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Identification and modeling of deformation mechanisms in two phase silicate aggregates subjected to large shear

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Synthetic aggregates of anorthite-diopside have been prepared by hot isostatic pressing in order to produce specimens with a controlled microstructure: a fine grained matrix ($< 5\mu$m) of anorthite containing coarser diopside inclusions ($< 45\ \mu$m). The specimens are subjected to torsion at T= 1000 to 1200 ˚C, confining pressure of 400 MPa and constant twist rates up to large shear strains (γ = 2 - 4). Deformation microstructures were characterized with scanning electron microscopy (SEM). The fine grained matrix showed evidences for grain scale phase mixing and cavitation coalescence, leading to micro cracking and ductile failure. The late are characteristic of grain boundary sliding mechanisms, which is in agreement with the macroscopic Newtonian viscous flow of the specimens. But, in the vicinity of and within the diopside inclusions we observed evidences for dislocation creep, such as cell structures and marginal dynamic recrystallization, which indicate substantial local stress enhancement. Electron back scatter diffraction (EBSD) was performed in order to record the local crystallographic orientations and to compute measures of textures.

These observations provide data for modeling the deformation of the samples using a finite element code which accounts for the rheology of the constituents. A few representative volume elements (RVE) are chosen for which the microstructure and phase distribution are known. In particular, we select representative areas with a single inclusion surrounded by the matrix. The exact geometry of the inclusion, as seen from

microstructural observations, is used in the finite element mesh. One thus considers almost equiaxed shapes or elongated ones. Several material behaviors may be implemented in the computer code, from elasticity to elasto-viscoplasticity. One uses material parameters identified experimentally for anorthite and diopside. In an incremental procedure, local distributions of strain and stresses are analyzed, of particular interest are the stress concentrations near the inclusion. The texture measurements are used to discuss the validity of our model and to provide an indication of the importance of local anisotropy and plasticity (intra or intergranular) in the overall behavior.