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Influence of movement regime of stick-slip process on the size distribution of accompanying acoustic emission characteristics

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Many scientific works on dynamics of earthquake generation are devoted to qualitative and quantitative reproduction of behavior of seismic faults. Number of theoretical, numerical or physical models are already designed for this purpose. Main assumption of these works is that the correct model must be capable to reproduce power law type relation for event sizes with magnitudes greater than or equal to a some threshold value, similar to Gutenberg–Richter (GR) law for the size distribution of earthquakes. To model behavior of a seismic faults in laboratory conditions spring-block experimental systems are often used. They enable to generate stick-slip movement, intermittent behavior occurring when two solids in contact slide relative to each other driven at a constant velocity. Wide interest to such spring-block models is caused by the fact that stick-slip is recognized as a basic process underlying earthquakes generation along pre-existing faults. It is worth to mention, that in stick slip experiments reproduction of power law, in slip events size distribution, with b values close or equal to the one found for natural seismicity is possible. Stick-slip process observed in these experimental models is accompanied by a transient elastic waves propagation generated during the rapid release of stress energy in spring-block system. Oscillations of stress energy can be detected as a characteristic acoustic emission (AE). Accompanying stick slip AE is the subject of intense investigation, but many aspects of this process are still unclear. In the present research we aimed to investigate dynamics of stick slip AE in order to find whether its distributional properties obey power law. Experiments have been carried out on spring-block system consisting of fixed and sliding plates of roughly finished basalt samples. The sliding block was driven with a constant velocity. Experiments have been carried out for five different stiffness of pulling spring. Thus five different regimes of stick slip movement has been maintained. The AE accompanying the elementary slip events of stick-slip process were recorded on a PC sound card. The sensor for the AE was a lead circonate-titanate with a natural frequency of 100 KHz. In order to ensure standard conditions in each experiment, sliding surfaces were sanded up by sandpaper and cleaned of a dust. AE data analysis consisted of signal conditioning, filtering, and correct wave trains separation. Onset time of AE was determined at a minimun of Akaike Information Criterion. Afterwards time series of AE characteristics such as: recurrence times between consecutive AE bursts as well as time intervals between their maximums, duration of AE bursts, energy and power of AE, max by modulus of AE wave train amplitudes, etc. have been compiled. Cumulative probability distributions for all these data sets have been constructed and tested on the subject of GR type power law relation. It was found that characteristics of AE of stick slip process are strongly depending on the movement regime. Number of registered AE essentially increased for stiffer spring. At the same time recurrence times and emitted AE energy decreases. Power law type relation have not been observed for all AE characteristics and not for all considered regimes of movement. Power law relation, close to observed for real seismicity, was found for power of AE time series at stiffer springs. It is interesting that recurrence times between maximums of consecutive AE bursts and duration of AE bursts, reveal b in the range of 0.6-1.65. These results point that experimental conditions of stick slip process including movement regimes should be selected with care to ensure similarity between model and natural seismicity distributional characteristics.