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Control of temporal distribution of stick slip acoustic emission by periodic electromagnetic forcing

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It was shown in the last several years that anthropogenic influence may invoke distinct changes in the dynamics of local seismic activity. In particular it was established that small and moderate external influences (such as magnetohydrodynamic soundings and/or periodic variation of water level in large reservoirs) may lead to the increase of degree of order in earthquakes temporal distribution. These findings acquire special importance in the light of recently established facts on possible control of dynamics of complex systems through small external influences.

At the same time, real field seismic data often are too short and incomplete to draw unambiguous conclusion on related complex dynamics and especially on possible controlling influences. Therefore, in the present research, in order to elucidate possible controlling influence of small external forcing, laboratory investigation of stick slip acoustic emission as a model of seismic process have been carried out.

Our laboratory set up contained two samples of roughly finished basalt. The lower sample was fixed and upper one was pulled with the constant speed, acoustic emissions accompanying the slip were registered.

Experiments have been carried out under or without periodic mechanical or electromagnetic (EM) forcing, which simulates the geophysical external periodic influence. If the pulling force can be modulated by a periodical force of EM or mechanical nature, this could show high sensitivity of critical or “nearly critical” systems to small external impact. As was mentioned, the aim was to prove experimentally the possibility of controlling slip dynamical regime by a weak mechanical or EM impact.

Modern phase synchronization testing and recurrence quantitative analysis (RQA) of

acoustic emission data sets have been carried out.

It was shown that at a constant pulling force, when the intensity of normal to slip surface periodic EM field increases from 7 to 950V, recurrent patterns of series of maximal amplitudes of acoustic emission increases. This means that increases the extent of regularity in time distribution of acoustic emission. At the same time we observe clear increase of phase synchronization between external influence and temporal distribution of acoustic emission, according to increased EM influence. Characteristic phase synchronization measure γ_{H-Sh} increases from 0.12 to 0.5.

We suggest that these experimental evidences confirm earlier field results on the possible controlling effect of external small/moderate periodic forcing on the temporal distribution in complex dynamical systems including seismic process.