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Diffusion creep, grain boundary sliding, grain shapes and seismic anisotropy

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It is commonly asserted that diffusion creep gives rise to, or may even be diagnosed from, equant grain shape fabrics. Some olivine rocks that are thought to have deformed by diffusion creep do show equant grains shapes in nature and experiment. However plagioclase shows more varied behaviour, including elongate grain shapes in nature and experiment. Grain growth is a key factor in grain shape evolution and I propose that the plagioclase examples relate to slow growth (relative to the buildup of strain) whereas the olivine examples relate to relatively fast growth. I do not expect, though, that either mineral will always behave thus, because the behaviour must depend on the *relative* rates of deformation and grain growth. Instead, the examples relate to a spectrum of behaviour.

A numerical model (named “DiffForm”) gives insight into how grain shapes evolve during diffusion creep in the absence of grain growth – it is thus a model of “end member” behaviour. Grain shapes become elongate but not as much as the strain ellipse. This is because grain boundary sliding (a key aspect of diffusion creep) and neighbour switching limit the shape change experienced by individual grains.

The model satisfactorily simulates “plagioclase type” behaviour. It is important beyond that because it allows predictions of grain rotations. Grain rotations will, if severe enough, destroy pre-existing lattice preferred orientations (LPO). However, the model shows that rotations will be limited and thus that this type of diffusion creep will not destroy LPO, contrary to some assumptions commonly made. LPO is a control on seismic anisotropy. The model discussed here allows, for the first time in Earth Sciences, the effects of diffusion creep, grain boundary sliding and grain shape on seismic anisotropy to be investigated.