Velocity Profiles and Deformation of Silicate Post-Perovskite in the Lowermost Mantle

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Seismic observations have found distinct regions approximately a few hundred km above the core-mantle boundary, called the D" layer, which exhibits V_S splitting anisotropy, anti-correlation between V_S and V_Φ, and decreased velocity gradient. The source of these seismic signatures in the D″ layer remains uncertain, but geodynamic models and mineral physics studies have suggested that the existence of silicate post-perovskite (PPv) at relevant P-T conditions may develop textures to account for the seismic anisotropy while the bridgmanite (Bgm) to PPv transition can account for the velocity discontinuity and anti-correlation. In this study, we have investigated the deformation of Fe-bearing PPv using synchrotron radial X-ray diffraction in a laser-heated diamond cell at lowermost mantle P-T conditions, and also measured V_P and V_S of Fe-bearing PPv at D" pressures using Impulsive and Brillouin Scattering. Analysis of the radial diffraction spectra shows dominant (001) textures, suggesting slip on (001)[100] and (001)[010] at D" P-T conditions [1]. Geophysical models of subducting slabs predict that PPv with slip on (001) would produce a Vs splitting anisotropy of ~3.7% with $V_{SH} > V_{SV}$. Comparison of the velocity profiles between Fe-bearing PPv and Bgm shows that the PPv transition is associated with a significant V_S increase and a marginal V_P change at 120 GPa. The anti-correlation in V_S and V_Φ, together with a low Poisson's ratio for Fe-bearing PPv at lowermost mantle conditions are most consistent seismic observations of the D" in certain regions. These results are compared with seismic observations to provide mineral physics constrains on the seismic signatures of the textured Fe-bearing PPv in the D" layer.

[1] Wu et al. (2017) Nature Comm. (in press).