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Influence of the confining pressure on precursory and rupture processes of Westerly granite.

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In the shallow crust, brittle deformation mechanisms lead to damage and rupture of rocks. These mechanisms are generally described by non-linear stress relations and decrease of the elastic moduli due to microcrak opening and sliding. However, failure mode depends on confining pressure and ranges from axial splitting to shear localization. Here we report experiments on Westerly granite samples deformed under controlled upper crustal stress conditions in the laboratory. Experiments were conducted under triaxial loading ($\sigma1>\sigma2=\sigma3$) at confining pressures ($\sigma3$) ranging from 2 to 50 MPa (similar to upper crustal stress conditions) and at constant axial strain rate 10-5/s. Usual a dual gain system, a high frequency acoustic monitoring array recorded particles acceleration during macroscopic rupture of the intact specimen and premonitory background microseismicity. Secondly, acoustic sensors were used in an active way to measure the evolution of elastic wave velocities. In addition, we used an amplified strain gage to record the dynamic stress change during the dynamic rupture.

Our preliminary results show that increasing confining pressure leads to the transition between axial cracks opening to shear localization. This result is supported by the moment tensor solutions of acoustic emissions and CT scan imaging of the post mortem sample. In addition, we systematically observe an exponential increase of the premonitory activity up to the shear failure of the sample. While the intensity of this precursory activity increase with the confining pressure in term of energy, the crack density leading to the failure of the sample is independent of the confinement.

We show that the dynamic rupture occurs in only few microseconds, suggesting a rupture speed close to the shear wave velocity. In addition, the ratio between the stress drop and the peak of stress increases with the confinement. This result suggest that the weakening of faulting increases with the confinement. Finally, using both dynamic stress drop and axial displacement measurement, we show that the fracture energy increases with both confining pressure and seismic slip.