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Chemically induced compaction bands in geomaterials

Ioannis Stefanou and Jean Sulem
Université Paris-Est, Laboratoire Navier (UMR 8205), CNRS, ENPC, IFSTTAR, France (ioannis.stefanou@enpc.fr)

Compaction bands play an important role in oil production and may provide useful information on various geological processes. Various mechanisms can be involved at different scales: the micro scale (e.g. the grain scale), the meso scale (e.g. the Representative Element Volume) and the macro scale (e.g. the structure). Moreover, hydro-chemo-mechanical couplings might play an important role in triggering instabilities in the form of compaction bands. Compaction bands can be seen as an instability of the underneath mathematical problem leading to localization of deformation [1,2,3]. Here we explore the conditions of compaction banding in quartz-based geomaterials by considering the effect of chemical dissolution and precipitation [4,5]. In due course of the loading process grain crushing affects the residual strength, the porosity and the permeability of the material. Moreover, at the micro-level, grain crushing results in an increase of the grain specific surface, which accelerates the dissolution [6]. Consequently, the silica is removed more rapidly from the grain skeleton and the overall mechanical properties are degraded due to chemical factors.
The proposed model accounts for these phenomena. In particular, the diffusion of the diluted in the water silica is considered through the mass balance equation of the porous medium. The reduction of the mechanical strength of the material is described through a macroscopic failure criterion with chemical softening. The grain size reduction is related to the total energy input [7]. A grain size and porosity dependent permeability law is adopted. These degradation mechanisms are coupled with the dissolution/precipitation reaction kinetics. The obtained hydro-chemo-mechanical model is used to investigate the conditions, the material parameters and the chemical factors inducing compaction bands formation.

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