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Post-stishovite transition of eclogitic stishovite: Insights from in-situ XRD and ultrasonic interferometry

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Al-bearing stishovite and, later, post-stishovite are among the chief hydrogen-bearing phases in subducted oceanic crust (eclogite) at lower mantle conditions [1], being able to carry up to ~0.3 wt. % of H_2O [1-4]. H_2O-bearing Al-stishovite was recently suggested to cause seismic discontinuities and heterogeneities in the deep Earth's lower mantle at ~1000 km depth [5].

The incorporation of Al into stishovite leads to significant changes to its phase diagram and ability to take up H_2O [5,6]. For instance, it halves the pressure required for its rutile- to $CaCl_2$-type transformation, which exhibits significant elastic softening and may be seismically observable [5,6].

In order to understand the effect of Al-H_2O-bearing stishovite in the mantle, a range of defective stishovite samples were synthesized between 15-32 GPa at ~1200 ºC from glasses using 10/5, 10/4 and 7/3 multianvil assemblies. Recovered samples were double-polished (~0.5 mm thick) and quantitatively analysed by EPMA. Combined in-situ X-ray diffraction and ultrasonic interferometry, using 10/4 and 7/3 geometries, were conducted at ID06-LVP of the ESRF to ~ 32 GPa and 1800 K. In highly defective samples the onset of the transition to post-stishovite was accompanied by significant softening of shear wave velocities V_S. Therefore, the effect of Al- and H_2O-defects on the acoustic velocities of stishovite and an estimate of the role of defects in controlling the transformation pressure to the post-stishovite phase were assessed.

This study provides density and sound velocity measurements and thus, enable better experimental constraints of bulk elastic properties and their P and T derivatives of Al-H_2O-bearing stishovite at mantle-relevant P, T. This study extends information essential to the interpretation of the seismic observables and contribute to more complete modelling of subducted oceanic crustal material (i. e. eclogitic bodies) inside the Earth's deep mantle.

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