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Elastic wave velocity anomalies of anorthite in a subducting plate: In situ experiments

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Abstract

To understand the origin of observed low velocities in the crustal portion of subducting plates, we performed in situ measurements of elastic wave velocities of anorthite at temperatures up to 1373 K at pressure of ~1 GPa and up to 773 K at 2.0–7.0 GPa. A fine-grained polycrystalline anorthite, which was synthesized using a gas pressure apparatus, was used for the measurements. The high-pressure experiments were performed using the multi-anvil apparatus installed on beamline BL04B1 at SPring-8. The elastic wave velocity was measured by the ultrasonic pulse method with synchrotron X-ray radiographic imaging and X-ray diffraction techniques. At ~1.0 GPa, elastic wave velocities exhibited a sharp temperature-induced kink at ~500 K. Below 500 K, the elastic wave velocities decrease with increasing temperature. In contrast, above 500 K, the elastic wave velocities show an increasing trend in the range of 500–900 K, and then revert back to a decreasing trend at above 900 K. We also found a pressure-induced velocity anomaly of anorthite. At 300–373 K, v_P is constant up to 4 GPa, but decrease above 4 GPa with increasing pressure, while v_S decreases monotonously with increasing pressure. These elastic anomalies are considered to be attributable to the tilting behavior of the corner-sharing TO_4 (T = Al, Si) tetrahedra in three-dimensional frameworks of anorthite. Our results suggest the presence of plagioclase feldspar has the potential to causes low-velocity anomaly in the subducting oceanic crust when it survives as a metastable phase in the slab at higher pressure and lower temperature conditions.

Keywords: Anorthite, plagioclase, elastic wave velocities, subduction, oceanic crust