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Study on fine logging interpretation of complex formation water profile

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Abstract: Wu Erhe Oilfield belongs to medium porosity, low permeability oil reservoir, and is intensively heterogeneous. The salinity of formation water is changeable, oil and water layers are difficult to identify. Reservoir petro physical property changes greatly, and the distribution of oil and water is complex. These have brought many difficulties to fine logging interpretation. In accordance with the changeableness of formation water resistivity, the resistivity is calculated by comprehensively using of multi methods on the basis of clear understanding of formation water distribution both laterally and vertically, and fine logging interpretation has been performed as a focal point. The improvement in logging interpretation accuracy of petro physical parameters like water saturation has provided reliable basic data for geological modeling and reserve calculation.

Key words: *complex formation water profile; logging interpretation; formation water; distribution law; calculation; Wu Erhe Oilfield*

I. PREFACE

Wu Erhe Oil field belongs to the fault nose structure conglomerate reservoir, its main characteristic is the high porosity, low permeability, and with glutenite reservoir in fan delta deposits, the reservoir is more and the thickness is thin on the longitudinal. The oil and water has the complex relations; Formation water resistivity changes largely in the vertical and horizontal, the oil layer and the water layer identification is difficult and Water saturation interpretation is inaccurate. For this reason, clear the distribution of formation water and precisely calculate the reservoir parameters has been taken more and more seriously. So, it is necessary to use the logging data to calculate the formation water resistivity and establish the logging interpretation model of reservoir parameter in this area, then to carry out fine reservoir description and further deepen the understanding of reservoir.

II. THE DISTRIBUTION REGULARITY OF FORMATION WATER

The formation water in Wu Erhe Oil field has the complex relationship and changes grately in the vertical and horizontal. The region's oil reservoir has the complex oil-water relationship, the oil and water without a certain distribution and the reservoir can be comparative difference between adjacent Wells; The regional water properties change largely, the water salinity is between 1×10^{-3} mg/L and 70×10^{-3} mg/L; In the water saturation interpretation of the past, often to the whole block using a R_w numerical value which leads to water saturation interpretation is not accurate.

The study found that regional water type mainly calcium carbonate and calcium chloride. The formation water salinity is mainly affected by sedimentary water environment and the buried depth and so on. Through the analysis of the large amounts of water data we learn that the main formation water type is sodium carbonate, formation water salinity is bigger and the formation water resistivity gradually become smaller from shallow to deep in Wu 6 well block; In the eastern of Wu 13 well block, the mainly formation water type is sodium chloride, in addition to sodium carbonate and calcium chloride and K_s'water layer resistivity is smaller which is 0. 20 ～ 0. 38 Ω ·m but the K_x'water layer resistivity is bigger which is 0. 6 ～ 0. 77 Ω·m ,this is because K_x is controlled by the faults.

III. THE CALCULATION OF FORMATION WATER RESISTIVITY

Formation water resistivity is an important parameter when using the logging date to calculate oil saturation. There are 7 kinds of method to make sure the formation water resistivity: ①According to the sample of formation water to determinate; ②According to the results of formation water chemical analysis; ③According to the sp to calculate; ④According to the standard water layer; ⑤Using the resistivity-porosity cross-plot to get; ⑥Using the R xo/R t ratio method to calculate; ⑦Using the R_{wa} –SP cross-plot to calculate.

Considering the geology of study area and the complexity of formation water data and the spontaneous potential logging curves is not very obvious in the whole well section, For this we mainly determine R_w comprehensive use the②、④and ⑤methods.

2.1 According to the results of formation water chemical analysis to confirm R_w

By the analysis of the formation water of each ion concentration C_i calculates the total salinity $T_c = \sum C_i$. According to the Tc calculate the weighted correction coefficient a of each ion concentration, then calculate the equivalent salinity for NaCl solution is $\sum C_i \cdot a$. At the end, the formation water resistivity is determined by NaCl solution salinity and the formation temperature.

2.2 According to the standard water layer determines R_w

Standard layer refers to the pure water-bearing formation, the formation water resistivity calculated by the following formula:

$$R_w = R_o \phi^m \qquad (1)$$

In the formula：R_o—pure water formation resistivity

ϕ —porosity

Standard layer determine R_w must satisfy that：①Standard layer which selected in explaining formation must be 100% Water-bearing formation that with large thickness and porosity; ②With the numerical value ϕ of the porosity log obtained is reliable and the parameters of the interpretation *m*&*a* is known.

2.3 Using the resistivity-porosity cross-plot to get R_w

According the water line of resistivity-porosity cross-plot to calculate the formation water resistivity . In the line for a point, read the porosity and resistivity of this point, Then input parameters *a*,*b* and *m*, the formation water resistivity can be calculated. The application conditions of resistivity-porosity cross-plot to calculate the formation water resistivity is that in interpreting layer has the pure water-bearing formation and formation water salinity is stable.

From the results of comprehensive utilization of the three kinds of method to calculate formation water resistivity can be seen that the formation water resistivity larger changes in the vertical and horizontal upward, therefore when explain water saturation the study area should be divided into six blocks on the transverse and three layer groups on the longitudinal respectively to calculate the Rw.

IV. THE ESTABLISHMENT OF THE LOGGING INTERPRETATION MODEL OF RESERVOIR PHYSICAL PARAMETERS

Application of log data can accurately calculate water saturation S_w of the reservoir And determine

the nature of the fluid. At present, saturation calculation equation has two basic classes: One kind is based on commensurate porosities and single medium saturation equation and the other is based on cracks and pores saturation equation. Saturation equation on the basis of a single medium to the lithology and pore structure was homogeneous sandstone reservoir can get satisfactory effect and to the heterogeneity of cracked sandstone reservoir the error is bigger. Sandstone reservoir in this area is mainly composed of pore type. So, based on rock electricity experiment of archie formula to calculate water saturation S_w

$$S_w^n = \frac{a \cdot b \cdot R_w}{\phi^m \cdot R_t} \tag{2}$$

In the formula: R_t—formation resistivity $\Omega \cdot m$;

m—bond index;

n—saturation index;

In order to improve the logging interpretation accuracy and reliability of the oil layer, we take Litho-electric experiment data of 11wells in this study area for processing and get within the numerical value of *m, n, a, b* in the area and its changing rule.

Using the core physical property data of coring wells, established the interpretation model of reservoir parameters such as porosity, permeability by the method of regression analysis.

New well porosity is obtained by using the formula of type 3 and the old well porosity is obtained by using the type formula 4.

$$\phi = 147.663 - 52.384\rho_r (n = 65, R = 0.974) \tag{3}$$

$$\phi = 0.615AC - 31.257(n = 92, R = 0.937) \tag{4}$$

In the formula: ρ_r —formation density g/cm^3;

AC—acoustic time μ s/f$_t$

V. CONCLUSION

(1) Through interpretation has been clear about the study area resistivity of formation water distribution in plane and vertical and use a variety of methods to calculate the formation water resistivity which in order to improve the interpretation precision of water saturation laid a foundation.

(2) Using the established model for calculating the reservoir physical parameters, getting the interpretation of more than 300 Wells in the area, the effect is good, which provides the basis of accurate parameters for geologic modeling and calculation of reserves in the region.

REFERENCE

[1] Yong Shihe Zhang, Chaomo. Integrated logging data processing and interpretation [M]. Beijing: petroleum industry press, 1996.

[2] Sun Lingfen, Qin Fei. Logging interpretation method of low salinity formation water complex profile study [J]. Journal of fault block oil and gas fields, 1999 (5) : 43 ~ 44.

[3] Huang Futang, Zou Xinfang. Main acids formation water research on influencing factors of reservoir property [J]. Journal of daqing petroleum geology and development, 1998 (3) : 13 ~ 16.

[4] Li Chaoliu, Li Guoping, Su Jianjie. The influence of formation water parameters of well logging interpretation study [J]. Journal of natural gas industry, 2000, 20 (1) : 41 ~ 44.