

Exploring the potential of titanium isotopes for tracing micrometeorite sources

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Micrometeorites (MMs) represent in mass the largest contributors to the flux of extraterrestrial material to Earth. A study of its sources in the solar system offers deeper insight into the discrepancies between MM collections and orbital models, which predict a dominant cometary dust flux to Earth, while most analysed MMs suggest an asteroidal origin [1].

Previous studies relying mostly on oxygen isotopes of cosmic spherules (CS), completely molten MMs due to atmospheric entry, suggest that the flux of the finest fraction is dominated by carbonaceous chondrite material [2]. However, a higher contribution of MMs with an ordinary chondrite affinity is observed with increasing size of the MM [2]. Furthermore, certain textural types of CSs are linked to specific chondrite groups [3].

To further investigate these relationships and test whether Ti isotope ratios provide a robust tracer of MM sources, we plan to obtain Ti isotope data for the first time on batches of separated CSs. Titanium isotopes are ideal for tracing MM sources as Ti is refractory, lithophile and resistant to secondary processes, and Ti isotope data show a clear dichotomy between inner and outer solar system materials [5]. Given the requirement for ~1 mg of Ti for high precision analyses, the Ti isotopic compositions of a single MM can generally not be measured at sufficient analytical precision, and batches of MMs are combined here.

Focus is placed on MMs collected from the Sør Rondane Mountains in Antarctica, including three batches with different size ranges (125–200 µm, 200–300 µm, and 300–400 µm) to assess the relationship between MM size and its source materials. Additionally, two batches categorized by textural type - composed solely of barred olivine or cryptocrystalline CSs - will be analysed to determine their connection to distinct source reservoirs in the solar system.

[1] Matthew J. Genge et al. (2020), P&SS 187, 104900

[2] Carole Cordier et Luigi Folco (2014), GCA 146, 18-26

[3] M. van Ginneken et al. (2017), GCA 212, 196-210

[4] Steven Goderis et al. (2020), GCA 270, 112-143

[5] Miriam Rüfenacht et al. (2023), GCA 355, 110-125