Water content of the oceanic mantle lithosphere at ridges

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Nominally anhydrous minerals such as olivine, clinopyroxene (cpx) and orthopyroxene (opx) can contain tens to hundreds of ppm H_2O incorporated as H in lattice defects [e.g. 1]. Moreover, water in olivine influences peridotite deformation [e.g. 2]. Consequently, determining the strength of the oceanic mantle lithosphere as well as its contribution to the water budget of the mantle upon subduction requires quantifying water in its main minerals.

Well characterized abyssal peridotites and pyroxenites from the Arctic (Gakkel ridge and Lena trough) and Southwest Indian (SWIR) ridges [3-6] are being analyzed by FTIR. Olivines contain 0-22 ppm H_2O. Water contents of cpx (130-362 ppm H_2O) and opx (25-145 ppm H_2O) from the Gakkel ridge peridotites, exceptionally fresh for abyssal peridotites, have lower pyroxene water contents than those of SWIR peridotites (cpx, ~300 ppm H_2O, opx, ~100 ppm H_2O). The water contents of these LREE-depleted peridotites are too high to be explained by melting processes. This study points instead towards localized water enrichments in the mantle oceanic lithosphere, even away from plume influence, as also seen in Atlantic ridge peridotites [7].

The opx of Lena pyroxenites have 260-350 ppm H_2O, while their cpx contain 614-860 ppm H_2O. The cpx water contents of the Lena pyroxenites are 10-50% higher than those of Hawaii garnet pyroxenites [8], despite having LREE depleted patterns [5]. Melts in equilibrium with the Lena pyroxenites would contain 1.5-4 wt% H_2O, i.e. more than in MORB [e.g. 9]. The peridotite water enrichments are likely linked to metasomatic melt percolation and stagnation beneath the ridge as expressed by the water-rich Lena pyroxenites. However, water is decoupled from LREE during this process.

[1] Peslier *et al.* 2017 *SSR* **212** p743. [2] Mackwell *et al.* 1985 *JGR* **90** p11319. [3] Liu *et al.* 2008 *Nature* **452** p311. [4] Warren *et al.* 2009 *JGR* **114**. [5] Laukert *et al.* 2014 *JP* **55** p427. [6] Warren & Hauri 2014 *JGR* **119** p1851. [7] Schmädicke *et al.* 2011 *Lithos* **125** p308. [8] Bizimis & Peslier 2015 *CG* **397** p61. [9] Saal *et al.* 2002 *Nature* **419** p451.