Iron isotope geochemistry of the Balmuccia peridotite massif and the composition of the upper mantle

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Extensive work on global, unmetasomatised oceanic and lithospheric mantle-derived peridotites reveals a scatter of ±0.1 ‰ δ^{57}Fe around the 0‰ value (vs.IRMM-014) [e.g. 1, 2]. Contrastingly, most primitive basaltic lavas cluster about δ^{57}Fe ≈ 0.1‰ [3]. This disparity has typically been ascribed to iron isotope fractionation during partial melting [4]. However, recent studies place the composition of primitive, undepleted mantle at ≈+0.1‰, obviating the need for such melting-induced fractionation [5]

In order to constrain the relative effects of partial melting and metasomatism on the iron isotope composition of the upper mantle, we present data from the remarkably fresh and well-characterised Balmuccia orogenic peridotite massif of the Ivrea Zone in northern Italy [6]. A spectrum of cogenetic ultramafic samples were analysed, comprising pyroxenites to lherzolites, harzburgites and dunites, faithfully capturing the variation recorded in the massif.

The starting composition of the Balmuccia lherzolite has about 39% MgO, 3.1% Al_2O_3, 2.9% CaO and 8.3% FeO, which could be explained by the extraction of ≈5±0.33% MORB from primitive mantle. This initial composition has a δ^{57}Fe ≈ 0.013‰ ±0.005‰ and defines an anchor point from which trends of pyroxene-addition, melt depletion and Fe-metasomatism are identified. Residual harzburgites extend to lighter δ^{57}Fe and higher Mg#s, while Fe-enriched harzburgites and dunites are typified by heavier iron isotope compositions and near-constant Mg# with respect to the lherzolites.

Lherzolites with lower MgO contents also exhibit heavier δ^{57}Fe values, nearing +0.05‰ at the MgO content of the primitive mantle (36.77%). However, given that MORBs, with δ^{57}Fe ≈ 0.15‰ [3] are derived from depleted mantle, a source of Fe isotope fractionation between partial melting and their eruption onto the ocean floor seems to be required.

[1] Weyer and Ionov, 2007, EPSL; [2] Huang *et al.*, 2011, GCA, 75; [3] Teng *et al.*, 2013, GCA; [4] Dauphas *et al.*, 2009, EPSL; [5] Poitrasson *et al.*, 2013, CMP; [6] Hartmann and Wedepohl, 1993, GCA

Hf isotope systematics of Archean anorthosites: The Manfred Complex, Yilgarn Craton, Western Australia

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Archean anorthosite complexes represent a minor, yet distinct rock type found within many Archean terranes. These mantle-derived melts are commonly found in layers with associated leucogabbro, gabbro, and ultramafic units of similar origin. Most Archean anorthosites are intensely deformed and metamorphosed yet preserved igneous minerals have been identified within several complexes. It has become obvious that Archean anorthosites contain zircon crystals, which can be used to establish robust crystallization ages for anorthosite complexes. These minerals are also ideal targets for in situ Lu-Hf isotopic analysis to further characterize the source of Archean anorthosites and provide insight into the formation and evolution of the continental crust during the Archean.

The ca. 3.7 Ga Manfred Complex is exposed northeast of Mount Narryer within the Narryer Gneiss Terrane, Yilgarn Craton, Western Australia. The layered anorthosite-gabbro-ultramafic intrusion outcrops in pods and lenses, engulfed by granitic gneisses [1, 2, 3]. We have sampled anorthosites, leucogabbros and gabbros from the Manfred Complex and determined their age by LA-ICPMS U-Pb zircon geochronology. Zircons separated from these rocks give ages of 3.63 Ga to 3.73 Ga. LA-MC-ICPMS Lu-Hf isotope analyses were performed by focusing the laser spot directly on top of the U-Pb analysis location for each zircon grain. Initial Hf isotope compositions of zircon grains from the Manfred complex range from ca. εHf +2 to -3. This range suggests contributions from both depleted mantle and ancient crustal sources to the parent magma of the Manfred Complex.

[1] Kinny *et al.* (1988) Prec. Res. 38, 325-341. [2] Myers (1988) Prec. Res. 38, 309-323. [3] Williams & Myers (1987) WA Geol. Surv. Rpt. 22, 32 pp.

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