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# Microstructural evolution of synthetic Fe-bearing forsterite aggregates deforming by grain size sensitive creep

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Microstructural modification processes such as dynamic recrystallization and grain growth can have a major effect on the flow behaviour of deforming rocks. High strain experiments on, for example, coarse grained olivine and calcite materials have demonstrated transient strain weakening related to grain refinement by dynamic recrystallization during grain size insensitive dislocation creep. In contrast, strain hardening has been shown to occur in fine grained olivine aggregates that coarsen in grain size while deforming in the grain size sensitive (diffusion/grain boundary sliding) creep field. The rate of grain coarsening not necessarily corresponds to that of static grain growth – it might be enhanced by the deformation. In this study, we aimed to quantify the contribution of a deformation-induced component of grain growth in olivine aggregates. We have conducted new deformation and heat-treatment tests on synthetic fine-grained wet olivine material containing Fe (fo90) plus 5 vol% enstatite. The samples have been hot isostatically pressed and deformed in axial compression in a constant volume, internally heated argon gas medium apparatus, at temperature 850-1000˚C and confining pressure 600 MPa pressure. Microstructural imaging has been carried out using a scanning electron microscope operating in orientation contrast mode. Grains and pores in the two-dimensional images obtained have been quantitatively analyzed as a function of experiment duration, strain and temperature. We found only minor static grain growth during heat treatment at pressure, suggesting that normal grain growth is hindered due to the presence of porosity and/or enstatite as second phase. An extra component of grain growth, however, was observed during deformation. This component of dynamic grain growth can be related to an increase with temperature

and strain of the fraction of non-hexagonal grains in 2-D. The evolution and flow behaviour observed for fo90 is very similar to that seen previously for pure forsterite (fo100). Comparison of the experimental results with theoretical models allows us to make a first step in quantifying dynamic grain growth in such a way that it can be included in geodynamic models relying on the rheology of olivine.