The distribution of lead in mantle rocks: Insights from the Balmuccia peridotite massif (Italian Alps)

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Sulfides in mantle rocks sometimes have unradiogenic Pb isotopic compositions and assuming specific conditions, may represent a low U/Pb reservoir that might balance the radiogenic Pb isotope reservoirs of the silicate Earth. A critical requirement to test this hypothesis is knowledge of typical Pb contents in sulfides from different types of mantle rocks and estimates of their contribution to the Pb budget of the mantle rocks. However, data on the distribution of Pb between mantle minerals in mantle rocks from different geologic settings are scarce. Here new Pb concentration data from well-characterized unserpentinized spinel-facies peridotites and pyroxenites from the Balmuccia mantle tectonite (Ivrea-Verbano Zone, Italian Alps) are presented as an example to better understand the Pb distribution in minerals and rocks of the upper mantle.

Most peridotites display variable bulk rock Pb contents (13-97 ng/g), which tend to be lower than Pb contents in the websterites (60-254 ng/g) and clinopyroxenites (174-657 ng/g). The pyroxenites show broadly positive correlations of Pb with Al_2O_3, Ce and also S contents. In-situ laser ablation ICP-MS data indicate low Pb contents in olivine, orthopyroxene and spinel (mostly below the detection limits of 50 ng/g); whereas Pb contents are higher in clinopyroxene (from < 50 to 920 ng/g) and in sulfides (typically a few μg/g and sometimes higher in chalcopyrites). Mass balance calculations indicate that silicates predominantly control Pb contents in bulk rocks, with a minor role for sulfides (mostly < 20%). This result from Phanerozoic subcontinental lithospheric mantle rocks is consistent with data on abyssal peridotites. As in some previous studies, bulk rock Pb contents calculated from constituent phases of peridotites are often lower than the measured values. This imbalance is mainly due to effects of trapped fluid inclusions. Because of their low Pb concentrations, mantle sulfides with unradiogenic Pb isotopic compositions likely cannot balance radiogenic Pb isotopic compositions of oceanic basalts.