Heterogeneous water distribution in the mantle lithosphere beneath Hawaii

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The amount and distribution of water in the oceanic mantle lithosphere has implications on its strength and of the role of volatiles during plume/lithosphere interaction. The latter plays a role in the Earth's deep water cycle as water-rich plume lavas [e.g. 1] could re-enrich an oceanic lithosphere depleted in water at the ridge, and when this heterogeneous lithosphere gets recycled back into the deep mantle. The main host of water in mantle lithologies are nominally anhydrous minerals like olivine, clino- and ortho-pyroxene (Cpx and Opx) and garnet, where hydrogen (H) is incorporated in mineral defects by bonding to structural oxygen. Here, we report water concentrations obtained by Fourier transform infrared spectrometry (FTIR) on olivine, Cpx and Opx from spinel peridotites from the Pali vent and garnet pyroxenite xenoliths from Aliamanu vent, both part of the rejuvenated volcanism at Oahu (Hawaii).

Pyroxenes from the Aliamanu pyroxenites have high water concentrations (Cpx ~ 400-500 ppm H_2O, Opx ~200 ppm H_2O), similar to the adjacent Salt Lake Crater (SLC) vent pyroxenites [3]. This confirms that pyroxenite cumulates form water-rich lithologies within the oceanic lithosphere. In contrast, Pali peridotites have lower reconstructed bulk water concentrations (< 25 ppm H_2O) than the SLC ones (50-96 ppm H_2O [4,5], an Aliamanu peridotite (103 ppm H_2O) and the MORB source estimates, despite being relatively fertile with >10% modal Cpx, low spinel Cr# (0.09-0.2) and LREE enrichments. These data show that fertility and melt metasomatism do not simply imply water enrichment in the lithosphere and that relatively dry lithosphere (peridotites) may be cross-cut by water-rich melt reaction zones (pyroxenites).

[1] Dixon & Clague (2001) *JP* **42**, 627-634.
[2] Bizimis *et al*. (2007) *EPSL* **257**, 259-273.
[3] Bizimis & Peslier (2015) *CG* **397**, 61-75.
[4] Peslier & Bizimis (2015) *GGG* **16**, 1-22.
[5] Peslier *et al*. (2015) *GCA* **154**, 98-117.