COMPRESSION STRENGTH OF PUMICE. E. B. Patmore[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 (patmore1eb@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: Asteroid impacts produce small particles that contribute to interplanetary dust particles, micrometeorites and meteors, all of which have the potential to reach the earth. Impact experiments have been conducted for several years at the NASA Ames Vertical Gun Range (AVGR) involving terrestrial and extraterrestrial samples [1]. Many asteroids are believed to be highly porous because their densities are considerably lower than the minerals out of which they are formed [2]. Pumice is a very porous material, so it is being used as a sample material to investigate the disruption of such materials. To better understand the characteristics of the rock, the density of the pumice needed to be determined. During cratering experiments at Ames, a low mass of ejecta was noted when pumice samples were impacted. It was also noticed that it takes more energy to disrupt porous targets than to disrupt non-porous targets; this implies that much of the energy goes into compaction of the target [3]. The compression strength of the pumice samples needs to be measured to help make sense of the transfer of energy that happens when the samples are cratered instead of disrupted.

Methods: A sample of pumice was acquired to find density and compression strength. Density was determined based on the standard density equation: $\rho = \frac{m}{V}$. The sample was cut into rectangular pieces averaging a mass of about 1 gram and a volume of about 2 cm^3; the same samples were subsequently used to find the compression strength. Ten samples were prepared and measured.

The Brazilian Disc Test is typically used to find the compression strength of various materials. A force is applied to a thin, circular disc until failure; the strength is then found using an equation involving the ratio between the force applied and the diameter and thickness of the disc [4]. Using the rock saw in our lab to cut the samples, a smooth, thin disc was too difficult to replicate consistently for accurate results. Instead, the samples were cut into rectangular pieces. Several attempts were made to find the strength of these rectangular pieces. First a c-clamp and a force sensor were connected to the sample. When the c-clamp was turned it applied a force to the sample being compressed. The results from this method had an error of ~90% when compared to the published value [5]. Next, the sample was set on a table and free weights were stacked on the sample until it crushed. During most measurements using this method, the weights became unbalanced and fell before the sample reached the fracture point. Finally, the sample was set between two smooth, flat metal surfaces and a 10-liter container was placed on top of the metal plates. Water was slowly added to the container until the fracture point was reached and the sample crushed. The container and it's water was weighed and used to find the force using $F = m \cdot a$. Using the contact area of the sample and the force calculated from the mass of the container, the compression strength could be calculated using the following equation: $\sigma = \frac{F}{A}$.

Results and Discussion: The first method was not successful because when the c-clamp was turned, the screw took away some of the force being applied so the sensor could not get an accurate reading. The second method ultimately failed because the weights were not balanced, which would cause the sample to crush before the failure point, giving inaccurate results. Compared to the published value of the compression strength of pumice [5], the third method was the most successful. When the error was high, it was because the sample needed an extra container that introduced more error.

Ten samples were measured using the final method. The overall density was 0.538 ± 0.059 g/cm^3. This compared with other measures of the density done on the same rock using image processing [6].

Samples 1, 5 and 8 shifted during the measurement of compression strength, making the point at which they crushed unclear, resulting in higher error. After removing these samples from the calculation, the average compression strength was 854 ± 195 kPa.

To better understand the energy transfer in the disruptions, a value for compression strength specific to our samples needed to be found. More measurements of the pumice samples will be made to improve the precision of our value and in the future this method will be used to find the compression strength of different materials.

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Table 1: Density and compression strength of pumice for the ten samples measured. Compression strength for samples 1, 5 and 8 were not used in further calculations. The percent error was calculated in comparison to the literature value of 1000 ± 250 kPa [5].

Sample #	Density (g/cm^3)	Compression Strength (kPa)	% Error
1	0.605	360	63.9
2	0.585	959	4.19
3	0.495	1190	19.1
4	0.453	642	35.7
5	0.473	562	43.6
6	0.566	742	25.6
7	0.561	911	8.7
8	0.618	692	30.7
9	0.551	649	35.1
10	0.477	882	12.8