Experimental determinations of the wave velocities and density of candidate lowermost mantle materials

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Within the last decade, the Earth sciences community has witnessed an explosion of advanced radiation technologies that have been directly linked to new discoveries concerning the main constituents of Earth's deep interior. In turn, more accurate seismic and geodynamic models have been presented. In our contribution, we will focus on the synergy between advanced experimental methods applied to mantle-relevant materials and the implications for Earth's deep interior.

Ferromagnesium pyroxene, perovskite, and post-perovskite structured silicate polymorphs exist in Earth's shallow and deepest parts of the mantle, respectively. In the lower mantle, perovskite and post-perovskite are suggested to co-exist with (Mg,Fe)O periclase. The electronic charge and spin state of iron in these phases may influence their hosts' physical and chemical properties. Even though the structure of select iron-bearing silicates and oxides is often understood from x-ray diffraction studies, information on the sound velocities and specific site behavior of iron at relevant mantle conditions are not well known. Mössbauer spectroscopy allows one to uniquely probe the site-specific behavior of iron in solid materials by direct determination of iron's hyperfine fields, namely its quadrupole splitting and isomer shift [1]. The low energy region of the ^{57}Fe-weighted phonon density of states determined from nuclear resonant inelastic x-ray scattering provides the Debye sound velocity (V_D). With our measured density from x-ray diffraction studies and V_D, the seismically relevant aggregate compressional (V_P) and shear (V_S) velocities are calculated [2]. Specifically, we will discuss the application of our results obtained to pressures greater than one megabar on iron-rich (Mg,Fe)O and the implications for Earth's core-mantle boundary region [3].

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2. Jackson, J. M., E. A. Hamecher, and W. Sturhahn (2009), Nuclear resonant X-ray spectroscopy of (Mg,Fe)SiO_3 orthoenstatites, Eur. J. Miner., 21(3), 551-560.

3. Wicks, J.K., J.M. Jackson, and W. Sturhahn (2010): Very low sound velocities in iron-rich (Mg,Fe)O: Implications for the core-mantle boundary region, Geophys. Res. Lett., in press.