

# PARTICLE STATISTICS FROM THE TAM MICROMETEORITE COLLECTION – INVESTIGATING THE RELATIONSHIP BETWEEN COSMIC SPHERULE TEXTURE AND PARTICLE SIZE

Folco, L. and Suttle, M.D., Dipartimento di Scienze della Terra, Università di Pisa, 56126 Pisa, Italy

([martindavid.suttle@dst.unipi.it](mailto:martindavid.suttle@dst.unipi.it), [luigi.folco@unipi.it](mailto:luigi.folco@unipi.it)).

**Introduction:** We provide a comprehensive overview of micrometeorite statistics from a single sediment trap within the TAM (Transantarctic Mountain) micrometeorite collection<sup>[1]</sup>. Trap No.65 was recovered from the glacially eroded, flat-topped nunatak: Mille Butte, within Victoria Land, Antarctica. The analysis of large numbers of micrometeorites is essential for the accurate characterization of the cosmic dust flux arriving on Earth. Here we provide the first data on micrometeorite size distribution by textural subtype, as well as unmelted micrometeorite abundance data.

**Methods:** Following an exhaustive search effort, potential micrometeorites were imaged optically and under BSE (back-scattered electron imaging), collecting both external and internal cross-section images. Micrometeorite classification follows an updated version of the conventional system, previously outlined by Genge et al., (2008)<sup>[2]</sup>.

In total we picked ~1784 micrometeorites, ranging in size between 100-1500µm. Currently, we have complete data for all particles >200µm, while the remaining 100-200µm size fraction (~616 particles) will be characterized in full prior to the conference. Particles were retrieved from ~2542g of sediment, however, because we performed partial searches of the smaller (<400µm) size fractions the total expected micrometeorite population accounting for the unpicked micrometeorites lies at ~2,271 particles (>200µm) among the entire 2542g sediment aliquot.

**Results:** From the 200-1500µm size fraction we identified 1168 micrometeorites as well as 69 microtektites and 1 meteorite fragment (a chip of ordinary chondrite, containing fusion crust). This includes 53 unmelted/scoriaceous particles, representing 4.54% of the total collection at a ratio of 1:22 unmelted:cosmic spherules. Of these fine-grained precursors are overwhelmingly dominant (~75% of unmelted particles).

Among the cosmic spherule population, both I and G types occur in equal proportions (1.6%), while S-types represent 96.7%. S-types can be subdivided based upon quench textures into porphyritic (PO - 13.3%), barred olivine (BO - 19.2%), cryptocrystalline (CC - 48.7%) and vitreous (V - 15.5%) subtypes. Splitting further, the PO group is composed of “normal” PO spherules (10.1%) containing “large” (>10µm) euhedral olivine crystals and µPO (3.2%) – as defined by van Ginneken et al., 2017<sup>[3]</sup>, dominated by many smaller equant olivine crystals (<10µm) as well as containing abundant vesicles. Collectively, among the PO group 25.3% are relict grain bearing, containing crystals which survived atmospheric entry unmelted. We also elected to further subdivide the CC class into “microcrystalline” (MC - 26.8%) – containing localized regions with a barred texture as well as regions lacking bars and dominated by randomly orientated olivine and magnetite crystallites, CC-normal (12.0%) – containing submicron olivine and magnetite dendrites with no evidence of barred textures and CC-turtleback (7.7%) composed of multiple crystalline domains whose boundaries present a “stitched” texture generated by crystal growth from the surface inward<sup>[4]</sup>. These subdivisions better reflect the transitional nature between BO-CC-V subtypes and address somewhat the subjective problems of micrometeorite classification by texture.

**Morphological features:** S-type spherules with elongate *tailed* morphologies or *arrow-shaped* forms<sup>[5]</sup> occur at a frequency of 3.7%, while those with hollow centers occupied by a single large vesicle represent <1.5% – they may reflect particles which entered the atmosphere with extremely high rotation rates (>1000 radians s<sup>-1</sup>) potentially indicating immature dust recently released from their parent bodies<sup>[6]</sup>. Particles with evidence of metal bead formation during atmospheric entry represent (as a conservative estimate) 17.4% of S-type spherules.

**Size distribution:** The particle size distribution is accurately described ( $R^2=0.97$ ) by a power law matched against the size range 200-700µm (96% of the population by number) and produces a slope exponent of -3.8. Neither the slope function nor fitting statistics change appreciably if cosmic spherules from only a single subtype are considered – Slope values varying between -3.4 (PO spherules) to -4.2 (V-types) and fitting statistics between  $R^2=0.96$  and 0.99. Likewise, median spherule size by subtype varies within a narrow range: 239µm (I-types) and 325µm (V-types). There does not appear to be a strong relationship between cosmic spherule texture and particle size – although a subtle statistical trend may be present, and this will be the focus of further research once the 100-200µm fractions are considered.

**Conclusions:** Population statistics from the TAM65 sediment trap are similar to data previously reported from other Antarctic micrometeorite collections. Further data is required before a statistically rigorous assessment of the relationship between cosmic spherule textural subtypes and particle size can be determined. At present the null hypothesis that “these variables are independent” appears to be valid.

**References:** [1] Rochette et al., 2008, PNAS, doi:10.1073/pnas.0806049105. [2] Genge et al., 2008, MAPS, doi:10.1111/j.1945-5100.2008.tb00668.x. [3] van Ginneken et al., 2017, GCA, doi:10.1016/j.gca.2017.05.008. [4] Sedaghatpour et al., 2009, MAPS, doi:10.1111/j.1945-5100.2009.tb00761.x. [5] Suttle et al., 2018 Space dust and debris in the vicinity of the Earth - Royal Astronomical Society Nov 2018. [6] Genge, 2016, MAPS, doi:10.1111/maps.12805.