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Study of strain distribution in the Earth's crust at the territory of Bishkek geodynamic proving ground by electromagnetic methods

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According to the traditional point of view, earthquakes occur when stress in crust, gradually accumulating, reaches the ultimate stress of mountain rocks. It may seem that prediction will become feasible, if we can directly measure the level of stress in the earth's crust using any method. However, this is wrong. We hardly know, or we do not know at all, the structure of the cross-section in the territory being observed, we don't know the distribution of hardness of the crust, especially at the depths of the earthquake hypocenters. Due to the heterogeneous medium structure, the hardness of the crust, undoubtedly, varies in space.

It is more acceptable to investigate and record the very stage of the process, when we observe the beginning of active crack formation and/or reconfiguration of the system of microcracks in deformation field of the earth's crust.

The formation of cracks involves the process of essential changes of physical properties of component rocks, in particular such properties as density, porosity, water saturation in the presence of fluids, specific electric resistivity, elastic wave velocity etc. Taking this into account, the study of crack formation at the depths of earthquake hypocenters should involve methods, which have sufficient intensity of investigations and which should directly react to the changes of the mentioned physical properties of the medium. The methods of deep electromagnetic monitoring based on the powerful current sources.

Features of resistivity changes caused by deformation processes in the earth's crust

Laboratory and field works have shown that resistivity is a rather sensitive parameter which reacts to changes of the strained state of rocks. As a criterion for correlation between resistivity variations and deformation processes we use data on spatio-temporal features of seismicity formation, and also data on direct deformation changes including the use of quartz deformograph and GPS observations of the system of sites on the Earth's surface. Changes of resistivity in medium volume have a rather complicated nature.

It was shown that deformation anomalies at the Earth's surface are reflected in changes of resistivity of only the upper part of cross-section up to the depths of 2-3 km. This type of variations is usually not accompanied by any seismic activity at the observed territory. This is a frequent case in forecasting observations when instrumentally recorded active deformations and changes of resistivity are not accompanied by earthquakes. While conducting electromagnetic observations we revealed active variations of resistivity of deep layers of cross-section, which are usually accompanied by earthquakes, while surface observations don't show any changes of these parameters. It evidences that shallow methods are not effective enough.

It is interesting that we can see variations of resistivity with different signs during synchronous observations at different sites of observed territory. Observations using receivers with orthogonal receiving dipoles have shown that the sign of variation is determined only by measured component of electric field, and it is in conflict with theoretical construction for isotropic medium. Thus, the obtained result may be explained by assuming the existence of anisotropy of electrical properties of medium which appears during activation of deformation processes in the medium.

Appearance of anisotropy of electrical properties of the Earth's crust in the periods of regional seismic activation

According to the detailed analysis of data on electromagnetic observations of changes of resistivity components at Bishkek geodynamic proving ground, we have revealed the appearance of anisotropy of electrical properties of rocks during the activation of seismic processes. In general, we can assume that specific resistance, as well as the stress field, has a tensorial nature. By investigating the anisotropy of resistivity, we can make some conclusions about the direction of force action and orientation of conducting cracks in the investigated medium.

The detailed works at multidipole azimuthal sounding configurations have revealed the sharp differentiation of anisotropy ellipses in depth. This fact can be explained by the geological concept about tectonic fibering of the earth's crust. In dynamic sense, every layer of the earth's crust has its own deformation processes, which proceed under different principles. Thus, the direction of forces and orientation of conducting cracks are different in different layers.

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