Geophysical Research Abstracts, Vol. 9, 09792, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-09792

Effect of stress on fluid-filled inclusions in elasto-plastic soils

M. Berli (1,4), B. Schäffer (2), R. Müller (3), R. Schulin (2), M.L. Accorsi (4), D. Or (4,5)

(1) Desert Research Institute, Division of Hydrologic Sciences, 755 E. Flamingo Road, Las Vegas NV 89119, (2) ETH Zurich, Institute of Terrestrial Ecosystems, Universitätstrasse 16, CH-8092 Zurich, (3) ETH Zurich, Institute for Biomechanics, Moussonstrasse 18, CH-8092 Zurich, (4) University of Connecticut, Department of Civil and Environmental Engineering, 261 Glenbrook Road, Storrs CT 06269, (5) Ecole Polytechnique Federale de Lausanne, School of Architecture, Civil and Environmental Engineering, Batiment GR 2, CH-1015 Lausanne, (markus.berli@dri.edu / phone: ++1 702-862-5452 / fax: ++1 702-862-5427)

This study presents relationships between pressure and deformation of fluid inclusions embedded in soft soils due to applied stress. The aim was to improve the understanding of pore-scale mechanical behavior and to develop methods for in-situ measurement of soil mechanical properties. Analytical expressions for fluid pressure and pore deformation as functions of biaxial remote stress and material properties were developed and tested on results from deformation experiments using X-ray micro-computed tomography and finite element calculations. From our simulations, we found that fluid pressure decreases with increasing fluid compressibility at constant applied mean stress. Pressure in an incompressible fluid inclusion (e.g. water) is mainly influenced by the applied mean stress, matrix yield stress and Poisson's ratio. Changes in inclusion shape are controlled by applied deviatoric stresses and matrix shear properties. Deformation of air-filled macro-pores, experimentally monitored with micro-computed tomography, could be well simulated by the analytical pore deformation model. The results of this study provide (a) improved insight into macro-pore stress-deformation behavior as well as (b) a framework for the development of sensors for in-situ measurement of soil mechanical and rheological properties required for linking soil mechanical and hydraulic properties.