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Reduced Fluids in the Crystalline Basement and the Sedimentary Basin

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The presentation considers geochemical data on the composition of the reduced fluids that have been found to penetrate the rocks of crystalline basement and sedimentary cover of two regions of the two ancient platforms – East European and Siberian. The study was based on the detailed petrographic research, a wide range of up-to-date geochemical and nuclear physical methods to study the fluid impact on the geological medium, such as thermobarogeochemical, chromatographic, mass spectrometric, bitumen, f-radiographic, instrumental neutron activation and other analyses.

The studies have shown that the above fluid systems, which penetrate into the sedimentary rocks from the crystalline basement in petroleum areas, are the complex, multicomponent systems, transporting the elements of lithophilous, chalcophilous and siderophilous groups, which differ in affinity to oxygen and sulphur. Associations of elements in the fluids can only be maintained by organic ligand complexes that permit the transportation of metals over considerable distances through the geological medium.

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 part of the East European platforms indicate that these were formed outside of the sedimentary cover and that the migration was directed upwards.

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 South Tatarstan and Nepsky arches of the Romashkino and Verkhne-Chonskoye oil fields.

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.