Geophysical Research Abstracts
Vol. 20, EGU2018-18270, 2018
EGU General Assembly 2018
© Author(s) 2018. CC Attribution 4.0 license.

Effective shear viscosity in two-phase aggregates: a numerical study

Giulia Fedrizzi, Manuele Faccenda, and Giorgio Pennacchioni
Universita' di Padova, Dipartimento di Geoscienze, Padova, Italy (manuele.faccenda@unipd.it)

Understanding the role of secondary phases dispersed in a rock matrix with different mechanical properties is crucial to obtain information about the rheology of polycrystalline aggregates. Crustal and mantle rocks deformed by viscous creep during shear deformation develop foliations and lineations, which might reflect both the bulk strain geometry and the viscosity contrast among the different phases.

The aim of this study is to estimate the evolution of the effective shear viscosity and microstructure as a function of strain, matrix-inclusions viscosity contrast, volume fraction of the inclusions and creep regime. We have performed 3D mechanical simulations of simple shear deformational experiments on two-phases crystalline aggregates, both in Newtonian and non-Newtonian regimes and up to shear strain of 10-20. Simple shear deformation is applied by two sliding rigid plates enclosing initially spherical inclusions dispersed in a matrix. The domain is periodic in both horizontal directions.

Inclusions weaker than the matrix experience flattening and eventually merge, resulting at high strain in a penetrative foliation. In this case, the effective shear viscosity decreases with strain toward the Reuss lower bound. In contrast, stronger inclusions experience constrictional deformation and become prolate spheroids. As a result, a prominent lineation progressively form and the effective viscosity decreases with strain. In both cases, the decrease in viscosity is proportional to the inclusion volume fraction. The inclusions closer to the rigid plates undergo a stronger deformation, which results in a higher aspect ratio and a lower vorticity. In the limit of rigid inclusions, the matrix accommodates the whole strain and the effective viscosity slightly oscillates around the one predicted by the Dougherty and Krieger's equation for suspension with rigid spheres.

In non-Newtonian simulations, the difference in behaviour of matrix and inclusions is emphasised. The effective shear viscosity decreases substantially with strain even when relatively weak inclusions are present. Relatively strong inclusions, instead, behave like rigid rotating bodies and the effective shear viscosity remains constant with strain.