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Platinum Group Elements in Cosmic Spherules

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Platinum group elements (PGEs: Os, Ir, Ru, Rh, Pt, Pd) are key tracers of planetary accretion, metal–silicate differentiation, and early Solar System processes. As highly refractory and strongly siderophile elements, they preserve information on high-temperature fractionation and core-formation mechanisms [1]. While bulk PGE abundances in meteorites are well documented, the physical hosts of PGEs at the micro-scale and the effects of thermal processing and secondary alteration remain incompletely resolved. This gap is particularly pronounced for micrometeorites (MMs, 10 μm–2 mm), which dominate the present-day extraterrestrial mass flux to Earth (~40,000 ± 20,000 metric tons yr^{-1} [2]). Despite being the primary modern carrier of extraterrestrial material, PGE systematics in micrometeorites remain largely unexplored. Although refractory metal nuggets have been identified in rare cases [3,4], other potential hosts, such as platinum-group minerals, sulphides, or matrix-dispersed PGEs, have not been systematically investigated. Consequently, the contribution of micrometeorites to Earth's highly siderophile element budget remains poorly constrained.

Here, we characterize mineralogical and microstructural PGE hosts in micrometeorites using high-resolution analytical techniques to resolve PGE-bearing phases at (sub-)microscopic scales. First, we investigate general metal bead occurrences as potential PGE carriers. Subsequently, we identify and characterize discrete PGE hosts, evaluate their textural context, and investigate the effects of atmospheric entry and alteration on potential PGE redistribution. In parallel, we develop a rapid screening workflow for high-throughput detection and first-order characterization of PGE-bearing phases. This study provides the first systematic constraints on PGE host phases in micrometeorites and quantifies their addition to the sustained ET PGE flux to Earth, refining our understanding of the contribution of cosmic dust to the terrestrial elemental inventory and offering new insight into small-scale metal fractionation processes in the Solar System.

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