Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04600, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04600
EGU General Assembly 2008


# Roles of stress and chemistry in the evolution of mechanical and transport properties of fractures and granular aggregates

D. Elsworth (1,3), C. Marone (2,3), A. Niemeijer (1,2,3), D. Saffer (2,3), K.-B. Min (1,3,4), I. Faoro (1,3), J. Samuelson (2,3), J. Taron (1,3), J. Liu (5), H. Yasuhara (6)

(1) Department of Energy and Mineral Engineering, The Pennsylvania State University, USA, (2) Department of Geosciences, The Pennsylvania State University, USA, (3) G3 Center and Energy Institute, The Pennsylvania State University, USA, (4) Now at the School of Civil, Environmental and Mining Engineering, University of Adelaide, Australia, (5) School of Mechanical Engineering, University of Western Australia, Australia, (6) Department of Civil and Environmental Engineering, Ehime University, Japan (elsworth@psu.edu / Fax: +1 814865 3248)

The interactions of stress and chemistry exert a strong influence on the evolution of the mechanical and transport properties of porous and fractured media. Stiffness, strength, evolving stress state and permeability are all influenced by paths of spherical and deviatoric stress and of chemical potential of the permeating fluids. These effects are strongly nonlinear, with important feedbacks between mechanical and reactive chemical processes. Mechanical processes include compaction and dilation with applied shear and normal loads, the extension of micro-cracks, and augmentation of reactive surface area and activity by stress-corrosion and other mechanisms of micro-cracking. Chemical processes include precipitation, dissolution, reaction and transformation – some of which take advantage of the modified mechanical state, and may be augmented and accelerated by stress effects. Chemical effects can be surprisingly significant and rapid in systems pushed far from equilibrium – common in many engineered and natural systems.

We illustrate the interaction of these processes through observations on fractures in novaculite, limestone, diorite and tuff, and on granular aggregates of quartz and

halite. These media illustrate a broad range of behaviors under differing mechanical and chemical regimes: where permeabilities decrease with net dissolution, then enigmatically switch with no apparent change in experimental conditions; and alternately regimes where products from failure dominate the response. Concomitantly, stress-mediated dissolution drives overgrowths in both fractured and granular media which results in the bonding of contacts; simultaneously influencing ambient stresses and contact strengths. We examine these behaviors using models for the interaction of surfaces in contact, as both lumped parameter systems, and as distributed parameter systems using Lagrangian-Eulerian models for dissolution-precipitation and transport.

Observed and modeled responses are upscaled into constitutive models to represent the interaction of stress and chemistry in the evolution of transport properties at the continuum scale, and with appropriate feedbacks. These are accomplished through the application of both weakly-coupled and strongly-coupled models to represent these responses, and to follow behavior. Applications of these models are to contemporary issues of reservoir engineering in geothermal systems, and in the safe isolation of high-level radioactive wastes.