Oceanic lithosphere refertilization: implications for the LAB and mantle evolution

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Refertilization of the oceanic lithosphere is potentially an important mechanism as demonstrated by new findings of metasomatic pyroxenes in petit spot lavas[1]. We will provide further evidence from petit-spot xenocrysts and xenoliths combined with results from numerical simulations[2] that melt percolation and differentiation at the base of the oceanic lithosphere is critical to understand the chemical evolution and the physical properties of the LAB.

Garnet xenocryst sampled by petit-spot lavas offshore Japan provides evidence for the formation of gabbroic cumulates within the Pacific lithosphere. The trace element signature indicates that garnet probably formed subsolidus from plagioclase-bearing cumulates during off-axis cooling of the lithosphere. The specific P-T conditions required for grt subsolidus formation (0.7 – 1.2 GPa) indicate that melt percolation to produce plagioclase-bearing cumulate occurs >150 km off-axis. These P-T conditions are in agreement with numerical simulations of melting and melt transport at mid-ocean ridges in presence of volatiles[1]. These simulations indicate that volatile extraction at mid ocean ridges is limited and up to 50% of deep, volatile-rich melt is not focused to the axis but percolated along the LAB. Magma evolution at lithospheric pressure[3] predicts that these distal volatile-rich melts will cool and crystallize producing anhydrous and hydrous metasomatic cumulates within the base of the lithosphere. As the lithosphere cools, residual volatile-rich melts will stay liquid far from the ridge while the hydrous metasomatic cumulates will stay close to their solidus temperature. So any thermal perturbation at the base of the lithosphere could potentially produce melts suitable to explain the formation of small-scale seamounts. The presence of hydrous phases and residual CO_2 –rich melt at depths around 40 to 70 km could also explain the seismic and electric anomalies observed within the oceanic lithosphere. Addition of 1-2% volatile-rich melt to the base of the lithosphere predicted by the numerical simulation[2] is sufficient to modify the composition of the oceanic lithospheric mantle and produce, after recycling into the convecting mantle, enriched isotopic signature such E-DMM or even HIMU signatures.

[1] Pilet et al. 2016 *NGeo* 9, 898-904 [2] Keller et al. 2017 *EPSL* 464, 55-68; [3] Pilet et al. 2010 *CMP* 159, 621–643.