

INITIAL RESULTS FROM THE KWAJALEIN MICROMETEORITE COLLECTIONS. P. J. Wozniakiewicz^{1,2}, J. P. Bradley³, M. C. Price², M. E. Zolensky⁴, H. A. Ishii³, D. E. Brownlee⁵, D. Dearborn⁶, T. Jones⁶, B. Barnett⁶, S. Yakuma⁶, T. Letendre⁶, C. Gonzalez⁴, R. Bastien⁴, and M. Rodriguez⁴. ¹Earth Sciences Department, Natural History Museum, Cromwell Road, London, SW7 5BD, UK. ²School of Physical Sciences, University of Kent, Canterbury, Kent, CT2 7NH, UK. ³Hawai'i Institute of Geophysics and Planetology, University of Hawai'i, Honolulu, HI 96822, USA. ⁴NASA Johnson Space Center (JSC), Houston, TX 77058, USA. ⁵Dept. of Astronomy, Univ. of Washington, Seattle, WA 98195, USA. ⁶Lawrence Livermore National Laboratory (LLNL), 7000 East Avenue, Livermore, CA 94550, USA. (p.wozniakiewicz@nhm.ac.uk).

Introduction: Micrometeorites are constantly arriving at the Earth's surface, however, they are quickly diluted by the natural and anthropogenic background dust. The successful collection of micrometeorites requires either the employment of a separation technique (e.g. using magnets to separate metal-bearing micrometeorites from deepsea sediments [e.g. 1,2] and dissolved pre-historic limestones and salts [e.g. 3,4]), or an approach that limits contamination by terrestrial dust (e.g. collecting from ice, snow and well water in polar regions - locations where the terrestrial dust flux is so low that micrometeorites represent the major dust component [e.g. 5-7]). We have recently set up a micrometeorite collection station on Kwajalein Island in the Republic of the Marshall Islands in the Pacific Ocean, using high volume air samplers to collect particles directly from the atmosphere. Collecting at this location exploits the considerably reduced anthropogenic background; Kwajalein is >1000 miles from the nearest continent and for much of the year, trade winds blow from the northeast at 15 to 20 knots providing a continuous stream of oceanic aerosol for sampling. By collecting directly from the atmosphere, the terrestrial age of the particles, and hence weathering they experience, is minimal. We therefore anticipate that the Kwajalein collection may include particles that are highly susceptible to weathering and either not preserved well or not found at all in other collections. In addition, this collection method allows for particle arrival times to be constrained so that collections can be timed to correlate with celestial events (e.g. meteor showers). Here we describe the collections and their preparation and report on the initial results.

Collection Method: Two high volume air samplers were installed on top of the two-story airport building on Kwajalein, upwind of the local anthropogenic sources of aerosols (Fig.1). The samplers were fitted with polycarbonate membrane filters with 5 μ m diameter perforations, and the flow rates were set to 0.5m³/min. The samplers were run continuously from mid-October 2011 to early January 2012 and again from mid-May 2012 to late August 2012. Filters were exchanged and replaced once a week. The filters are

now being prepared and studied by groups at Johnson Space Center, the University of Kent and the Natural History Museum London.

Sample Preparation and Analysis: Due to the humid, salt laden environment of Kwajalein, all of the filters developed a coating of salt. The filters are also very large, measuring $\sim 8 \times 10$ inches, an area over which it would be impractical to search for micrometeorites. It was therefore necessary to devise a method of washing and concentrating the particles in a smaller area on the filters prior to searching for micrometeorites. High purity water was used to dissolve the salt and dislodge the particles, while simultaneously using a small vacuum pump beneath the filter to create a well at the centre to concentrate the particles and remove the salt water. After concentration, the central area was cut free and mounted for imaging and energy dispersive X-ray (EDX) analyses of particles using the scanning electron microscope (SEM) at the University of Kent. These surveys aimed to identify 1) common types of contamination (to speed up our later surveys) as well as 2) particles of interest, i.e. possible micrometeorites that require additional analysis.



Fig. 1: One of the high volume air samplers installed on Kwajalein Island.

Results: To date, three filters have been prepared and studied. Even with the lower levels of background terrestrial dust, the filters contain a large total number of particles. SEM imaging and EDX analyses of these particles show that the majority are terrestrial in origin: a mixture of biological materials such as coral

fragments, diatoms, and plant spores together with industrial materials such as exhaust particles and rust. However, there are also many particles of interest, having either morphologies consistent with cosmic spherules (examples shown in Fig. 2) or compositions consistent with meteoritic materials and, in some cases, with what appears to be an Fe-rich (magnetite) crust (Fig. 3). The spherules range in size from a few microns to ~30 microns in diameter and exhibit silicate or Fe-rich compositions. These particles of interest are currently being picked off the filters, embedded and sectioned for further study by SEM and Raman spectroscopy.

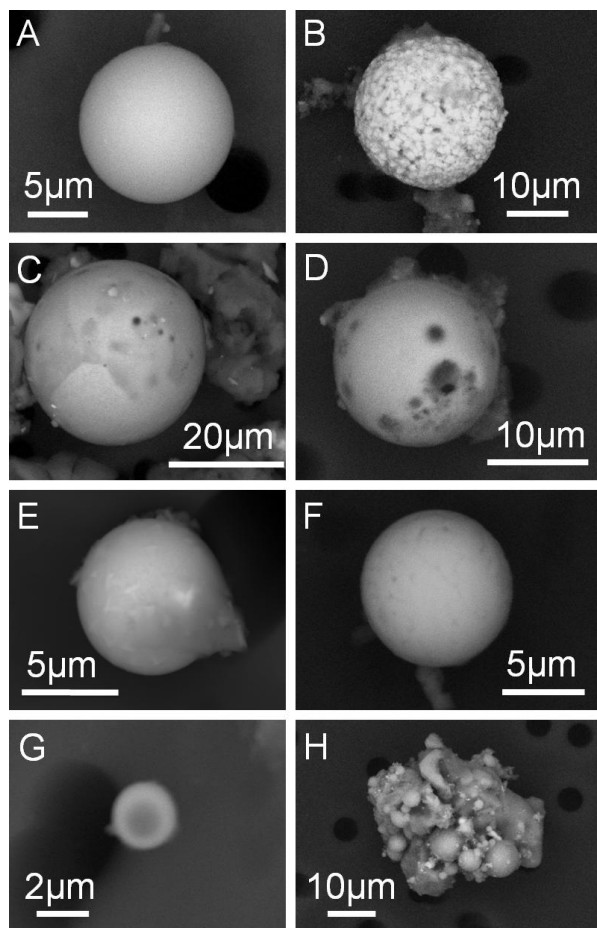


Fig. 2: Examples of particles of interest found on filters surveyed to date. **A-G:** Particles with morphologies consistent with cosmic spherules. **H:** Aggregate of multiple silicate and Fe-rich spherules.

The collectors have been removed from Kwajalein, and we are now planning to install them on Mauna Loa, at an elevation of ~11,000 ft, a site that is expected to have even lower levels of anthropogenic background particles and significantly less salt aerosol allowing us to minimize the use of solvents.

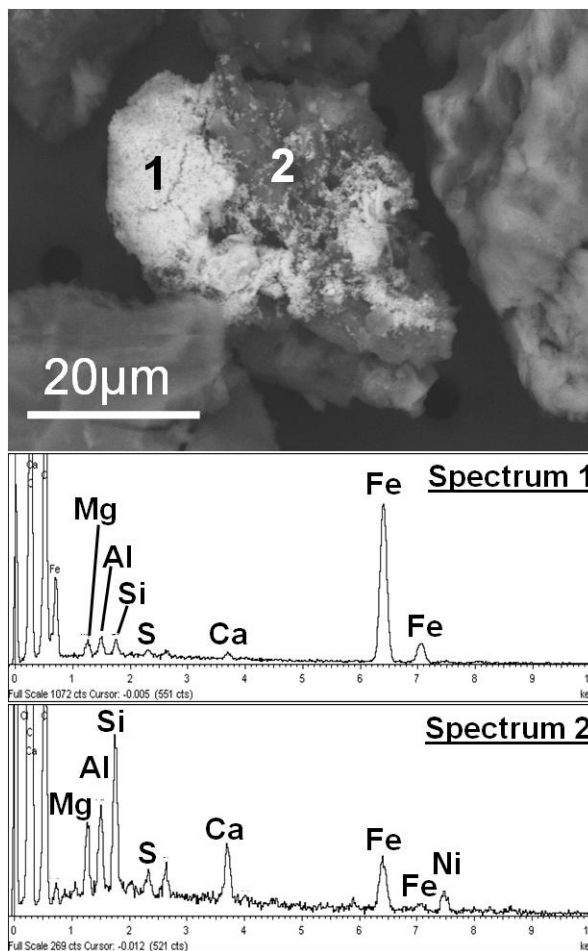


Fig. 3: A particle exhibiting what appears to be an Fe-rich (magnetite) crust (spectrum 1) with underlying material having compositions consistent with meteoritic materials (spectrum 2).

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Acknowledgements: We thank K. Hosek and C. DeBrum for running the collections. These collections were funded by a grant from NASA's Laboratory Analysis of Returned Samples Program. PJW is funded by a Marie Curie Fellowship. Curation at JSC is funded by NASA's Cosmochemistry Program. Parts of this work were performed under the auspices of U.S. DOE by LLNL under Contract DE-AC52-07NA27344.