Geophysical Research Abstracts
Vol. 14, EGU2012-2433, 2012
EGU General Assembly 2012

Fracture and Faulting Induced Permeability Change in Porous Sedimentary Rocks

W.-L. Zhu

University of Maryland, Department of Geology, College Park, United States (wzhu@umd.edu, +1 301-405-3597)

Flow of interstitial fluids exerts important control over seismogenic, sedimentary, and metamorphic processes. Since the seminal work of Hubbert and Rubey [1959] on the motion of thrust sheet, elevated pore fluid pressure has been used to reconcile the heat flow paradox during seismogenic faulting, and more recently, as a possible mechanism for slow slip events observed at subduction zones. Many working hypotheses for generating and maintaining high pore fluid pressure have been proposed. However, one important ingredient still missing in these models is quantitative knowledge of permeability as a dynamics physical property that varies significantly in different tectonic settings. In this study, we conducted systematic laboratory characterization of how permeability and its anisotropy evolve as porous sandstones and limestones undergo the transition from brittle faulting to cataclastic flow. Our data show that highly porous silicate rocks experience permeability reduction during dilatant brittle fracture whereas their low porosity counterparts exhibit permeability enhancement. With increasing confinement, brittle fracture is inhibited and the porous rocks exhibit shear enhanced compaction, resulting in significant porosity reduction accompanied by strain hardening and drastic loss of permeability. Hertzian fracture and pore collapse are the primary micomechanisms responsible for the brittle faulting or pervasive fracturing in porous silicate rocks. In contrast, the stress-induced permeability evolution in porous limestones is markedly different. Because crystal plasticity as well as solution transfer can be activated at relatively low temperatures in calcite compared to quartz, the inelastic behavior and failure mode of carbonate rocks are not only a function of pressure, but also sensitive to temperature. Laboratory measurements show that the presence of water enhances compaction and considerably lower the yield strength of carbonate rocks. The yield cap is strongly dependent upon temperature. Permeability evolution during shear enhanced compaction in carbonate rocks show different characteristics in porous limestones. The water weakening at elevated temperature is likely resulted from the interplay between crystal plasticity, pressure solution, microcracking and pore collapse. A better understanding of the dominant processes affecting permeability in different lithologic settings is critical for the formulation of robust constitutive relations.