American Mineralogist, Volume 91, pages 191–195, 2006

Unique W-rich alloy of Os and Ir and associated Fe-rich alloy of Os, Ru, and Ir from California

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ABSTRACT

A shell-like polycrystalline grain (ca. 1 mm) of W-(Mo)-bearing Os-Ir alloy (11.4–18.6 wt% W; up to 1.5% Mo) is present in a very old collection (probably the 1890s) of tiny nuggets from Trinity Co., California. An extensive compositional series [$(Os_{0.43–0.80}Ir_{0.28–0.05})$ $W_{0.12–0.18}$], and inverse Ir-Os correlation, are observed; the mean composition [$Os_{0.676}W_{0.153}Ir_{0.124}Fe_{0.021}Mo_{0.015}Ru_{0.011}$; Σatoms = 1], based on results of 50 electron-microprobe analyses, displays a ratio (Os + Ir):W of 5:1. The observed variations and element correlations suggest that (W + Mo) contents are controlled by Ir, and incorporated via the following substitution scheme: [(W + Mo) + Ir] ↔ Os. The X-ray diffraction data indicate that the W-rich alloy has a hexagonal close-packed structure, related to that of osmium and allargentum, with a = 2.7297(4) Å, c = 4.3377(6) Å, and V = 27.99(1) Å^3; the c:a ratio is 1.59. The probable space-group is $P6_3/mmc$, and Z = 2; the calculated density is 21.86(1) g/cm^3. The W-rich alloy is associated with an Os-Ru-Ir alloy rich in Fe (7.0–9.7 wt%), which exhibits atomic Fe ↔ [Os + Ru] and Ir ↔ [Os + Ru] mechanisms of substitution. We suggest that these W-(Mo)- and Fe-rich alloys formed by metasomatic alteration of a primary Os-Ir-Ru alloy, associated with mineralized ultramafic-mafic rocks of ophiolite affinity. A fluid phase may well have remobilized and transported W, Mo, and Fe. The W-rich alloy likely crystallized from a reducing fluid under conditions of low fugacities of O_2 and S_2, thus promoting the observed siderophile behavior of W and Mo. These unusual W-(Mo)- and Fe-rich alloy grains were likely derived, as a placer material, from the Trinity ophiolite complex of northern California.

Keywords: W-rich Os-Ir alloy, Fe-rich Os-Ru-Ir alloy, platinum-group minerals, Trinity ophiolite complex, California, U.S.A.