Original Research Article

The application of digital logging in exploration of Jiang Cang coalfield in Qinghai province

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***Abstract*:** A lot of well logging on to Jiang Cang coalfield in the past work and achieved good results, but due to differ in age, instrumentation equipment and method were different. In order to understand the application effect of the equipment used in the area now and in order to provide the basis for the future working to choose the appropriate logging parameters and well logging interpretation, we chose GJS-1b intelligent engineering logging system produced by Chongqing geological instrument factory in Jiang Cang mining area, we collected the data when cable were ascending, according to "the requirements of the rules of coalfield geophysical logging",. JGS-1b instrument full hole resistivity logging velocity of 3 m/s, the sampling interval was 5 cm, acoustic logging measurement parameter for the acoustic time, adopt the device of single-emission and double-receiving, detector source space was 0.5 meters, 0.7 meters, the full hole velocity was 6 m/s, the sampling interval was 10 cm. In this paper, we introduce the application of multiple well logging methods in coalfield geology through to the logging examples in Mu Li Jang Cang coalfield four field of Qinghai province, the effect was remarkable.

***Keywords*:** digital logging; Qinghai Province coal; geology method application

***Citation*:** Liu ZY, Huo JH, Zhu XG. The application of digital logging in exploration of Jiang Cang coalfield in Qinghai province. Int J Geol 2016; 1(1): 44–49; http://dx.doi.org/10.26789/IJG.2016.006.

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Received: 9th May 2016; **Accepted:** 27th June 2016; **Published Online:** 1st September 2016

Coalfield geology

The stratum included from new to old by various drilling: Firstly, the fourth system[1], the fourth Holocene, there were two genetic types, one was the gravel layer alluvialed by river; the second was modern swamp facies[2], the fourth Pleistocene series: it was mainly consist of the moraine gravel layer and conglomeratic sand loam and was unconformable contact with underlying Jurassic. Secondly, Jurassic system[2], the Jurassic system lie hall on group bore (J3x) in 90 and 171 the north of the line, the upper was mainly consist of purple mudstone, siltstone and sandstone, the middle was mainly consist of mottle porphyritic shale and greyish–green sandstone, the bottom was mainly consist of gray copper post and siltstone, and else red purple mudstone folder black mudstone, accidentally line clip thin coal seams and coal[2], the Jurassic middle kiln street group (Jy) in the exploration zone distribution of large area, as the continental coal-bearing rock series, a total of 19 coal bearing layer, according to the characteristics of coal bearing and plant fossil assemblage (taper leaf fern–thorn kwai flora) can be divided into upper and lower two coal-bearing section and the top of the sand clay lithologic section. On rock section (Jy3) (coal section not included): banded distribution in the central

of exploration area, the whole thickness was 92 m, main lithology for fine-grained sandstone, followed by powder sandstone and mudstone. In the rock section (Jy2) (secondary coal-bearing section): the upper bound for the rock section of the ash - colored layer of fine sandstone and floor for 10 coal floor. Mainly lacustrine siltstone, time for river flood phase fine sandstone, mudstone, siltstone and black clip several layers of lacustrine shale and riverbed, gray sandstone in coal floor is often seen with irregular siderite tuberculosis, 1–10 coal coal bearing. For thick layer at the bottom of the gray thick - medium grained sandstone, 235–356 m thick, generally was 320 m. Rock under paragraph (Jy1) (main coal-bearing section): the upper bound of 12 coal thick sandstone roof, lower bounds for moeller group of celadon of sandstone and conglomeratic sandstone top interface; Local area for large Xigou variegated mudstone and sandstone interbedding rock groups. This section was mainly consist of river, river flood phase of gray, gray sandstone, ash, colored powder sandstone, mudstone and siderite tuberculosis, including coal 11 to coal 20. In the thickness of 186–298 m, generally is 280 m[3], the lower Jurassic big Xigou group (Jd) distribution area was lesser, mainly between 25 to 27 line, north of F8 fault distribution within a small scale. Second in line 29 sporadic exposed hole near 328, nearly east-west distribution of wedge formation, and lower Triassic series moeller on group of the underlying strata (T3M) fault contact, local parallel unconformity contact. North street and Jurassic middle kiln group rock under paragraph (Jy1) continuous deposition. Overall lithology for noise, gray, reddish brown, sage green mudstone and light grey fine sandstone and sandstone interbed, see more along the level distribution in mudstone of silty inclusions, oolitic structure, local oil shale 22–65 m thick, usually about 43 m.

The geophysical characteristics of the situation

The main physical parameters in area include combination features of laterolog-3 resistivity. 0.1 a-m normal resistivity and electric wave, *etc.*, the physical parameters were displayed as follows:

There were two sonic wave holes in the prospecting area. The statistics of longitudinal wave velocity is shown in *Table 1*.

Table 1. The statistics of longitudinal wave velocity in Jiang Cang coal field the fourth field

Lithology	Coal	Coarse Sandstone	Medium Sandstone	Fine Sandstone	Siltstone	Mudstone	Carbon Mudstone
The Longitudinal Wave (km/s)	1.3–2.3	1.7–5.8	1.7–4.2	1.8–4.6	1.8–4.4	1.7–3.9	2.0–3.5

Application effect of the instance

Resistivity logging

According to the results of logging in *Table 2*, sandstone and mudstone in the area and so on all has the feature of low resistance, there was little different between different graded resistivity difference, but it still showed as graded coarsen resistivity has a tendency to increase according to the statistical results, namely $\rho_{\text{coarse sandstone}} \geqslant \rho_{\text{medium sandstone}}$, $\rho_{\text{fine-stone}} \geqslant \rho_{\text{siltstone}}$, ρ_{mudstone}. Within the same drilling, coal seam resistivity than sandstone type rock resistivity 2–3 times, reflect this feature was very obvious on the well logging curve. In a caliper to normal location, coal seam resistivity curve values significantly higher value of roof and floor rock resistivity curve, but if when the coal seam location hole collapse phenomenon, affected by completion fluid resistivity, resistivity coal-bearing area with roof and base rock resistivity value differences become smaller, even no difference (*Figure 1*).

Table 2. The statistics of normal resistivity tool in Jiang Cang coal field the fourth field

Lithology Instrument Model	Coal (Ω m)	Carbon Mudstone (Ω m)	Coarse Sandstone (Ω m)	Medium Sandstone (Ω m)	Fine Sandstone (Ω m)	Siltstone (Ω m)	Mudstone (Ω m)
JGS-1B Electrode System Pipe Locator	33–373	11–275	27–237	17–193	13–182	8–148	10–102
JGS-1B Combination Pipe Locator	55–120	5–55	31–81	24–56	18–44	14–40	11–40

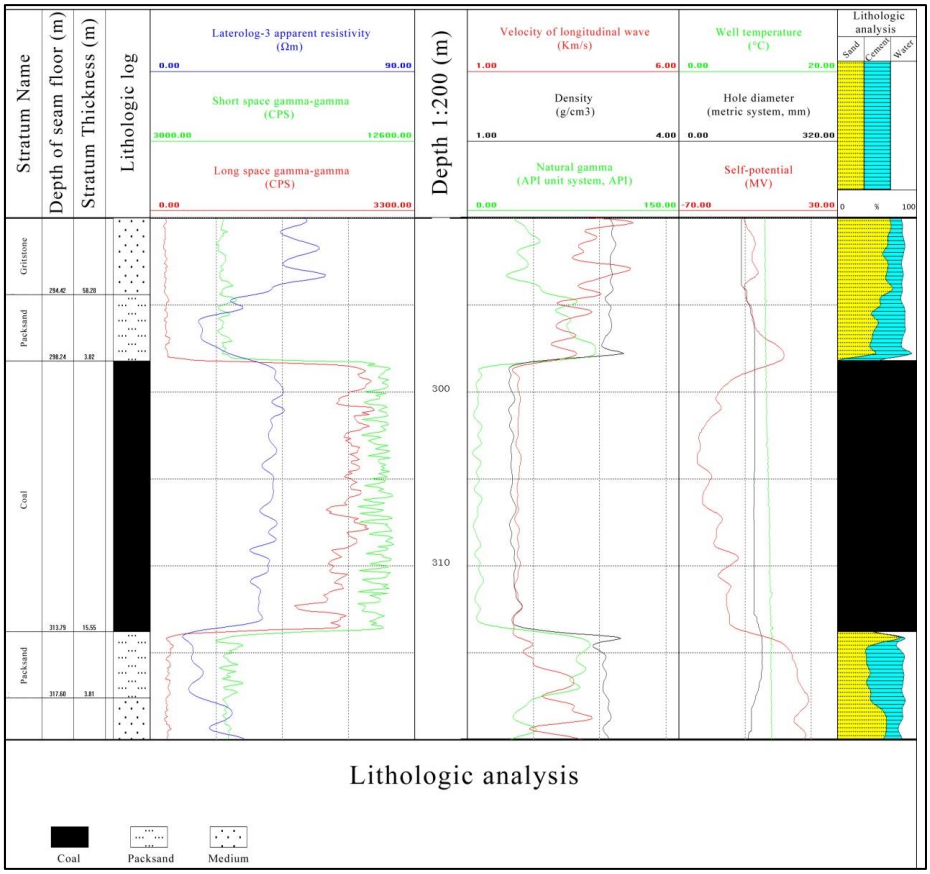

Figure 1. ZK27-1 Acoustic logging curve of coal seam characteristics

Spontaneous potential log

The measurement of the natural potential were executed in all of the seven see coal borehole in the fourth field. exploration phase seven hole, ZK27-2 hole self-potential curve of coal seam no reflection, natural potential of the hole of the other had reflect in the coal seam, compared with roof and base rock, negative self-potential reflect coal seam, but not anomaly amplitude, and the top, bottom line is not clear, natural potential curve can only be used for qualitative explanation of coal seam, the thick interpretation precision is not enough. Holes ZK20-2, ZK27-1 sp curve of coal seam reflected effect significantly, compared with roof and base rock, coal seam area was significantly negative anomaly reflected, anomalous amplitude is larger compared with sandstone low 50–70 mv, and the top, bottom line is clear, the half range values of natural potential point corresponding to the coal seam roof and floor, sp curve can be used as one of the effective parameters of thickness explanation of coal seam. Four Jiang Cang mining area coal seam mining field sp curve features (*Figure 2*).

doi: 10.18282/ijg.v1.i1.5

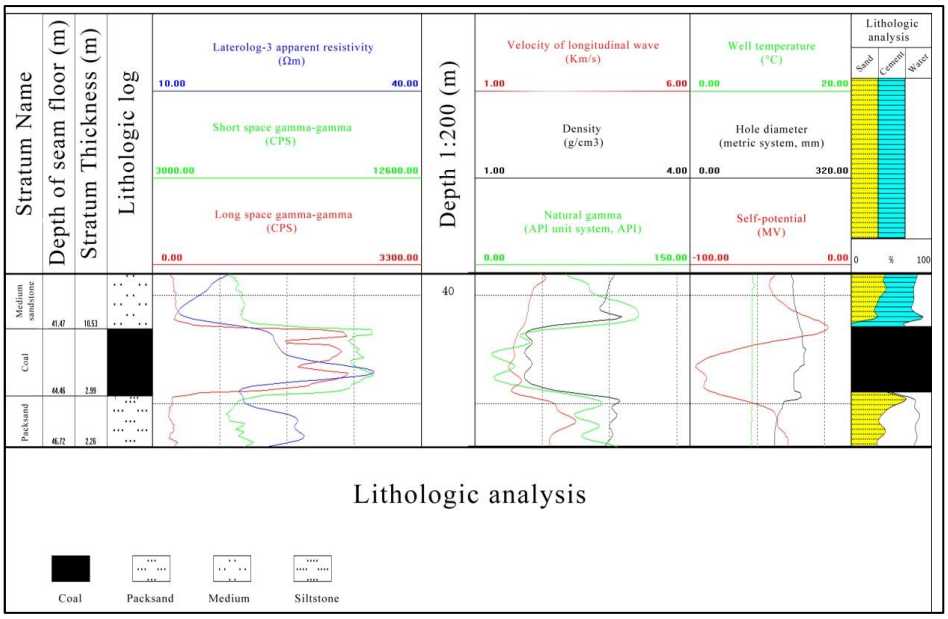

Figure 2. ZK27 SP 1 coal seam parts reflect the situation

But the resolution of sp curve for the sandstone is poor, may be the cause of this phenomenon within the work area drilling construction unit is more, there are large difference between the mud properties, the reflect the effect of the natural potential parameters also is put in bigger difference, but this kind of analysis is shown slightly rough, to be further confirmed in later work.

Acoustic logging

According to *Table 1*, the wave velocity in coal seam was the lowest, coarse sandstone and sandstone in The Times, the fine sandstone and siltstone wave velocity were the highest. Longitudinal wave speed of the sequence from low to high is a coal and mudstone, carbonaceous mudstone, in thick sandstone, fine sandstone and siltstone. Mudstone, carbonaceous mudstone, wave velocity of 1.7 to 1.7 km/s, difference is very small, fine sandstone and siltstone wave velocity of 1.8 to 1.8 km/s, which difference is not big, also on the acoustic logging curve makes it difficult to fine sandstone, siltstone and mudstone, carbonaceous mudstone. The longitudinal wave speed of coal seam and its roof and floor rocks, 1.4–2 times lower in acoustic logging curve is easy to distinguish between them. Logging according to the results in the formation, especially in the wave velocity of coal seams is relatively stable, curve bouncing, which could reflect the area on acoustic logging section of formation is relatively complete, pore and fissure development degree is not high. Four Jiang Cang mining area coal seam mining field acoustic curve features (*Figure 1*).

Through taking rock mechanics analysis by acoustic parameters in Jiang Cang coal field, can also calculate the paragraphs of the rock acoustic velocity, young's modulus, bulk modulus, poisson ratio, shear modulus, rock strength, four in mining field, ZK28 ZK27-1 '2-3 holes in the acoustic measurement, acoustic measurement of drill are calculated to formation rock mechanics properties, the following table is a statistical mechanical parameters for rock ZK27-1 case are shown in *Table 3*.

Table 3. The combination of coal and rock logging features in Jiang Cang coal field the fourth field

Lithology	Coal	Coarse Sandstone	Medium Sandstone	Fine Sandstone	Siltstone	Mudstone
The property of logging curve	High resistance; low voice wave velocity; Low spontaneous potential	Medium and high resistance; Medium and high wave velocity	Low resistance; high Wave velocity	Low resistance; high Wave velocity	Low resistance; Medium Wave velocity	Low resistance; Medium Wave velocity

Calculation results show that the strength of coal rock was lowest, rock strength index was about 90 MPa, followed by carbonaceous mudstone, fine sandstone, sand stone, coarse sandstone and conglomerate rock strength, the highest was 180 MPa. Based on results of calculating the rock mechanics properties, the carbonaceous mud stone belongs to weak stratum; the rock strength index of less than 160 MPa, siltstone and fine sandstone rock strength of medium, rock strength index was 160–175 MPa.

Jiang Cang mining area of four field of fine sandstone and sandstone and siltstone rock strength of medium but not rock strength differences.

As show from the explanation (*Tables 4* and *Tables 5*), according to the thickness and thickness of coal seam depth interpretation principle finally obtained the parameters and explains the differences determine the depth and thickness of the small, conform to the requirements of the specification. ZK7 compares'–2 hole logging interpretation and drilling (*refer to the supplementary file on the journal website for more details.*).

Table 4. The principle to determine about Jiang Cang coal area seam thickness

Thickness of Coal Seam Seemingly (m)	Normal Resistivity	Density	Natural Gamma Ray	Interval Transit Time	Natural Potential
<0.80	half value of amplitude point	2/5 of amplitude point	3/5 of amplitude point	3/5 of amplitude point	half value of amplitude point
≥0.80	heel inflection point	1/3 of amplitude point	half value of amplitude point	half value of amplitude point	half value of amplitude point

Table 5. ZK27-1 Rock mass mechanics parameters TAB

Depth (m)	Lithology	Velocity of Longitudinal Wave (km/s)	Young Modulus (KMPa)	Poisson's Ratio (%)	Bulk Modulus (KMPa)	Shear Modulus (KMPa)	Strength of Rock (MPa)
50-75	Gritstone	2.8–5.8	115–150	0.26	95	60	180
125-130	Fine Sandstone	3.52	140	0.27	95	58	170
320-350	Medium Sandstone	2.2–4.2	135–150	0.26	95	54–60	170–175
515-520	Siltstone	3.0–4.4	143	0.25	95	50–60	160–175
450-455	Coal	2.2	20–30	0.45	80	10	90
612-615	Carbon Mudstone	3.0–3.5	80–150	0.34	90	30-60	140–160

According to the results of contrast, log to reflect the dirt band was very sensitive, some thin layer of dirt band may be due to its high carbon content and the core is broken, although coring drilling rate is high, but the use of dirt band core was still difficult to distinguish, while logging curves reflect very clear.

Conclusion

Logging as a very mature coalfield geophysical exploration technology has been widely used in the field of coal exploration, through the above results show that it can take advantage of the apparent resistivity, sonic, natural potential well logging parameters, such as coal seam effect was remarkable. Acoustic logging can provide rock mechanics parameters

doi: 10.18282/ijg.v1.i1.5

data and can provide the basis for mine exploitation. The log parameters method choose was reasonable, to explain qualitative, thick coal seam principle is correct, accurate and reliable, the information may take part in the calculation of reserves.

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