Geophysical Research Abstracts
Vol. 20, EGU2018-15436-1, 2018
EGU General Assembly 2018
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Earthquake hazard mitigation by electromagnetic influence on seismic activity: Results of forty-years field experiment on injection of DC electrical pulses into the Earth crust

Vladimir Zeigarnik (1), Arben Avagimov (1), Victor Novikov (1), Anatoly Rybin (2), Gennady Schelochkov (2), Vitaly Bragin (2), Vladimir Sychev (2), Leonid Bogomolov (3), and Nikolay Tarasov (4)

(1) Joint Institute for High Temperatures of Russian Academy of Sciences, Laboratory of Pulsed MHD Power Systems for Geophysics, Moscow, Russian Federation (novikov@ihed.ras.ru), (2) Research Station of Russian Academy of Sciences, Bishkek, Kirghizia, (3) Institute of Marine Geology and Geophysics of Far Eastern Branch of Russian Academy of Sciences, Yuzhno-Sakhalinsk, Russian Federation, (4) Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences, Moscow, Russian Federation

An overview of the state-of-the art of pioneering research carried out in Russia on the electric/electromagnetic triggering of weak seismicity is presented. The overview covers various researches carried out in the field of artificial partial release of tectonic stresses by local electric processing of the Earth crust for earthquake hazard mitigation.

The field experiments on DC electric pulses injection were started more than forty years ago at Garm geophysical test site (Tajikistan, Pamir mountains) and were continued at the test site near Bishkek city, Kirgizia (Northern Tien Shan) in 1978 with application of pulsed magneto-hydrodynamic (MHD) power systems, and later of ERGU-600 pulsed electric system (PES) powered from industrial electric line. The PESs provided DC current of 600-2500 A in emitting dipole grounded into the earth crust with a distance between electrodes of about 4 km. The prime goal of the field experiments was deep electromagnetic (EM) sounding of the Earth crust for monitoring of EM precursors of strong earthquakes.

Nevertheless, after a few years of operation of MHD power systems it was found that electric pulses resulted in spatiotemporal re-distribution of local seismicity (increasing the number of weak earthquakes after DC pulse injection). During forty years of the filed experiments there is clear deficit of strong earthquakes in the region under study (100 x 100 km). The results of monitoring of seismic activity by KNET seismic stations were supported by measurement of acoustic emission in the wells, which sharply raised during the sessions of DC current injections.

The field results were verified under laboratory conditions with application of various press equipment and spring-block sliders simulated behavior of the fault during its electric processing. Some theoretical attempts were taken to explain the electric/electromagnetic triggering phenomena, which consider not only interaction of electric/EM-fields with stressed rocks, but fluid migration under electric action which may result in triggering of weak earthquakes.

Today it is clearly shown that the electric processing of the Earth crust may be used for development of advanced technology of prevention or mitigation of catastrophic earthquakes. The future research is discussed directed to application of electric processing of the seismogenic fault for transformation of "stick-slip" seismic mode to the mode of slow-slip events or creep.