ANALYSIS OF FRAGMENTATION PATTERNS IN DISRUPTED METEORITES AND SINGLE MINERAL END-MEMBERS. M. D. Lipman[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 (lipman1md@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: Collisions are believed to be the dominant mechanism for dust production, surface erosion, and catastrophic disruption in main-belt asteroids. In order to understand the collisional evolution of asteroids and interplanetary dust and to accurately model the infrared signature of small particles in our own Solar System and in other planetary systems, it is critical to address the fundamental problem of dust production from primary impact disruption events over a wide range of fragment sizes. Of particular interest is the possibility that differences in the size-frequency distribution of dust produced by hydrous and by anhydrous asteroids might result in different populations of particles in the interplanetary dust size range (5 to 50 micrometers) and the micrometeorite size range (50 micrometers to millimeters) [1].

To determine the size-frequency distribution of the fragments produced by hypervelocity impacts on asteroids we have disrupted both anhydrous and hydrous asteroid targets at the NASA Ames Vertical Gun Range (AVGR) and determined the mass-frequency distribution of the resulting debris by: 1) weighing all fragments >0.01 grams collected from the floor of the AVGR chamber, and 2) measuring the diameters of puncture holes in passive Aluminum foil detectors placed around the target [2].

Experimental: In this work, meteorites and meteorite analogs are disrupted at the NASA Ames Vertical Gun Range (AVGR) in Moffett Field, California. A meteorite is suspended in the middle of a chamber in the AVGR. Four detectors are placed around the meteorite. The detectors are comprised of foil held in 35 mm slide mounts, utilizing three different thicknesses of foil. The meteorite is shot with a quarter inch aluminum projectile having a speed of ~5 km/s, simulating the collisions that occur in the main belt. The detector slides are then scanned under back-lit conditions to determine hole frequency and size. Production of dust from the targets is monitored by the foil penetrations and by the larger fragments, which are retrieved from the floor of the chamber and weighed [1]. The mass-frequency distribution of the debris can then be determined. The data are used to understand the way that the meteorite shattered.

To test the idea that silicate structures might disrupt differently, quartz and mica were disrupted at the AVGR as end-member samples. An 84.6 gram sample of quartz was disrupted to demonstrate the distributions produced by a three dimensional rock structure. A 54.0 gram sample of mica was disrupted to demonstrate the distributions produced by a two dimensional layered structure. Slopes of the mass frequency distribution diagrams were calculated at three ranges to compare the cumulative mass-frequency distributions of the disrupted particles with the goal of determining if layered and primary silicates fracture differently [3]. The distributions are divided into three individual regions: small, medium and large fragment sizes. The large section represents the larger micrometeorite size ranged particles. The medium section represents a combination of smaller micrometeorites and larger interplanetary dust particle size ranged particles. The small section represents the smaller interplanetary dust particle size ranged particles. The breaks between the regions are selected visually at significant changes in the slope of the distribution. Transition regions between small to medium sizes and medium to large sizes are not used in slope analysis. Microsoft Excel is then used to determine the slopes of the selected regions.

The end member samples then were compared to ordinary and carbonaceous chondrites to evaluate the makeup of the materials in the meteorites and to determine the nature of the pattern of particles produced. Two samples of NWA 869 (L4/6 ordinary chondrite), each approximately 30 g, and a 48 g sample of Allende (CV3 ordinary chondrite) were disrupted at the AVGR. All three sections of the slopes were calculated and compared to each of the end-member slopes to determine the nature of the fractional distributions.

As observed in Figure 1, the mass-frequency distribution of the two end-members are substantially different. The curve for the large particle region is significantly steeper for quartz than it is for mica. For the medium particle region, the slopes are similar, although quartz slope is closer to zero and mica is closer to 1. The slope for the small particle region is steeper for quartz than it is for mica. Overall the mica has much smoother curve shape than the quartz.

The slopes of the cumulative mass-frequency distributions of quartz, mica, Allende and the two NWA 869 samples are shown in Table 1. The distribution range has been divided into regions of small, medium and large particle sizes and the slopes measured on the mass-frequency diagram for each region. As observed in Figure 2, the mass-frequency of the two NWA 869 differ slightly and Allende differs from the other four. Although the curves for the two NWA 869 shots are not identical looking, the slopes show that the curves are comparable. This shows a reproducability in data collection. It is apparent that the values of the slopes in the meteorites fall somewhere between the values determined from the end-members. The large sized particles fall in the slope range of the quartz end-member. So they have a three dimensional rock structure. The small sized particles fall in the slope range of the mica end-member, so they have a two dimensional layered structure. This implies that the micrometeorite and larger sized particles produced in asteroid impacts are described by the three dimensional rock structure modeled by the quartz end-member. Conversely, interplanetary dust sized particles produced in asteroid impacts are are described by the two dimensional layered structure seen in mica end-members. Allende is different than the NWA 869 samples because it has a flatter medium particle region a flat tail so is no differentiation between the medium range and the small range.

This work has been extended by disrupting hydrous and more porous samples at the AVGR. Murchison (CM2) was disrupted to be compared to Allende as a hydrous-anhydrous comparison. Pumice, charcoal and coal terrestrial samples were disrupted to determine if the porosity of the sample affects the disruption pattern. Analysis of these samples have not yet been completed for comparison.

Acknowledgements: This work was supported by NASA Planetary Geology and Geophysics Program Project Number 1066089. Support was also provided by Alma College.

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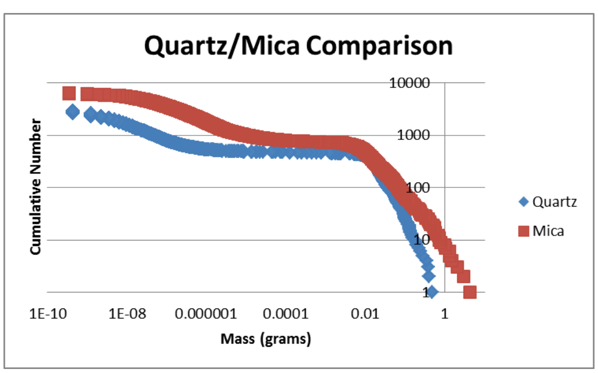

Figure 1. Cumulative mass-frequency distribution for samples of disrupted end-members quartz and mica.

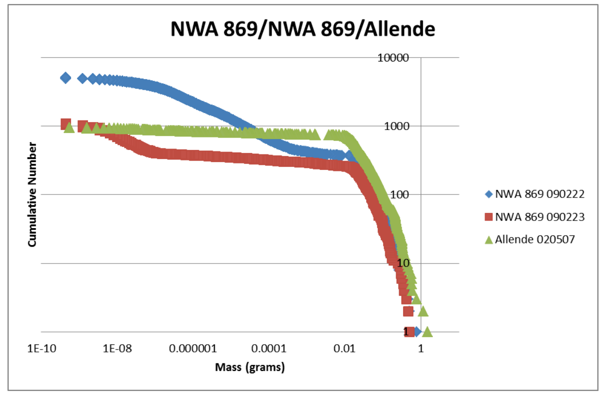

Figure 2. Cumulative mass-frequency distribution for samples of disrupted meteorites NWA 869 and Allende.

Table 1. Slopes of the five samples analyzed.

Sample	Region	Slope*
Quartz	Large	1.398
	Medium	0.018
	Small	0.221
Mica	Large	0.916
	Medium	0.075
	Small	0.1
NWA 869	Large	1.325
	Medium	0.078
	Small	0.054
NWA 869	Large	1.466
	Medium	0.039
	Small	0.108
Allende	Large	1.161
	Medium	0.017
	Small	0.017

*All slope values are negative.