Dynamics of geophysical parameters of oil deposits

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A rational complex of resource base stations express evaluation, including direct forecast methods, was created at the Department of Geophysics, Faculty of Geology, Saratov State University.[1]

Working efficiency of the complex was estimated using exploration areas belonging to different regions of Russia, including an oil deposit in the southwest of Saratov Oblast. As objects of study, such oil deposits appear in almost all geophysical fields as small geophysical anomalies. It is associated with Ilovlinsky-Rodnikovsky displacement in the area of Ryazan-Saratov downfold of complex structure and belongs to the Volga-Ural petroleum province. Industrial oil-bearing capacity of the deposit is identified in Ardatovsky district sediments of Middle Devonian age. Productive formation is divided into blocks by tectonic disturbances containing separate oil deposits.

This study analyzes comparison results of concentration of productive deposits of real geological section along the well profile and graphs of parameter values obtained using field methods of gravimetry and magnitometry, gas geochemistry, thermomagnetic survey, geoelectric chemistry, which were implemented in original technologies. [2,3]

A gravity minimum, sometimes with steep horizontal gradient at each end, is usually observed in the anomalous gravity field above an oil and gas deposit. Its presence may be a major prospecting indicator when evaluating oil-and-gas bearing deposits, although such a clear indication of a deposit in the resultant field is not always observed.

The initial gravity profile (Δg) shows that the positive values are dropping to zero in the zone of tectonic fault and the boundary between water-bearing and oil-bearing formations. A rise if the gravity profile is recorded in the well area, with consistent oil-bearing capacity. The following profile of gravitational field values, presented without the effect of the regional background, shows that the minimum matches the beginning of the second tectonic block, and in the area of the next well Δg increases again, i.e. an inverse correlation of residual anomalies with the structural geometry is observed. The Δg profile, obtained from a 1:200000 scale map, demonstrates the minimum through the whole profile of the well.

Minimums can also be often observed in the magnetic field (ΔT) over the deposit. Based on theoretical considerations, they can be interpreted as conditioned by the diamagnetism of oil. A profile drawn from a 1:200000 scale map of the magnetic field demonstrates the minimum, and local minimums under -4 nT match with faults. Δg and ΔT values were transformed into charts of complex artificial parameter of similarity and

difference. Maximum similarity can be observed in the well, minimum similarity - in the contact zone between water-bearing and oil-bearing formations. On the charts of complex parameter of small scale, the configuration of isoanomalies of similarities in the southeast of the area, in the zone of wells, partially matched the geometry of contour lines of the reflecting horizon, which highlights the structural factor of the studied object. A map of geopotential field differences does not reveal anything in common with structural features in the contour lines, i.e. it maximally displays the non-structural effect, where in the area between wells a morphologically unclosed area that constitutes a field of positive values can be observed.

A transition of sulfides and iron carbonates to black iron ore takes place during a special heat treatment of samples taken from the area of hydrocarbon influence, which is accompanied by a change in the sample's magnetism.

Absence of authigenic minerals directly over the deposits indicates a possible presence of hydrocarbons, but in this case this criterion could is not consistent through the whole profile. Thermomagnetic coefficient reaches its maximum in wells, which does not match the productivity model and theoretical assumptions. A possible explanation of this fact is an overlying seal breach in the well area or soil contamination by hydrocarbons in the area of sampling.

Therefore, in the course of thorough profile interpretation of the results of a combination of indirect and boundary methods of geophysics it has become evident that their use does not lend decisive interpretive results, suggested by theoretical considerations. The designed field model demonstrated a variability of parameters within a close geological setting.

References:

1. Ryskin M.I., Volkova E.N., Mikheev S.I., Shigaev V.Yu. Ratsionalnoye kompleksirovanie geofizicheskikh I geokhimicheskikh metodof prognoza neftegazovykh zalezhei [Rational integration of geophysical and geochemical methods of oil and gas deposits forecasting] // Izv. VUZov. Ser. Geologiya i razvedka [Geology and surveying]. 2010. №1. p. 59-64.

2. Shigaev V.Yu., Shigaev Yu.G. Geoelektrokhimicheskie issledovaniya pri poiskakh neftegazoperspektivnykh objektov [Geoelectrochemical research in the search for oil and gas potential objects]. Saratov: GosUNTS "Kolledzh". 2002. 147 pages.

3. Ryskin M.I., Volkova E.N., Mikheev S.I., Shigaev V.Yu. Frolov I.Yu. A method of geophysical exploration of deposits of oil and gas. Application for the invention 2009. 117565/28 (024 137) from 12.5.2009. Favourable decision from May 4, 2010.