Geophysical Research Abstracts, Vol. 8, 03819, 2006
SRef-ID: 1607-7962/gra/EGU06-A-03819

Localized compaction in rocks: numerical and analytical approaches

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Porous rocks, subjected to compressive stress, often undergo mechanical compaction via grain crushing and rearrangement, and chemical compaction via pressure solution. The compaction leads to irreversible volume reduction that spontaneously localizes into elongated features under some conditions. However, the localization process is poorly understood. The formation and propagation of compaction bands has recently been studied using an elasto-plastic Spring Network Model [Katsman et al., 2005]. Simulation results show that compacted regions experience stress concentrations at their tips, reminiscent of Mode I cracks. However, aside from this similarity point, comparison of stress around compacted regions to stress around cracks reveals that the stress/strain distribution in such defects is quite different than that around Mode I cracks (or anticracks introduced by Fletcher and Pollard [1981]). This work presents an analytical solution for the stress around a 2D localized compaction band (CB), using the “transformation problem” introduced by Eshelby [1957]. The analytical solution is shown to agree with results from our recently introduced elasto-plastic Spring Network Model for simulating mechanical and chemical compaction.