Hot-pressing and analysis of polycrystalline specimens of hydrated wadsleyite (β-Mg2SiO4) for acoustic velocity measurements.

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Abstract

The nominally anhydrous mineral (NAMs) phases – olivine (α), wadsleyite (β) and ringwoodite [(γ-Mg,Fe)2SiO4), believed to be stable in the Earth's upper mantle and the transition zone (410-660 km depth), incorporate considerable amounts of water as structurally bonded OH, causing changes in their physical properties, including elastic wave speeds and elastic properties. Experimental and theoretical studies indicate that wadsleyite (β-Mg,Fe)2SiO4) in particular, can accommodate varying amounts of water up to 3.3 wt.%, depending on the pressure (P) and temperature (T) and phase assembly. The elastic properties of hydrated mantle mineral are essential for assessing mantle composition based on matching laboratory velocity and density profiles for mantle phases with data from regional seismic studies, to assess the role of water in the lateral inhomogeneity observed from seismic tomographic studies of the Earth's mantle, and to improve our general understanding of the Earth's mineralogical and chemical composition. The data are also valuable for assessing the Earth's water budget, and for locating the water repositories in the Earth's interior. Due to the significant difficulty in synthesizing large single crystals of the high pressure phases of mantle minerals for ultrasonic studies, we have adapted techniques to fabricate optimum acoustic-quality synthetic polycrystalline specimens of hydrous wadsleyite (β-Mg2SiO4) suitable for ultrasonic studies. Results for polycrystalline specimens of hydrous β-Mg2SiO4 containing 0.5 wt.%, 0.8 wt.% and 1wt.% OH, respectively hot-pressed in a multi-anvil press, and characterized by Fourier transform infrared (FTIR) spectroscopy, Raman Spectroscopy, non-destructive X-ray diffraction, scanning electron microscopy (SEM), immersion bulk density measurements and bench-top acoustic velocity measurements are presented, including results of preliminary high pressure ultrasonic studies carried out on the13-ID-C,D beam line at the Advanced Photon Light Source (APS) in Chicago, in the USA.

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