FRACTURE CHARACTERIZATION OF METEORITES.

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Introduction: NASA Ames Research Center has been tasked with understanding the behavior of ~100 m asteroids entering the atmosphere and with quantifying the impact hazard. Objects in this size range are difficult to detect astronomically, and therefore difficult to deflect, but large enough to destroy a major city. Among the uncertainties required for this task are the composition and physical properties of the incoming objects [1] and their fracture mechanics [2,4]. Here we report the preliminary results of a survey of the fracture properties of meteorites.

Methods: Meteorites in the Natural History Museums of Vienna and London were examined using different strategies at each. In Vienna we looked at a few samples from all classes while in London we looked at all of their H and L chondrites. The fracture patterns in selected individuals were imaged.

Results (Vienna collection): Of ~1000 meteorites examined, only 33 showed fractures of some kind with different classes displaying different modes of fracture: (1) Chondrites usually showed random fractures with no particular sensitivity to meteorite texture. (2) Coarse irons fractured along kamacite grain boundaries, while (3) fine irons fragmented randomly, c.f. chondrites, but a torn fracture face on Braunau showed kamacite stepwise failure. (4) Fine irons with large crystal boundaries (e.g. Arispe) fragmented along the crystal boundaries. Finally, (5) previous work on Sutter's Mill [3] showed that water-rich meteorites fracture around clasts.

Results (London collection): Of the 1048 H and L chondrites in the London collection, 87 showed fractures and 33 were imaged. A large slab of Rio Limay had several long and thick veins, some filled with black glass and some contain 2-3 mm metal blebs. The fractures are straight lines that intercept at about 60^o. Numerous fine fractures appeared random. Two large Ochansk fragments were heavily fractured and highly friable with fractures running parallel to frontal fusion curst producing blocky pieces. To generalize the others: (1) Most fractures are in the form of thin veins lines with no obvious orientation (a piece of Girgenti spalled along the plane of a vein), (2) sometimes veins radiate from a point of weakness, (3) occasionally veins have chicken-wire or brick-wall networks.

Discussion: This preliminary glimpse at the data indicates that the fracture mechanism varies greatly with class. Furthermore, even within a class fracture mechanisms and level of fracturing can vary considerably from meteorite to meteorite. Representative cases from this survey will later be selected to further analyze and perform detailed structural and thermal-structural analyses to determine the state of stress during entry.

References: [1] Ostrowski et al., this volume. [2] Baldwin B. and Sheaffer Y., 1971. *Jour. Geophys. Res.* 76:4653-4668. [3] Popova O. et al. 2011. *Meteorit. Planet. Sci.* 46:1525–1550. [4] Beauford R. and Sears D.W.G. 2014. *Unpub. manuscript.*

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