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Sound velocities across calcite phase transitions by Brillouin scattering spectroscopy

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Abstract

Calcite ($CaCO_3$) is widely considered an important carbon carrier in the Earth's interior. Laboratory measurements of the velocities and elastic properties of calcite are important for understanding the deep carbon cycle. The sound velocities of calcite were determined up to 10.3 GPa at ambient temperature by Brillouin scattering spectroscopy. Dramatic decreases in the velocity of compressional wave (V_p) and shear wave (V_s) and abrupt increases in the V_p anisotropy (Ap) and maximum V_s anisotropy (As_{max}) were detected across the phase transition from $CaCO_3$-I to $CaCO_3$-II. Dramatic increases in the V_p and V_s and an abrupt decrease in Ap were observed across the phase transition from $CaCO_3$-II to $CaCO_3$-III. The phase transition from $CaCO_3$-I to $CaCO_3$-II may potentially explain the Gutenberg discontinuity at 51 km in the Izu-Bonin region. The V_p and V_s values of calcite were low. Our new results combined with literature data suggest that the low velocities of $CaCO_3$ could potentially explain the low-velocity zone occurring in northeastern (NE) Japan.

Keywords: Brillouin scattering, sound velocity, elasticity, $CaCO_3$, high pressure