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Physical model and numerical simulation of electromagnetic field variations during formation of the fault rupture before earthquake

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Clear understanding of physical processes in the earthquake source, especially at the final stage of preparation of the fault rupture, is very important for development of a method of short-term earthquake prediction. Commonly used algorithm based on monitoring of geophysical fields, detection of "anomaly", and earthquake early warning does not work due to different geological and geophysical conditions in the earthquake sources.

We propose another approach based on consideration of geological structure with geoelectric parameters typical for areas with high seismic activity followed by an analysis of the structure behavior during the final stage of earthquake preparation with application of mathematical model of the processes of occurrence of electromagnetic (EM) precursors, and finally – definition of a possibility of the EM precursor monitoring on the earth surface (determination of EM-precursor location and its amplitude).

Using this approach a 2D geoelectric model of heterogeneous geological medium has been developed taking into account the processes occurred in the geological structure of flexure type which transforms into the uplift-thrust structure due to the crust deformations. The model is based on a hypothesis of variation of electrical conductivity of geomaterials in the local area of the fault under subcritical stress-state conditions due to geodynamical processes. In an area of the shear stress maximum in the plane of fault rupture of the uplift-thrust type a zone of increased fracturing is developed contributed to essential decrease of local electric resistance of the fault due to filling the fractures by crustal fluids.

Numerical 2D simulation demonstrates essential redistribution of the net current density in the medium taking into account of assumed formation of the fracturing zone due to effect of occurrence of highly-conductive split. In this case, the amplitude of EM-field for the longitudinal polarization increases far apart from the split location. The obtained results may be applied as a background of development of monitoring technique of EM-fields measured on a surface of the Earth far apart from the future earthquake epicenter and directly over the fault for determination of the fault maturity for occurrence of the seismic event.