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EXTREME FRACTIONATION OF PLATINUM GROUP ELEMENTS IN VOLCANOGENIC MASSIVE SULFIDE DEPOSITS

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Abstract

Platinum group elements (PGE) and gold in selected ore samples and associated lithologies from four well-known volcanogenic massive sulfide (VMS) districts (i.e., the kuroko Zn-Pb-Cu deposits of Hokuroku, Japan; the Besshi Cu-Zn deposit of Shikoku, Japan; the Cu-Zn-Au-Ag deposits of Manitouwadge, Ontario, Canada; and the Cu-Zn-Co deposits of Outokumpu, Finland) have been determined by nickel sulfide fire assay preconcentration, tellurium coprecipitation, and inductively coupled plasma mass spectrometry analysis. The chalcopyrite-rich samples associated with mafic-ultramafic rocks from Besshi, Manitouwadge, and Outokumpu locally contain elevated contents of Pd (up to 1.8 ppm), Rh (up to 0.8 ppm), and Au (up to 14 ppm), whereas those of the kuroko deposits hosted by felsic volcanic rocks are poor in PGE. Moreover, the chalcopyrite-rich samples and cordierite-orthoamphibole gneisses show extreme fractionation of Au, Ir, Pd, and Pt (Au/Ir values up to 108,000; Pd/Ir, up to 29,500; and Pd/Pt, up to 2,100), which are somewhat similar to previously reported Au/Ir and Pd/Ir values in modern sea-floor hydrothermal sulfides but are significantly higher than those in magmatic Ni-Cu sulfides. The extreme fractionation of Au, Ir, Pd, and Pt in these volcanogenic massive sulfide deposits cannot be explained by the relative metal solubilities in sea-floor hydrothermal fluids but may be related to local remobilization of PGE and Au during late hydrothermal alteration and/or metamorphism.