GC2026-SGG057

Deep fluid systems of the lithosphere based on seismic and geochemical data

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The deep fluid flow regime is important for understanding seismicity and the processes of oil and ore genesis. A more complete picture of the fluid regime can be obtained using a combination of seismicity and geochemical data, particularly the ME trace element composition of various fluid types. Let's consider the results obtained using these two types of data.

According to seismic data [1], earthquakes in the depth range of approximately 20 to 80-90 km are characterized by shallower earthquake depths based on the seismic moment solution than based on the hypocenter position. That is, in this depth range, the seismic process tends to develop upward, which can be explained by the presence of low-density fluid at the source, with a tendency to break upward along the resulting fault system. Conversely, for shallower earthquakes and for events deeper than 90-100 km, the sources predominantly develop downward; this can be attributed to the increase in temperature with depth. Similar evidence is provided by the trend in changing depths of weak earthquakes in the vicinity of a strong earthquake [2]. For earthquakes with depths of up to 70-100 km, a systematic decrease in the depth of weak earthquakes is observed in the interval of approximately 100 days before and after a strong earthquake, which can also naturally be explained by the presence of low-density fluid in the focal region.

Seismicity data are significantly supplemented by the results of analysis of the trace element (TE) composition of hydrocarbon (HC), mud volcanic and carbon dioxide fluids. Correlation coefficients of the TE composition of fluid samples are compared with model chemical compositions of biota and continental crust at different levels (middle, lower and upper crust) [5]. Models of the average chemical composition of biota (plants and animals, terrestrial and marine) and the middle, lower and upper continental crust are taken from data of classical models (Bowen, 1966; Rudnick, Gao, 2003). The calculations used the database [6]. The difference in the correlation coefficients of the ME composition of samples from different crustal horizons characterizes the difference in fluid connectivity with different lithospheric horizons, while the correlation coefficient with biota characterizes the role of the biogenic component. In these coordinates, carbon dioxide and hydrocarbon fluids correspond to sharply different and virtually non-overlapping ranges of parameter values, while mud volcanic fluids correspond to a range of values in between. The obtained results indicate the development of two types of ascending fluid flows associated with carbon dioxide and hydrocarbon fluid systems, as previously noted in the works of P.N. Kropotkin, based on other considerations and factual data.

The above demonstrates the possibility of studying the deep fluid regime based on a combination of geochemical and seismological data.

References

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This research has been supported by:

1. "Oil and Gas Research Institute, Russian Academy of Sciences", grant Госзадание № 125021302095-2

2. "Institute of Earthquake Prediction Theory and Mathematical Geophysics, Russian Academy of Sciences", grant Госзадание