Geophysical Research Abstracts
Vol. 12, EGU2010-2526, 2010
EGU General Assembly 2010

Can an electro-kinetic mechanism explain artificial earthquakes?

Guillaume Cyr (1), Paul Glover (1), and Victor Novikov (2)

(1) Université Laval, Département de géologie et de génie géologique, Québec, Canada (paglover@ggl.ulaval.ca, +1 (418) 656 7339), (2) Joint Institute for High Temperatures of Russian Academy of Sciences

Researchers of the Joint Institute for High Temperatures of the Russian Academy of Sciences have carried out a large number of current injection experiments using a 4.2 km long dipole at the Bishkek Research Station in the Chu valley area of the Kyrgyz mountains (northern Tien Shan). The current is generated using Pulsed Magneto-Hydrodynamic (MHD) generators that can produce 2800 amperes at 1350 volts for up to 12.1 seconds. They have found that the number of earthquakes in the region within 150 km of the injection site increased by over 10 standard deviations of the background seismicity. The probability of this occurring by chance is only one in every thousand million million (10̂15) measurements. It is certain, therefore, that we can generate earthquakes by current injection. However, no satisfactory physical mechanism for it currently exists.

Paul Glover has suggested that an electro-kinetic mechanism may be the missing causal link. In his theory the injected current creates a three-dimensional electric field in the subsurface. The electro-kinetic mechanism uses the electric field to move the pore fluid at depth. If the pore fluid flows into a fault zone it may accumulate and transiently raise the pore fluid pressure within the fault zone. It is known that increases of pore fluid pressure within fault zones more than a critical pressure of 0.05 MPa are sufficient to trigger an earthquake if the fault has sufficient accumulated strain. Earthquakes are therefore possible while the pore fluid pressure is over the critical pressure. While the electro-kinetic drive has been well studied around the world, it is uncertain if the mechanism can provide fluid pressures sufficient to trigger earthquakes up to 150 km from the injection point.

In this work we present two dimensional numerical modelling of the proposed coupled mechanism using a finite element approach and using the software package Comsol Multiphysics. The initial results are promising and indicate that (i) transient pressures greater than the critical pressure can be easily generated by the mechanism, (ii) the transient pressures in the model farther than 200 m from the electrodes can take values of up to 2 MPa (40 times the critical value), (iii) the transient pressures remain above the critical value up to 160 km from the dipole, which is consistent with the range of the field experiments. However, the modelling has only been able to generate the transient pressures quasi-instantaneously. There is a clear delay in the field experiment data of two days between current injection and earthquake occurrence. We cannot currently account for this in our modelling, although research is continuing.