CONSTRUCTION OF HYDROUS METEORITES FROM ORDINARY CHONDRITE FRAGMENTS

A.N. Clayton[1], M. M. Strait[1], G. J. Flynn[2], and D. D. Durda[3] [1]Dept. Of Chemistry, Alma College, 614 W. Superior St., Alma MI 48801 (clayton1an@alma.edu), [2]Dept. Of Physics, State University of New York-Plattsburgh, Plattsburgh NY 12901, [3]Southwest Research Institute, 1050 Walnut Street Suite 3400, Boulder CO 80302

Introduction: Meteorites can be used in studies about the fundamental differences between cosmic dust, meteorites, and asteroids. The difference between disruption patterns of hydrous and anhydrous meteorites ignites particular interest concerning the creation of smaller particles observed in the Solar System [1]. Hydrous meteorites are primarily present as carbonaceous chondrites, which account for about 5% of chondritic falls [2]. Access to these materials for disruption experiments is limited. Previous experiments have studied the differences in the disruption of terrestrial and extraterrestrial samples. The disruption of these meteorites took place at the NASA Ames Vertical Gun Range in Moffett Field, California where foil detectors were set up inside the vacuum chamber. Penetrations in the foil were measured and particles found in the debris were individually weighed in order to produce mass-frequency distribution graphs for each sample [3]. The meteorite disruptions have produced particles in the cosmic dust range as well as the micrometeorite range. The experiments 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]. Several carbonaceous chondrites have been disrupted and these produced significantly different results when compared with anhydrous samples. It is important to disrupt more hydrated chondrites in order to understand the differences in mass-frequency distribution between hydrous and anhydrous chondrites. Due to the valuable nature of these meteorites, we are developing a method of hydrating ordinary chondrites to use as analogues.

Previously, a method was developed to create analogues for carbonaceous chondrites using samples of anhydrous NWA 869, a readily available ordinary chondrite. Samples of about 15 g were placed inside a pressure bomb in a solution of pH ~ 13, and kept in an oven at 150°C for up to two years. When the samples were removed from the pressure bombs, they were cut in half, polished and mounted in preparation for scanning with an FTIR. Scans were taken every millimeter, once along the length of the sample and twice across the width of the sample [6]. However it is unclear if the sample had sufficient contact with the ATR plate because neighboring points would show significantly different signals. One possibility is that the method of polishing did not provide an adequately smooth surface for producing reliable data.

Experimental: In order to achieve an appropriately smooth sample, half of each hydrous analogue was sent to Johnson Space Center to be mounted in epoxy and polished. Preliminary scans of the newly polished samples found evidence of hydration in all samples [7]. This shows the method developed will produce a hydrated sample, however a significant amount of time is necessary to fully hydrate an anhydrous sample.

Another approach to fabricating a hydrous meteorite involves hydrating smaller samples of anhydrous NWA 869 and attempting to bind the fragments together to create a hydrous meteorite. The smaller grain size will allow the sample to hydrate at a faster rate allowing a faster production of artificially hydrated samples. Once the particles are hydrated, they need to be formed into a hand-sized artificial rock. Experiments were done to determine the best method for compressing the small particles.

Small fragments of California clay were pulverized to ensure that none of the fragments were larger than 2mm in length. The fragments were then placed inside a small piece of metal pipe sitting on a plastic weigh boat. The pore space of the fragments was filled in with a small amount of deionized water to aid in the binding process. A metal plug was fitted to sit on top of the sample on the inside of the pipe. The device was then placed in a hydraulic press and compressed to ~5 tons. The sample was left at this pressure for 6 weeks. At the end of this time, the weigh boat was easily removed from the bottom of the device. However, pushing the sample through with the plug proved more challenging. Upon successful removal from the device, the sample seemed to be adhered together although it crumbled easily. The suspension apparatus was successfully attached to the sample (Figure 1). The sample was suspended in the vacuum chamber at the Ames Vertical Gun Range and disrupted using a 1/8 inch aluminum sphere with a speed of ~5 km/sec. Foil data from this disruption are currently being processed.

In a visual review of the particles produced from the disruption, there is concern that the original set of particles just disintegrated, and we got no new distribution of particle sizes. To evaluate this concern, size- frequency data will be collected on future samples prior to binding to look changes due to the disruption. Further studies are also being conducted to determine the length of time necessary to hydrate the fragments of NWA 869 and the time necessary to consolidate the particles under pressure. Finally, experiments are being performed to prefect the construction of the device to ease removing the sample intact.

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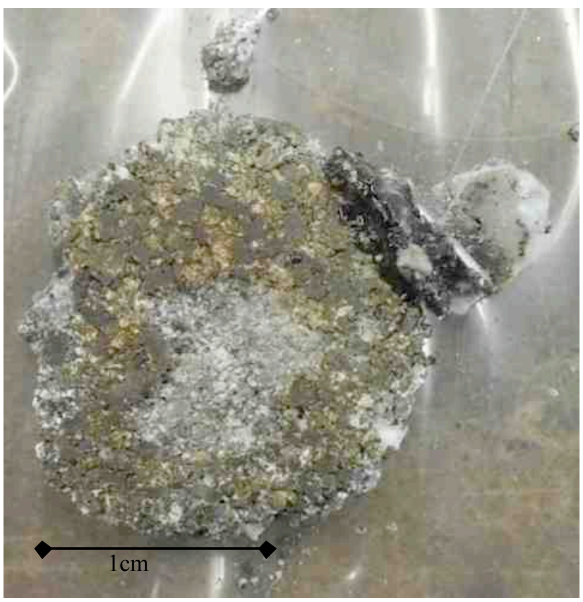

Figure 1. This shows the sample of California Clay fragments after 6 weeks in the hydraulic press. The top right corner shows the suspension apparatus that consists of fishing line tied to a piece of paperclip and superglued to the sample. The sample can be seen to crumble around the edge.