EARLY MICROSTRUCTURES OF ASTEROIDAL BUILDING BLOCKS FROM 3D PETROGRAPHY: A COMPACTION AND POROSITY PERSPECTIVE. Jon M. Friedrich[1,2], Alex Ruzicka[3], Denton S. Ebel[2], James O. Thostenson[4], Rebecca A. Rudolph[4], Mark L. Rivers[5], [1]Department of Chemistry, Fordham University, Bronx, NY 10458, [2]Department of Earth and Planetary Sciences, American Museum of Natural History, New York, NY 10024 (email: friedrich@fordham.edu), [3]Cascadia Meteorite Laboratory, Department of Geology, Portland State University, 1721 SW Broadway, Portland, OR, 97207, [4]Microscopy and Imaging Facility, American Museum of Natural History, New York, NY 10024, [5]Consortium for Advanced Radiation Sources, University of Chicago, Argonne, IL 60439.

Introduction: Ordinary chondrites (OC) originate in the inner asteroid belt [1] and comprise about 85% of all known meteorites [2]. The study of the physical properties of OC is essential for establishing the interior structure of and effect of impacts on their parent asteroids [3]. Most of the OC material that reaches the Earth has been processed by impacts to some extent [4]. Identifying and examining the least shock-processed materials reaching the Earth gives insight into the primordial nature of OC parent bodies. With our techniques, we are able to establish the degree of compaction that OC have experienced and visualize changes in structure and porosity that evolve with increasing compaction. One goal is to identify the most structurally primitive OC.

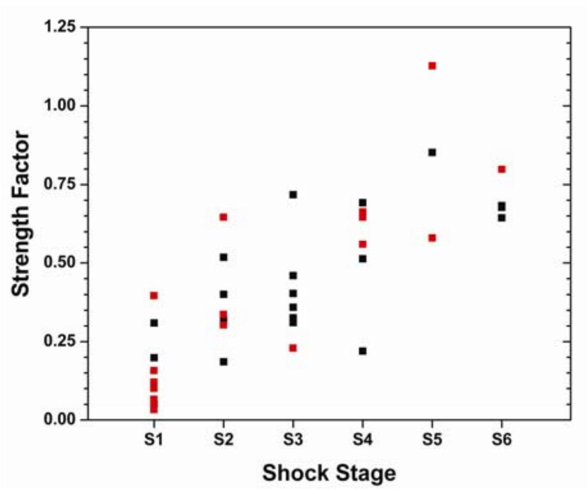

Figure 1. Degree of compaction (given as strength factor), determined by collective orientation of metal grains in chondritic samples [5], versus shock stage. Data in black [5] incorporates only L chondrites; new data (red symbols) incorporates H and LL chondrites, demonstrating the compaction identification scheme holds for other groups of OC. The least compacted samples are readily identified and structures of porosity can be examined.

Methods: We use x-ray microtomography (µCT) combined with qualitative visualization and quantitative 3D techniques [see 5-9]. Resolution for µCT imaging ranges from single micron (e.g. Fig. 2) to tens of µm. With such resolution, we are able to visualize the majority of porosity in our samples. OC material representing wide ranges of petrographic types and degrees of shock loading have been investigated.

Current Status: We have previously discussed the porosity in nine variably compacted, equilibrated OC [6-8] (e.g. Fig. 2). Recently, we have identified several other OC with very mild degrees of compaction (Fig. 1). We have also found evidence for early, pre thermal metamorphic impacts [9]. Our work is moving toward identifying OC materials that are optimal examples of the primordial physical structure of their respective asteroidal parent bodies.

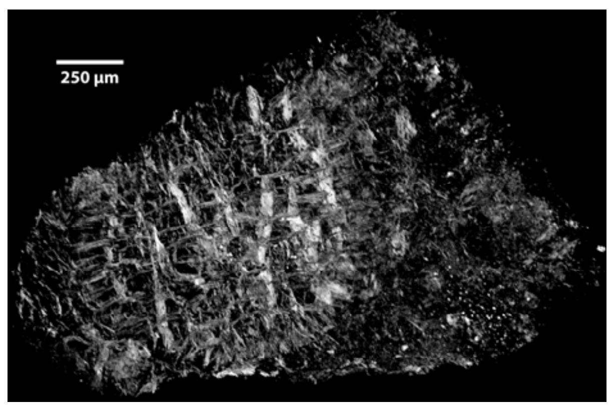

Figure 2. Frame from a 3D visualization showing microporosity in a 9.2 mm^3 chip of the strongly shocked Kyushu (L6, S5) chondrite. For 3D video, see [8]. Structurally primitive OC material is free of such sheet-like microcracks and possesses porosity in intergranular voids rather than the fractures seen here.

References: [1] Bottke W. F. et al. (eds.) (2002) *Asteroids III*, Univ. Arizona. [2] Grady M. M. (2000) *Catalogue of Meteorites*, Oxford. [3] Consolmagno G. J. et al. (2008) *Chemie der Erde, 68,* 1-29. [4] Stöffler D. et al. (1991) *Geochim. Cosmochim Acta, 55*, 3845-3867. [5] Friedrich et al. (2008) *Earth Planet. Sci. Lett. 275*, 172-180. [6] Friedrich J. M. et al. (2008) *Planet. Space Sci., 56,* 895-900. [7] Sasso M. R. et al. (2009) *Meteoritics & Planet. Sci., 44,* 1743-1753. [8] Friedrich J. M. and Rivers M. L. *GCA* (in press, doi: 10.1016/j.gca.2011.08.045). [9] Friedrich et al. (2012) *LPS 43*, Abstract #1197.