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Modeling of two-phase porous flow with damage: porosity wave propagation

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Two-phase dynamics has been broadly studied in Earth Science in a convective system. We investigate the basic physics of compaction with damage theory proposed by Bercovici $et\ al.$[2001a, JGR] and present preliminary results of both steady-state and time-dependent transport when fluid migrates through porous medium. For 1-D simple compaction, melt segregates and ascends through the residual solid matrix due to its differential buoyancy and pressure field. We examine the depth profile of porosity and show that steady-state pumping is self-limiting. However, linear stability analysis and our time-dependent model show that the propagation velocity of porosity waves is strongly dependent on damage, which can theoretically transform dispersive waves into shock waves which are rapidly propagating. This result provides a framework for understanding the percolating fluid migration with a pore-generating damage front. Hydro-fracturing stimulation is probably the most plausible mechanism for exposing new mineral surfaces and keeping fluid pathways open, which is promise particularly for sequestration of CO_2 because of its direct relation between damage propagation and porosity evolution. Further development and expansion with necessary physical conditions, forcings and chemical reactions would help examine the viability of CO_2 injection into subterranean formations.