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The effects of a second phase on rates of grain boundary diffusion creep and grain boundary migration

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The behaviour of grain and phase boundaries in polycrystalline geological materials has received relatively little attention compared to the behaviour of grains themselves, despite the fact that boundaries are often the most dynamic regions within rocks, and are known to exert fundamental controls on the bulk properties of crystalline materials. For example, during high temperature deformation, mechanisms such as grain boundary diffusion creep and dynamic recrystallization by grain boundary migration are clearly influenced by the density and dynamics of grain boundaries. Grain growth, which is driven by reduction in interface energy and depends on grain boundary mobility, can lead to a switch in dominant deformation mechanism from (grain size dependent) diffusion creep to dislocation creep.

Wheeler (2009) posits that the interplay between grain growth kinetics (i.e. boundary mobility) and grain boundary diffusion creep rates will fundamentally affect resultant deformation microstructures. Real rocks are polyphase materials, and a second phase can influence microstructural evolution by inhibiting grain growth through pinning of boundaries. In contrast, there is no evidence to suggest diffusion creep is inhibited (in fact it may be enhanced) by the presence of a second phase. We will present the results of numerical simulations of microstructural evolution during coupled diffusion creep and grain growth, in which a second phase varies in volume and distribution. We will compare the results to some natural microstructures in which the lifetime of diffusion creep is thought to have been extended due to phase mixing and boundary pinning.

Wheeler, J. (2009). The preservation of seismic anisotropy in the Earth's mantle during diffusion creep. Geophysical Journal International, 178(3), 1723-1732. doi:10.1111/j.1365-246X.2009.04241.x