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Silurian fossil micrometeorites from Gotland (Sweden): implications for the post-Ordovician cosmic dust flux

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Earth has continuously accreted extraterrestrial material throughout geological time, from kilometer-scale impactors to microscopic dust. Micrometeorites (10 µm to 2 mm; [1]) constitute the dominant mass fraction of the modern extraterrestrial influx (40,000 ± 20,000 metric tons yearly [2]) and provide a sensitive archive of Solar System dynamics. Temporal variations in micrometeorite flux may reflect asteroid family-forming events and illuminate links between Solar System evolution and Earth's past climate and biosphere [3].

While Ordovician fossil micrometeorites associated with the L-chondrite breakup are extensively documented, Silurian records remain rare [4]. We present one of the first Silurian micrometeorite collections, recovered from Wenlock-aged limestones from Gotland (Sweden). Complementary material from Anticosti Island (Canada), currently under investigation, targets Hirnantian (Late Ordovician) strata and will help constrain the Ordovician-Silurian transition micrometeorite flux.

Micrometeorites were extracted by acid dissolution (15% HCl), followed by magnetic separation and optical microscopy. Four samples from the Gotland section (7.5 kg total) are analysed to date. SEM analyses identified six I-type spherules, four from marly limestone, challenging assumptions that purer limestones preferentially preserve micrometeorites (Fig. 1). Energy-dispersive X-ray spectroscopy indicates typical I-type compositions (mean: 53.4 at% O, 46.3 at% Fe, minor Mn and Si), consistent with magnetite-wüstite spherules. SIMS triple oxygen isotope analyses of three particles reveal variable results: one plots within the ordinary chondrite field, while two fall near the terrestrial fractionation line, potentially reflecting alteration or isotopic exchange during diagenesis (Fig. 2).

These preliminary results demonstrate that Silurian sediments preserve micrometeorites and may imply a continued, yet reduced delivery following the Ordovician L-chondrite breakup. Ongoing geochemical analyses will further constrain preservation effects and allow comparison between Baltic and Laurentian paleoenvironments, as well as existing Devonian records [3], refining our understanding of the mid-Paleozoic extraterrestrial flux.

References. **[1]** Genge *et al.* 2008 *Meteorit. Planet. Sci.* 43(3)497-515. **[2]** Love & Brownlee (1993) *Science* 262:550-553. **[3]** Krämer Ruggiu *et al.* 2025 *Geochim. Cosmochim. Acta* 405:114-131. **[4]** Mutch (1964) *Ann. N.Y. Acad. Sci.* 119:166-185. **[5]** Clayton (1993) *Annu. Rev. Earth. Planet. Sci.* 21:115-149. **[6]** Thiemens & Brenninkmeijer (1995) *Geophys. Res. Lett.* 22(3):255-257. **[7]** Suavet et al. (2010) *Earth Planet. Sci. Lett.* 293:313-320.

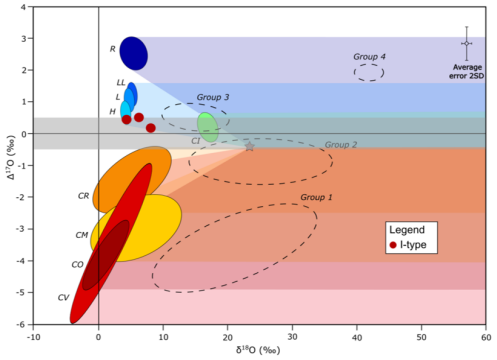

Figure 2. Triple oxygen data by SIMS of the three I-types plotted with $\delta^{18}O$(‰) versus $\Delta^{17}O$ (‰). Micrometeorites are plotted in the figure in relation to the micrometeorite groups and meteorite parent body sources. The solid line and grey rectangle represent the TFL (~ $\delta^{17}O = 0.52 \times \delta^{18}O$; [5]). The star represents the present average atmospheric isotopic composition of oxygen around the stratosphere-mesosphere transition ($\delta^{18}O$ ~ 23.5‰ and $\delta^{17}O$ ~ 11.8‰; [6]). The plot is adapted from [7].

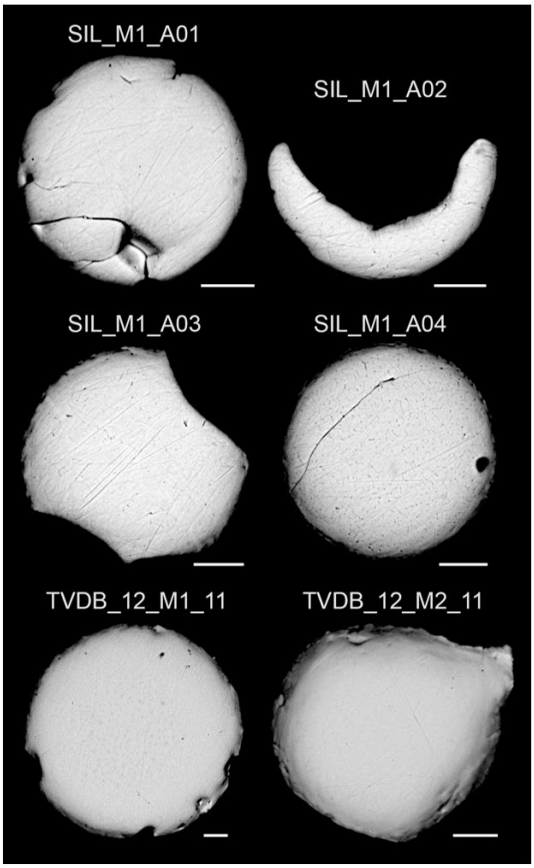

Figure 1. Six extracted I-types from the Gotland section. Scalebar is 10 µm.