Os Isotopic Heterogeneity in Mantle Peridotites from the Troodos Complex, Cyprus

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Based on the mineralogy and chemical composition of spinel and clinopyroxene the mantle section of the Troodos Complex can be divided into two parts (Batanova and Sobolev, 2000). Unit 1 is mainly composed of spinel-lherzolite (Cr# in spinel: 0.22-0.28), which represents a residue after 10-15% MORB extraction and includes melt channels composed of dunites (Cr# in spinel: 0.70-0.88) surrounded by cpx-bearing harzburgites (Cr# in spinel: 0.32-0.62). Unit 2 of the mantle section is composed of harzburgites (Cr# in spinel: 0.49-0.70) and dunites (Cr# in spinel: 0.44-0.80), representing a mantle through which melts percolated (Batanova and Sobolev, 2000). Another important difference is that only Unit 2 contains chromitite deposits. The Os isotopic composition and Re concentration of all lithologies from the mantle section of the Troodos Ophiolite Complex have been measured in order to monitor mantle processes at the time the volcanic rocks of the ophiolite were formed (90 Ma).

Unit 1 peridotites.

In Unit 1 Spinel-Lherzolites contain 4.3 ± 0.25 ng/g Os, which are typical for mantle peridotites. Os concentrations in the cpx-bearing harzburgites are variable and significantly higher (6.0 ± 1.7 ng/g Os). In contrast dunites are relatively depleted in Os containing 3.0 ± 0.2 ng/g Os (excluding one sample with 7.3 ng/g Os). The spinel-lherzolites have constant and near-chondritic 187Os/188Os ratios (0.125-0.127). However, the 187Os/188Os ratios of the cpx-bearing harzburgites and dunites are highly variable, ranging from 187Os/188Os 0.116 to 0.136. In single melt channels the 187Os/188Os ratios of cpx-bearing harzburgites and dunites show complementary patterns, in that dunites have radiogenic Os isotopic compositions and the cpx-bearing harzburgites have lower than chondritic 187Os/188Os ratios, or vice versa. These observations imply that during the interaction of percolating melt with the spinel-lherzolites Os is mobilized by concentrating it in the cpx-bearing harzburgites and depleting it in the dunites. The highly variable 187Os/188Os ratios in the cpx-bearing harzburgites and dunites could indicate that during the melt percolation Os was not equilibrated between the different lithologies and the melt. This can be expected in systems with low melt-rock ratios. Alternatively, the isotopic variations can be explained by assuming that the melt percolation events are old. This is supported by Re depletion model ages of cpx-bearing harzburgite and dunite of up to 1.6 Ga.

Unit 2 peridotites.

The Os concentrations in harzburgites and dunites of Unit 2 are significantly lower than those of the spinel-lherzolites from Unit 1. The harzburgites have on average 2.5 ± 1.8 ng/g Os and the dunites 1.7 ± 0.8 ng/g Os. Chromitites from Unit 2 have very high Os concentrations, up to 288 ng/g. In contrast to Unit 1, the harzburgites, dunites and chromitites of Unit 2 show a small range in 187Os/188Os isotopic ratios (0.124-0.128). These features can be explained if Unit 2 represents a zone of pervasive melt percolation as was suggested by Sobolev and Batanova (1995). The dunites and harzburgites have a lower Os content than expected in mantle peridotites. This missing Os might be stored in the Chromitite deposits. This suggests that during the process of melt percolation Os does not behave compatible. It also implies that the genesis of chromite deposits in ophiolites is associated with these processes. The small variation of the Os isotopic composition of Unit 2 indicates that mantle and melt Os have been re-equilibrated on a large scale, which is probably caused by melts percolating through the whole Unit. This implies that Unit 2 represents a system with a large melt-rock ratio, which is also necessary to form the Cr-rich deposits.

This study confirms that Unit 1 and Unit 2 represent different mantle sections which experienced different mantle processes. It also indicates that the Troodos mantle is isotopically very heterogeneous on a small scale. The Os isotopic compositions of the chromitites do not reflect this heterogeneity and are therefore not suitable tracers of the isotopic evolution of the upper mantle.

References:

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