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A possible thermal mechanism of electromagnetic earthquake triggering: Insight from laboratory press experiments and field estimations

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During the fields experiments on electromagnetic monitoring of the Earth crust at the Pamir and Northern Tien-Shan regions, when DC current of 0.6-3.5 kA has been injected into the crust through emitting grounded dipole of 4.2 km length, the spatio-temporal variation of regional seismicity has been found, which is explained by electromagnetic triggering of weak earthquakes around the dipole. The field data were confirmed by laboratory experiments at the press and shear machines, where it was demonstrated that DC current injection into the tested rock sample is resulted in sharp increase of acoustic emission (crack formation), sample failure, and triggering of laboratory "earthquakes" at the spring-block models of seismogenic fault. Nevertheless, the mechanism of electromagnetic earthquake triggering is still poorly understood. We discuss a possibility of earthquake triggering by Joule heating of porous fluid-saturated rocks during DC current flow through the rocks resulted in increase of fluid pore pressure and corresponding decrease of the effective rock strength followed by the fault rupture, when it is in subcritical strain-stress state. For verification of this hypothesis, we carried out the laboratory experiments at the specialized press, where the increase of the sample deformation rate is observed during electrical processing of the sample. The experimental results are compared with numerical data calculated by COMSOL Multiphysics© software, which indicate the clear pore pressure increase due to DC current impact. Nevertheless, the DC current density applied in the laboratory experiments is by 6-7 orders more than the numerical estimations of the current density in the earthquake preparation areas of the Northern Tien Shan where the field experiments on DC current injection were carried out. Thus, in our opinion, the Joule heating mechanism resulted in pore pressure increase and rock strength reduction cannot be employed for explanation of earthquake triggering observed during the field experiments.

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