Behavior of Mo and Mo/Ce in the mantle: Insights from peridotites and pyroxenites of the Balmuccia and Baldissero massifs, Italian Alps

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Ratios of the highly incompatible elements Mo and Ce in basalts are relatively uniform and commonly assumed to be representative of their mantle sources. However, the lack of Mo concentration data in mantle rocks limits a full understanding of the magmatic behavior of Mo in comparison to other highly incompatible elements (such as Ce) in the mantle. Such data are critical for testing the validity of the assumption that uniform Mo/Ce in oceanic basalts indeed reflect the composition of the mantle sources.

Here we present bulk rock Mo concentration data obtained by isotope dilution ICP-MS for well characterized fresh peridotites (n=29) and pyroxenites (n=17) from the Balmuccia and Baldissero peridotite massifs (Ivrea Zone, Italian Alps) to address these issues. The peridotites underwent variable extents of depletion and refertilization, however, their Mo contents are very low (4-16 ng/g). Cumulative websterites and clinopyroxenites display similar low Mo contents of 3-11 ng/g. Peridotites and pyroxenites contain different proportions of olivine, pyroxene and sulfide, but the Mo contents remain relatively constant with changing Al_2O_3 and S contents. This indicates limited incorporation of Mo into olivine and pyroxene and also suggests weakly chalcophile behavior of Mo at mantle conditions, consistent with experimentally determined partition coefficients and its presence mainly as Mo^{6+} in silicate melt at log f_{O2} > QFM-2. The behavior of Mo contrasts with that of Ce and other REE, which are mainly controlled by pyroxenes in these mantle rocks.

These results indicate a large variation of Mo/Ce in mantle rocks, which is mostly controlled by Ce abundances. The very different behavior compared to basalts implies a very different behavior of Mo and Ce (and thus Mo/Ce) during magmatic processes in the mantle in comparison to later magmatic processing in the oceanic crust. The depletion of highly incompatible elements in fertile mantle rocks may be a consequence of melt infiltration processes in which infiltrating melts are already strongly depleted in highly incompatible elements. Relatively uniform Mo/Ce in basalts suggest that basalts are hybrid melts that reflect efficient mixing at the top of the melting column. Thus, basalts likely do not retain the Mo/Ce of local mantle sources of primitive precursor magmas of basalts.