Sound velocities of CaSiO3 perovskite

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Abstract

Laboratory measurements of sound velocities of high-pressure minerals provide crucial information on the composition and constitution of the deep mantle via comparisons with observed seismic velocities. CaSiO3 perovskite (CaPv) is considered to be a major high-pressure phase at depths greater than _˜560 km in the mantle and the subducting oceanic crust. On the basis of experimental data on the elastic properties of tetragonal CaPv, previous studies have argued that variation in the abundance of CaPv in the mantle could explain high shear to longitudinal wave velocity heterogeneities in the deep mantle. At the P and T of the mantle however, CaPv adopts a cubic structure above _˜600 K but despite its importance, measurements of sound velocity of the cubic CaPv under the corresponding P, T conditions has never been performed because this phase is unquenchable to atmospheric pressure and adequate samples for such measurements are unavailable. Here we report *in situ* X-ray diffraction and ultrasonic sound velocity measurements up to 23 GPa and 1700K (equivalent to the depths of the bottom of mantle transition region) using a high-density CaSiO3 glass rod specimen, that is first converted to a sintered polycrystalline body of cubic CaPv under high pressure and temperature in a multianvil apparatus. We observed a sudden change in sound velocities around _˜650K, consistent with the temperatures of the cubic to tetragonal transition in CaPv, thereby obtaining the elastic properties of both of these perovskites independently. We found cubic CaPv, which is more likely to be relevant to the mineralogy of the mantle, has a shear modulus _˜26% lower than theoretical predictions, implying that either pyrolite or basaltic compositions yield too low seismic velocities and fail to explain the observed velocities in the lower half of the mantle transition region. The existence of the former basaltic crust below the 660 km depth underneath some subduction zones may however explain the low shear-velocity region observed atop of the lower mantle.

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