Genesis Mission Bulk Metallic Glass Solar Wind Collector: Characterization of Return Samples Available for Re-Allocation. C. P. Gonzalez[1], K. K. Allums[2], J. H. Allton[3], R. Harrington[1], L. Le[1], and K. Thomas-Keprta[1], [1]Jacobs, NASA Johnson Space Center, Houston, TX 77058, [2]HX5- Jacobs JETS Contract, NASA Johnson Space Center, Houston, TX 77058, [3]NASA Johnson Space Center , Houston, TX 77058

Introduction: The Genesis mission collected solar wind atoms for 28 months with a variety of collectors mounted on a spacecraft. A total of fifteen pure materials were selected as collectors based on engineering and science requirements. One of the materials was the bulk metallic glass (BMG). It was intended for collecting noble gases and solar energetic particles (SEP). This material is an amorphous metal which was custom made by C.C. Hays at the California Institute of Technology. The final glass composition is $Zr_{58.5}Nb_{2.8}Cu_{15.6}Ni_{12.8}Al_{10.3}$ (in atom percent) [1].

The BMG was located on top of the wafer array mechanism and was exposed for the entire time the science canister was open (~28 months). Fortunately, the BMG did not suffer any serious damage and was intact after the Genesis canister's "hard-landing" into the Utah dessert (Fig. 1).

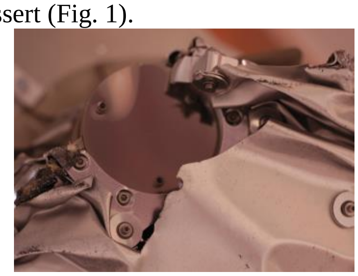

Fig. 1. Image of the BMG recovered from the Genesis science canister.

Previous work: After the Genesis capsule landed, the BMG was sent to Ansgar Grimberg and staff from ETH Zurich (Swiss Federal Institute of Technology in Zurich) for subdivision and noble gas research [2]. This group was able to subdivide ~ 20% of the disk into 35 pieces using a diamond blade. A total of 12 pieces was consumed, 14 were plasma etched, and 9 were unetched (Fig. 2). The non-consumed pieces along with the parent piece are stored in the Genesis lab at the Johnson Space Center (JSC). These sample pieces are available for re-allocation and can be requested through the Genesis online catalog (https://curator.jsc.nasa.gov/gencatalog/index.cfm).

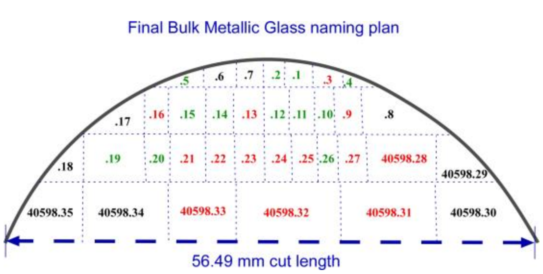

Fig. 2. Image shows the subdivision made to the Genesis BMG. Only the last two digits of samples 40598.1 through 40598.27 appear in the image. Sample numbers in green have been etched, red have been consumed, and black are available for re-allocation. The undivided piece is labeled 40598.0 (parent sample).

Recent work: The BMG parent piece was imaged using optical through-focus imaging to produce several two-dimensional images of a three-dimensional object. This imaging method was used to observe possible crater-like features shown in Figures 3 & 4. For example, in Fig. 3 two possible craters, designated as 1 & 2, are shown. Both in focus images, or those taken at the uppermost surface of the feature, and images taken at or near a possible crater floor, are shown. Possible crater 1 is ~90-100 μm in diameter (∅). Possible crater 2 is ~40-50 μm ∅.

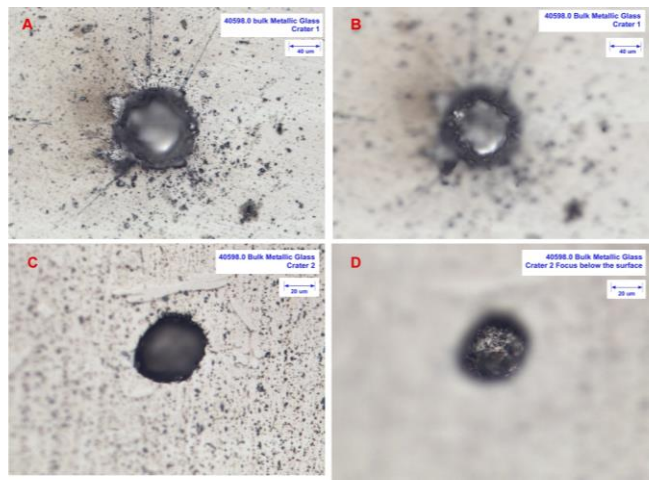

Fig. 3. A) Possible crater 1 with the optical image focused at the uppermost surface. B) Possible crater 1 optical image focused below the surface, near a purported crater floor. C) Possible crater 2 optical image focused at the uppermost surface. D) Possible crater 2 image focused below the surface, near a purported crater floor.

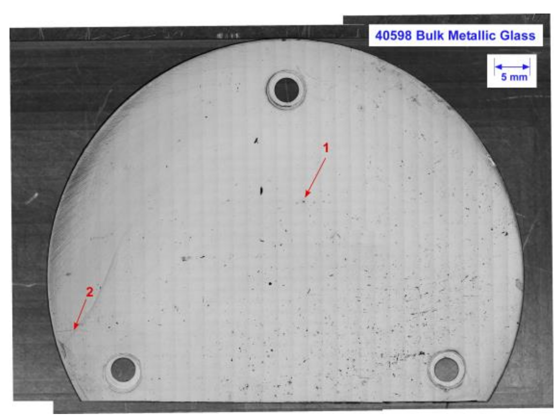

Fig. 4. Optical image taken of BMG 40598.0. Red arrows point to possible craters 1 & 2.

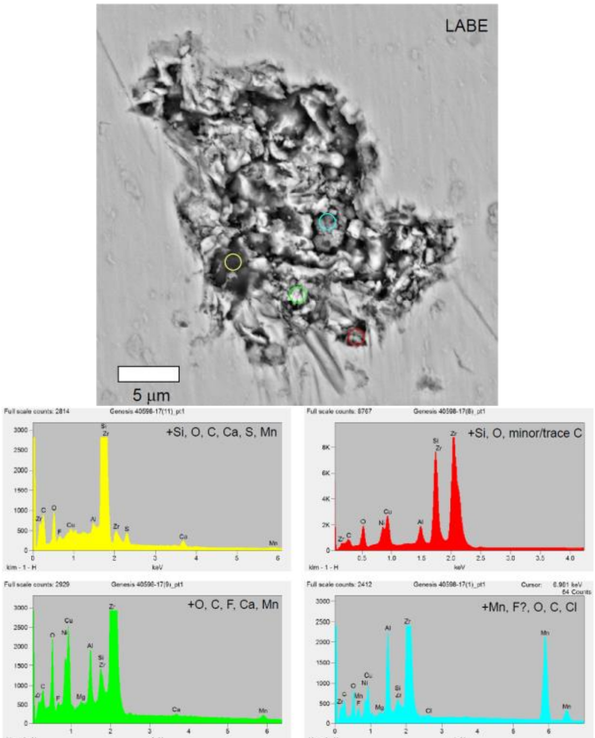

Fig. 5. *Top*: FESEM/low angle backscatter electron image of an intriguing feature, ~ 15 x 25 µm, in sample 40598.17. This feature may be interpreted as a low velocity impact feature or corrosion behavior of a BMG. Circles designate regions of interest (ROIs) analyzed using energy dispersive X-ray spectrometry (EDX; 15 kV/sample uncoated). *Bottom*: Four EDX spectra of ROIs located within the feature. They are color coordinated with the circles in the upper view. The BMG is composed of Zr, Cu, Ni, Al & Nb. Additional elements detected in the feature include C, O, Si, Mn & F resulting from a possible impact event or corrosion behavior of the BMG during the reentry crash.

High magnification optical microscopy revealed semi-circular, µm-size features subsequent to characterization using field emission scanning electron microscopy (FESEM) on samples 40598.13, 40598.16, 40598.17, and 40598.35 No features were interpreted as possible craters with one exception in 40598.17 (Fig. 5). This feature *may be* interpreted as a possible low velocity impact crater or is consistent with corrosion behavior of the BMG substrate exposed to the Utah soil. The presence of elements within the void not associated with the background/BMG matrix pose an intriguing question as to the origin of this feature. Unfortunately the BMG surface has many voids and scratches likely acquired during reentry and crash landing.

Initial work has begun in house to subdivide the BMG. Roger Harrington was able to subdivide sample 40598.9 into 3 pieces by hand-sawing with a diamond blade. Subdivision plan and final sample images are shown in Figs. 6 & 7. The partial devitrification of the BMG is visible in most optical images of the subsamples and is also evident in FESEM images.

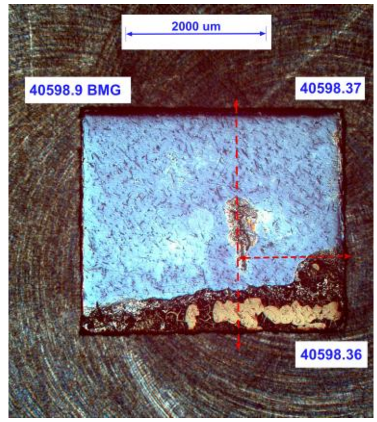

Fig. 6. Red dash line shows the cutting path followed to subdivide sample 40598.9

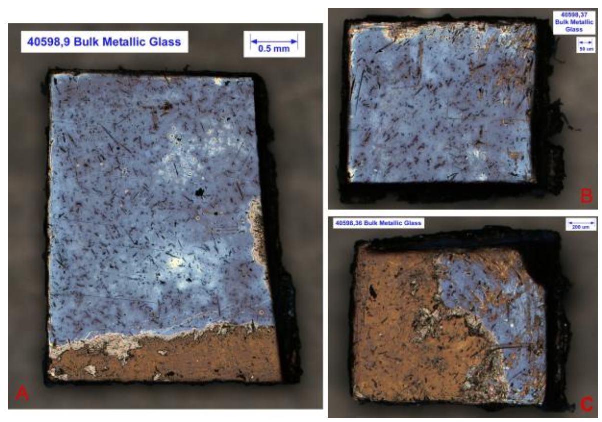

Fig. 7. Sample image taken after subdivision with a diamond blade. A) Sample 40598.9 B) Sample 40598.37 C) Sample 40598.36

References:

[1] Jurewicz A. J. G. *et al*.(2003) *Space Sci. Rev.* 105, 535-560 [2]Grimberg A. (2008) *Geochim. Cosmochim. Acta.* 72, 626-645