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Constraining density and velocity jumps across the 410 km discontinuity

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We investigate the velocity and density structure of the olivine-to-wadsleyite transition using polarities of precursor arrivals to PP seismic waves that reflect off the 410 km discontinuity beneath the Northern Atlantic. Numerous source-receiver combinations have been used in order to collect a dataset of reflection points beneath our investigation area. We analyzed over 1700 seismograms from Mw > 5.8 using array seismology methods to enhance the signal to noise ratio. For each event the polarity of the PP phase is compared to polarity of the precursor signal and we find several events where the polarity of the precursors are opposite to that of PP. There does not seem to be any dependency of the observed polarities on the propagation direction of the seismic waves but interestingly there seems to be a dependency on the distance between source and receiver. The events with epicentral distances greater than 119 degrees mostly show opposite polarities, while for those with smaller epicentral distances the same polarity of the main phase and precursor signal is dominant. Using Zeoppritz equations, we analyzed more than 64 million combinations of density, compressional and shear wave velocities for both layers, above and below the 410 km discontinuity in order to find the best combination of those parameters that can explain the observations. The results are indicating combinations of density, P and S wave velocity exhibiting a smaller contrast compared to those from the pyrolite model (the density jump, however is still positive to provide physically meaningful results). The calculated reductions in both compressional and shear wave velocities go up to 13% but mostly fall within the range of less than 7- 8%. We interpret this reduction in elastic properties and seismic velocity of minerals as the effect of a higher than normal content of water of wadsleyite in this region, while we can exclude a reduction in iron.