Magmatic fractionation of chalcogen and highly siderophile elements in the mantle: constraints from pyroxenites in the Balmuccia peridotite massif

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Mantle peridotites and ocean ridge basalts are commonly viewed as complementary products of mantle melting. The abundances of some highly siderophile elements (HSE) are not consistent with this simple view. Notably, Pd and Pt, which are highly compatible in sulphides, often display low concentrations in both peridotites and in basalts. Studies of mantle rocks and experimental work indicate that melt-peridotite reaction and fractional crystallization are additional processes that modify the composition of mantle-derived magma during ascent in the mantle. Here, we use chalcogen element (S, Se, Te), HSE compositions and Os isotopes in mantle pyroxenites of the Balmuccia peridotite massif (Ivrea-Verbano Zone, Italian Alps) to determine the changes of ratios and concentrations of these elements in magmas during crystallization and assimilation processes in the mantle.

The compositions of pyroxenites from the Balmuccia peridotite massif reflect accumulation of pyroxenes, spinel and sulfide segregation from S saturated melts. Websterites and clinopyroxenites have different abundances and ratios of chalcogens and the HSE. The websterites display high HSE and chalcogen abundances and chondritic to subchondritic S/Se and Se/Te, consistent with initial sulfide precipitates from primitive melts. Calculated HSE abundances in sulphides of the websterites share many similarities with interstitial sulfides of refertilized peridotites. The similarities support the view that preferential dissolution of interstitial sulfides in peridotites into migrating silicate melts must be an important process of melt extraction and melt-peridotite reaction. Clinopyroxenites have MORB-like HSE and chalcogen compositions and much lower abundances and stronger fractionations of the PGE and Te than websterites. Subparallel HSE patterns with abundance variations over several orders of magnitude, and S/Se and Se/Te, suggest that the clinopyroxenites formed from evolved melts that have undergone different extents of sulfide segregation in the mantle. The range of Re/Os and Pd/Ir in the pyroxenites is similar to the range of these ratios in upper and lower oceanic crustal rocks, indicating that most of the compositional variation of these elements in the oceanic crust may reflect magma transport and sulphide fractionation in the mantle.