Fossil Micrometeorites: Echo of Ancient Air

ANDREW G. TOMKINS[1]* AND MATTHEW GENGE[2]

[1]School of Earth, Atmosphere & Environment, Monash University, Melbourne, Australia (*correspondance: andy.tomkins@monash.edu)

[2]Impact and Astromaterials Research Centre, Department of Earth Science and Engineering, Imperial College London, United Kingdom

Micrometeorites (extraterrestrial material <2 mm diameter) are constantly falling to Earth and represent approximately 100 times the mass contributed by meteorite falls. As such, very slowly accumulated sediments invariably contain elevated abundances of micrometeorites, to the extent that magnetic rakes dragged across the abyssal ocean floor readily aquire thousands of cosmic spherules (CS), partially melted and unmelted micrometeorites. Cosmic spherules are fully melted interplanetary dust particles resulting from collisions between asteroids, planets and comets, and from solar ablation of comets. They melt during atmospheric entry, typically at altitudes of 95-75 km (the upper mesosphere), and the extent, duration and temperature of melting varies primarily as a function of entry velocity and angle, and particle size and density. Some are particles of meteoritic metal, which melt to form iron-type CS composed of varying proportions of magnetite, wüstite and FeNi metal. These I-type CS acquired their characteristic mineralogies by chemically reacting with, and becoming oxidised by, the upper atmosphere. By targeting ancient slowly deposited sedimentary rocks for extraction of I-type CS, we can investigate the chemistry of the upper atmosphere of the Earth at any point in time sampled by the geological record [1]. For example, we have shown that the upper atmosphere at 2.72 Ga was sufficiently oxidising to form magnetite and/or wüstite in all micrometeorites recovered [1]. This information places limitations on atmospheric structure and composition.

Our ongoing research is sampling sedimentary rocks from the Pilbara region of northwestern Australia, representing much of the Archean and the start of the Proterozoic (3.45 – 2.22 Ga). Micrometeorites from these are allowing us to investigate upper atmosphere changes during the Great Oxidation Event. We are also investigating whether isotopic signatures of atmospheric processes can be preserved in micrometeorites. Furthermore, we will discuss the use of analogue sites to investigate micrometeorites preservation on Mars, in locations accessible to rovers.

[1] Tomkins et al. (2016) *Nature* **533**, 235-238.