FABRICATION OF HYDROUS METEORITES FOR USE IN METEORITE DISRUPTION EXPERIMENTS

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Introduction: Meteorites can be used in studies about the fundamental differences between cosmic dust, meteorites, and asteroids. Of particular interest is the difference between anhydrous and hydrous meteorites and the way these two samples disrupt to create the population of smaller particles observed in the Solar System [1]. Hydrated meteorites are primarily present as carbonaceous chondrites. However, carbonaceous chondrites account for only 5% of chondritic falls [2] and access to these materials for disruption experiments is limited.

In past studies, terrestrial and extraterrestrial samples have been disrupted at the NASA Ames Vertical Gun Range in Moffett Field, California. Foil detectors were set up inside the vacuum chamber. Penetrations in the foil were measured using a computer processing program [3] and mass-frequency distribution graphs were produced for each sample. In addition, the debris was collected from the vacuum chamber, individual particles were weighed and the data added to the foil penetration data. The meteorite disruptions have produced particles in the cosmic dust range as well as the meteoritic range. The disruptions have also shown a significant difference between the mass-frequency distributions of terrestrial and extraterrestrial samples [4]. These studies primarily looked at ordinary chondrites, and the carbonaceous chondrites studied were anhydrous [5]. One carbonaceous chondrite was disrupted and produced significantly different results when compared with anhydrous samples (Figure 1).

To understand the differences in the mass-frequency distribution of hydrated chondrites when compared to anhydrous chondrites, it is important to disrupt more of these. Due to the valuable nature of these meteorites, we are developing a method of hydrating ordinary chondrites to use as analogues.

Experimental: In this work, a method was developed to create analogues for carbonaceous chondrites. NWA 869 (meteorite type), a commonly available ordinary chondrite was chosen to develop the hydration procedures. Samples of about 15 g were placed in a solution of pH ~ 13. The samples were placed in a pressure bomb and kept in an oven at 150^{o}C for varying lengths of time.

The samples were removed from the pressure bombs and cut in half. Clay molds were made of the rough edges of the sample to provide a flat surface on which to apply even pressure. The cut edges of the samples were polished using a flat lap with 120 grit. Once the samples were adequately smoothed, they were scanned using the ATR attachment of a Bruker ALPHA FTIR instrument. Scans are taken every millimeter once along the length of the sample and twice across the width of the sample (Figure 2). These scans were conducted on both halves of each meteorite sample. Peaks were chosen for integration based on correlation with hydrated minerals and graphs were produced to show the penetration of water into the sample (Figure 3). The meteorite samples must be sufficiently smooth to achieve satisfactory contact with the FTIR instrument. The scanning and polishing techniques have been refined and preliminary scans were conducted on 5 samples. Three peaks in the spectrum were integrated and graphs were produced relating the area of these peaks to the distance from the edge of the sample. The initial work was done on a 16 gram sample of NWA 869 that was hydrated at neutral pH for 30 days. This sample did not show any signs of hydration. This validates the need for a basic pH and for more extended periods of time. IR scans for two other samples did not show any peaks, but the problem appears to be good contact between the sample and the ATR plate. The samples are currently in the process of being repolished and rescanned to produce more reliable data.

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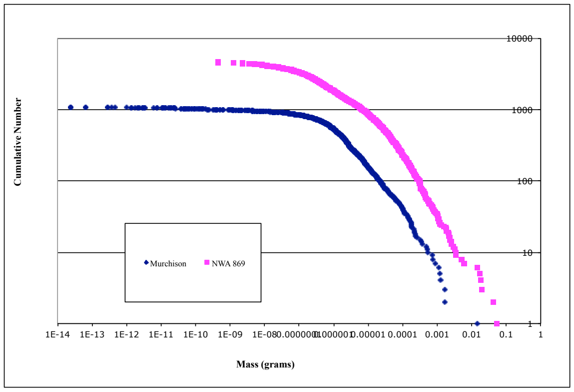

Figure 1. Cumulative mass-frequency distribution for samples of Murchison and NWA869 after disruption.

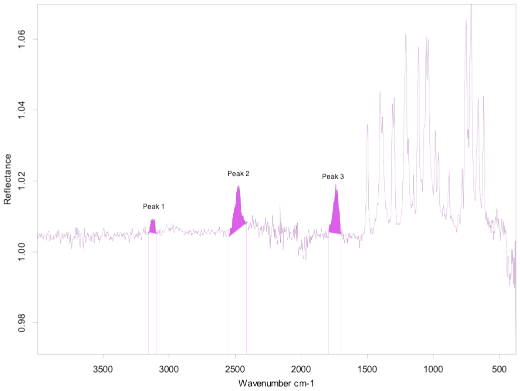

Figure 2. FTIR scan of a sample of NWA 869.

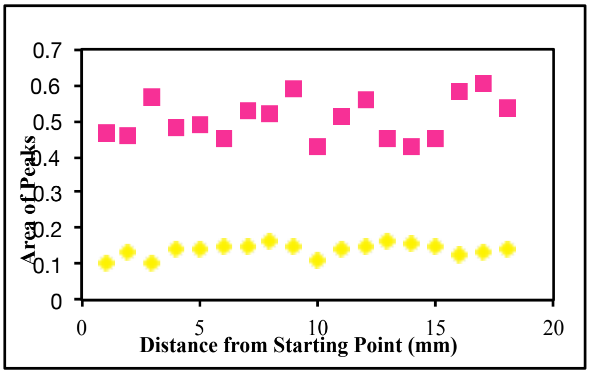

Figure 3. Graph showing the penetration of water into an NWA 869 Sample. The pink squares represent the integration of Peak 2 and the yellow diamonds represent the integration of peak 1 as shown above.