Fracturing Behaviors of Unfavorably Oriented Faults Investigated Using an Acoustic Emission Monitor

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Reactivation of pre-existing unfavourably oriented faults is an important issue in earthquake seismology, particularly in the cases, in which high pressure fluid has a role. Researching of favourably oriented faults provides the lower limiting bound to overpressures, which is a key parameter in the design and management of injection applications. At the same time, unfavourably oriented faults are also important because they are stable and show very low levels of background seismicity under regional stress conditions, but might be reactivated by pore pressure increasing.
In order to shed light on the mechanism and characteristics of the reactivation of unfavourably oriented faults due to natural or man-made stress changes, we investigated the stick-slip behaviour of pre-cut faults having different angles to the greatest principal stress in granite rock samples using an acoustic emission (AE) technique under well-controlled laboratory conditions. The results show that the friction coefficient of a pre-cut fault depends only on its stick-slip history, being independent of fault angle. In all cases, the fault friction drops from ~0.75 to 0.6 after a few stick-slip iterations. Many AE events preceding each stick-slip event were observed. We mapped both on-fault and off-fault microcracks in detail with their AE hypocenters. A tendency toward decreased AE activity was observed. Experimental results suggest that there are two competing mechanisms governing the evolution of the frictional properties and the damage zone characteristics of such faults. On one hand, the fault plane is smoothed by fault slippage as a result of asperities failing on the fault plane and a fault gauge is created. On the other hand, the fault plane is roughened by new damage. As a result, both AE activity and fault friction tend to decrease, but with significant fluctuations.

Keywords: Acoustic emission, Stick-slip, Unfavourably oriented faults, Laboratory experiment

