LABORATORY MEASUREMENTS OF METEORITE PHYSICAL PROPERTIES.

D. R. Ostrowski[1,2] and K. L. Bryson[1,2], [1]NASA Ames Research Center (ARC), Moffett Field, CA, USA. E-mail: daniel.r.ostrowski@nasa.gov [2]BAER Institute, Ames Research Center, Moffett Field, CA, USA

Introduction: Physical properties provide information to understand the behavior of meteors during atmospheric entry. These measurements help determine methods to deflect potentially hazardous objects [1] and are essential to determine the characteristics of parent bodies [2]. The Asteroid Threat Assessment Project (ATAP) has been set up to investigate the full risk and outcomes that near Earth asteroids pose to the planet. One tasks of the program is to study the physical properties of asteroids and meteors, one way to do this is by studying the properties of meteorites.

Experimental: The physical properties of density, porosity, acoustic velocities, and thermal emissivity are studied. Bulk density is determined from 3D laser scanning, while grain density is determined from gas pycnometery. Porosity is calculated from these densities. Acoustic velocities are measured using an Olympus 45-MG, allowing for the calculation of Young's and Shear moduli. Emissivity is measured from 20°C up to entry temperatures.

Physical Properties Data: Average bulk density of ordinary chondrites ranges from 3.20-3.53±0.07 g/cm^3, which is within published class values (Fig 1) [3]. Porosity of Tamdakht and Chelyabinsk are close to class averages, while Tenham has a very low porosity of 4.9±0.1%. Weathering of the Antarctic finds causes porosity to be 1.5-2 times larger than falls. NWA 7874 (eucrite) and NWA 2060 (howardite) they have well above class average porosities at 27.45±0.10% and 35.54±0.05% respectfully.

The average acoustic velocities of most ordinary chondrite falls and finds are slower than 4,000 m/s, which puts them at or below the class averages [4]. The exception to this is Tenham and Chelyabinsk impact melt with longitudinal velocities of 6330.19±15.86 m/s and 6265.67±20.35 m/s and shear velocities of 4169.92±5.80 m/s and 3157.73±8.69 m/s. These result in much higher Young's and Shear moduli, but an average Poisson's ratio (Fig 2). Average longitudinal and shear velocities for meteorites NWA 2060 (3282.44±4.54 m/s and 2619.76±2.58 m/s) and NWA 7874 (3766.23±10.36 m/s and 2638.55±4.20 m/s) are some of the first measured for a howardite and a eucrite.

Average emissivity of ordinary chondrite falls and Antarctic's at 20°C is 0.988±0.008, in agreement with most ordinary chondrites [5]. As temperature increases to 100°C the emissivity decreases then rebounds slightly and stabilizes for the next 100°. Roughly 0.05 decrease is seen when meteorites are heated to 300°C and above. Heated meteorites range in emissivity, 0.85-0.95, with no noticeable difference between falls and Antarctic meteorites.

Conclusion: Ordinary chondrite falls align with class ranges for density, porosity, and (20°C) emissivity. Tenham's low-end porosity and high Young's and Shear moduli mean that it is very rigid and thus interpreted to probably be strong. Chelyabinsk is a mixed case on acoustic velocity with moduli of the light color material near class averages where as the impact melt has much higher moduli giving the interpretation that it is much stronger. When comparing Chelyabinsk to its impact melt, the impact melt resembles more of an average LL chondrite physical property wise. NWA 7874 and NWA 2060, being weathered finds, show much higher than class average porosity. NWA 7874 and NWA 2060 acoustic velocities, being some of the first ever measured, are similar to that of Antarctic meteorites. NEO properties along with physical properties of meteorites in this study and collected from other authors are available at https://neoproperties.arc.nasa.gov.

References: [1] Sears D.W.G. et al. (2016) PSS, *124,* 105–117. [2] Bruck Syal M. et al. (2016) Icarus, 269, 50-61. [3] Britt D. and Consolmagno G. (2003) M&PS, 38, 1161-1180. [4] Yomogida K. and Matsui T. (1983) JGR, 88, 9513-9533. [5] Baldridge A. M. et al. (2009) Remote Sensing of Environment, 113, 711-715.

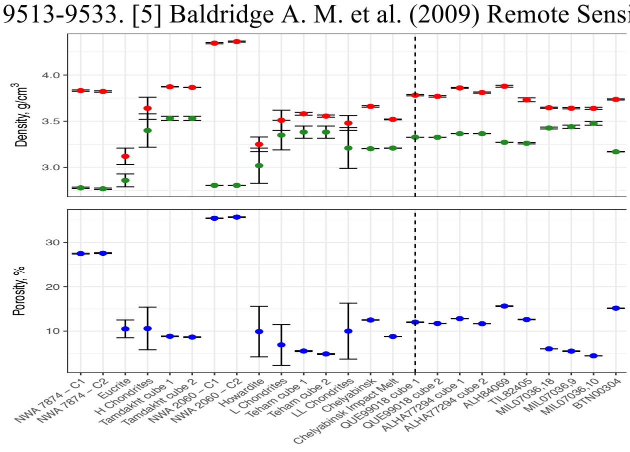

Figure 1. *Bulk (green) and grain (red) density and porosity (blue) comparison to meteorite class averages.*

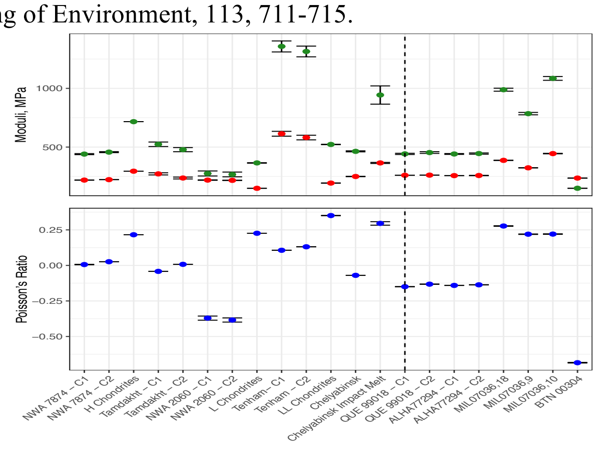

Figure 2. *Young's moduli (green), Shear moduli (red), and Poisson's ratio (blue) comparison to class averages.*