METEORITE FRACTURES AND SCALING FOR ASTEROID STRENGTHS.

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Introduction: We are attempting to understand the behavior of asteroids entering the atmosphere in order to help quantify their impact hazard. The strength of meteorites plays a critical role in determining the outcome of their impact events [1]. Our objective is to scale fracture parameters in meteorites to their parent body.

Experimental: Meteorites in the Natural History Museums of Vienna and London were examined. In Vienna we looked at samples from all classes, while in London we looked at all of their H and L chondrites. The fracture patterns in selected fragments were imaged. The density and length of the observed fractures were measured in hand specimens and thin sections.

Results: We identified six kinds of fracturing behavior. (1) Chondrites usually displayed random fractures with no particular sensitivity to meteorite texture. Approximately 80% of these indicated no point of origin. (2) About 10% of the chondrites have a distinct network of fractures making an orthogonal or triple intersection structure. (3) Fine irons with large crystal boundaries fragmented along these boundaries. (4) Coarse irons fractured along kamacite grain boundaries, while (5) other fine irons fragmented randomly. (6) CM chondrites showed that water-rich meteorites fracture around clasts.

Discussion: We assume that fracturing follows the Weibull distribution [3], where fractures are assumed to be randomly distributed through the body and the likelihood of encountering a fracture increases with distance. The images collected provide a two-dimensional view of the fractures. A relationship exists between the distributions of measured trace length and actual fracture size [4], where the slope of a log-log plot of trace length vs fracture density is proportional to α, the shape parameter. α can be used to scale strengths, but the value is unclear [5] and a large range has been determined from light curve data [1]. As an example, figure 1 plots the fracture lengths and densities measured of both the slab and thin section of Bluff (a). A power law is fit to the data, and an α of 0.186 ± 0.013 was determined, compared to the commonly used 0.166.

Conclusions: Based on the meteorites examined in our study, six fracture patterns have been observed. The majority of the meteorites displayed no particular sensitivity to meteorite texture. Figure 2 displays gausian distributions of our weibull values in comparison to those used by other studies. Basalt is shown to be too low to be an anologue and the commonly used 0.166 is too low for the examined L Chondrites in this study. For the more basaltic Howardite, α was lower heading towards a basaltic value. This study's values of α also overlaps with Popova's fireball and Cotto-Figueroa's strength determined values. Values of α will be used in models created by the Asteroid Threat Assessment Project (ATAP) to try to determine the behavior of asteroids entering the atmosphere and quantify their impact hazard.

References: [1] Popova O. et al. (2011) *MAPS.* 46, 1525. [2] Sears D.W.G. et al. (2016) *Proceedings of the AIAA SciTech,* AIAA-2016-0997. [3] Weibull W. (1939) *Proceedings of the Royal Swedish Institute for Engineering Research*. No. 153. [4] Piggot A.R. (1997) *JGR,* 102, 18,121. [5] Asphaug E. et al. (2002) *Asteroids III.* 463. [6] Cotto-Figueroa D. et al (2016) *Icarus*, 277, 73. [7] Nakamura A.M. et al (2007) *JGR,* 112, E02001.

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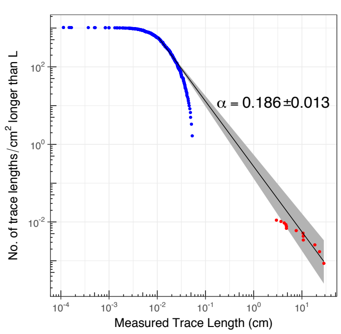

Figure 1. *Distribution of flaw trace length for Bluff (a). The black line is based on the relationship between trace density and length, with a slope providing α. The grey shaded area displays the error on α.*

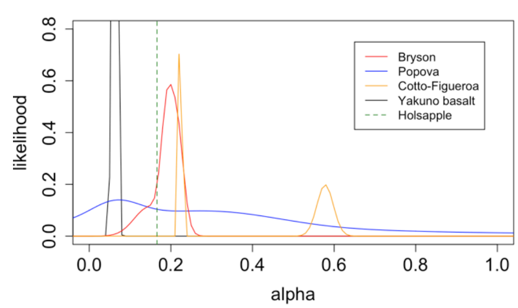

Figure 2. *Gausian distributions of weibull values for values presented in this abstract (red), Popova's fireball data (blue)[1], Cotto-Figueroa's strength data (orange)[6], Yakuno basalt (black) [7], and Holsapple's standard asteroid value (green dashed) [5].*