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# The effect of dynamic recrystallization on the evolution of flow stress during deformation to high strain

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Grain size reduction by dynamic recrystallization is often put forward as a process that can result in rheological weakening and associated strain localization, by bringing about a switch in deformation mechanism from grain size insensitive dislocation creep to grain size sensitive diffusion creep. In recent years, however, the hypothesis has been advanced that, rather than a switch, dynamic recrystallization leads to a balance between grain size reduction and grain growth processes, set up at the boundary between the dislocation and diffusion creep fields. If generally valid, such a balance would imply that significant weakening in localized zones is unlikely to take place. One problem with the approach, however, is that it is based on representing the grain size by a single mean value, while rocks invariably exhibit grain size distributions. This hampers full assessment of the rheological consequences of recrystallization. To help solving this problem, we have now developed a model for dynamic recrystallization that describes transient evolution of a polycrystalline material with distributed grain size towards a dynamic recrystallized steady state including all processes involved. In the model, we consider new grain nucleation by progressive subgrain rotation, grain boundary migration driven by gradients in various forms of free energy, and the operation of grain size sensitive diffusion creep and grain size insensitive dislocation creep. The complexity of the problem demands a numerical implementation. First application using olivine material parameters shows that evolution of grain size distribution can be highly complex involving multimode stages. Associated with this, the evolution in flow stress can be complex, giving new insights in rheological weakening and strain localization induced by dynamic recrystallization.