THE COLLECTION OF URBAN MMS – NOT AN URBAN MYTH

J. Larsen[1] and M. J. Genge[2], [1]Project Stardust, Oslo, Norway, contact email: project.stardust@getmail.no
[2]Department of Earth Science and Engineering, Imperial College London, Exhibition Road, London SW7 2AZ.

Introduction: A popular belief amongst amateur astronomers is that micrometeorites (MMs) can be collected from the roofs of their homes. The concensus opinion amongst MM researchers, however, has been that collection in urban areas is impossible due to the large abundance of artificial particles and the low flux of extraterrestrial particles. Although early studies by Nininger [1] reported large numbers of magnetic spherules in urban areas suggested to be MMs, later studies showed that the abundance magnetic spherules decreases away from urban areas, and that urban spherules are largely artificial in origin [2,3]. Micrometeorites collection in towns and cities have thus been considered an urban myth.

We report the discovery of >500 magnetic spherules (150-600 μm in size) with external morphologies consistent with MMs collected from roofs in urban areas in Europe. A randomly selected subset of 47 of these particles is shown to consist of S-type cosmic spherules on the basis of their textures, mineralogies and bulk compositions.

Methods: In order to separate the MMs from other types of terrestrial spherules, Project Stardust conducted ~1000 field searches for particles (~50-5,000μm in size) in ~50 countries worldwide over 7 years. The collected particles were examined under an optical microscope and systematically classified by type into anthropogenic, biogenic, terrestrial and extraterrestrial. Development of identification criteria was based on published accounts [e.g. 4].

After the positive identification of the first MM, particles were collected from accumulated sediments on flat roofs, or in the gutters of pitched roofs mostly in Norway, although one was also recovered in France. The total mass of sediment collected was ~300 kg and was processed by magnetic separation, washing with water, and size fraction separation. Particles were selected under a binocular microscope on the basis of several criteria: (1) spherical or subspherical shape/aerodynamic forms, (2) colour and lustre, with black vitreous, black to grey metallic and translucent vitreous particles selected, and (3) the presence of surface dendrites or metallic surface protrusions. The surface texture of particles were recorded in detail photographically using a specially designed camera rig to obtain colour images lacking depth of field effects that allow inspection of textures over an entire hemisphere. Colour images are particularly useful as a visual tool in identification of MMs. The collection is described in a book by Larsen [5].

Results: Nine porphyritic olivine, 23 barred olivine and 15 cryptocrystalline spherules were identified and have textures and mineral compositions identical to Antarctic cosmic spherules. Porphyritic spherules include particles with equant to skeletal, zoned olivine phenocrysts within a glassy mesostasis containing cruciform magnetite dendrites. Some of these particles also include relict cores of forsterite. Two porphyritic particles contain rounded relict Fe-bearing olivine with low-Ca contents within the range of equilibrated ordinary chondrites, one also contains a 5 μm Ni-rich metal bead and chromite. Barred olivine spherules are dominated by parallel growth olivines in 1-3 orientations within a glassy mesostasis containing magnetite. Two barred olivine spherules contained metal-sulphide beads consisting of Ni-rich metal and sulphide. A magnetite-rim is present in both particles. One barred olivine particle contains a large (40 μm), central vesicle. Cryptocrystalline spherules consist of radiating clusters of olivine dendrites within a glassy mesostasis often containing magnetite. Minimal alteration of particles was observed with minor etching of glass in some particles and minor replacement of metal by ferrihydrite.

The bulk compositions of the particles, determined by wide beam electron microprobe analyses, confirm the extraterrestrial origins of particles. Abundances of Ca, Al, Ti, Mg, Si, Cr, Mn and Fe are mainly within a factor of 3 of CI chondrite although some exhibit depletions in Ca (<0.7xCI) and Cr (<0.01xCI). Elements are broadly depleted according to volatility with the largest depletion in K, Na and S probably due to entry heating. Depletions also occur in Co and Ni suggesting partitioning into metal.

Implications: MMs can be collected in urban environments, however, their abundances are low compared and effective criteria based on morphology are required in their identification. The large abundance of glassy artificial spheres in particular makes identification of V-type spherules difficult, likewise I-type particles are easily confused with the abundant iron-rich artificial spherules. Some gutters in commercial and municipal buildings are cleaned once a year, and none of the buildings searched were older than ~50 years; many of these particles represent samples of the most recent large MMs landing on Earth. Despite accelerated weathering under temperate environments very little alteration occurs.

References: [1] Nininger (1941) *Pop. Astron* 49, 159-162, [2] Handy R. L. and Davidson D. T., (1953) *Proc. Iowa Acad. Sci* 60, 373-379; [3] Hoppe J. and Zimmerman H., (1958) *Die Sterne* 30, 33-36, [4] Genge M. J. et al (2008) *MAPS* 43, 497–515, [5] Larsen, J. 2016. *In Search of Stardust*. Arthouse DGB, Oslo. ISBN: ISBN: 978-82-8181-201-7.