MICROMETEORITES RECOVERED FROM LAKE MICHIGAN, USA.

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Introduction: Micrometeorites (MMs) are extraterrestrial particles 10 µm–2 mm in size, which represent in terms of mass the largest proportion of the flux of extraterrestrial material to fall on the Earth's surface (e.g. [1]). One of the most important objectives of MM studies is to identify their parent bodies. Here we identify six MM candidates in material dredged from the bottom of Lake Michigan during the Aquarius Project [2], a collaborative effort between the Adler Planetarium, the Shedd Aquarium, the Field Museum, and NASA to search, robotically, for fragments of a 600-pound meteorite that fell into the lake on Monday, February 6, 2017, 10 miles off the coast of Sheboygan, Wisconsin. Textural and chemical analyses were performed to confirm the grains' characterization as MMs and classify them.

Methods: Six candidate MMs were mounted in 1-inch epoxy rounds and polished by hand to reveal cross sections. The petrology of polished MM sections were evaluated quantitatively using Raman spectroscopy, scanning electron microscopy and energy dispersive X-ray spectroscopy (SEM/EDS):

Raman spectroscopy. The Field Museum's WITec alpha300R Raman spectroscopy system, equipped with a 532 nm green laser, was used to identify mineral phases in the MM candidates. At least two different spots were analyzed for each MM candidate sample. The averaged spectrum of the two spots was used for phase analysis. Identification of the mineralogical phases was done using RRUFF reference spectra and a calibration of olivine spectra for forsterite/fayalite molar compositions [3].

SEM/EDS. To evaluate petrological textures of cross sectioned MMs, high-resolution, backstattered electron (BSE) images were obtained using a TESCAN LYRA3 field emission SEM equipped with an in-column BSE detector in the Department of the Geophysical Sciences at the University of Chicago. To generate quantitative chemical maps (TruMaps), the SEM is also equipped with two Oxford Instruments XMax 80 silicon drift energy dispersive X-ray spectroscopy (EDS) detectors; these, coupled with Oxford Instruments AZTec software, were used for simultaneous determination of O, Mg, Al, Si, Ca, Ti, Cr, Mn, Fe, Ni compositions. The system was calibrated with mineral and metal standards; the current stability and intensity is monitored using a Co standard and the beginning and end of each analysis session. Compositional analyses of the entire surface and of regions of interests (ROI) with individual phases (between 15-30 per grain) were made. For ROI analyses, freehand borders were drawn around regions of contiguous pixels as established by the overlayed Si and Mg maps. A quantitative chemical analysis was generated for each region.

Results and discussion: Five of the six grains were observed to have Raman spectra with peak positions consistent with either olivine, pyroxene, or both. One grain was organic in nature. MMs are dominantly composed of olivine and pyroxene (e.g. [4]); therefore, the five grains containing these minerals were considered MM candidates. SEM-BSE analyses supported the characterization of these grains as MMs, as all five grains appeared to be melted, silicate- (S-) type cosmic spherules, which are the most common cosmic spherule sub-type (e.g., [4, 5]). Four of the five had cryptocrystalline (Cc) to barred olivine (BO) textures, which may indicate that they derived from a chondritic parent body [6]. Quantitative EDS analyses were used to calculate fayalite (Fa) numbers for olivines (31.7±2.37, 26.6±2.68, 27.3±2.17; errors are 1SD) and ferrosilite (Fs) numbers of pyroxenes (21.8±2.27, 31.8±3.03, 26.4±2.18, 27.2±2.81, 22.8±5.85). Based on these calculations, all five MMs likely derived from equilibrated ordinary chondrite parent bodies, four of them specifically from the L or LL groups. The fifth MM, which has an irregular, granular pyroxene texture, is an unequilibrated ordinary chondrite because its Fs compositions are not uniform and span the range of all three ordinary chondrite groups.

References: [1] Rubin, A. E. and Grossman, J. N. (2010) *Meteoritics & Planetary Science* 45, 114-122. [2] C. Bresky and M. Fries (2018) *49th Lunar and Planetary Science Conference*, Abstract #2083. [3] Kuebler, K. E. et al. (2006) *Geochimica et Cosmochimica Acta* 70, 6201-6222. [4] Genge, M. et al. (2008) *Meteoritics & Planetary Science 43*, 497-515. [5] Taylor, S. et al. (2000) *Meteoritics & Planetary Science* 55, 651-666. [6] van Ginneken, M. et al. (2017) *Geochimica et Cosmochimica Acta* 212, 196-210.