ELASTIC WAVE VELOCITY VARIATION ACROSS METEORITES.

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 strength of the meteoroid is a critical imput for how the meteoroid will fragment durning atmospheric entry [3]. Elastic moduli can be used as a non-destructive method to aproximate the mechanical strength of meteorites. It has been shown for Allende and Tamdakht that the elastic modulus from sound velocity is similar, but usually slightly lower, to elastic modulus derived from compression test [4]. The moduli are derived from the elactic wave velocities and density. 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.

Experimental: The physical properties of density, porosity, and acoustic velocities, both longitudinal and shear are measured. 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, with the addition of density the Young's and Shear moduli can be calulated.

Physical Properties Data: Bulk density of most meteorites range from 2.90 to 4.25 g/cm^3 [5,6], while most longitudinal velocities range between 1500 to 6500 m/s [7,8,9]. No difinative correlation between bulk density and longitudinal velocity is observed (fig.1). The data does indicate that meteorites can not have longitudinal velocities above 4100 m/s if the bulk density is below 3.20 g/cm^3. This is not dependent on the metal content in the meteorite. In terms of porosity, as it decreases longitudinal velocity increases. Due to compositional makeup and structure of pore space, many meteorites have porosities below 10% and measured slow velocities below 3000 m/s. Similar to bulk density, at longitudinal velocities above 4100 m/s, the majority of meteorites having porosities below 9%. The one exception is the CV Bali with a longitudinal velocity of 4203 m/s and 10% porosity [7,5]. In terms of the shear velocity these same trends exist. For bulk density, no meteorite with a density below 3.10 g/cm^3 has a measured shear velocity higher than 2700 m/s. Meteorites with shear velocities above 2800 m/s have porosities below 9%.

The relationship of meteorite groups to longitudinal velocity is seen in figure 2. Measured longitudinal velocities range from 1,000 to 6,900 m/s with most meteorites across all groups, except irons, below 4500 m/s. The bulk of meteorites measured are ordinary chondrites and they cover the full range, at 1113 m/s for Bjurböle and goes up to 6910 m/s for MIL 07036. For the ordinary chondrites it transitions from the L and LL chondrites at lower velocities to mostly H and some L chondrites at higher velocities. This implies that small changes in the metal content in stony meteorites has a large affect on elastic wave velocity, disregarding the effect of porosity.

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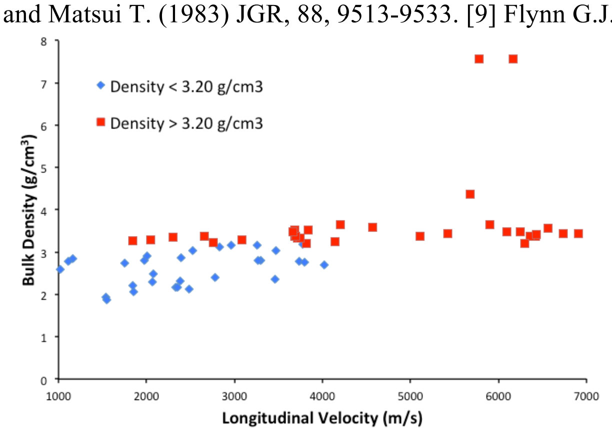

Figure 1. *Relationship between longitudinal velocity and bulk density. Density must be above 3.20g.cm^3 for velocities faster than 4100 m/s.*

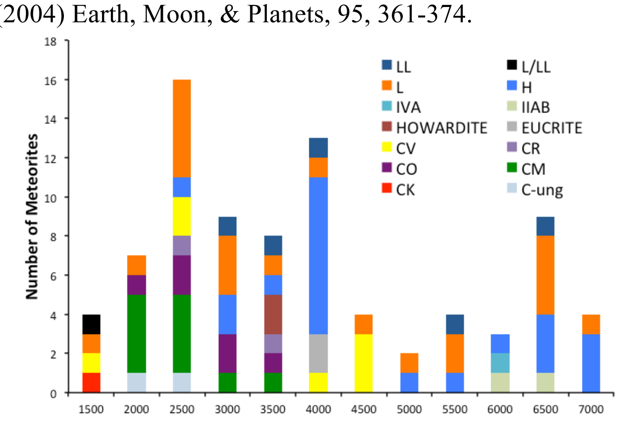

Figure 2. *Number of meteorites for each group with longitudinal velocities between 1000-7000 m/s.*