Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36949

Reconstructing Late Devonian extraterrestrial flux composition from fossil micrometeorites: a multi-section approach

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Micrometeorites (MMs) constitute the dominant present-day flux of extraterrestrial (ET) material to Earth, mainly sourced from the asteroid belt and from comets. These sub-millimeter particles provide a unique and underexploited archive of Solar System material, recording a broader diversity of parent bodies than the meteorite record and offering the potential to reconstruct variations in ET flux composition through geological time. Most previous reconstructions of past ET fluxes rely on indirect or bulk proxies such as iridium enrichments, ^{3}He, osmium isotopes, or ET spinels [1-4], which integrate only part of the incoming flux. More recently, fossil micrometeorites have been used to directly retrace past extraterrestrial fluxes, including intervals such as the Cambrian and Silurian (e.g., studies presented at this conference). Unlike bulk or indirect proxies, fossil MMs preserve petrographic, geochemical, and isotopic signatures diagnostic of their parent bodies (e.g., carbonaceous, ordinary, or enstatite chondrites and achondrites [5]), or the atmospheric composition at the time of their fall.

Here we present the first fossil MM dataset from the Late Devonian (~360 Ma), based on a cross-section study of three carbonate dominated successions from Belgium (Chanxhe and Royseux) and Germany (Drewer). More than 50 kg of sediment spanning <2 Myr were processed using a novel extraction protocol designed to minimize biases. Recovered spherules were characterized by SEM-EDS, EMPA, and SIMS to assess their petrography, chemistry, terrestrial alteration, and parent body. The Late Devonian collection is dominated by small particles (<125 μm) and shows an overabundance of I- and G-type spherules, although S-types are still present despite extensive weathering. Oxygen isotope data indicate a CC/OC ratio of ~5.6, with ~33% CC and ~5.8% OC affinities, compared to a modern CC/OC ratio of ~3.6 [6]. Stratigraphic comparisons suggest variations in ET flux composition across the Late Devonian.

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