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Micromechanical modeling of non-hydrostatic compaction and decompaction

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To understand dilatant and compactant failure in many sedimentary rocks one needs to consider inelastic behavior of porous media. One of the ways how the mechanical compaction and decompaction of porous rocks can be treated is provided by a micromechanical approach. Micromechanical spherical model which considers a hollow sphere subjected to homogeneous tractions on the outer boundary as a representative elementary volume succeeded in predicting the volumetric compaction behavior of porous rocks and metals to a hydrostatic pressure in a very wide range of porosities. But the real stress state in rocks usually is not a hydrostatic one. The presence of a shear stress generally tends to enhance void compaction and decompaction. So micromechanical model should be able to describe the deviatoric loads contribution as well. Usually it is more complicated problem since there are not so much analytical solutions available for non-hydrostatic load. The spherical model has its own internal limitations as it fails to reconstruct yield surface for both hydrostatic and non-hydrostatic loads with the same set of parameters.

In this contribution, a micromechanical model of void compaction and decompaction due to the non-hydrostatic load is presented. The infinite elasto- (visco-) plastic layer with a cylindrical hole is considered as a representative volume element. The remote boundary of the volume is subjected to a homogeneous non-hydrostatic load such that plane strain conditions are fulfilled through the volume. At some critical value of remote stresses plastic zone develops around the hole. The dependence of the effective rock properties on the properties of individual components is examined. The effect of shear stresses on compaction and decompaction is of the special interest.