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Influence of aluminum on the elasticity of majorite-pyrope garnets

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Abstract

The effect of aluminum (Al) on the elasticity of majorite-pyrope garnets was investigated by means of ultrasonic interferometry measurements on well-fabricated polycrystalline specimens. Both velocities and elastic moduli increase almost linearly with increasing Al content within analytical uncertainty. No significant variation of the velocities and elastic moduli is observed across the tetragonal-to-cubic phase transition at majorite with the pyrope content up to 26 mol% along the majorite-pyrope system. The elasticity variation of majorite-pyrope garnets is largely dominated by the Al content, while the phase transition as a result of cation ordering/disordering of Mg and Si via substitution of Al on octahedral sites cannot significantly affect elastic properties. Seismic velocity variations of a garnet-bearing mantle transition zone are therefore dominated by garnet composition (e.g., Al, Fe, Ca, and Na) rather than the tetragonal-to-cubic phase transition because of cation ordering/disordering.

Keywords: Aluminum, garnet, phase transition, velocity, elastic modulus, mantle transition zone; Physics and Chemistry of Earth's Deep Mantle and Core