Evaluation characteristics of coal structure Base on logging data

Youzhi Wang

Exploration and Development Research Institute of Daqing Oilfield Company Ltd., Daqing 163712, China

83520447@qq.com

Abstract. There is rich Coalbed Methane (CBM) resources in south of Huhehu Depression for its multi-set thick coal. The research of coal structure distribution in the study area is not enough that restricts the target optimization of CBM. Base on log curve and core samples, concluding the combination characteristic of different coal structure of gamma ray log resistivity log density log and acoustic log, analyzing the matching relations of coal between macroscopic with microscopic. We can promulgate the law of distribution and controlling factors of coal. The results show that there are four types of coal, type I to the original texture coal, type II - IV for the tectonic coal. Type I gamma curve is box, such as micro bore and pore exist; type II coal resistivity curve amplitude decrease is wavy and contribution of micro bore for the surface to volume ratio is increasing; The log curve of type III is campaniform or reversed campaniform; The log curve showed irregular M. The coal damage degree is most serious, microporous dominant. The fracture distribution of Jiangjunmiao and Hushumiao tectonic zone has obvious control effect for coal structure. Type IV around two fault zones, type I are mainly distributed in the middle of the sub-sag, fracture control function is weak. Type II and type III has the characteristics of the transition. Therefore, the application of the method can be qualitative judgment coal damage and pore microstructure, provided the scientific basis for coalbed methane development work.

Keywords: characteristics of log curves, coal structure, pore structure, law of distribution, Huhehu depression.

1. Introduction

Coal begins to receive widespread attention as an unconventional reservoir which is widely distributed with special structure [1]. Its macro-scale is closely related to its micro-pore structure, and both together control enrichment and output of coalbed methane (CBM) [2-3]. Some scholars tried to predict structures and distribution characteristics of different coal by evaluating coal structure using logging information [4]. The micro-pore structure of coal has an important impact on adsorption and seepage capacity of coal. This is because form, size and connectivity of coal change in different deformation, and the change can lead to gas dispersion in a different mode. This paper intended to find out the coalbed logging curve combination features of the south of the Huhehu depression, explore coal structure and micro-pore characteristics in different logging curve forms, and reveal the regularities of distribution of coal reservoir.

2. Geologic features

The Huhehu depression is a dustpan-shaped faulted sag that faults to the east and overlaps to the west. It is adjacent to Xilinbeier uplift to the east, connected with the Bayanshan upheaval to the west, neighboring Yimin depression to the north, and linked with Mongolia to the south [5]. Two tectonic zones and one syncline develop in the south of Huh Lake depression (Figure 1), namely, Jiangjun Temple tectonic zone (I), East Bayangun syncline (II) and Hushu Temple tectonic zone (III) from west to east in succession. At present, the second section of Dameguaihe Group is an important prospecting seam section with its thick coalbed, stable development and moderate depth .

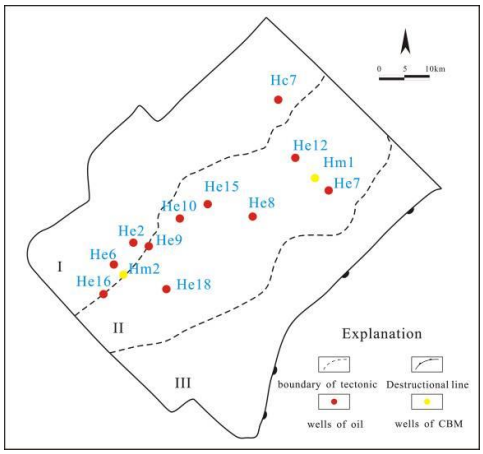

Fig.1 Plane position of study area and classification of structural unit

3. Logging curves and model features

3.1 Logging curve features

(1)Gamma logging features: Pores and cracks develop better in structural coal. The gamma value of structural coal is greater than that of primary structural coal because of action of dirt band and stratum water rich in radioactive elements in coal.

(2)Resistivity logging features: The specific resistivity of structural coal decreases with its low global hardness, strong water bearing and good electrical conductivity.

(3)Acoustic logging features: Structural coal is more cementitious and loose than primary structural coal, with well-developed pores. Generally the sound wave spread speed in structural coal is less than that of primary structural coal.

(4)Density logging features: Structural coal contains more impurities with invasion of stratum water into its fractures, so that coal purity decreases and the density curve value increases remarkably.

3.2 Logging model features

It is believed that there are the following four types of coal in the coal seams in the south of Huhehu depression based on coring observation and sample test in two CBM wells and the logging curve combination features of 11 oil-gas wells in the research area.

Type I: The coal is described in the box-type curves of gamma value, specific resistivity and density, with steep interface and smooth or slight wave in peak point (Figure 2a and b). It forms mainly in primary structure, with pure coal quality and perfect structure. No fissure is observed, but it feels harder in strength by hand. The pore diameter for this type of coal shows a two-peak type (Figure 3a), and the pore area accumulation curve goes up in a linear way, indicating the micro-pores contributes to the same specific surface area with small holes.

Type II**:** Compared with Type-I coal, the Type-II coal presents a dentate gamma curve with a high gamma value. Its electrical resistivity decreases in a wavy shape, and its density and acoustic curve shows a dentate undulation (Figure 2c), indicating the coal is destroyed to some extent in the abnormal position of the curve. It has more fractures than Type I coal in structure. After the coal structure is destroyed, small holes are in less proportion than that of Type I (Figure 3b) but to a smaller degree. This demonstrates micro-pores increase gradually in quantity; accordingly, its more contribution is made to specific surface area.

Type III: Its gamma and electrical resistivity curves are bell-shaped or in a converse bell shape, and then its density and acoustic curves change accordingly (Figure 2d). Due to tectonic impacts, this type of coal shows more severe smashes at the beginning or end of its formation. There is a transition of small holes to micro-pores in coal pore (Figure 3c).

Type IV: The remarkable features for this type of coal are: gamma value and electrical resistivity curves are shown in an irregular M-shape; density curve is mainly presents in a ladder pattern or a bell shape, and the acoustic curve is wavy or finger-shaped (Figure 2e and f). These abnormal features

result from the large-scale interformational sliding of coal, so as to form fragments at 1-5cm in diameter. It is seen from Figure 2d that micro-pores take hold, the cumulative pore area curve becomes very steep at r≤10nm, while it is sluggish gradually at r≥10, indicating micro-pores take up maximum pore volume in coal.

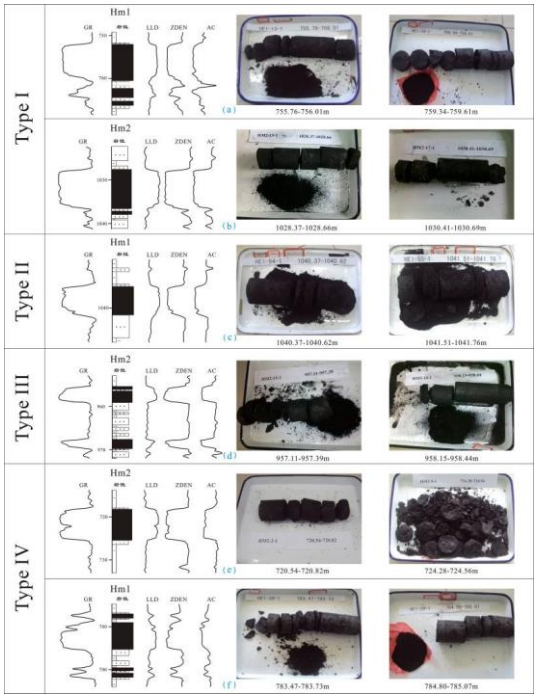

Fig. 2 characteristics of different coal composition and core photo

4. Distribution and main controlling factors of coal

The type-I coal is mainly primary structural coal, distributed in the center of the depression. Its coal seam has a striped distribution in the same direction with the basin, and becomes thin and even disappears gradually to four directions. It is seen from Figure 4a that no fault develops nearly within the distributing area of coal seam. There is a stable coal-forming environment, and the coal gathering center is just the syncline center, indicating two sides of faults show a certain control action to coal distribution, but have no direct impact on the whole coal structure. Thus, coal remains a relatively primitive state in a macroscopic or microscopic view.

Type-II coal is distributed widely, but it is not seen only at the edge of the basin. Its coal seam is thick or thin alternatively from south to north, and r directs to northeast. Based on demonstration of logging curves, the coal is destroyed to some extent in structure. This is because in the sediment of this set of coal seam, the lake surface covers both Jiangjun and Hushu Temple tectonic zones with its further expansion; the lake pool becomes a main coal accumulating environment. It is concluded that the normal fault activity in development of this tectonic zone destroys the coal seam structure, but it still has a weak control to coal seams. The coal accumulating center is always distributed along the East Bayangun syncline.

Figure 4c shows that the Type-IV coal seam is mainly distributed in two fault zones at the intersections of three tectonic zones, and doesn't develop in the middle of syncline zone and two sides of the depression. The thick seam is close to the major dislocation, indicating the fault has an obvious control to the accumulation of seams. As the largest-scale dense zones of faults developed in the depression, both Jiangjun and Hushu Temple tectonic zones have stronger destruction to coal structure. Type-III and Type-IV coals are distributed similarly, and they are destroyed relatively less due to their thinner developed coal seam. The tectonic zones form the fault terrace stripes in different altitude differences in the impact of tectonic rising and fault activity. The Hushu Temple tectonic zone is situated in a steep slope with a bigger fault fall. In addition to multi-provenance and nearby

provenance, it has better sediment control. For this reason, the coalbed thickness of this tectonic zone is greater than that Jiangjun Temple tectonic zone.

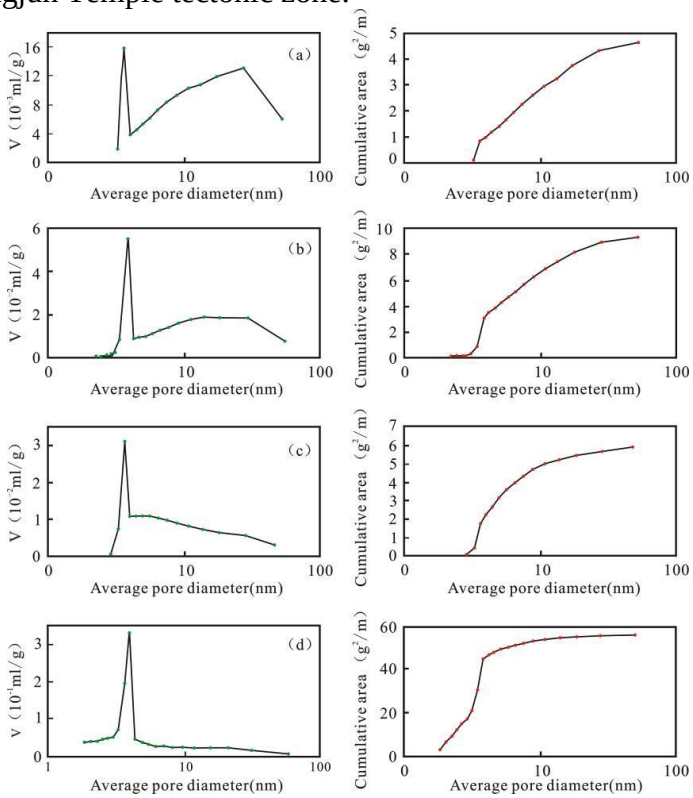

Fig. 3 Distribution curves of aperture and bore area of different coal composition

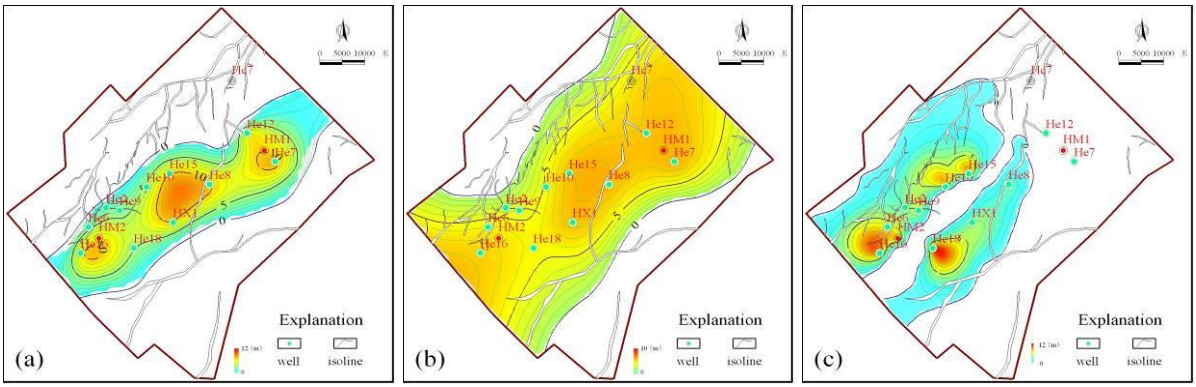

Fig. 4 Distribution graph of coal I, II, IV in Huhehu Depression

5. Conclusions

(1)The coal body has the different logging curve combination feature because of difference of coal structure in the south of Huhehu depression: Type-I coal develops mainly in primary structure. Type II and IV form structural coal, with stronger destruction, and their pores increase accordingly in quantity.

(2)The faults developed from Jiangjun and Hushu Temple tectonic zones show a significant control to coalseam structural distribution. Type-I coal is mainly distributed in the center of the depression, with weaker control to fault. Type-IV coal is distributed around two fault zones, and both Type II and III are featured a transition distribution.

(3)According to studies, the approach by combining coal structure with micro-pore structure can provide the scientific bases for qualitative judgment of destruction to coal, and it is of important reference significance for CBA development. Due to limits of data, the further in-depth study should be done for quantitative evaluation in the future.

References

[1] Y. Qin: Advances in overseas geological research on coalbed gas: Origin and reservoir characteristics of coalbed gas, Earth Science Frontiers, 12(2005) No.3, p: 289-298.

[2] Q. L. Hou, H. J. Li, J. J. Fan, et al: Structure and coalbed methane occurrence in tectonically deformed coals, Science China, 42(2012) No.10, p: 1487-1495.

[3] M. F. Zhang and Q. Jia. Impacts from tectonic deformation on coal reservoir pore geometry and specific surface, Coal Geology of China, 25(2013)No.7, p:1-4.

[4] F. Y. Chen, Y. W. Ju, X. S. Li, et al: Diffusion-osmosis characteristics of coalbed methane in tectonically deformed coals and theirmechanism, Earth Science Frontiers, 17(2010)) No.1, p: 195-201.

[5] H. B. Wu Haibo, J. H. Li Junhui and H. Liu: Types of structural slope-break zone and its controls on sand bodies and hydrocarbon of Huhehu depression in Hailar basin, Acta Sedimentology Sinca, 31(2013) No.2, p: 358-364.