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Stick-slip and strain waves in the physics of earthquake rupture: experiments and models

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A b s t r a c t

The study of stick-slip is directly connected with the formulation of the consistent concept of seismicity migration and explanation of the nature of strain waves observed at the contacts of blocks and plates. We propose a phenomenological model to describe the initiation of stick-slip at the rough contact of blocks of rocks. The model contains the leading factors of stick-slip process (friction, roughness of contact surfaces, and asperity). The model reproduces the universal profile of slip velocity and displacement, velocity of dynamic rupture observed in experiments. The stick-slip motion at a rough surface of a fault is shown to be a nonlinear process and can be described by the generalized sine-Gordon equation.

The results of calculations and a comparison with experimental data testify to the existence of waves of a new type – solitary waves of sliding. The analogies are found between the strain waves generated due to stick-slip at the contact of the blocks of rocks, strain waves in the crustal faults, and those within the lithosphere.

Key words: stick-slip, strain waves, earthquake rupture, autowave processes.