Conditions for pore collapse instabilities in high-porosity rocks undergoing compaction banding and cataclastic flow

By Ronaldo I. Borja and Atilla Aydin
Stanford University, Stanford, CA 94305

Abstract

We review conditions for material instabilities in high-porosity solids induced by a bifurcation of solution into non-unique strain rate fields. Bifurcation modes considered include jumps in the strain rate tensor of ranks one and higher representing deformation band and diffuse instability modes, respectively. Eigenmodes (e-modes) are extracted for each type of instability to fully characterize various frameworks of deformation in collapsible solids. For diffuse instability these e-modes are determined from a homogeneous system of linear equations emanating from the condition of zero jump in the stress rate tensor, which in turn demands that the tangent constitutive tensor be singular for the existence of nontrivial solutions. For isotropic materials we describe two types of singularity of the constitutive tensor: (a) singularity of the constitutive matrix in principal axes, and (b) singularity of spin. Accordingly, we derive the e-modes for each type of singularity. We utilize the singularity of the constitutive matrix in principal axes as a precursor to volume implosion in collapsible solids such as high-porosity rocks undergoing cataclastic flow. Finally, we compare conditions and e-modes for cataclastic flow and compaction banding, two similar failure modes ubiquitous in high-porosity rocks.

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References

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