Brittle/Ductile Transition and Rupture Dynamics: Experiments on Gypsum

Nicolas Brantut, ENS Paris

The purpose of this study is to better understand the processes acting during the deformation of rocks at the brittle/ductile transition. We performed experiments on gypsum aggregates at different temperatures (25°C -- 150°C) and pressures (2 -- 95 MPa) in a triaxial apparatus, while measuring elastic wave velocities and acoustic emissions.

At room temperature, the brittle/ductile transition occurs at around 20 MPa confining pressure. Below this value, a single shear band is observed and stick slip occurs on the fault. Above that value, the deformation is localized within multiple shear bands and we record stress drops when a shear band is formed. Elastic wave velocities decrease linearly with increasing strain, which can be explained by microcracks accumulation. AE activity generally decrease with increasing confining pressure.

At 70°C, the samples deform in an essentially similar way. The only major difference is the occurence of large amplitude, low frequency acoustic events during the stress drops. These signals indicate that the formation of the shear band is dynamic. Indeed, after waveform processing we find an event duration of less than 1 ms, i.e., a rupture velocity af a few 100 m/s.

When heated up to 150°C, gypsum dehydrates to form bassanite. Hydrostatic heating tests were performed that show a dramatic P and S wave velocity decrease during the reaction. It can be interpreted as the formation of cracks which aspect ratio are of the order of 0.1. Surprisingly, the Poisson's ratio (or equivalently, the Vp/Vs ratio) actually *decreases* during the reaction. It can be explained by the formation of a stiffer phase (bassanite). We record more than 2000 AE during the dehydration reaction. Focal mechanisms indicate that they are associated with the compaction of the porosity created by the solid volume decrease of the chemical reaction.