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Micrometeorites from western Greenland: extending micrometeorite collections to sediment traps in the northern hemisphere.

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An estimated 4 (±2) x10^7 kg of cosmic dust reaches the Earth annually [1], three orders of magnitude greater than the corresponding flux of macroscopic meteorites [2]. Particles between 10 µm and 2 mm contribute the vast majority of cosmic dust ultimately accreting to Earth, known as micrometeorites (MMs) upon surviving atmospheric entry. MMs provide unique information on the composition and dynamics of small bodies in the Solar System. For example, geochemical evidence implies over 60% of MMs ≤1000 µm derive from carbonaceous chondritic parent bodies, while the corresponding number for meteorites is only c. 4% [3]. MMs have been collected from various environments, with hot and cold deserts in particular offering ideal dry environments for MM preservation owing to limited aqueous alteration and sedimentary reworking, and limited background sedimentation [4]. MM collections assembled by melting ice and snow are complemented by collections based on processing glacial sediment from ice-free high altitude sediment traps, for example in the Sør Rondane and Transantarctic Mountains, Antarctica [5, 6]. While MMs have been collected from residue in melt zones of glaciers in Greenland and Novaya Zemlya [7, 8], sediment traps in the Arctic have thus far not been targeted for MM extraction, and hence represent an untapped reservoir to better characterise the cosmic dust flux to Earth in the geologically recent past. Here we report MMs extracted from three sediment samples collected from sediment traps in western Greenland (two from the Nuussuaq peninsula, one from Disko Island) during a 2023 field campaign, adding to the five MMs extracted from 800 g of sediment previously reported [9].

Each 500 g sediment sample was washed and sieved wet into six size fractions <2 mm. A magnetic separation was applied to each size fraction, and MMs were picked from the magnetic portions based on their shape and surface appearance using an optical light Zeiss Stereoscope Discovery V.20 binocular microscope. Candidate MMs were mounted, polished to expose a representative cross-section, and subsequently imaged and analysed for their major and minor element compositions via SEM-EDS (JEOL JSMIT300). A representative portion of the non-magnetic residue was screened optically to ensure significant numbers of MMs were not missed. The first two samples, from sediment traps in two locations on the Nuussuaq peninsula, yielded 11 and 63 MMs. MM extraction from a third sample (from Disko Island) is underway. All recovered MMs are cosmic spherules, and comprise three S-types, two G-types, and six I-types in the first sample, and 48 S-types, five G-types, one mixed S/G-type, and nine I-types in the second sample. Preliminary comparison against Antarctic sediment trap collections reveals lower overall MM abundance, higher proportions of iron-rich (I- and G-type) to silicate-rich (S-type) cosmic spherules, and more prevalent weathered textures among Greenland sediment trap MMs. These features point to more advanced weathering in the Greenland sediment trap collection, likely due to differing environmental conditions, demonstrating the importance of comparative studies between MM collections from different polar environments. Further analytical campaigns are planned to measure detailed element compositions (EMPA) and triple oxygen isotopic compositions (SIMS) in order to constrain MM provenance and atmospheric entry effects.

MMs reported here greatly enlarge the current western Greenland sediment trap collection, and together with previously reported MMs represent the first sediment trap-derived MM collection from the northern hemisphere, allowing comparison of preservation between MMs extracted from sediment traps in Greenland and Antarctica. Ultimately, study of MMs collected from different environments across hemispheres will lead to a more comprehensive understanding of the spatial and temporal variabilities in the flux and delivery of extraterrestrial material to Earth. Arctic sediment trap MM collections also present an opportunity to gain new insight into sources of cosmic dust in the Solar System.

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