Reconstruction of the stress-strain field heterogeneity and fluid dynamics of fault zones based on the analysis of microstructural indicators

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One of the main tectonophysics tasks is the reconstruction of stress-strain fields (SSF) of various ranks and their parameters. Methods of structural, dislocation and quasiplastic stress analysis are applied to solve it. In addition, it is extremely important to restore the sequence of changes in parameters of the SSF. Often, taking into account opportunities of the applied methods, this task is unsolvable.

In the Russian geological science for the reconstruction of SSF rock massifs parameters, studying of ore fields and deposits the method of microstructural analysis was developed and applied. However, the use of the analysis, due to the extreme difficulty from a technical point of view of its conduction, the need of collecting and processing large volume of information, as well as the absence of other independent methods for verifying the obtained results, has practically ceased.

Currently, in tectonophysics, to solve the problem of inhomogeneous SSF parameters reconstruction, the emphasis is increasingly placed on studying cracks and microcracks in oriented rock samples, measuring their geometrical parameters and analyzing mineral performance. A new approach is called the "special technique of microstructural analysis" (STMA). The results received with its help allow to draw conclusions about the sequence of structures formation, to identify the tectonic movements stages, to restore fluid migration pathways in the fissure rock space, to reconstruct the SSF parameters associated with a particular tectonic stage. The implementation of STMA is automated by the authors on the basis of development of an original software module integrated with GIS. In STMA, all types of microstructures (open and mineralized microcracks, microbreccia, orientation of mineral grains, etc.) in rocks are studied, but fluid inclusion planes (FIPs) as reliable indicators of SSF heterogeneity are considered.

The spatial orientation of each FIPs generation directly depends on the SSF parameters operating at the time of its formation. Therefore, studies of FIPs in combination with a detailed comprehensive study of other microstructure systems types can be used for restoration of deformation stages and permeability of rocks, reconstruction of fluid migration pathways geometry, and establishment of dynamics of changes in temperature, pressure, physical and chemical conditions associated with certain stages of deformation of geological bodies.

The capabilities of the STMA in combination with precision methods for analyzing mineral substance were tested at the Antey uranium deposit located in the southeastern Transbaikalia. As a result, in the history of the deposit formation, three structural episodes, characterized by different parameters of SSF, which led to the formation of specific microstructures generation sets that played the role of fluid conducting channels within the hydrothermal process, were established for the first time. Based on a detailed analysis of the microstructures, the filtration characteristics of the rocks were calculated for paleo- and modern conditions.

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