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Sound velocities of CaSiO3 perovskite

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Calcium silicate perovskite (CPv) is the most significant Ca-bearing mineral of the mantle transition zone and the third most abundant phase of the lower mantle within the pyrolite assumption (ONeill and Jeanloz, 1990; Ringwood, 1976). In addition, it is believed that subducted materials such as Mid-Ocean Ridge Basalts (MORB) may involve substantial amount of CPv. Thus the high-pressure and high-temperature structural and elastic behaviours of CPv have been extensively studied for their importance in understanding the internal structure of the Earth mantle. However, and besides reports by theoretical calculations, high-pressure experimental measurements of sound velocities of CPv are few (Li et al., 2004; Kudo et al., 2012).

Here, we examinated the sound velocities of $CaSiO_3$ perovskite in situ at high-pressure and high-temperature up to 23 GPa and 1700 K using a combination of ultrasonic interferometry and synchrotron X-ray diffraction techniques within a DIA-type multi-anvil press apparatus at BL04B1 in SPring-8. The velocities of P- and S-wave appeared to behave quasi-linearly within the P and T range studied. Linear fitting for the tetragonal structure of CPv at 300 K yielded $V_P(0)$ = 10.171 km/s and $V_S(0)$ = 5.285 km/s. Generally our results agreed with Kudo et al. (2012), with V_S being slower than previous estimates by theoretical and experimental methods. In addition we present new high P and T data for the cubic structure of CPv, which displayed velocities about ˜5% faster than the tetragonal structure at $T > 500$ K.

This new results suggested that V_P and V_S of CPv are high compared to surrounding mantle in the uppermost part of the mantle transition region (MTR). In the lowermost part of the MTR, CPv would have velocities comparable to PREM velocities, which make this phase barely detectable in this region. On the other hand, velocities of CPv would be significantly slower than lower mantle.

Keywords: CaSiO3 perovskite, high-pressure, high-temperature, ultrasonic interferometry, X-ray diffraction