Method of Recognition of Zones of Oil and Gas Accumulation from Analysis of Dynamics and Geochemistry of Fluids

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The first stage in the solution of the problem of recognizing zones of oil and gas accumulation is the determination of the type of organic matter present. In the second stage the zonality in distribution of gaseous components of formation waters is ascertained. The third stage examines the direction of migration of fluids and the presence of traps. As an example the hydrogeochemical, hydrodynamic, and geothermal conditions of the Triassic and Jurassic sediments of the Peri-Caspian depression are examined.

The Peri-Caspian depression has a low geothermal gradient. The Jurassic sediments fail to reach the oil window over a large part of the study area; temperatures of 70°C are reached at depths exceeding 2000 m. The Triassic sediments reached 70°C over a large part of the area.

The Lower Triassic sediments in the southwest sector are a zone of generation of gas related to humic organic matter. In the central region these same sediments are oil-gas generating; the organic matter is humic and sapropelic here. The Middle Triassic of the southwest sector has sapropelic organic matter and is oil generating, whereas in the central sector it is humic and gas generating. The Middle Jurassic carries sapropelic-humic organic matter and is oil-gas generating.

Several genetic types of gases are presently dissolved in the subsurface waters of the Jurassic sediments. See Fig. 1.

Zones of gas of the methane type occur in the Jurassic sediments in small sectors on the north, southwest, south, and east borders of the depression. The content of methane here exceeds 90%, and concentration of this dissolved gas is 100 to 1500 cm$^3$ per liter of water. There are four small sectors where nitrogen-methane is the predominant composition of the dissolved gases. Methane content ranges from 55 to 85%, and heavy hydrocarbons 0 to 7%. A zone of gas of the CO$_2$-nitrogen-methane type given as CO$_2$-H$_2$S-methane in Fig. 1 is present in the Makat region. The CO$_2$ content is 20-65%, methane 20-67%, and heavy hydrocarbons 4-14%. A zone of gas of the nitrogen type occupies the entire western part of the depression. Seven separate zones of oil and gas accumulation are recognized for the Jurassic in the depression. See Fig. 1.

The gas component of the subsurface waters of the Triassic sediments includes three types - methane, nitrogen-methane, and nitrogen. See Fig. 2.

An extensive zone of nitrogen-methane gas is present in the southwest part of the depression. Smaller zones are in the central and northwest parts. Methane is the predominant gas dissolved in the formation water in several areas through the middle of the depression. Four zones of oil and gas accumulation are recognized for the Triassic in the Peri-Caspian depression. See Fig. 2.

Symbols for Fig’s 1 and 2. 1-Zone of hydrocarbon generation; 2-direction of hydrocarbon migration; 3-hydrodynamic traps for gas; 4-hydrodynamic traps for oil; 5-areas highly favorable for gas; 6-sectors highly favorable for oil; 7-10-types of gas saturating the formation waters: 7-methane, 8-nitrogen-methane, 9-CO$_2$-H$_2$S-methane, 10-nitrogen; 11-zone of gas accumulation; 12-zone of oil-gas accumulation. Potential based on hydrogeologic indexes: 13-very reliable, 14-reliable, 15-less reliable. Border of depression.