

Trace elements in mantle olivine and orthopyroxene from the North Atlantic and Kaapvaal Cratons

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We present olivine (ol) and orthopyroxene (opx) trace element data of garnet peridotite xenoliths from West Greenland (North Atlantic Craton), Jagersfontein and Kimberley (Kaapvaal Craton), representing samples of Archaean subcratonic lithospheric mantle. Peridotites from both cratons experienced high degree partial melting. However, while West Greenland peridotites are mostly pristine [1], Kaapvaal peridotites have experienced silica-enrichment and crystallization of secondary diopside [2, 3]. This is discernable e.g. from differences in texture, whole-rock Al/Si (0.001-0.02 and 0.002-0.08, respectively) and modal opx content (8±7 vol.% and 28±9 vol.%, respectively).

Mn, Co, Ni, Cu, Zn and Ga in ol and opx correlate with $Mg\# = Mg/(Mg+Fe)$. Slightly higher values in West Greenland peridotites compared to Kaapvaal peridotites, probably reflects the more refractory composition of the former, since these elements are compatible. B, Al, Sc, V, Cr and Y in ol are moderately enriched in West Greenland compared to Kaapvaal peridotites. These elements do not correlate with Fo content, but most of them correlate with Ca content reflecting possible pressure dependency. In opx these elements have similar concentrations in peridotites from both localities. Al, V and B in opx decrease with increasing Mg# and may reflect correlation with the degree of melt depletion. Compared to West Greenland peridotites, trace element contents in Kaapvaal opx are mostly low, which may be due to inheritance from replacement of primary ol. Secondary ionisation mass spectrometry analyses of opx show overall rare earth element (REE) enrichment in Kaapvaal peridotites, especially light REE, compared to West Greenland peridotites. This might be genetically related to light REE-enrichment in secondary diopsides in Kaapvaal peridotites that crystallized from light REE enriched mantle melts [3].

[1] Wittig *et al.* (2008) *EPSL* **274**, 24-33. [2] Simon *et al.* (2007) *J. Petrol.* **48**, 589-625. [3] Rehfeldt *et al.* (2008) *GCA* **72**, 5722-5756.

Cd isotope constraints on nutrient cycling in the Southern Ocean

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The marine geochemistry of Cd is of particular interest because its distribution in seawater is correlated with the macronutrient phosphate. Recent investigations have furthermore revealed considerable Cd isotope fractionations in the oceans as a consequence of biological utilization. Nutrient depleted surface waters exhibit $\epsilon^{114/110}\text{Cd}$ values as high as +40, whilst the deep ocean is characterized by $\epsilon^{114/110}\text{Cd} \approx +4$ ($\epsilon^{114/110}\text{Cd}$ is reported relative to JMC Münster Cd). In this study, cadmium concentrations and isotope compositions were determined for 46 seawater samples from the 2008 IPY GEOTRACES expedition 'Zero & Drake' aboard RV Polarstern (ANT 24-3). This includes samples from 3 depth profiles (in the Drake Passage, and northwestern & central Weddell Sea) as well as 13 surface waters from the Zero Meridian between 62° and 69°S.

The Southern Ocean seawater samples display a good correlation of $\epsilon^{114/110}\text{Cd}$ with Cd contents, which suggests that Cd cycling is dominated by closed-system uptake at the surface and remineralization at depth. The Cd concentrations of the surface waters are high at about 0.4 to 0.7 nM, which is typical for this HNLC region, whilst Cd isotope compositions are only moderately fractionated ($\epsilon^{114/110}\text{Cd} \approx +5$ to +8) due to limited nutrient (and Cd) utilization. These samples provide a particularly well-defined correlation of $\epsilon^{114/110}\text{Cd}$ with [Cd] that is indicative of biological fractionation at $\alpha \approx 1.0005$.

Water samples from below 1 km depth have similar Cd contents of 0.77 ± 0.04 nM and relatively constant Cd isotope compositions of $\epsilon^{114/110}\text{Cd} \approx +3.5 \pm 0.5$ (1s, n = 15), in excellent agreement with published global deep water data. The Drake Passage profile reveals significant Cd isotope fractionation at 250-500 m depth with $\epsilon^{114/110}\text{Cd}$ values of about +5. This may reflect influx of Antarctic mode water from the west. The $\epsilon^{114/110}\text{Cd}$ values of about +2 to +3 for depths of 200-400 m at the two Weddell Sea stations are also unusual and are indicative of remineralization of biological material with low/negative $\epsilon^{114/110}\text{Cd}$, due to incomplete nutrient utilization at the surface.

Taken together, these results show that Cd isotope data provide new constraints on marine nutrient cycling and may be a useful paleoceanographic proxy of nutrient utilization.