Olivine composition: resolving effects of mantle sources and processes

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Using new high precision electron microprobe data on high Mg olivines from Hawaii, W. Greenland, Gorgona and Archean komatiites we investigated the proposed effect on the Ni content of olivine of the temperature difference between melt separation deep in the mantle and its crystallization near the surface [1]. Of the 120 highly magnesian olivines from Hawaii (Fo 90.5-91.5), only 5% are consistent with low delta T<150ºC (calculated using Ni content in olivine and the approach of [1]) expected for a peridotitic mantle source under 90-100 km lithosphere, but over 74% would require delta T>200ºC and over 50% >300ºC. **Thus the compositions of Hawaiian olivines are inconsistent with the proposed temperature drop and instead require a specific source composition.** In olivines from the HSDP2 core, the Ni excess and Mn deficiency strongly correlate with $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ of their host rocks. This confirms melting of olivine-free lithologies from recycled crust in the mantle source under Hawaii [2]. Compositions of highly magnesian olivines from W. Greenland and Gorgona correspond to a delta T of 150-170ºC, which is consistent with the estimated lithosphere thickness at these locations. However, the compositions of the great majority of high-Mg olivines from Archean komatiites indicate a temperature effect of less than 150ºC, which is inconsistent with their high-pressure origin. Thus, the proposed temperature dependence of the Ni Kd between olivine and melt [1] may be exaggerated.

[1] Matzen *et al* 2013 *J.Petrology* **54**, 2521-2545 [2] Sobolev *et al* 2005 *Nature* **434**, 590-597.