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Geochemical Specific Characters of the Oil and the Origin of the Oil and Gas Fields

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It is generally assumed that the fluid regime of the basement of ancient platforms is not associated with that of the sedimentary cover. This assumption is mainly due to the substantial time gap between the formation of the crystalline and sedimentary rocks as well as the evolutionary differences between the thermal regime of the interior and the redox potentials of fluid systems. The presence of loosely aggregated zones filled with salt-water solutions, oil or gas in the upper basement is explained by downward fluid flows from sedimentary rocks through tectonic faults into the disintegrated crystalline rocks. The formation of such zones is believed to be due to the crustal stratification due to Earth's pulsation, periodic variations of its rotational rate, hydrogenic deconsolidation, burial of the post-Early Proterozoic disintegration zones, etc. This pattern suggests that the matter and energy exchange between the Earth's spheres in the late stages of the platform development could only take place with the help of magmatic melts and the associated fluids during the tectonomagmatic cycles of the Earth's crust transformation.

Gas and liquid hydrocarbon components mainly occur in crystalline basement rocks of ancient platforms penetrated to a depth of more than 3000 m due to deep degassing processes. The traces of the upward migration of fluids are sealed in the geological sequence, including the sedimentary cover, within secondary inclusions of rocks and minerals.

The fluids are complex, reduced, multicomponent systems that transport lithophilous, chalcophilous and siderophilous elements. The presence of microelements in the bituminous phase of inclusions indicates that metals mainly occur in the complexes containing organic ligands.

During the evolution of the fluid systems under new pressure and temperature conditions, low-solubility substances were separated out of the fluid to form hard bitumen, and the lighter components migrated into the overlying fractured and porous rocks. The high metal content of carbonaceous substances and their compositional variations governed by homogenisation temperatures of the inclusions suggest that they are not the products of the decomposition of oil fields.

The constant presence of uranium in the fluid and its differentiation products allows the tracing of the systems' migration ways from the crystalline basement to oil-saturated reservoir zones of the sedimentary cover

The known geochemical properties of bitumen and oil – high platinum content, specific distributions of rare earth elements, that are not characteristic of the upper crust formations, as well as 143Nd/144Nd and 87Sr/86Sr isotopic compounds, which are out of balance with the organic matter of sedimentary rocks – suggest that hydrocarbons are accumulated in the presence of cooling high-alkalinity mafite-ultramafite intrusions.

This logically corresponds to the distribution of seismic anomalies and magnetic and gravity fields in the consolidated crust below the various petroleum fields (for example, South Tatarstan and Nepsky arches of the Romashkino and Verkhne-Chonskoye oil fields). The acquired geochemical and thermodynamic characteristics of the reduced fluids and their differentiation products from the crystalline basement and the sedimentary cover of the southern Siberian and eastern East European platforms indicate that these were formed outside of the sedimentary cover and that the migration was directed upwards.

The analysis of the magmatic evolution on platforms reveals its alkaline trend due to the impeded degassing of magmatic sources at depth and the inflow of new doses of alkaline fluids or melts into them. Further evolution of the zones of partial melting of the substratum led, in the authors' view, to the generation of oil-forming fluids and their transportation into the Earth's upper crust. Their interaction with the surrounding rocks in turn led to the formation of oil accumulations.

Thus, oil is the product of the interaction of deep, reduced fluids. Oil, graphite of the Archaean crystalline complexes and hard bitumens are interrelated elements of the evolution of deep, high-enthalpy systems.

These large-scale reduced palaeofluid phenomena are obviously related to geodynamic and tectonomagmatic processes. The source of these fluid systems, their impact on the geological environment and its consequences can be determined through additional integrated geochemical studies using the isotopes of heavy elements and through the correlation of the observed potential fields with the structure of the consolidated crust and the sedimentary cover for the identification of geodynamic processes in geophysically inhomogeneous zones of the geological medium.