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In situ deformation of eclogite at high pressure and temperature

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Little is known about the physical behaviour of heterogeneous, rheological contrasting rocks in the Earth's mantle and their impact on mantle processes. Understanding of the stress/strain partitioning, microstructural evolution, and seismic signatures in bimineralic eclogites provide crucial information for transport modeling of these dense materials into and out of the deep Earth. For example, heterogeneity in the peridotite-dominated mantle may develop via a variety of processes such as entrainment and mixing of discrete eclogite bodies from subducted slabs or from detachment of deep continental roots into the convecting mantle. Exhumed eclogitic bodies are characterized by intense foliation and strain localization and strong shape- and crystallographic preferred orientations. In this preliminary study we used synchrotron X-ray diffraction at the ID06 beamline at ESRF to estimate the stresses *in situ* on a deforming bimineralic eclogite (˜40% garnet and ˜60% clinopyroxene) and a dunite (100% olivine) at 5 GPa and a range of temperatures (1473 - 1673 K), i.e. at subsolidus conditions. The starting material was prepared as a residual eclogite after extraction of ˜46 wt% melt from GA2 eclogite (Spandler *et al.*, 2008, *J Petrology* 49, 771-795) and was pre-sintered at 5 GPa and 1673 K using a multi anvil apparatus. The run products yield well-equilibrated sub-/euhedral crystals of garnet and tabular crystals of clinopyroxene with average grain sizes of <30 μm. Coesite was present only as multiple small, rounded inclusions in garnet. The compressive deformation experiments were carried out at constant strain rates of 10^{-6} to 10^{-5} s^{-1} to axial strains of 5 to 30% on a stack comprising the pre-sintered bimineralic eclogite sample above a pure San Carlos olivine sample (as a reference). The cylindrical samples have dimensions of 1.2 mm in diameter by 1.5 mm in length and are separated by metal foils (e.g. Re) acting as strain markers visible in radiographic images. The deviatoric stresses are transmitted via hard alumina pistons above and below the sample stack. Furthermore, the samples are surrounded by a boron nitride sleeve and graphite resistance heater and the cubic pressure medium is made of boron epoxy, which is transparent to synchrotron X-rays. We expect results on the strength partitioning between garnet and pyroxene in a residual bimineralic eclogite and between the eclogite and the dunite deformed under conditions applicable to the upper mantle. Complementary information on crystallographic preferred orientation development of garnet and clinopyroxene in eclogite, and of olivine in dunite will give insight into the deformation mechanisms and interpretation of fast seismic wave propagation directions and anisotropy relative to the prevalent stress direction. The data will be compared against natural field and seismic observations and offer insight into deep crustal seismic reflectors seen in regions of intense deformation.

キーワード: two-phase deformation, eclogite rheology, in situ X-ray diffraction, mantle heterogeneity
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