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On the formation of peridotite-derived Os-rich PGE alloys

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ABSTRACT

Osmium-rich Pt group element (PGE) alloys occur worldwide in association with chromite in ultramafic (peridotite) complexes. It has been suggested that these Os-rich alloys formed under extreme *P-T* conditions in the lowermost mantle, before the metallic core of the Earth formed, or later, in the outer core, and have been transported to the upper mantle as xenoliths in deep-rooted mantle plumes.

Our investigation of syn- and pregenetic inclusions (including silicate and chromite) found in Os-rich alloys from peridotites in northern California and southwest Oregon yield no evidence that these alloys formed under extreme *P-T* conditions. Instead these inclusions point to a hydrous magmatic origin in the shallow upper mantle, most likely in an arc-environment. Indeed, the common occurrence of Os-rich PGE alloys as primary inclusions in massive (commonly podiform), chromite deposits and, conversely, the occurrence of chromite, olivine, pyroxene, laurite, and siliceous (boninitic) melt inclusions in Os-rich PGE alloys suggest a common origin for all these minerals.

Integrating our observations with recent experimental work and with observed field relations, we find support for a model in which massive chromite deposits, olivine, laurite, and Os-rich PGE alloys form in a single magmatic process. In an arc-environment, H_2O-rich fluids and siliceous melts (e.g., boninites) are produced in the mantle wedge above the descending and dehydrating plate. Large differences in interfacial energy between the precipitated chromite and PGE alloys, and the hydrous fluid(s) and siliceous melt(s), cause a strong concentration of chromite and PGE alloys in the hydrous fluid(s). This general scenario is capable of simultaneously explaining all key observations, including: (1) the formation of massive chromite deposits; (2) nodular chromite textures; (3) Os-rich PGE alloys, laurite, olivine, and pyroxene as common inclusions in massive chromite; (4) inclusions of chromite, olivine, pyroxene, and hydrated siliceous inclusions (the current study) in the Os-rich PGE alloys; and (5) a similar range of variation in $^{187}Os/^{188}Os$ ratios among Os-rich PGE alloys and massive chromite deposits from individual ultramafic bodies world-wide.