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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Ninetyeast Ridge, Indian Ocean: Constraining its origin and relation with the Kerguelen, Amsterdam and St. Paul hotspots

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With a length of ~5000 km in the eastern Indian Ocean, the Ninetyeast Ridge (NER) is the longest linear feature on Earth, corresponding to ~44 Myr of evolution of the Indian Ocean basin and of the Kerguelen mantle plume. Despite being the subject of several geochemical studies during the late 1970's to early 1990's, debate regarding its mantle sources still persists. Since ODP Leg 121 in 1988, where the NER basement was last successfully drilled (~82 m on Site 756; ~52 m on Site 757; and ~178 m on Site 758) and subject of a thorough geochemical study, analytical techniques and sample processing have greatly improved.

In this study, we present new high-precision isotopic compositions by MC-ICP-MS (Pb, Hf) and TIMS (Sr, Nd) obtained on samples recovered during ODP Leg 121. Our extended multi-isotopic analyses demonstrate that components comparable to the Kerguelen, Amsterdam and St. Paul mantle plumes contribute to the generation of NER basalts, but not Indian MORB mantle, which supports previous Hf and Pb isotopic studies [1]. In all isotopic spaces, the age-corrected NER isotopic compositions define distinct fields for each site that plot within a triangle defined by Kerguelen, Amsterdam and St. Paul islands. Site 756 (~43 Ma) overlaps with the isotopic compositional field of St. Paul Island basalts, reflecting a greater contribution from this component in its generation. In both Hf-Sr and Hf-Nd isotopic spaces, Sites 757 (~56 Ma) and 758 (~82 Ma) show isotopic compositions intermediate between those represented by Amsterdam Island and Kerguelen. Site 758 has Pb isotopic compositions that plot closer to the field proposed for the Kerguelen plume head [2] as defined by basalts from Kerguelen Plateau Site 1138 (~100 Ma), whereas Site 757 shows much more radiogenic Pb isotopic compositions, plotting between the proposed Kerguelen plume tail component [2] and Amsterdam Island basalts. Hf isotopic compositions further support the absence of a continental crust contribution for the origin and evolution of the NER.

References

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