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How Luigi saved our (experimental) life?

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Compressional and shear wave velocities have been measured during the experimental deformation of Carrara marble and Solnhofen limestone in the cataclastic regime, both in dry and wet conditions at room temperature. Measurements were performed under hydrostatic conditions (up to 260 MPa confining pressure and 10 MPa pore pressure) during triaxial loading (at the constant strain rate of 10-5/s) as well as during differential stress relaxation. During a full cycle, our results show that the seismic velocities first increase as effective mean stress increases. However, when the stress onset of cataclastic deformation was reached, elastic velocities showed rapid decrease due to stress-induced damage in the rock. During stress relaxation tests we observed an increase of elastic velocities with time, which suggested a fast 'recovery' of the microstructure. A substantial and rapid drop in the velocities occurred when reloading, suggesting that the previous 'recovery' was only transient. Subsequent relaxation tests showed other marked increases in velocities. These experimental results suggest that during the deformation of low-porosity calcite-rich rocks, dilatant (crack opening and frictional sliding) and compaction micro mechanism (pore closure) compete. Evolutions of elastic properties (mainly sensitive to crack density) and macroscopic volumetric strain (more sensitive to porosity) are therefore not systematically correlated and depend on the strain rate, the solid stress conditions and the pore pressure.