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Coalbed methane reservoir characteristics and well logging evaluation method

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Abstract: -Because the coal seam has the characteristics of double porosity, well logging evaluation method suitable for conventional natural gas cannot explain the correct interpretation of coalbed methane. It is necessary to build a new logging evaluation method on coal seam gas content, permeability, matrix porosity and fracture pore for correct interpretation method. This paper based on the investigation of a large amount of literature data, analyzed some characteristics of coal bed gas in the reservoir and various logging parameters in coal seam. Using the "four high and four low" logging response characteristics of the coal seam to accurately identify the coal seam. Finally, a calculation formula for calculating gas content in coal bed is given.
Key words:*-coalbed gas;gas content;porosity;double porosity*

I. INTRODUCTION

The main component of coalbed gas is CH_4, is stored in the coal seam methane as the main component, the adsorption of hydrocarbon gas in the coal particle surface, free from the coal pores or dissolved in the water of the coal seam.Coal bed gas is the associated mineral resources of coal, which belongs to unconventional natural gas. The coal seam has the characteristics of dual porosity medium, which is composed of the micro pore of coal and the system of cutting. Coalbed methane showed three kinds of state exists in coal,namely the molecular state adsorption at the inner surface of the microporous matrix; free gas state exists in cracks and dissolved in the formation water of coal seam, so the traditional evaluation method of conventional gas reservoir cannot be suitable for the evaluation of coalbed methane reservoir.

CBM well logging technology is considered as one of the most promising means, once the log data is calibrated with coal core data, the characteristics of coalbed methane reservoir can be estimated using well logging data. The logging interpretation has the characteristics of fast and intuitive, high resolution, low cost and so on, it can make up for the deficiency of coring, well testing and coal analysis. Therefore, well logging is an important method in CBM exploration and development in the study of coalbed gas logging evaluation technology has very important significance and broad application prospects. This paper will start with the study of the characteristics of the coal seam, and the selection principle of the coalbed methane logging series, and further study the relationship between the coalbed methane and the logging parameters. And using the existing logging data, using a variety of mathematical models to calculate the porosity and permeability of coal seam, and then estimate the gas content of the coal seam.

II. POROSITY CHARACTERISTICS OF COAL SEAM

The porosity of coal seam is composed of fracture and matrix pore system. Therefore, The porosity of coal seam can be divided into two kinds of cleat (fracture) porosity and matrix porosity, and The sum of the two is the total porosity of the coal seam.

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Cleats are coal seam coalification, metamorphic and tectonic effect of a series of processes in the formation of endogenous fracture system, according to the extension of the length of different points to face cleat and end cleat, face cleat and level parallel, end cutting and perpendicular to the plane. Cutting theory generally does not wear layer extension[1].

In addition, the coal seam and the structure of the larger cracks, such as fracture, wrinkle, uneven compaction caused by. Generally, before the mining of in-situ cracks, not containing gas, it has nothing to do with the gas content. These cracks are only the channels to provide fluid flow, that is only related to permeability.

The matrix micro pore space is developed in the coal block, which has a great inner surface area and is the main reservoir space of the coal bed gas. The coal seams are divided into small blocks, called matrix (bedrock) blocks, by roughly perpendicular to each other. In the matrix block developed pore pore, according to the size of the division for the big hole (φ>50nm) and hole (2nm<φ<50nm) and micropores (φ<0.8nm), the theory research and practice show that, within the pore surface area general only with micropores, and the size of the pore volume mainly by the hole decided. Matrix pore is the main site of adsorption gas, which is independent of the

permeability. The pore characteristics are controlled in rank, coal macerals, mineral content and coal structure etc[2].

III. LOGGING RESPONSE OF COALBED METHANE RESERVOIR

Overall, the log curve of coal seam is mainly characterized by "four high and four low".

(1) High acoustic time. Due to the coal bearing strata are mainly distributed in the Carboniferous and Permian and Jurassic strata, the strata generally experienced strong buried deep compaction, sandstone and mudstone sonic basic between 200 ~ 300 $\mu s / m$ and the characteristics of coal seam is high acoustic time very obvious.

(2) High compensated neutron. It can be used to determine the depth and thickness of the coal seam by using the neutron porosity logging curve. The neutron porosity of coal seam is generally 50% ~ 40%, and the porosity of the surrounding rock is obviously different.

(3) High resistivity value. The resistivity of coal derived gas reservoir is generally higher than that of adjacent water layer, so it is often used to identify and evaluate the coal forming gas reservoir by using bilateral or dual induction logging.

(4) High caliper value. Due to the soft coal seam, the cutting theory and the development of the drilling, the easy to expand diameter, which makes the well diameter enlargement rate[3].

(5)Low natural gamma value. It is similar to the sandstone and carbonate strata, because it does not contain highly radioactive clay minerals, coal seams also have low natural gamma value, which is slightly lower than that of sandstone, which is slightly higher than that of carbonate rock.

(6)Low compensation density. By the coal seam molecular composition, the value of the bulk density of coal in 1.2 ~ 1.75g/cm3, compared with other strata, the characteristics are very obvious [4]. Compensated density logging is one of the most effective logging methods used to determine the coal seam.

(7)Low effective photoelectric absorption cross section. Carbon, hydrogen, oxygen low atomic number determined that the effective absorption of coal cross section only about 1.0b/e, and the oil and gas and water close to the lower than any other strata.

(8)Low acoustic impedance. Acoustic impedance is equal to the product of the velocity and density of the medium, and the acoustic impedance of the coal seam is lower than that of the other strata.

Besides, in the natural potential well logging, based on the natural potential of mudstone, (1) Fresh water mud, coal seam corresponds naturally to a potential negative anomaly. (2) the brine mud, coal seam corresponds naturally to a potential for positive anomaly. And study sedimentary facies and tectonic study of diplog; used to obtain the mechanical parameters of rock acoustic wavetrain logging; used for the analysis of coal pore size distribution and porosity of coal seam is determined, water saturation estimated formation permeability of nuclear magnetic resonance imaging logging and so on. All of these play an important role in determining the parameters of coal seam.

Through the well logging response characteristics of the coal seam obtained above, we can easily divide the coal seam. The following figure is a typical coal seam logging response characteristics in a region[5].

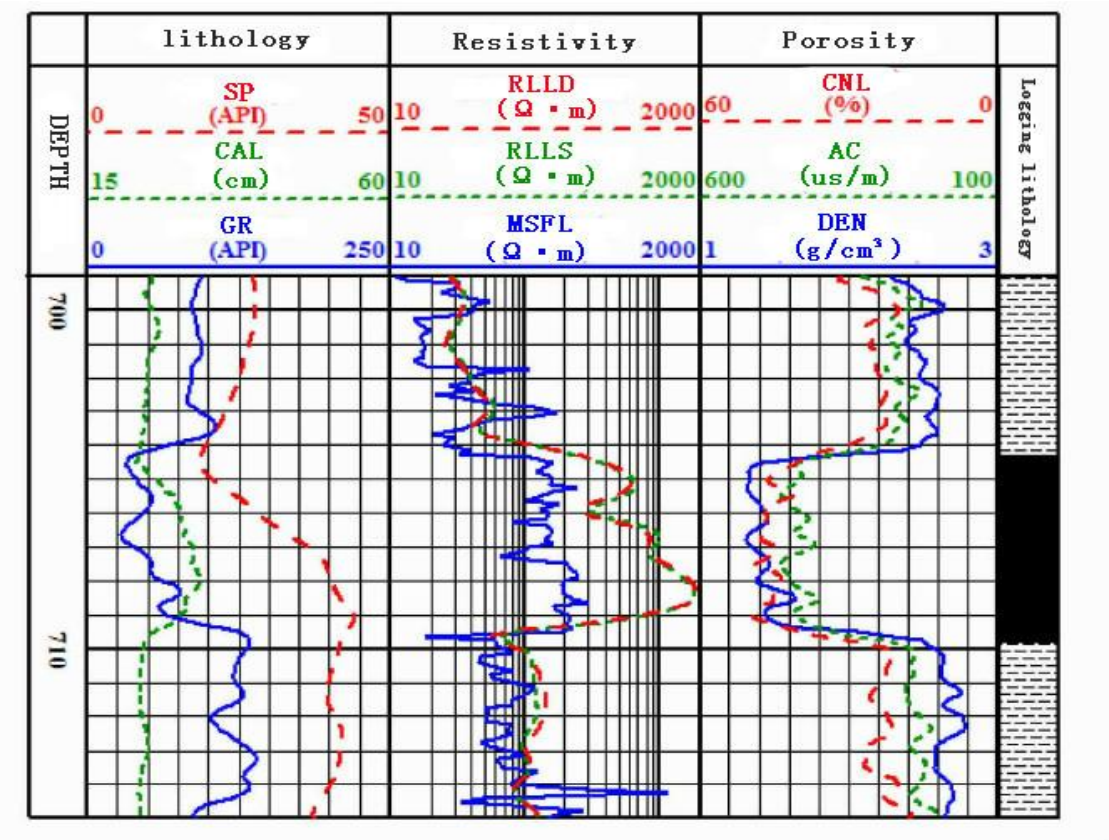

Fig 1 typical coal seam logging response characteristics

From Figure 1 can be seen in depth in the area of 704 ~ 710m range, the performance of the spontaneous potential curve A is a positive anomaly, with increasing hole diameter, natural gamma for low value, significantly increases the resistivity logging curve, and deep, shallow laterolog curves almost overlap, compensated neutron and compensation acoustic curve is greatly increased. At the same time, density curves for low value. Therefore, we can explain the depth of 704 ~ 710m for coal strata in this area.

IV. GAS CONTENT IN COAL SEAM

If the shale content is low, the resistivity is relatively high, and the gas test shows good, then it can be interpreted as the coal bed, otherwise it will be interpreted as the gas bearing layer.

Using longitudinal and shear wave velocity values can also be determined content of coalbed methane is good or bad, generally using longitudinal and shear wave velocity value 1.8 as gas of good and bad line: when the longitudinal and shear wave velocity value is less than 1.8 could explain for coal seam gas, or gas bearing.

We generally use the next type of calculation of coalbed methane content:

$$\frac{\rho_b - \rho_b^*}{V_r} = \Delta\rho \tag{1}$$

Where ρ_b is coal bed density log value after adsorbed methane gas;$\rho_b^*$is coal bed density log value before adsorbed methane gas; V_r is volume percentage of combustion; $\Delta\rho$added value of combustion mass density after adsorbed methane gas.

V. CONCLUSION

The unique dual porosity of coal seams is mainly the influence of the matrix porosity on the coalbed methane content.at the same time, the fracture porosity affects the permeability of coalbed methane. The logging response characteristics of coalbed methane reservoirs are mainly "four high and four low"."Four high" refers to the high acoustic time difference, high compensation neutron, high resistivity value and the expansion rate of the well diameter. "Four low" refers to low natural gamma, low compensation density, low acoustic impedance and low effective photoelectric absorption cross section. Moreover, natural potential logging and formation dip logging, acoustic full waveform logging, nuclear magnetic resonance imaging logging logging method for identification and classification of coal seam provides important data.

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