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Numerical study of the deformation mechanisms of two-phase silicate aggregates subjected to large shear : interaction between inclusions and identification of the activation of different mechanisms

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The finite element simulations are based on experiments and observations conducted on synthetic aggregates of diopside-anorthite. The samples have been prepared by hot isostatic pressing in order to produce specimens with a controlled microstructure: a fine grained matrix (<5μm) of anorthite containing coarser diopside inclusions (< 45 μm). The specimens are subjected to torsion at T= 1000 to 1200 °C, confining pressure of 400 MPa and constant twist rates up to large shears. SEM (scanning electron microscope) observations have been made to characterize the microstructure. Samples exhibited Newtonian flow (stress exponent n=1). The fine grained matrix also showed evidences of grain boundary sliding (GBS) mechanisms, such as cavitation coalescence leading to microcracking and ductile failure. However, we have also identified substantial local stress enhancement and localized dislocation creep in the vicinity of the diopside inclusions. These observations provide data for modeling the deformation of the samples using a finite element code which accounts for the rheology of the constituents. Several models can be implemented, from linear elasticity to elasto-viscoplasticity and in the latter regime, the transition between a Newtonian and non-Newtonian behavior. A few representative volume elements (RVE) are chosen for which the local distributions of strains and stresses are computed incrementally. The shapes of the inclusions and their orientation with respect to the applied shear have strong local consequences on the computed stress fields. Even at relatively low concentrations, the interactions between neighboring inclusions seem to play a significant part for strain amplification of stress relaxation. One tries to assess through the study of a few significant examples, the consequences of these local situations for triggering other modes of deformation or accommodation of the imposed overall deformation, such as damage or recrystallization. In this continuing part of the project, the emphasis is placed both on the rheology and the boundary conditions imposed on the structure : from the overall shear to local conditions, with an effort to take into account 3D effects.