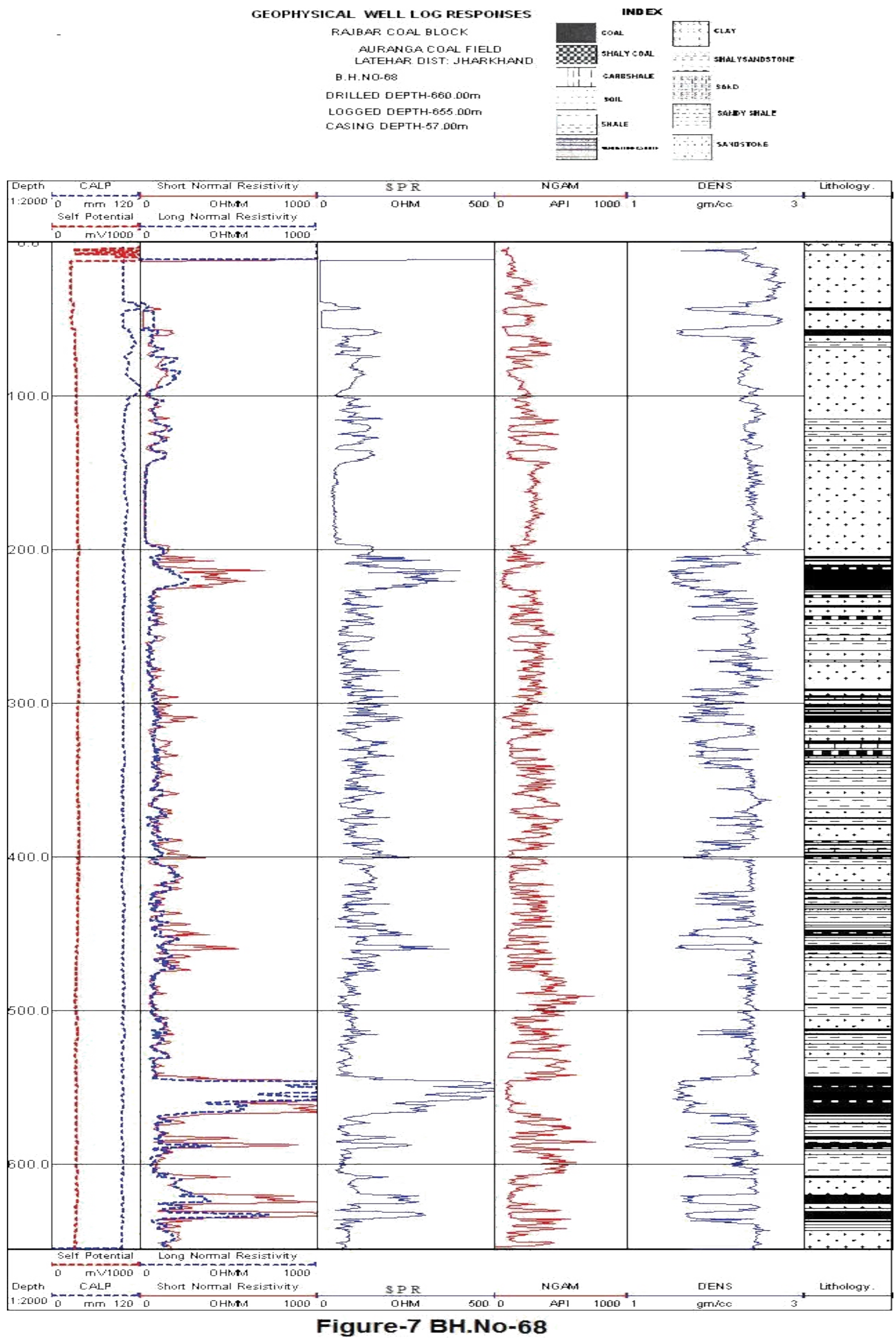

Figure 7: Characteristic of Geophysical logs and response (BH No- 68).

zone comprises a number of coal seam sections having an identifiable facies development cycle. Their crops 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 the occurrence of ten regional coal seams zone and these have numbers I text in ascending order [11].

Each coal seams zone barring seam zone –X is composite one comprising more than one coal seam section with sandstone and shale inter-bands. Tables 2-6 had shown the coal seams depth and thickness of boreholes 45, 46, 53, 62 and 68 respectively.

Borehole to Borehole Coal Seams Correlation

Correlation of well logs is an important step in geophysical and geological interpretation, to develop geologic models and time – depth conversion. Well log correlation is the process of determining corresponding depths among the boreholes. Figure 8 has shown the borehole to borehole (BH No -53, 45& 46) coal seam correlation and Figure 9 has shown the borehole to borehole (BH No -62 &68) coal seam correlation.

		Depth Range (m)			
Sr.No	BH.No	From	To	Thickness (m)	Seam
1	BH.No-45	124.25	126.12	1.9	X
2		138.68	140.68	2.0	IX
3		141.82	157.7	15.9	VIII
4		161.08	164.2	3.1	VII
5		168.56	169.94	1.4	VI T
6		171.8	173.8	2.0	VIB
7		186.06	188.18	2.1	V
8		243.76	250.86	7.1	VA
9		261.32	268.88	7.6	IV T
10		293.44	297	3.6	IVB
11		317.94	324.44	6.5	III
12		348.94	351.62	2.7	II
13		379.56	382.64	3.1	II
14		401.74	404.88	3.1	IT
15		408.88	410.76	1.9	IB

Table 2: BH No- 45 Coal seams depth & thickness.

		Depth Range (m)			
Sr.No	BH.No	From	To	Thickness (m)	Seam
1	BH.No-46	149.44	151.12	1.7	X
2		153.44	155.82	2.4	IX
3		158.44	169.38	10.9	VIII
4		173.2	174.94	1.7	VII
5		182.06	184.74	2.7	VI T
6		226	227.18	1.2	VIB
7		234.2	236.44	2.2	V
8		237.15	243.69	6.5	VA
9		244.16	245.79	1.6	IV T
10		248.03	252.54	4.5	IVB
11		315.66	323.51	7.8	III
12		344.91	349.04	4.1	II
13		372.9	375.59	2.7	II
14		439.1	441.94	2.8	IT
15		457.56	460.47	2.9	IB

Table 3: BH No- 46 Coal seams depth & thickness.

		Depth Range (m)			
Sr.No	BH.No	From	To	Thickness (m)	Seam
1	BH.No-53	121.47	122.68	1.2	X
2		124.91	126.75	1.8	IX
3		152.37	155.18	2.8	VIII
4		158.6	159.31	0.7	VII
5		223.56	228.47	4.9	VI T
6		229.75	231.66	1.9	VIB
7		236.1	236.9	0.8	V
8		248.41	254.63	6.2	VA
9		285.59	287.59	2.0	IV T
10		318.93	325.4	6.5	IVB
11		347.41	354.03	6.6	III
12		363.34	364.84	1.5	II
13		369.15	371.12	2.0	II
14		400.53	405.03	4.5	IT
15		410.28	410.97	0.7	IB

Table 4: BH No- 53 Coal seams depth & thickness.

		Depth Range (m)			
Sr.No	BH.No	From	To	Thickness (m)	Seam
1	BH.No-62	50.44	54.63	4.2	X
2		65.56	71.9	6.3	IX
3		169.31	170.5	1.2	VIII
4		171.16	188	16.8	VII
5		192.94	194.41	1.5	VI T
6		246	248.91	2.9	VIB
7		250.62	251.91	1.3	V
8		257.1	260.1	3.0	VA
9		266.25	268.5	2.3	IV T
10		270	276.31	6.3	IVB
11		329.97	335.19	5.2	III
12		485.1	488.6	3.5	II
13		489.44	495.37	5.9	II
14		550.15	554.91	4.8	IT
15		556.16	560.1	3.9	IB

Table 5: BH No- 62 Coal seams depth & thickness.

		Depth Range (m)			
Sr.No	BH.No	From	To	Thickness (m)	Seam
1	BH.No-68	42.43	44.56	2.1	X
2		56.72	61.06	4.3	IX
3		211.47	214.6	3.1	VIII
4		215.2	220.16	5.0	VII
5		295.25	298.2	2.9	VI T
6		308.41	312.5	4.1	VIB
7		326.15	335.8	9.7	V
8		395.1	401.26	6.2	VA
9		447.35	451.44	4.1	IV T
10		545	567	22.0	IVB
11		582	583.95	2.0	III
12		586.1	590	3.9	II
13		607.66	608.88	1.2	II
14		619.85	625.8	5.9	IT
15		631.07	635.5	4.4	IB

Table 6: BH No- 68 Coal seams depth & thickness.

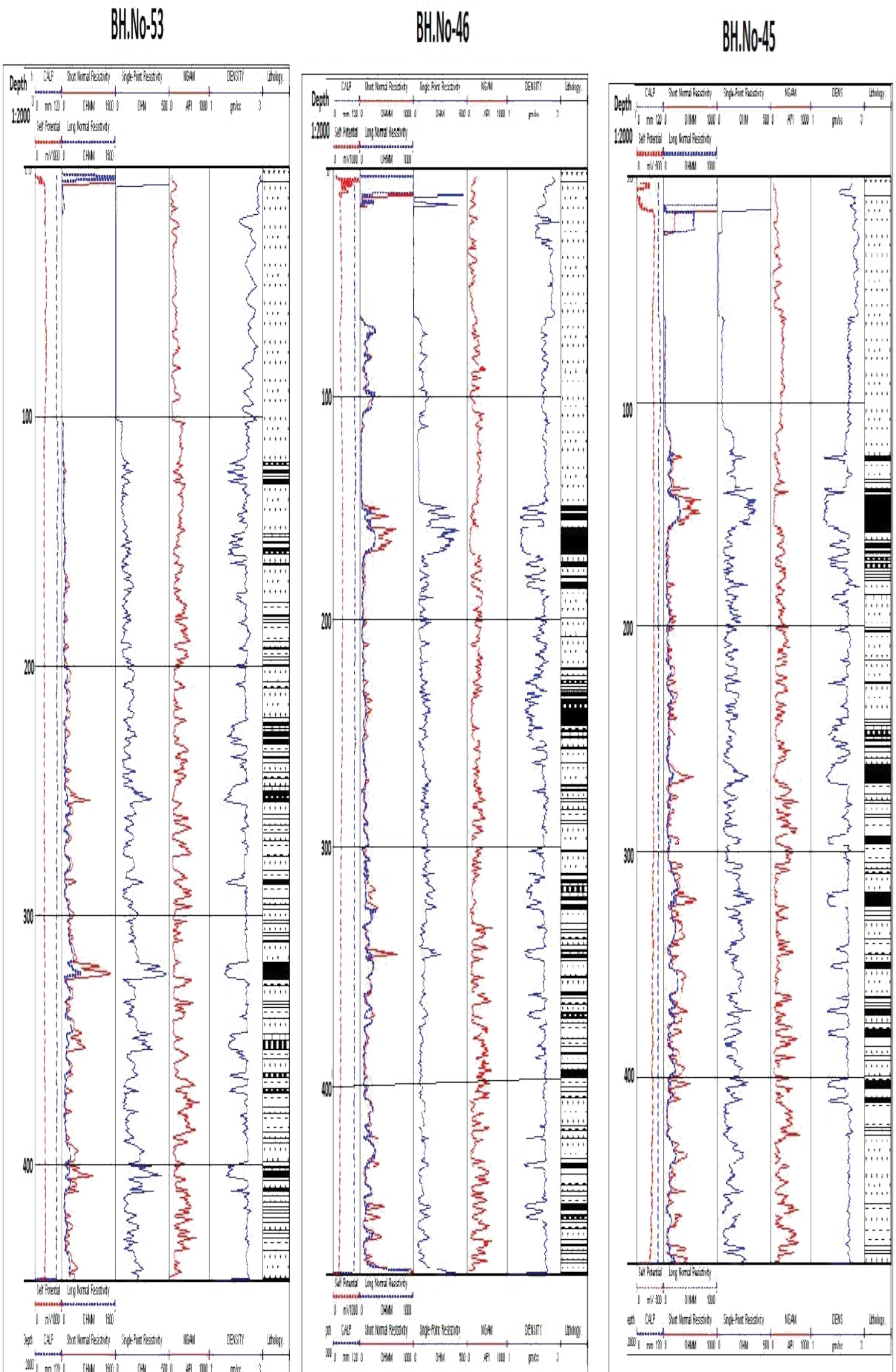

Figure 8: Correlation borehole to borehole (BH. No- 53, 45 and 46).

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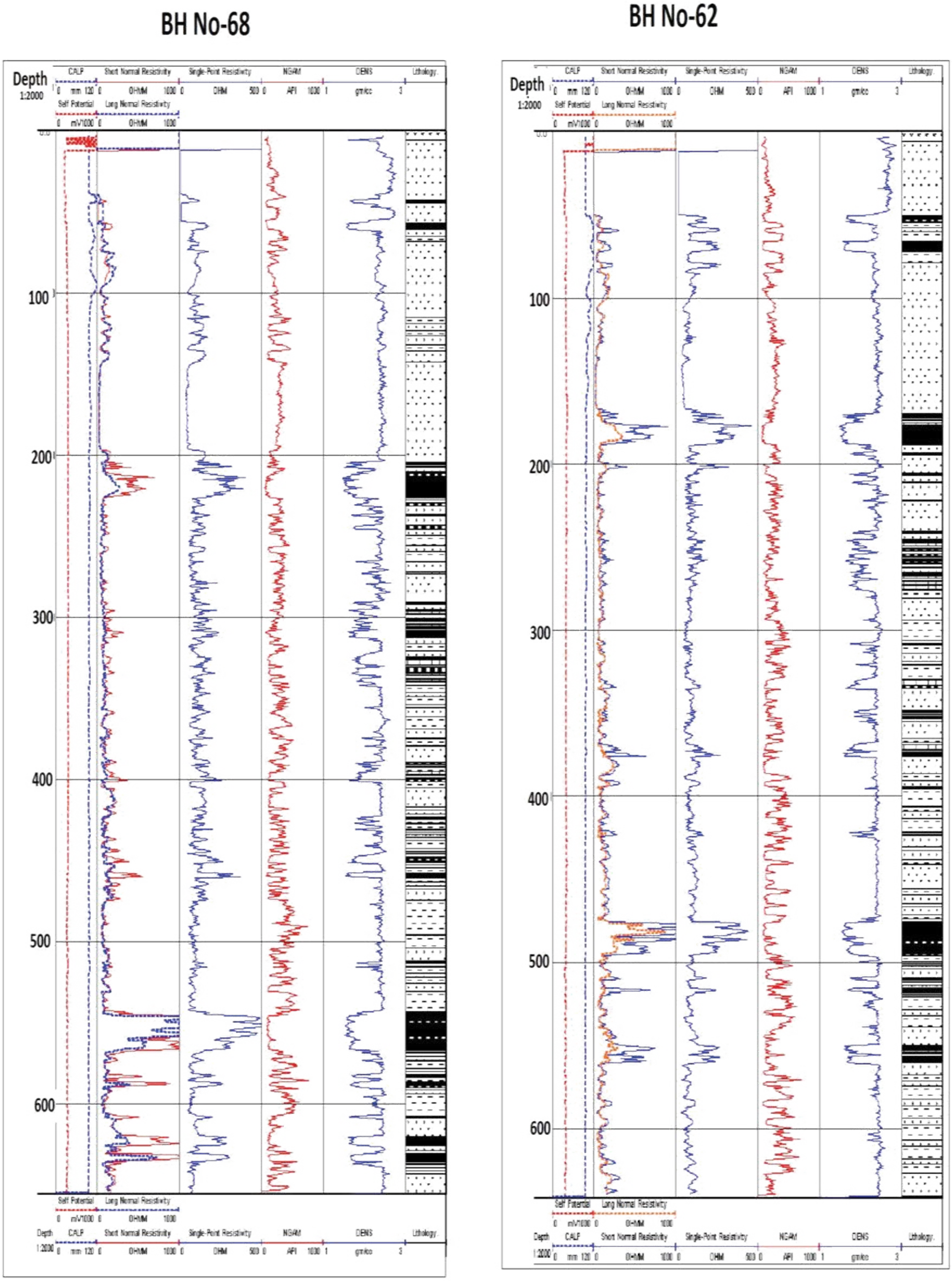

Figure 9: Correlation borehole to borehole (BH.No-68 and 62).

Conclusion

The present work has definite the capabilities of the density, resistivity, natural gamma, self-potential techniques for borehole logging of coal exploration. Correlation of the geophysical well logging data revealed a good agreement, which indicates the usefulness of down hole geophysical techniques, particularly in coal seams depth and thickness. Ten coal seams are delineated at depth range of 41.00 m to 633.00 m, with a minimum to maximum thickness of 1.2 -4.2 m to 5.2-8.7 m from the density, resistivity, natural gamma, self-potential logs in the Auranga coalfield.

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