An *in-situ* synchrotron radial X-ray diffraction study of deformation mechanisms and plastic anisotropy of a polycrystalline MgO

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Radial X-ray diffraction provides a powerful tool to study the plastic deformation of minerals under high-pressure and temperature conditions. However, previous studies using this approach used a theory developed by [*Singh*, 1993] where only elastic deformation is considered. This theory predicts that the (hkl) dependence of lattice strain is controlled solely by elastic anisotropy of minerals, but observations show a large deviation from this prediction suggesting the importance of plastic deformation on lattice strain. [*Karato*, 2009] developed a new theory including the influence of both elastic and plastic deformation on lattice strain. This theory predicts (i) that when there is no elastic anisotropy, the (hkl) dependence of lattice strain will vanish (for a cubic material) if deformation takes place by diffusion creep, and (ii) that when deformation takes place via dislocation creep, the relative strength of various slip systems (plastic anisotropy) can be inferred from the (hkl) dependence of stress.

To explore the potential of this theory, we performed deformation experiments using Rotational Drickamer Apparatus (RDA) on MgO polycrystalline samples, at mantle pressures (19 GPa $<P<$27 GPa) and temperature (~1500K). At these pressure conditions, MgO has very small elastic anisotropy [*Karki et al.*, 1997]. Using the unique X-ray synchrotron diffraction technique available at 6-BM-B beamline at APS, we estimated *in situ* stresses for (200) and (220) MgO diffraction planes and thus directly observed plastic anisotropy of the samples. Using different sample grain sizes we were able to control the active deformation mechanism (for e.g. diffusion creep or dislocation creep). For coarse-grained specimens ($\geq$1µm), we observed strong (hkl) dependence of radial strain indicating the operation of dislocation creep. The observed (hkl) dependence changes with pressure: at pressures higher than 27 GPa, (200) shows larger stress estimate than (220). In contrast, at lower pressures, (220) shows larger stress estimate than (200). This likely corresponds to a transition of the easy slip system in MgO as a function of pressure, from {110} plane to {100} plane. These results are in good agreement with low pressure experiments, theoretical predictions and numerical calculation [*Amodeo et al.*, 2011] and could have important implications for the interpretation of seismic anisotropy in the D" layer [*Karato*, 1998].

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