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Surface transformations of platinum grains from Fifield, New South Wales, Australia

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Abstract

A growing literature is demonstrating that platinum (Pt) is transformed under surface conditions; yet (bio)geochemical processes at the nugget-soil-solution interface are incompletely understood. The reactivity of Pt exposed to Earth-surface weathering conditions, highlighted by this study, may improve our ability to track its movement in natural systems, e.g., focusing on nanoparticles as a strategy for searching for new, undiscovered sources of this precious metal. To study dissolution/re-precipitation processes of Pt and associated elements, grains of Pt-Fe alloy were collected from a soil placer deposit at the Fifield Pt-field, Australia. Optical- and electron-microscopy revealed morphologies indicative of physical transport as well as chemical weathering. Dissolution "pits," cavities, striations, colloidal nano-particles, and aggregates of secondary Pt platelets as well as acicular, iron (Fe) hydroxide coatings were observed. FIB-SEM-(EBSD) combined with S-μ-XRF of a sectioned grain showed a fine layer of up to 5 μm thick composed of refined, aggregates of 0.2 to 2 μm sized crystalline secondary Pt overlying more coarsely crystalline Pt-Fe-alloy of primary magmatic origin. These results confirm that Pt is affected by geochemical transformations in supergene environments; structural and chemical signatures of grains surfaces, rims, and cores are linked to the grains' primary and secondary (trans)formational histories; and Pt mobility can occur under Earth surface conditions. Intuitively, this nanophase-Pt can disperse much further from primary sources of ore than previously thought. This considerable mineral reactivity demonstrates that the formation and/or release of Pt nanoparticles needs to be measured and incorporated into exploration geochemistry programs.

Keywords: Platinum, weathering, Fifield Pt-Province, secondary mineralization, Australia