Comparative Brillouin Spectroscopy Measurements Suggest that Water May be Seismically Invisible in Earth's Transition Zone

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Ringwoodite, the major mineral in the Earth's transition zone between 520 and 660 km depths, can incorporate significant amounts of "water" into its crystal structure through point defect mechanisms. Previous studies have documented a strong reduction of acoustic wave velocities in hydrous ringwoodite at room pressure. This observation implies that the distribution of "water" in the transition zone could be mapped using seismic observables. However, conflicting experimental results about the pressure-dependence of the acoustic velocities hamper any quantitative estimate of the velocity reduction at conditions of the transition zone.

Here, we will present novel acoustic wave velocity measurements on ringwodite single-crystals conducted in a multi-sample approach [1]. In our experiments, four focused ion beam prepared single-crystals with different chemical compositions were loaded in a single sample chamber of a resistively-heated diamond-anvil cell (DAC). Our approach facilitates a direct quantification of the effects of "water" and iron-incorporation on the elasticity and acoustic wave velocities of ringwoodite at non-ambient conditions by Brillouin spectroscopy and x-ray diffraction measurements. The methods eliminates uncertainties arising from the combination of data collected under (potentially) different conditions in several DAC runs, in different laboratories, and/or from using different pressure-temperature sensors.

Preliminary analysis of our data indicate that seismic wave velocities of iron-bearing ringwoodite decrease only mildly with "water"-content in Earth's transition zone. This finding raises the possiblity that water is seismically invisible in Earth's transition zone.

[1] Schulze, K., Buchen, J., Marquardt, K., Marquardt, H., 2017, High Pressure Research, DOI: 10.1080/08957959.2017.1299719.