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Hydrogen isotope fractionation in the deep Earth

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The most abundant mineral in the mantle, olivine, is described as nominally anhydrous whereas its high-pressure polymorph, wadsleyite, can contain up to 3% H_2O by weight. This study aims to measure the effect of polymorphism on isotopic fractionation as well as the effect of hydrogen speciation. Samples were synthesized in the multi-anvil press at 12-14 GPa and low temperature conditions of 550-1100 °C, similar to conditions prevailing in a subducting slab. High pressure experiments are realized in fluid saturation conditions. The study focuses on the quantification of the water contents and speciation of olivine, wadsleyite and enstatite and their respective D/H isotope ratios, using a multi-instrumental approach for wadsleyite. Raman spectroscopy is used to monitor hydrogen speciation while Secondary Ion Mass Spectrometry (SIMS) provides total hydrogen contents and D/H ratios. SIMS calibration is performed using samples characterized with Elastic Recoil Detection Analysis (ERDA) nuclear probe. We report the D/H fractionation between olivine and its high-pressure polymorph, using enstatite as a witness of the fluid isotopic composition. We find that Deuterium fractionates more into olivine compared to wadsleyite with a $\ln(\alpha)_{\text{wadsleyite-olivine}}$ negative up to 1100°C.