Stick-slip of rocks in the laboratory experiment

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Brace and Byerlee [Brace W.F., Byerlee J.D. Stick-slip as a mechanism for earthquakes // Science. 1966. V. 153. P. 990-992.] suggested in 1966 that the cause of earthquakes could be the repeated instability of the slip blocks of rocks. Since then, friction phenomena at contacts in geomaterials, in particular, in the formation of shear cracks, have become a subject of particular interest in seismology and geomechanics. The purpose of this work is to investigate the mineral composition of the surface layers of rocks after friction and the formation of shear cracks. Installations were constructed to obtain time dependences of the friction force of plates from rocks, create shear cracks during compression of cores, obtain to tribo- and photoluminescence spectra, study the dynamics of signals of luminescence and estimate the local temperature in the friction zone. Samples are Riphean sandstone, gneiss, basalt, granite; diorite, tonalite and xenolite. To study the mineral composition of friction surfaces and shear cracks, infrared, Raman and photo luminescent spectroscopy were used. Friction and shear cracking have been found to result in the formation of clay minerals (kaolinite, illite, glauconite and montmorillonite) saturated with water and having a low coefficient of friction. An analysis of the tribo-luminescence spectra showed that friction produces electronically excited free radicals $\equiv Si-O-$, $-Si-Al+$ and $=Si2+$. They interact with water and minerals dissolved in it and can cause chemical reactions leading to the formation of clays. These results can to refine the previously proposed mechanism of stick-slip phenomena. Friction and shear destroy the crystal lattices of minerals, which leads to the formation of chemically active radicals, which, when interacting with water and the minerals dissolved in it, initiate chemical reactions leading to the formation of clays. The formation of a clay interlayer in the friction zone, apparently, can be considered as a factor causing a switch from a mode of smooth growth of deformation to its abrupt increase. Until a clay layer forms in the friction zone, the stress increases. At the moment when it covers a sufficiently large friction surface, the friction force decreases sharply and and stick-slip occurs.