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The role of geodynamics and the deep fluid regime in seismicity, and oil and ore generation processes

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The geodynamic processes play a key role in seismicity, and in the genesis of oil and ore. The very important characteristic of the geodynamic processes and the mostly changeable one is the deep fluid regime. Fluid concentrations in the lithosphere can vary by a few orders of magnitude, the permeability values of rocks vary in the very wide range of 5-7, and rarely up to 10 orders of magnitude. Thus, it is clear that the deep fluid regime can play a key role in the mentioned processes.

The important role of the deep fluid in seismicity is generally recognized. At the high pressures and temperatures typical of the Earth's interior, the brittle failure cannot occur at depths greater than a few dozen kilometers [1-3]. Nevertheless, earthquakes do occur at depths up to 700 km depth. The paradox is explained by the presence of the deep fluid that decreases the effective friction in rocks; this model is believed to be applied for explanation of earthquakes occurring at depth shallower about 150-200 km [3, and others]. The main source of the fluid appears to origin in dehydration processes occurring in the subduction zones and other deep crust thrust faults. The deeper earthquakes down to depth 700 km appears to be connected with the phase transformations occurring in the downgoing slabs [1, 2, 4, and others].

Examination of the trace element (TE) content in oils and other caustobiolites revealed that the uprising deep fluid flow is a typical, and apparently a necessary, component in process of oil generation. The involvement of the deep fluids in TE content in hydrocarbons (HC) is shown to increase as the original dispersed organic matter is being transformed into bitumen, to crude oil, and finally to products of oil degradation [5]. Data on HC deposits, especially the deep ones (H>4.5 km), indicate that the corresponding uprising deep fluid flow appears to be a result of dehydration processes occurring in the deep thrust zones. This model of oil genesis combines the preferable aspects of the biogenic and abiogenic concepts of oil genesis. The model also explains the process of concentration of dispersed hydrocarbons into high resource oil fields. The model explains also the typical features of the deep oil deposits and thus can be used for offering a set of practically required criteria for searching the deep oil fields. This is the actual task because of the high potential input of the deep HC deposits in the total balance of HC reserves. Detection of such deposits in the past took place largely accidental, because the predictive criteria that are used in the search for traditional HC deposits are inefficient in the case of the deep ones.

The role of thrusts is very important also in the formation of ore deposits. It is known that a huge number of ore deposits are confined to the Pacific ring of the subduction zones. The formation of these deposits is associated with the subsidence of the lithospheric plate, its dehydration and the development of the ascending flows of melts and fluids.

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References

1. Kasahara, K., Earthguake Mechanies, Cambriage: Cambriage Univ. Press, 1981

2. Kalinin V.A., Rodkin M.V., Tomashevskaya I.S. Geodynamic effects of physicochemical transformations in solid media // M., Nauka, 1989, 158 p. (In Russian).

3. Role of water in earthquake generation. Special Issue, Bull. Earth. Res. Inst., 2001, 76, 3-4.

4. Lucilla de Arcangelis, Cataldo Godano, Jean Robert Grasso, Eugenio Lippiello. Phys. Rep., (2016). 628, 1-91.

5. Punanova S.A., Rodkin M.V. Georesources, 2019, 21(3), 14-24.