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Weakening mechanism and energy budget of laboratory earthquakes

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The dynamics of earthquake ruptures in subduction zone are expected to be partially governed by the dehydration of minerals during shear heating. In this study, we conducted and compared results coming from stick-slip experiments on Westerly granite, serpentinized peridotite, and serpentinite. Experiments were conducted under triaxial loading ($\sigma 1 > \sigma 2 = \sigma 3$) at confining pressures ($\sigma 3$) of 50 and 100 MPa. The angle between the fault plane and the maximum stress ($\sigma 1$) was imposed to be equal to 30°. Usual a dual gain system, a high frequency acoustic monitoring array recorded particles acceleration during macroscopic stick-slip events and premonitory background microseismicity. In addition, we used an amplified strain gage located at 3 mm to fault plane to record the dynamic stress change during laboratory earthquakes. In all rocks, we show that increasing the stress acting on the fault leads to an increase of the seismic slip, which in turns leads to a decrease in the dynamic friction coefficient. However, for a same initial stress, displacements are larger in serpentinized peridotite and in serpentinite than in Westerly granite. While the partial melting of the fault surface is observed in each rock tested, the dynamic friction drop is larger in peridotite and serpentinite. This larger friction drop is explained by the dehydration of antigorite, which leaves a partially amorphised material and leads to the production of a low viscosity melt. Finally, using theroretical assumptions, we show that the radiation efficiency of laboratory earthquakes is larger in peridotite and serpentinite than in granite. This calculation is supported by larger elastic wave radiation, and by microstructural analysis.