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Metal and metalloid enrichment in the upper mantle

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The formation of large-scale ore deposits of metals and metalloids requires the preconcentration of these elements. To investigate potential sources and pathways of such enrichment, we analyzed the bulk and mineral compositions of peridotites and pyroxenites from Balmuccia (Ivrea Verbano zone, Italy), as well as mantle peridotites and ophiolitic gabbros, serpentinites, amphibolites and eclogites from western Serbia. Gabbros, followed by serpentinites and amphibolites, generally exhibit higher contents of Sn, Sb, As, Cu, Mo, Zn, Cd, Co, whereas Ag concentrations are nearly indistinguishable compared to peridotites. In ilmenite-rich gabbro, Ag also shows strong enrichment. Molybdenum and Sn are the only elements with concentrations approximately ten times higher than those in peridotites; other elements are enriched only two- to fivefold. Although these enrichment levels appear insufficient for ore genesis, they indicate an initial enrichment stage in mantle-derived melts and their metamorphosed products. In situ LA-ICP-MS analyses were conducted across direct contacts between peridotite and augite pyroxenite veins from Balmuccia. As anticipated, most of the studied metals are hosted in sulfides. An exception is spinel, which can accommodate >1000 ppm Zn and up to 400 ppm Co. Pyroxenes and amphiboles contain several tens of ppm of these elements, as well as Cu, and up to 1 ppm Sn. Spinels from peridotites and the contact zone show higher Zn and Co contents than those from pyroxenites. Sulfides in peridotites and the contact zone display notably elevated Ag and Cu concentrations compared to those in pyroxenites. However, Sb and As remained below the detection limit in all analyzed minerals.

These observations suggest that melt infiltration into peridotite tends to elevate metal contents in the upper mantle, although certain volatile elements may escape from the contact zone during the process.