

Rational complex of field methods and unified technology of complex interpretation of geophysical and geochemical research data of direct prediction of hydrocarbons deposits

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A sharp increase in costs of geological survey works for oil and gas attaches special importance to implementation of new low-cost technologies that are suitable for the preliminary assessment of poorly-researched territories and rapid assessment of prospects of revealed structures. Such problems can be solved with the help of a rational complex of geophysical and geochemical methods of direct prospecting.

It is assumed that the created complex will greatly increase the accuracy of prediction of oil-and-gas potential of local objects in complex geological conditions, as well as reduce costs for exploration due to a reasonable decline in seismic measurements and exploratory drilling. All this leads to an increase in the efficiency of geological data interpretation, an increase in hydrocarbon reserves, and a reduction of investment risks in prospecting and further exploration of oil and gas deposits.

Research on direct prospecting of gas-and-oil structures has been conducted for many years both in Russia and abroad, but, in general, it is based on separate geophysical and geochemical methods. It was found that deposits of hydrocarbons — light and diamagnetic fluids — find some reflection in geopotential fields because they create a density defect and an area of negative magnetization in the crest of a deposit (Vitvitskij O.V. 1990, Chernov A.A. and Kolesov V.V. 2004, Mikhailov I.N. 2005, and others). In 85% of cases, the deposit is reflected in the magnetic field. As a rule, deposits correspond with a slight decrease in the intensity of the anomalous magnetic field.

A traditional direct method of forecast is the geochemical method. In the last decades, due to a significant increase in the cost of seismic exploration works, in many territories geochemical exploration is conducted before the start of seismic exploration works. The research staff members of the Faculty of Geology at Saratov State University Molostovskij E.A., Frolov I.Ju., Shigaev V.Ju, and Mikheev A.S. have developed the following methods which showed good results: the geoelectrochemical method of exploration of carbohydrate deposits; thermomagnetic method of forecasting gas-and-oil content of structures; method of geophysical exploration for oil and gas deposits. A combination of these methods will help to create a rational low-cost geological and geophysical prospecting complex.

The distinctive features of this complex that determine its novelty and increased geological efficiency compared to the known analogues, are the use of an extended complex of geological and geophysical features of the oil and gas content of a section, and the simultaneous analysis of experimental data from the position of linear and fundamentally new nonlinear models of geological environment.

The first stage is to zone the research territory in correspondence with the peculiarities of geophysical fields by means of spotting potentially oil and gas bearing areas for field works using low-cost geophysical, geochemical, and conterminal methods. All this work is based entirely on geological library materials.

The second stage is to conduct field observations on the spotted potentially oil and gas bearing areas. The field complex includes the gravity and magnetic exploration methods, geoelectrochemical, gas-geochemical, and thermomagnetometrical methods. All these methods are implemented in original technological processes patented by research faculty of Saratov State University. After that, maps of distribution of registered indicators and parameters of oil and gas potential of the research area are created. Anomalous zones that are detected based on these maps can be found both within the oil and gas potential contour and outside of it, forming circular anomalies with lows above the deposit. Therefore, all the methods which are included in the field complex show a similar distribution pattern of anomalies that prove the existence of a deposit.

The third stage is to match and link the aforementioned cartographic document and results of shallow seismic and electrical prospecting research to the existing library geological and geophysical maps, which helps to significantly increase the accuracy of hydrocarbon deposit forecast.

The last stage of the complex interpretation of all the obtained materials is to build consistent two-dimensional and three-dimensional physical and geological models (PGMs).

This developed complex features research complexity and a combined use of existing and fundamentally new technologies that help to decrease investment costs of oil and gas prospecting and extraction. The use of these technological processes in the real sector of economy will lead to an increase of forecast efficiency of potential oil and gas content with minimum material costs and a reduction of investment risks in prospecting and further exploration of oil and gas deposits.