Varying Ni in OIB olivines – Product of process not source

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The source of ocean island basalts (OIB) has been widely accepted as resulting from ancient recycled oceanic crust (ROC) [1] although there are many more difficulties than certainties in this model [2]. Sobolev *et al.* [3] concluded that Ni content in olivines of Hawaiian shield basalts is too high, precluding basalt origin by partial melting of mantle peridotite, asserting that this can only be explained by melting of an olivine-free pyroxenite. This pyroxenite originated by reacting mantle peridotite with a SiO_2-rich melt derived from partial melting of recycled oceanic crust in the form of "SiO_2-oversaturated eclogite". This is a revised version of the ROC model, but the complex behavior of Ni makes the interpretation non-unique. Sobolev *et al.* [4] show that while Ni content in olivines of basalts varies widely, it is conspicuously higher in basalts erupted on thick (> 70 km) lithosphere (THICK, including Hawaii) than on thin (< 70 km) lithosphere (THIN, including Iceland), and is still higher than in MORB. For primitive olivines with Fo > 89, Ni_{THICK} (3417±452ppm, 1937; mean±1σ, *n*) > Ni_{THIN} (2477±263ppm, 746) > Ni_{MORB} (2324±296ppm, 1700). This lithospheric thickness control (lid effect) poses the question why recycled oceanic crust prefers to exist and participate in magmatism beneath thickened lithosphere relative to beneath thin lithosphere and ocean ridges. Melting beneath thick (> 70km) lithosphere is largely in the garnet peridotite facies: *a*Cpx + *b*Gnt + *c*Ol = *1.0*Melt + *d*Opx, where olivine, the primary Ni host, contributes to the melt. Melting beneath thin lithosphere occurs mostly in the spinel peridotite facies: *a*Cpx + *b*Opx + *c*Spl = *1.0*Melt + *d*Ol, where olivine crystallizes and demands Ni from the melt. A common peridotite source Ni = 1900 ppm, and ~ 10% melting, can yield ~ 400 ppm and > 560 ppm Ni in melts parental to MORB and those erupted on thick lithosphere respectively. With these results and realistic magma chamber process models [5], the observed Ni_{THICK}, Ni_{THIN} and Ni_{MORB} in olivines can be explained without invoking the revised ROC model which still has to address the difficulties noted in [2].

References

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