

X-RAY IMAGING APPLIED TO PROBLEMS IN PLANETARY MATERIALS. A. J. G. Jurewicz^{1,2}, D. T. Mih¹, S. M. Jones¹ and H. Connolly²; ¹Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109-8099; ²Department of Geology and Planetary Sciences, Caltech, Pasadena, CA 91125).

Introduction: Research in planetary materials may benefit from progress in X-ray imaging technology developed for the commercial sector. Developments include real time, digital imaging, the need for high contrast among similar tissues for medical imaging, and high-resolution requirement for the non-destructive evaluation (NDE) of hardware and semiconductor devices. The following results are from the demonstration of a high-performance microfocus x-ray imaging system coupled with an amorphous silicon detector array (dPix[®]), one of several brands under consideration for acquisition by the Quality Assurance section at JPL. We expect to have a basic, digital x-ray imaging system at JPL by early in 2000.

Background: The technique demonstrated is essentially a high-tech version of the radiography we frequently encounter at our dentist or doctors office. The major difference is the image is captured directly in a digital format in real time, and there is no need to process films. This direct radiography technology provides up to a full field, 14" x 17" imaging area by using a matrix of thin-film transistor (TFT) array to capture and convert x-ray energy directly into digital signals. This technology is similar to that used in active-matrix LCD displays (cf., www.dpix.com, www.agfa.com, and others). The result is a digital image that can be immediately viewed on a video monitor, and can be forwarded via a network for data storage or for transmission to other locations.

Examples: Images of three sets of relevant materials are shown here to demonstrate the flexibility of the technique. We note that these images were taken during a short demonstration of the basic imaging system, without special collimation of the X-ray beam or tomography. We also note that the original images are photographic quality and require large files; accordingly, these images have necessarily been somewhat degraded from the original in order to fit into abstract format.

Fig. 1 is a x-ray image of a prototype for a Genesis sapphire "collector" hexagon. The uniformity suggests no apparent cracks, voids, or other flaws are present, and the close-up of the beveled edge shows the consistency of manufactured sapphire wafer. Note that this is a standard NDE use for radiography.

Fig. 2 is an image of a CAI-composition crystal/quench-melt charge (~3mm diameter) still inside a graphite capsule. A close-up of the charge gives the distribution of spinel grains in the melt, and also of

secondary metal grains. Images like this could easily aid sectioning of similar charges for analysis. Natural samples (such as meteorite fragments, IDP's, or chondrules) might also be x-rayed prior to sectioning, to help ensure that important features of the sample are exposed for analysis.

Figure 3 and 4 are two pieces of gradient-density aerogel similar to those used for the STARDUST Discovery Mission. In one, a 100 x 500 micron fragment of Allende has been manually inserted into the aerogel. Viewing macroscopically, both the aerogel gradient (~12 mg/cc to 60 mg/cc) and cracks can be easily seen. High resolution images showed dense particulates decorating the crack tips, thus indicating that they are fabrication cracks. Similarly, high-resolution imaging of the Allende inside the other piece of aerogel shows the texture of the fragment and the fact that it is multi-granular. Accordingly, this method is a quick way to screen particulates entrained during manufacture from fragments captured by hypervelocity impacts. In addition, this imaging technique might allow the use of visually opaque aerogels for intact-capture collection of extraterrestrial particles, since the fragments could be imaged and located for analysis through radiography.

Summary and Conclusion: X-ray imaging is reaching the spatial resolution, the density contrast, the convenience and the cost per image where it could be a useful tool for planetary scientists. X-ray imaging can be used as an NDE technique to qualify various collector materials for flight experiments. More importantly, the technique can be used to perform preliminary examinations of opaque samples, as well as being aid for optimizing the sectioning of opaque samples for more traditional microscopy and chemical analysis.

Fig 1a. Beveled edge of GENESIS flight hexagon.

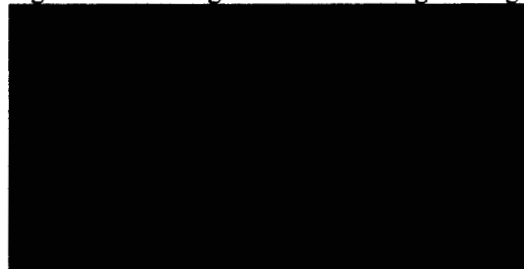


Fig. 1b. Macroscopic view of Genesis flight hexagon.

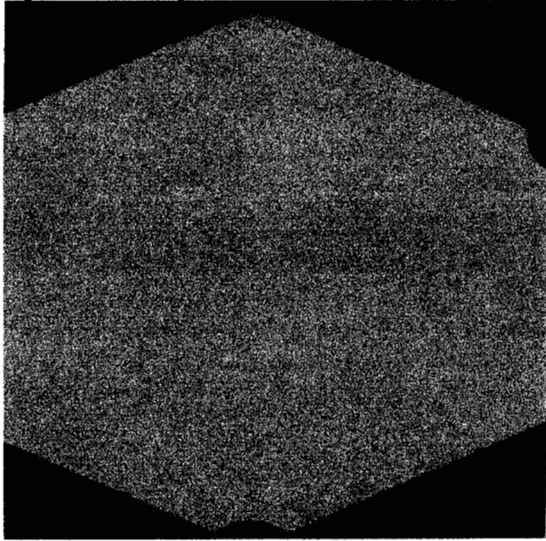


Fig. 2b. Closeup of experimental charge.

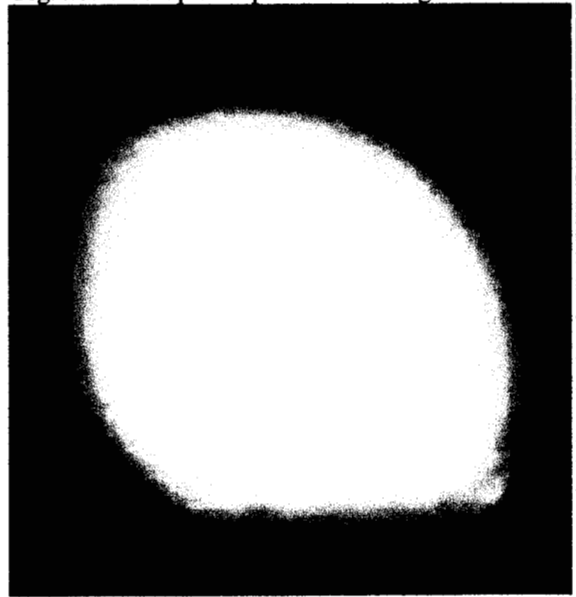


Fig. 2a. Experimental charge in graphite capsule.

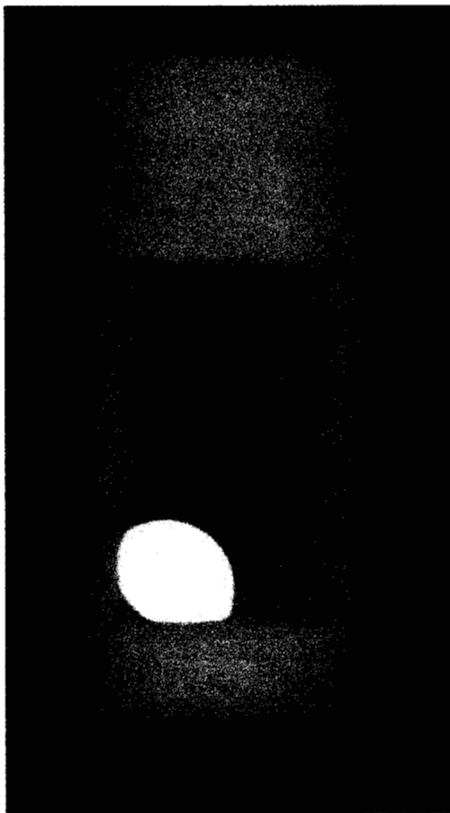


Fig. 4a: Allende fragment in aerogel, showing damage to aerogel.

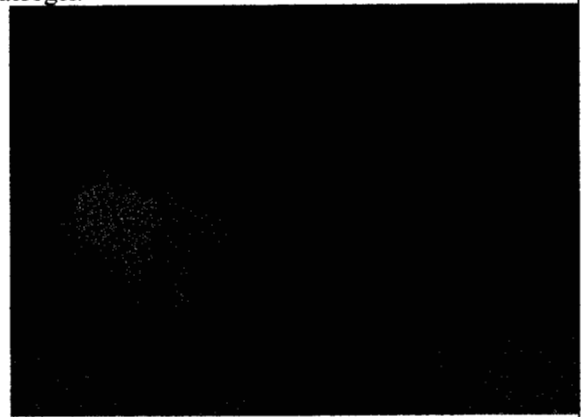


Figure 4b. Closeup of Allende fragment.

