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Coseismic dehydration of gypsum: combination of experiments and numerical simulation.

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A number of mechanisms are known for the weakening recorded on faults during seismic slip, such as thermal pressurization or flash heating. The presence of water plays an important role in some of these mechanisms through either enhancing the process (e.g. an increase of pore fluid pressure by thermal expansion) or inhibiting them (e.g. water to gas transition). A common source of water is the presence of hydrous minerals that, with temperature increase, release water as they dehydrate, simultaneously creating porosity. However, despite much research and progress linking these processes, comparatively little is known as to how changing fault slip speed affect the coupled process, which has the potential to feed into the microseismicity what often seen in fluid-pressurised fault zones.

We report new high speed (1m/s) and low speed (0.01m/s) velocity shear experiments using powdered gypsum at a range of normal stresses. The results of those experiments were integrated with a numerical model in order to calculate the temperature changes and the amount of dehydration reaction. The experiments were performed at dry room conditions.

At low velocity, the frictional strength is approximately constant throughout the experiment at $\sim$0.8. At high velocities, frictional strength evolves from high peak values ($\sim$0.8), attained during the first few centimetres of slip, to low quasi-steady state values between 0.2 and 0.4, varying with the normal stress. At the slip-weakening, the deformation localises within a thin principal slip zone. Frictional heating within the slip zone causes gypsum dehydration, which expands progressively in the surrounding regions. The reaction observed is from gypsum to bassanite (hemihydrate calcium sulphate) and it was only detected after the onset of the weakening. Preliminary numerical models at high velocity show that the heat consumed during the endothermic reaction is a few orders of magnitude lower than the heat generated due to friction.

These experiments suggest that the temperature within the fault gouge is strongly controlled by frictional processes and that the temperature sink due to the reaction is comparatively small. Further work is needed to constrain the pore fluid pressure in the system and understand its contribution in the mechanics and reaction kinetics.