Geophysical Research Abstracts,
Vol. 11, EGU2009-10770, 2009
EGU General Assembly 2009

A LA-HR-ICPMS study of abyssal peridotites from ODP Sites 920 and 1274 (23°N and 15°20N, Mid-Atlantic Ridge): New insights on the (re-)distribution of highly incompatible elements in the mantle during magmatic processes and serpentinisation

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The bulk composition of highly refractory peridotites is characterised by a strong depletion in trace elements together with relative enrichments in the most incompatible elements, such as Rb, Ba, Sr and U (considered as fluid-mobile), but also in Pb and LREE, Th, Nb and Ta (less/not affected by fluid-rock interactions). The origin of these trace element variations in the mantle exhumed on the seafloor has been little discussed: they may result either from mantle processes and/or serpentinization, but the later process is often considered as dominant in the highly altered abyssal peridotites. In order to better characterize the distribution of highly incompatible elements between primary and alteration minerals in these rock samples, we carried out an in situ multi-elemental study of a series of serpentinized harzburgites sampled on the Mid-Atlantic Ridge at ODP Site 920 (23°N, MARK) and at ODP Site 1274 drilled to the north of the Fifteen-Twenty Fracture Zone using ICP-MS and HR-ICP-MS coupled to laser ablation.

Site 1274 peridotites preserve abundant primary minerals (up to 40%–50%). Site 920 peridotites are almost entirely serpentinized and few relics of primary minerals are observed (0%–<10%). At both sites, clinopyroxene (cpx) has interstitial or/and reactional textures, which suggest they are secondary. In spite of their highly variable degree of alteration, the peridotites sampled at Sites 920 and 1274 have the depleted yet spiked trace element patterns (mostly < 0.1 x PM) that is typical of refractory mantle peridotites, except for a few Site 920 serpentinites which are distinguished by high U and Pb contents (up to 7 x PM). Pyroxene and olivine have depleted compositions, although Site 920 pyroxenes are slightly enriched relative to that of Site 1274 (Yb: cpx = 1.6-3 x PM (Site 920) and 0.5-1 x PM (Site 1274), opx (orthopyroxene) $\sim$ 0.5 x PM (Site 920) and 0.2-0.4 x PM (Site 1274), olivine $\sim$ 0.02 x PM). Pyroxenes and olivine are characterized by selective enrichments in highly incompatible elements relative to REE (e.g., $\sim$0.1 x PM up to $\sim$1 x PM for U and Pb and Ce $\sim$ 0.001 x PM in opx), similar to what observed in the bulk rock except for Sr. The bulk rock trace element content is mostly controlled the opx trace element budget. In detail, cpx is not in equilibrium with opx. These compositions cannot be solely explained by mantle partial melting and indicates melt rock interactions in the upwelling mantle, which is also marked by the late precipitation of cpx.

Our results suggest that the bulk rock geochemistry of the serpentinized samples preserves the peridotite primary signature for most trace elements. Nevertheless, in situ analyses of alteration minerals indicate extensive chemical exchanges at the thin section scale (Andreani et al, this session). These results are discussed in terms of trace element re-distribution between phases and at the mineral boundaries during magmatic processes and consequences on the composition and type of alteration minerals during serpentinization.