International Journal for Multiscale Computational Engineering, 4(5&6)693–732(2006)

# Computational Homogenization of Nonlinear Hydromechanical Coupling in Poroplasticity

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## ABSTRACT

*In this paper, we propose a new two-scale model of fluid-saturated elastoplastic porous media based on micromechanical considerations. A formal nonlinear homogenization procedure using asymptotic expansion techniques is adopted to up-scale the microscopic constitutive behavior of an elastoplastic solid coupled with the movement of a Stokesian fluid. Considering the yield criterion at the microscale governed by the Mohr-Coulomb function and that the plastic deformation obeys the principle of maximum dissipation, we build up, computationally, a sharper macroscopic yield criterion and provide precise two-scale computations for the effective parameters of the homogenized medium. Within this context, we show that the homogenized results incorporate additional features inherent to the nonlinear hydromechanical coupling that have been overlooked by the purely macroscopic approaches. Variational principles along with the corresponding Galerkin approximations are proposed to discretize the local nonlinear closure problems leading to numerical effective constitutive laws. The influence of the new constitutive features obtained at the Darcy-scale effective model is propagated to the field-scale and illustrated numerically in a example of land subsidence caused by oil extraction of a weak heterogeneous reservoir with hydraulic conductivity characterized by long-range correlations displaying fractal character.*

## KEYWORDS

*poroplasticity, homogenization, Terzaghi's decomposition, nonlinear poromechanics, reservoir compaction*

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