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# Localized vs Distributed Deformation as a Rheological Control on the Evolution of Permeability in Anhydrite Rocks

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We have taken an experimental approach to understand and quantify the deformation processes and fluid flow within anhydrite-bearing fault damage zones during the seismic cycle. Triaxial loading tests have been performed on borehole samples of anhydrites at room temperature, 100 MPa confining pressure (Pc), and range of pore fluid pressures (Pf). Permeability (k) and porosity development was continuously measured prior and throughout the deformation experiments. The tests were conducted on samples with different grain sizes (10 microns to 1 mm) that were cored in different directions relative to the macroscopic foliation. Mechanical results after triaxial loading tests show that the brittle-ductile transition occurs for Pe = 20-40 MPa and is almost independent of fabric orientation and grain size. Brittle failure is localized along discrete fractures and is always associated with a sudden stress drop. Conversely, ductile failure occurs by distributed deformation along cataclastic bands. In this case no stress drop is observed. The static k of the anhydrites, measured prior to loading for Pe = Pc-Pf = 10-60 MPa, is generally low, k = 10E-21 - 10E-19 m2, and, for a given Pe, is controlled by grain size and fabrics orientation with variations up to 2 orders of magnitude. The dynamic k measured at failure under constant Pe = 10-40 MPa, k = 10E-20-10E-17 m2, is controlled by the grain size, fabrics and Pe, as k increases up to about 1-2 orders of magnitude for decreasing Pe. All samples, independently whether deforming in a brittle or ductile way, show dilatancy after yielding. The onset

of dilatancy coincides with the first increase in k, which increases dramatically prior to localized failure (upward concave curve), whilst tends to stabilize prior to distributed deformation (downward concave curve). In natural environments, fluid pressure fluctuations, such as might be experienced during the seismic cycle within fault damage zones or within a reservoir, can promote a switch from distributed (ductile behaviour) to more localized (brittle behaviour) deformation, leading to complex permeability patterns.