MASS AND SIZE FREQUENCY DISTRIBUTION OF THE IMPACT DEBRIS FROM DISRUPTION OF CHONDRITIC METEORITES.

T. W. VanVeghten,[1] G. J. Flynn,[1] D. D. Durda,[2] S. Hart,[3] and E. Asphaug,[3] [1] State University of New York-Plattsburgh, 217 Hudson Hall, 101 Broad Street, Plattsburgh, NY 12901, (twvanve@umr.edu), [2] Southwest Research Institute, 1050 Walnut Street, Suite 400, Boulder, CO 80302, [3] Univ. of California-Santa Cruz, Santa Cruz CA 95064.

Introduction: Since direct observation of the collision of asteroids in space is not always convenient for earthbound observers, we have undertaken simulations of these collisions using the NASA Ames Vertical Gun Range (AVGR). To simulate the collision of asteroids in space, ¼" and ⅛" aluminum projectiles with velocities ranging from ~1 to ~6 km/sec were fired at 70g to ~200 g fragments of chondritic meteorites. The target meteorite was placed in an evacuated chamber at the AVGR. Detectors, usually four, were set up around the target meteorite. These detectors consisted of aerogel and aluminum foil of varying thickness. The aerogel's purpose was to catch debris after the collision, and the aluminum foil's purpose was to show the size of the debris particles through the size of the holes in the aluminum foil. Outside the chamber, a camera was set up to record high-speed film of the collision. This camera recorded at either 500 frames per second or 1000 frames per second.

Three different types of targets were used for these tests. The first were actual meteorites, which varied in mineralogical composition, density, and porosity. The second type of target was a Hawaiian basalt, consisting of olivine phenocrysts in a porous matrix, which we thought might be similar to the chondritic meteorites, thus providing data for comparison. The final type was made out of Styrofoam. The Styrofoam was thought to simulate very low-density asteroids and comets.

Methods: The details for the most recent meteorite shots are given in Table 1. The target for the low energy Mbale shot (020509) remained almost intact, with the largest fragment having a mass of ~152.5 gm. This fragment was used as the target for the intermediate energy Mbale shot (020510), and it may have experienced some fracturing from the previous shot. After each shot the debris was recovered from the floor of the AVGR chamber. The remains from each shot were sieved with standard geological sieves of sizes 4.00 mm, 2.00 mm, 1.00 mm, 0.500 mm, 0.250 mm, 0.125 mm, and 0.063 mm. The material collected on each sieve was massed with an electronic balance with a sensitivity of 0.001 g. Each particle from the 4.00 mm and 2.00 mm size sieves was also massed individually using this same balance. The use of the sieves allowed us to extend the size (or mass) frequency distribution down to much smaller sizes (or masses) than was possible by weighing individual fragments, as we had done in our previous work [1].

Table 1
Meteorite Shot Conditions

Meteorite (shot #)	K.E. of Impactor	Mass of Target	Mass of Largest Fragment
Mbale (020508)	724.6 J	182.5 g	31.23 g
Mbale (020509)	28.5 J	152.7 g	0.1 g
Mbale (020510)	366.8 J	~152.5 g	26.1 g
Allende (020507)	743.4 J	70.9 g	1.506 g
Saratov (020506)	424.5 J	105 g	11.572 g

Log-log plots of the mass collected on each sieve for shots 011007 (basalt) and 011016 (MOR 001) are shown in Figure 1 and 020506 (Saratov), 020507 (Allende), 020508 (Mbale), and 020510 (Mbale) are shown in Figure 2.

Each of the fragments on the two largest sieves was weighed. Log-log plots of the mass-frequency distribution from shots 020506 (Saratov), 020507 (Allende), 020508 (Mbale), and 020510 (Mbale) are shown in Figure 3.

We have also extended the sieve data sets from the individual particle masses. The material caught in a particular sieve is between the size of that sieve and the sieve above it. For example, in the 2mm sieve, we get particles from 2mm up to the next sieve, 4mm. Using that idea on the larger sieves, we assumed that all particles have a density of 3.0 g/cm^3, consistent with bulk densities. We then converted the individual masses to an equivalent diameter assuming that density and found the mass of particles for the next two larger sieves, 4mm and 8mm. The extended size distributions for shots 020506

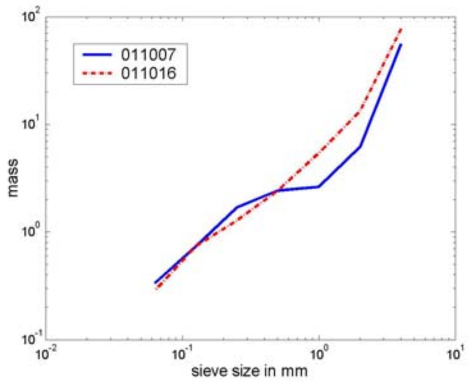

Figure 1: The log-log plot of the sieve size in mm vs. the mass of each sieve size from shot 011007 (basalt) and 011016 (MOR 001).

(Saratov), 020507 (Allende), 020508 (Mbale), and 020510 (Mbale) are shown in Figure 4.

Results: Each Hawaiian basalt shot showed a change in the slope of the mass-frequency distribution of the fragments at mass roughly comparable to that of the olivine phenocrysts [1]. This suggests there is poor adhesion between the phenocrysts and the matrix, allowing either intact phenocrysts or large phenocryst fragments to pop out during fragmentation. Our new study was intended to determine if chondritic meteorites behave in a similar fashion.

Allende shows a change of slope at a mass of 0.2 gm (Fig. 3) which may indicate preferential failure at chondrule-matrix boundaries.

Saratov is an extremely friable ordinary chondrite, which sheds chondrules when touched. We expected that Saratov might produce a mass-frequency distribution sharply peaked at the mass of individual chondrules. However, the mass-frequency distribution follows a single power law of the whole range of measurement from 0.003 g to 11.572 g.

Mbale mass-frequency distributions follow a single power law of almost the entire mass range (Fig. 3), possibly indicating that chondrules are well adhered to the matrix in this meteorite.

References: [1] Durda, D. D. and G. J. Flynn 1999. Experimental study of the impact disruption of a porous, inhomogeneous target. *Icarus* **142**, 46-55.

Acknowledgements: This work was supported by a NASA PG&G Grant (G.J.F. & D.D.D.) and by PGGURP summer support (T.W.V.). We also thank Don Bowling, Don Holt, and Rick Smythe at the NASA AVGR for their valuable assistance in conducting these experiments, and Tom Reddy for high-speed video and photographic documentation.

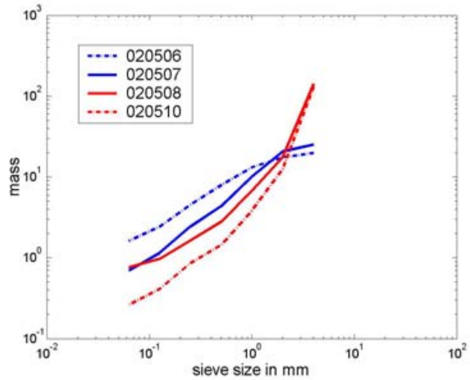

Figure 2: Log-log plot of the sieve size in mm vs. the mass of each sieve size from meteorites 020506 (Saratov), 020507 (Allende), 020508 (Mbale), and 020510 (Mbale).

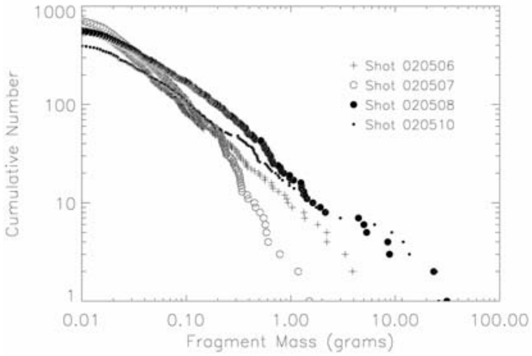

Figure 3: Log-log plot of the mass distribution of meteorites 020506 Saratov, 020507 Allende, 020508 Mbale, and 020510 Mbale.

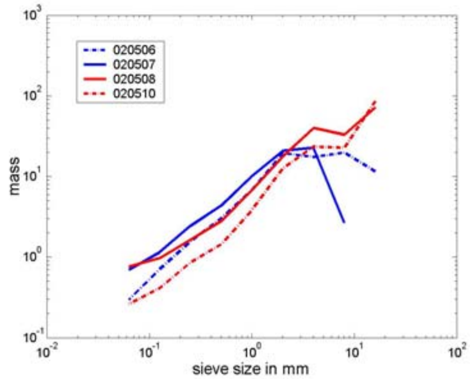

Figure 4: The extended log-log plot of the sieve size in mm vs. the mass of each sieve size from meteorites 020506 (Saratov), 020507 (Allende), 020508 (Mbale), and 020510 (Mbale).