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Electromagnetic stimulation of fluid migration into fault area and earthquake triggering phenomena

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A large amount of laboratory and field studies carried out over the past fifteen years clearly showed a possibility of weak regional seismicity triggering by high-power pulses of electric current of 0.6 – 2.5 kA injected into 4 km-length emitting dipole. These phenomena have been verified under laboratory conditions with application of various press equipment and spring-block models. Nevertheless, the physical mechanism of electromagnetic earthquake triggering is not clear yet. 3-D numerical analysis of the current density distribution in the Earth crust has shown that for conditions of the field experiments the current value on 5-10 km depth of the earthquake epicenters typical for the region under study (Northern Tien Shan) is 10^{-7} – 10^{-8} A/m^2, which is not sufficient to trigger earthquakes due to generation of additional stresses in the rocks.

It is well known that fluids play an important role in the preparation and initiation of earthquakes, and therefore, it is reasonable to consider a secondary triggering mechanism involving fluid interaction with an electric current in the geomagnetic field resulted in stimulation of fluid migration. It should be noted that even a small amount of fluid migrated into a seismogenic fault under critical stress-strain state can provide a reduction of its strength due to friction reduction and Rebinder effect resulted in earthquake triggering. For verification of this hypothesis laboratory experiments were carried out on the spring-block model with water injection into the contact area between movable and fixed blocks. The experimental results confirm a possibility of application of fluid mechanism to explain the phenomenon of weak electrical impacts on the regional seismicity. It was shown that at the stress level in the fault area of 0.99 critical value, when the lab earthquake (slip of movable block) occurs, the threshold value of fluid action is about of 1% of contact area/volume. For triggering the slip of the spring-block model it is sufficient to inject 0.2-0.3 g of water into contact area that is 0.5% of weight of granulated material (fault gauge) filled the contact area. Application of obtained experimental results for field conditions is discussed.