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Observations of grain- to multi-grain-scale deformation of mineral aggregates deformed by diffusion creep

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We deformed cylindrical polycrystalline samples of synthesized forsterite + diopside and anorthite mineral aggregates at its diffusion creep regime. We polished the lateral side of the sample where we imposed grooves parallel to the compression axis of the sample using a focused ion beam. These marker lines allow us to observe fine-scale deformation of the sample. After the high temperature one atmosphere compression creep experiment, we observed the sample surface with marker lines under scanning electron microscope.

Strains of bulk sample and of the marker line exhibited the similar values indicating that the similar deformation proceeded both at bulk and surface regions of the samples. Grain rotation, which was identified by misfits of the markers at grain boundaries and rotation of intra-granular markers, were frequently observed in all the samples. No distortion of the markers within the grains was found indicating the absence of intragranular deformation process such as a glide of dislocations; however, in the samples deformed at high stress (˜300 MPa), curved intra-granular markers were observed, which is consistent with dislocation activity at high stress condition. The changes in grain configuration were also observed elsewhere in the samples demonstrating significant operation of grain boundary sliding which produced grain switching. Grain rotations were controlled by the orientation of long flat crystallography-controlled grain boundaries with respect to the compressional direction. Such grain rotation resulted in a significant development of crystallographic preferred orientation in the samples.

Keywords: diffusion creep, mineral