Geophysical Research Abstracts
Vol. 12, EGU2010-14484, 2010
EGU General Assembly 2010

Earthquake Triggering by High Power Electric Pulses

Victor Novikov, Yuri Konev, and Vladimir Zeigarnik

Joint Institute for High Temperatures of Russian Academy of Sciences, Moscow, Russian Federation (novikov@ihed.ras.ru, +7-495-484-1947)

The study carried out by the Joint Institute for High Temperatures in cooperation with the Institute of Physics of the Earth and the Research Station in Bishkek of Russian Academy of Sciences in 1999-2008 showed a response of weak seismicity at field experiments with electric pulsed power systems, as well as acoustic emission of rock specimens under laboratory conditions on high-power electric current pulses applied to the rocks. It was suggested that the phenomenon discovered may be used in practice for partial release of tectonic stresses in the Earth crust for earthquake hazard mitigation. Nevertheless, the mechanism of the influence of man-made electromagnetic field on the regional seismicity is not clear yet. One of possible cause of the phenomenon may be pore fluid pressure increase in the rocks under stressed conditions due to Joule heat generation by electric current injected into the Earth crust. It is known that increase of pore fluid pressure in the fault zone over a critical pressure of about 0.05 MPa is sufficient to trigger an earthquake if the fault is near the critical state due to accumulated tectonic deformations. Detailed 3D-calculaton of electric current density in the Earth crust of the Northern Tien Shan provided by pulsed electric high-power system connected to grounded electric dipole showed that at the depth of earthquake epicenters (over 5 km) the electric current density is lower than 10-7 A/m2 that is not sufficient for increase of pressure in the fluid-saturated porous geological medium due to Joule heat generation, which may provide formation of cracks resulting in the fault propagation and release of tectonic stresses in the Earth crust. Nevertheless, under certain conditions, when electric current will be injected into the fault through the casing pipes of two deep wells with preliminary injection of conductive fluid into the fault, the current density may be high enough for significant increase of mechanic pressure in the porous two-phase geological medium. Numerical analysis of generation of mechanical pressure in the geological medium due to action of high-power electric was carried out. It was shown that calculation of impulse of mechanical pressure due to high-power electrical current in the porous two-phase medium may be performed neglecting thermal conductance by solving the non-stationary equation of piezo-conductivity with Joule heat generation. For calculation of heat generation the known solution of the task of current spreading from spherical or elliptic electrode submerged into unbounded medium is used. Pressure increase due to electric current is determined by voltage of the current source and the medium parameters, and it does not depend on the electrode radius. The pressure increase is proportional to viscosity factor, electric conductivity of fluid in the pores, and inverse proportional to squared average radius of capillaries. These parameters may vary for different rocks and fluids in the pores by many orders of magnitude. The pressure increase for water is insignificant. If a high-mineralized fluid (e.g. sludge) is injected into the fault, the pressure may be increased by several orders and may obtain tens kilobars that is sufficient for triggering the seismic event. An estimation of parameters of portable pulsed power system for electric processing of the fault was performed, when the current is injected into the fault through two casing pipes of deep wells with preliminary injection of conductive fluid into the fault between the wells.
The work is supported by grant No. 09-05-12059-ofi_m of Russian Foundation for Basic Research.