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Synthesis and deformation experiments on polycrystalline olivine

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It is very important to examine the flow properties of the upper mantle for understanding the mantle flow and the origin of asthenosphere. Previous studies on creep properties of polycrystalline olivine prepared from naturally derived olivine have shown the effects of temperature, grain size, stress, and the amount of water and melt, which help to construct an applicable flow law to the natural condition (Karato et al 1986, Hirth and Kohlstedt 1995, Hirth and Kohlstedt 2003). However, Faul and Jackson (2007) showed that olivine aggregates prepared from reagents using sol-gel technique had 1 ˜2 orders of magnitude lager strength compared to the naturally derived olivine aggregates indicating a presence of significant but unknown factor that controls creep rate of olivine aggregate. In this study, we synthesized olivine aggregates by using new technique and conducted high-temperature creep experiment on the synthesized olivine aggregates. Also we introduced small amount of impurities on such aggregates to investigate the effect of impurities on the creep properties of olivine aggregates.

The aggregates were prepared by applying vaccum sintering to nano-sized olivine powder synthesized from highly pure and fine-grained (<100 nm) raw powders (Koizumi et al 2010). An appropriate source of Fe and a method to achieve reductive atmosphere were searched. Olivine aggregates with and without dopants of 0.1% Al2O3, CaO, NiO, TiO2 were prepared. Deformation tests on these samples showed no major difference in their strength under diffusion creep. Further, the strength was essentially identical to the aggregates by Faul and Jackson (2007). Our results indicate that the some chemical species other than those investigated in this study has a significant effect on creep properties of polycrystalline olivine.

Keywords: Synthesis of polycrystalline olivine, High-temperature deformation experiments