SECONDARY PROCESSES AS INDICATORS OF PRODUCTIVITY IN LOW-RESISTANCE RESERVOIR

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A variety of oil and gas saturated deposits have been discovered in Western Siberia over the past 30 years, including rocks with abnormally low specific electrical resistance. Such reservoirs with low resistance are in most cases identified as water-saturated and are not accounted for the conventional well logging.

Such specialists and scientists as F.Ya. Borkun, V.G. Vinogradov, K.I. Sokova, V.V. Semenov, E.I. Leontiev, R.A. Shishkin, O.G. Zaripov, V.P. Sonich and others have been studying this issue. On the researches basis of the authors' data it is possible to draw a conclusion that metasomatic processes occur in aqueous solution, producing uncompensated electric charges. Cations formed as a result of metamorphism reduce the total electrical resistance of the rock and create inter-layer conductivity. Thus, secondary processes lead to a decrease in the formation specific resistance due to the accumulation of charge on the surface, and the higher their concentration, the lower the electrical resistance. Thereby, determination of intensity of secondary processes and the degree of their influence on the rock resistance is a relevance task. The innovative technology of statistical well logging interpretation using data from new and old material stocks can lead to additional geochemical information increasing the possibility of finding previously omitted hydrocarbon deposits.

The new technology of statistical well logging interpretation is based on the following principle: if an epigenetic process is the cause of simultaneous changes in two (or more) of the studied characteristics of the rock, statistical parameters of correlation dependencies between samples of characteristics will show the impact of process intensities on the rock. Statistical intensity of secondary processes:

$$i=YR^2$$

includes such parameters, where the approximation coefficient (R^2) shows a qualitative measure, but the interval parameter (Y) a quantitative measure of statistical regression bonds. The technology of statistical well logging interpretation is created on the basis of a unique software set based on the old well logging data that makes it possible to calculate the intensity of such secondary processes as: pyritzation, kaolinization, carbonation, pelitization, formation of electrical double layer.

The results of the core laboratory tests confirmed the accuracy and reliability of the technology.

As the intensity of secondary processes rises, the inter-layer conductivity and cation concentration in the double electric layer also increase. This increases the electrical conductivity used in the conventional well logging.

Let's consider the possibility of increasing the efficiency of detection in the lower and middle jurassic oil-saturated deposits by means of the innovative technology of statistical well logging interpretation on the basis of the old data. For this purpose, 22 oil-saturated and 98 water-saturated sand reservoirs were examined via wildcats and exploration wells of the Tomsk region [3].

Let's assume that initially all the sand reservoirs were interpreted by the standard well logging as prospective oil-saturated deposits. The success rate in this case:

$$Kstandard= 22/120 \approx 0,18.$$

Such a low success rate is associated not only with the assumption that all tested sand deposits were initially interpreted as prospective oil-saturated formations, but also with the use of the conventional well logging interpretation.

The innovative technology of statistical well logging interpretation was used to examine the Lower and Middle Jurassic sand formations of the Tomsk region deposits. Thus, the values of the intensity of pelitization, pyritzation and a double electric layer may indicate the presence of oil and gas in sandy zones.

Table

Average results of statistical well logging interpretation for oil-saturated and water-saturated zones in the Lower and Middle Jurassic of the Tomsk region

Composition	$<i_{pyr}>$, unitspiritization intensity	$<i_{kaol}>$, unitskaolinitization intensity	$<i_{DEL}>$, unitsStatistical parameter DEL
Oil	0,17	0,09	0,24
Water	0,18	0,11	0,16
Oil/Water	0,89	0,82	1,5

The values of secondary processes intensity of pyritzation, kaolinization, statistical parameter of DEL and pyrite content in 120 tested formations of Lower and Middle Jurassic (for 98 non-productive and 22 oil-saturated) were averaged.

The analysis of the table results indicates a slight decrease in the intensity of secondary processes in the productive zones. Also, the average value of i_{DEL} parameter in the zones with oil is 1.5 times higher than in the zones with water, which

indicates an increased electrical conductivity of oil-saturated sandstones compared to water-saturated sandstones [3]. Thus, it follows that this parameter can be used to find pay zones in the Lower and Middle Jurassic deposits.

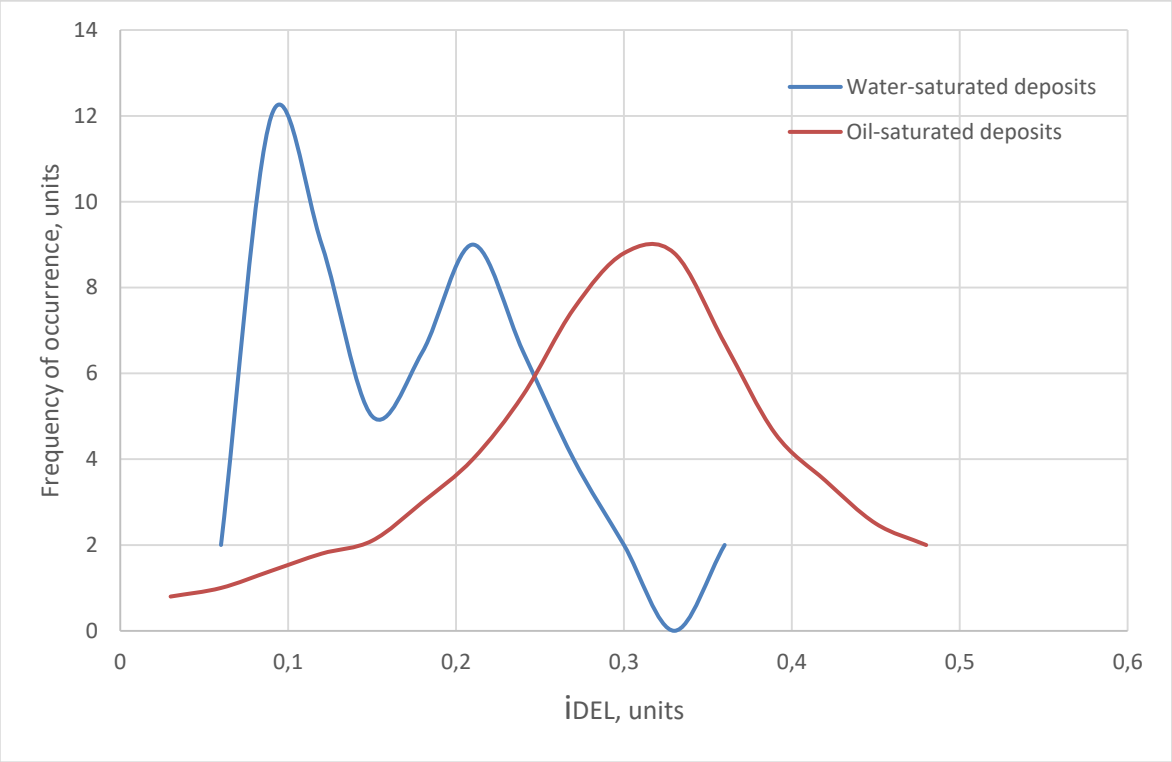

Fig. Bar charts of DEL statistical parameter of clay fraction of sandy rocks in Lower and Middle Jurassic deposits of Tomsk region

The analysis of DEL parameter values for 36 water-saturated and 22 oil-saturated sandstones made it possible to determine the boundary value of i_{DEL}(boundary)>0.26 st. unit. This allows us to determine the probability of detection of oil-saturated formations. As can be seen from the bar charts, the number of oil-saturated zones is equal to 9 out of 12 water and oil-saturated zones, so the success rate is equal to (Fig. 1):

$$\mathbf{K_{DEL}=9/12=0,75}$$

In this case, ~41% of the total number of oil-saturated reservoirs remained in the sample, the success rate of statistical interpretation to increase by 4 times, compared to the conventional well logging [3].

The values of boundary parameters and hydrocarbon indicator-parameters are determined empirically depending on the territory and its geology.

Based on the results of innovative statistical well logging interpretation in sand zones it is possible to determine the following: the omitted low-resistance oil and gas-saturated reservoirs, the quality of reservoir cap rock, the cause and probability of formation of hydrocarbon low-resistance zones, the content of various elements (iron, boron, potassium), the intensity of secondary processes, as well as the concentration of relevant secondary minerals.

Thus, based on the well logging, both new and old, we will obtain geochemical information, and identify oil and gas saturated formations with low resistance missed by the conventional well logging interpretation when examining the sand zones.

References

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