VISUALIZATION OF POROSITY. M. M. Strait[1], M. D. Lipman[1] and P. J. McCausland[2] ; [1]Department of Chemistry, Alma College, Alma, MI 48801 (straitm@alma.edu) [2]University of Western Ontario, London, Ontario, Canada

Introduction: Porosity is an important parameter in a variety of areas of planetary science. Porosity is currently being measured in three ways: image analysis of thin sections [1], helium pycnometry of whole rock samples [2], and X-ray tomography of prepared whole rock samples [3].

Earlier work in this lab has shown a good correlation between measurements of ordinary chondrites using image analysis and pycnometry. When measurements moved beyond this core group, discrepancies appeared between the two sets of measurements, some of them large. It has become apparent that the problem may be the nature and scale of the porosity [4]. Pycnometry measurements may look at whole rock samples but have the disadvantage of not being able to see the nature of the porosity measured. Thin section measurements do see the nature of the porosity, but are limited by the two-dimensional nature of the sample and the small size of the sample. X-ray tomography provides three-dimensional views of the porosity, but is limited in the resolution and the equipment is expensive and of limited availability. We have been exploring other methods to visualize the porosity in geological materials.

We have had the opportunity to use a Micro-CT to acquire images of smaller whole rock samples. We report here the preliminary results of our examination of a suite of materials that have been measured using both pycnometry and imaging.

Experimental: Whole rock samples imaged using a GE eXplore specCZT scanner with an x-ray voltage of 110 kV and a current of 32 mA. The images were acquired and reconstructed at an isotropic voxel size of 0.05 mm and 0.100 mm depending upon the size of the sample. Sample sizes ranged 20 x 20 x 5 mm to 80 x 60 x 40 mm. Larger samples were reconstructed only at the larger voxel size due to file size constraints. Calibration was done with air, water and aluminum. The resulting data sets were viewed using GE MicroView.

The samples analyzed were grouped to make an initial evaluation of three questions: How does the porosity appear in the Micro CT whole-rock analysis in comparison to the BSE-SEM thin section analysis? What effect do hydration and impact have on the appearance of the porosity? Can you see the effect of impact in the structure of highly porous materials? To answer these questions a suite of terrestrial samples that have been measured previously were scanned, as well as a suite of materials that were available from work being done looking at impact disruption of meteorites.

Results and Discussion: A preliminary look at the data generated can begin to answer the questions we posed. This type of imaging can clearly answer the questions about discrepancies in porosity. While porosity measurements have not yet been done on the Micro-CT images, two things are observed: resolution is clearly a problem with the x-ray techniques and porosity is highly variable in some samples, as expected. Of the five terrestrial samples evaluated, four of them had a porosity less than 5% and the size of the porosity is apparently at the voxel resolution of these images as there are hints of pores, but no clear images of pores. The fifth sample had a huge discrepancy in the measured porosity via the two methods employed (3.3% in thin section and 14.3% with pycnometry). The reason for this is clearly evident in the x-ray imagery (Figure 1). The porosity is highly variable across the volume of the rock and the thin section happened to sample as less porous area.

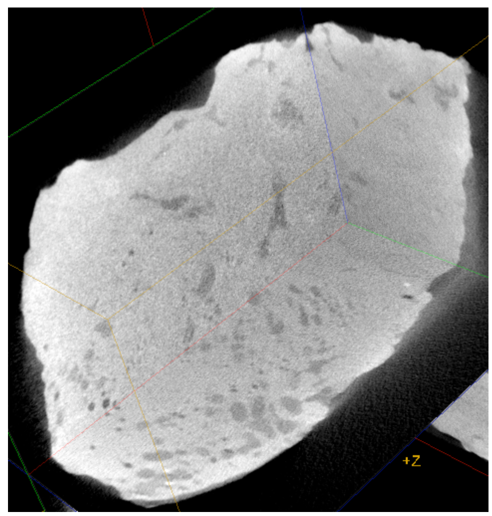

Figure 1. MicroCT image of an interior portion of the basalt breccia. Notice the inhomogeneity of the distribution of the porosity. (The sample size is 50 x 35 x 30 mm.)

NWA 869 has been used in a variety of ways because of the availability of the meteorite. We have been using it to study impact disruption and more recently attempting to hydrate the sample to create artificial carbonaceous chondrites to further studies of impact disruption. We imaged an unaltered sample of NWA 869, a sample that had been disrupted [5] and a sample that had been hydrated [6]. There does not appear to be a significant difference between the three samples, although the hydrated sample does appear to have brighter rings around chondrules and some of the chondrule texture seems to have degraded in the shot sample.

Finally, we looked at the appearances of the porosity in a series of highly porous materials that are being impact disrupted. There was no evidence of the impact, even in a pumice sample that survived that shot [7], but the nature of the three-dimensional layering in these samples is very evident (Figure 2).

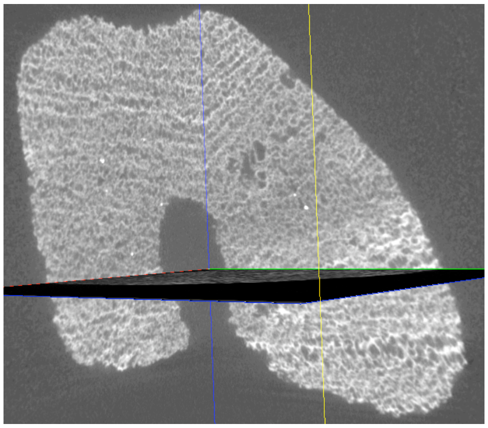

Figure 2. MicroCT image of an interior portion of a sample of pumice that was impacted twice at the Ames Vertical Gun. The impact crater is apparent, as is the layering in the pumice. (The sample size is 80 x 65 x 40 mm.)

Conclusions: Work is in progress to develop a procedure to calibrate the images to measure porosity where possible. However, the nature of the view of porosity makes continuing to do this type of work very valuable. Although the porosity measurements may not be very successful because of resolution limitations, this type of imaging can answer questions about the nature and distribution of porosity in extraterrestrial samples. Coupled with thin section work at higher resolution and pycnometry work for throughput, the three methods together provide a powerful tool to explore porosity.

References: [1] Strait, M. M. and Consolmagno, G. J. (2002) *Meteoritics & Planet. Sci.*, 37, A137. [2] Britt, D. T. and Consolmagno, G. J. (2003) *Meteoritics & Planet. Sci.*, 38, 1161-1180. [3] Friedrich, J.M.et al. (2008) *Planet. and Space Sci.*, 56, 895-900. [4] Strait, M. M. and Consolmagno, G. J. (2010) *LPS*, XXI, Abstract #2258. [5] Flynn, G. J. and D. D. Durda (2005) *LPS* XXXVI, Abstract # 1152. [6] Minnick, M. A., et al. (2009) *LPS* XX, Abstract #1078. [7] Flynn, G. J. et al. (2010) *LPS* XXI, Abstract #2224.

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