MEASUREMENT OF DENSITY AND COMPRESSION STRENGTH IN METEORITES

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Introduction: This lab has conducted impact disruption studies of extraterrestrial materials at the NASA Ames Vertical Gun Range (AVGR) for many years [1], yet little is known about the physical characteristics of the meteorites used in this work. It is important to determine physical characteristics of meteorites in order to better understand how they disrupt.

Physical characteristics currently being studied include speed of sound, density, and compression strength. Work has been previously done in this lab on the compression strength of pumice [2]. Some of those techniques have been applied here to look at compression strength in meteorites.

Experiment: A piece of Columbia River basalt was obtained from Horsetail Falls, Oregon to develop the method. NWA 869 was measured as representative of ordinary chondrites. The basalt samples were cut into cubes averaging a mass of 10.33 g and volume of 3.78 mL. The classic Archimedean method was used to find the volume of samples. Density was then determined based on the standard density equation: $d = m/V$. Following the design by Patmore, et al. [2], physical weights were loaded onto the samples. This was unsuccessful in crushing any samples due to inadequate amount of pressure. Instead, a hydraulic pump was used. Pressure was recorded using a pressure gauge attached to the pump. Using the cross-sectional area of the sample and the pressure used to crush the sample, the compression strength can be calculated from $S = F/A$, where F = pressured applied, A is the cross-section area of the sample, and S is the compression strength in N/m^2.

Results: Our density measurements for the basalt samples averaged 2.75 g/cm^3 with a standard deviation of 0.03. This is within 4% of the literature density of basalt at about 2.65 g/cm^3 [3]. Compression strength testing resulted in an average value of 154.3 MPa with a standard deviation of 33.3. The literature value for the compression strength of generic basalt is 266 ± 98 MPa [4], showing we are in the right range. For many samples, cracking noises were recorded as the ends flattened when pressure was added, even after polishing of the ends. Several measurements also failed due to problems such as twisting in the press, and imperfections such as cracks and pores within the rock itself. Preliminary results for the NWA 869 meteorite samples include an average density of 3.51 g/cm^3 with a standard deviation of 0.0021. Compression strength testing resulted in average compression strength of 98.42 MPa with a standard deviation of 13.35.

Conclusion and Future Plans: We will continue formulating ways to more accurately test the force required for determining the compression strength of basalt. When established, we will verify the accuracy of the experiment. Once speed of sound testing has been verified and tested, experiments will measure density, speed of sound, and compression strength on the same meteorite samples.

References: [1] Durda, D.D. and Flynn, G.F. (1999) *Icarus*, **142**, 46-55. [2] Patmore E. B., et al. (2014) *LPSC*, **45,** 2429. [3] Stetler, L. (2014) Basic Rock Mechanics, *Webpages.sdsmt.edu /~elstetler/merlot/rock_mechanics.htm* [4] Schultz, R. A. (1995) *Rock Mech. Rock Engng.,* **28 (1),** 1-15