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From dry to damp but stiff mantle lithosphere by reactive melt percolation atop the Hawaii plume

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Predicting the incorporation of hydrogen in upper mantle minerals is a major target in geodynamics since its presence in the atomic structure impacts essential physico-chemical properties of mantle rocks such as the melting temperature or viscosity. Here we quantify the hydrogen (H) concentration in nine mantle peridotites from Pali (Oahu island, Hawaii), which experienced an increasing degree of reactive melt percolation leading to refertilization and olivine recrystallisation. Hydrogen concentration is quantified using Fourier transform infrared spectroscopy with unpolarized and polarized light. Despite important contamination by H_2O-bearing and CO_2-bearing melt/fluid inclusions, quantitative analysis of OH by infrared was successful in olivines of all samples and almost all orthopyroxenes (excepted for the two most reacted peridotites). Olivines are dry (0-5 ppm H_2O wt, 0.8 ppm H_2O wt in average) and orthopyroxenes contain very small amounts of hydrogen (4 to 44 ppm H_2O wt., 19.5 ppm H_2O wt in average). The hydrogen concentration in clinopyroxene could not be properly quantified due to ubiquitous water-species bearing inclusions. Despite low concentration, H and Al in orthopyroxene are positively correlated, but comparison with of the worldwide database shows that variations in degree of melting/metasomatism in different geological settings overcome the Al crystallographic control on H incorporation. The whole-rock hydrogen concentration based on the FTIR data is estimated around 10 ppm H_2O wt, which is at the extreme low end-member of the current database for the mantle lithosphere (average at 150 ppm H_2O wt). The hydrogen concentration in orthopyroxene is positively correlated with both the recrystallized olivine fraction and the clinopyroxenes fraction, indicating that the reactive melt percolation is responsible for the limited hydration of the Pali peridotites. However, this melt percolation did not produce hydrogen-rich olivine, thus it did not weaken the oceanic mantle lithosphere.