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Testing orbital control on the extraterrestrial dust flux across the Frasnian-Famennian boundary using fossil micrometeorites

STEVEN GODERIS[1], LISA KRÄMER RUGGIU[1], SAMUELE BOSCHI[1], DEEPAK BINU BEENA[1], JOLANTHA ESCHRIG[1,2,3], PHOENIX HEYLIGHEN[1], FIEN M. R. JONCKHEERE[1], JULIUS PESOLA[1], GABRIEL PINTO[3], TRYGVE J. PRESTGARD[1], MAXWELL THIEMENS[1], CLARA ZELINSKY[1], NINA WICHERN[4], JAKOB QUABECK[4] AND DAVID DE VLEESCHOUWER[4]

[1]Vrije Universiteit Brussel
[2]Geological Survey of Belgium
[3]Université Libre de Bruxelles
[4]University of Münster

Micrometeorites (MMs) constitute the dominant present-day flux of extraterrestrial (ET) material to Earth, sourced primarily from the asteroid belt. Fossil MMs recovered from stratigraphic records provide a direct archive of the past ET flux, preserving petrographic textures and geochemical signatures diagnostic of their parent bodies or reflecting exchange with mesospheric oxygen during atmospheric entry [1,2]. Unlike indirect tracers (e.g., Ir enrichments or chrome-spinel grains), fossil MMs enable reconstruction of the flux composition and variability. Recent Late Devonian work demonstrated the abundance and compositional diversity of Famennian fossil MMs, underscoring their value as recorders of Solar System dynamics [3].

Here, we investigate the ET dust flux across the Frasnian-Famennian (~372 Ma) boundary by testing a proposed link between orbital eccentricity and cosmic dust delivery. Previous work at the Coumiac stratotype section (France) identified an enrichment of ~10 ordinary chondritic chrome-spinel grains (>63 μm) per 100 kg of rock and interpreted this as an enhancement of dust capture under a low-eccentricity Earth orbit configuration [4]. Within the cyclostratigraphic framework established for the contemporaneous Winsenberg roadcut (Germany), four long-eccentricity minima and three maxima have been identified [5].

Fourteen closely spaced samples at Winsenberg target these orbital extrema. More than 40 kg of sediment spanning ~1.2 Myr will be processed using an optimized extraction protocol. Recovered micrometeorites will be classified into I-, S-, and G-types, and analyzed by SEM-EDS, EMPA, and SIMS to constrain their petrography, chemistry, and oxygen isotope systematics. Variations in MM abundance, type proportions, and carbonaceous versus ordinary chondritic contributions between eccentricity minima and maxima directly evaluate whether Earth's capture efficiency of cosmic dust is modulated by orbital configuration.

By integrating cyclostratigraphy with fossil MM petrography, geochemistry, and isotope data, this study provides one of the first direct deep-time tests of eccentricity-driven modulation of the ET dust flux.

References: [1] Suttle and Genge (2017), *EPSL* 476, 132-142. [2] Zahnow et al. (2025), *Comm. Earth Env.* 6, 577. [3] Krämer Ruggiu et al. (2025), *GCA* 405, 114-131. [4] Schmitz et al. (2019), *EPSL* 522, 234-243. [5] Wichern N. et al. (2024), *Clim. Past* 20, 415-448.