Reactive migration and re-fertilization of melts from ancient, refractory mantle domains

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The use of combined radiogenic isotope systematics (e.g., Os, Nd, Hf, Sr, Pb) show that the upper mantle consists of portions re-enriched in fusible elements and portions of old (>1Ga), refractory lithosphere survived from homogeneization in the asthenosphere. Although likely obiquitous in the asthenospere, melts produced by these refractory domains are easily concealed by mixing with melts from more enriched compounds. As such, melt-modified lithospheric peridotites retaining ultra-depleted compositions may offer the chance to study melts produced by these refractory mantle domains, before mixing and aggregation at shallow levels may erase their chemical fingerprint.

This contribution will examine different study cases where melts produced by ancient and refractory portions of the mantle migrated through, and interacted with the shallow lithosphere. Trace element compositions and combined Nd-Hf-Os isotopes are used to define the ultra-depleted and ancient character of their mantle sources. I will show melt-modified peridotites from the Lanzo Massif (Western Italian Alps), a lithospheric mantle exhumed during the opening of a Jurassic slow-spreading ocean. These peridotites have an highly depleted incompatible trace elements signature and clinopyroxene with a strong decoupling in Nd-Hf isotopes. The same rocks present unradiogenic Os isotopic ratios pointing to 1.2 Ga-old Re depletion ages. Similarly, I will report preliminary data on abyssal peridotites from an intra-transform domain in the Eqatorial Atlantic (Doldrums Fracture Zone; 8ºN). Here, residual mantle peridotites are percolated by ultra-depleted melts, most likely produced by re-melting a depleted portion of the lithospheric mantle drifted along the transform.

The evidence for melts with an ultra-depleted character are finally used to discuss their contributions in the chemistry of basalts erupted on the seafloor. I focus on Knipovich and Mohns ridges, in the Arctic ocean, where basalts with highly radiogenic Hf isotopes reveal the occurrence of a mantle source with large proportions of highly depleted, ancient mantle.