GENESIS CONCENTRATOR TARGET PARTICLE CONTAMINATION MAPPING AND MATERIAL IDENTIFICATION. M.J. Calaway[1], M.C. Rodriguez[2], and J.H. Allton[3]: (1) Jacobs (ESCG) at NASA Johnson Space Center, Houston, TX; (2) Geocontrol Systems (ESCG) at NASA Johnson Space Center, Houston, TX; (3) NASA, Johnson Space Center, Houston, TX; michael.calaway-1@nasa.gov.

Introduction: Surface particle contamination on three Genesis concentrator targets [1, 2] was closely examined to evaluate cleaning strategies. Two silicon carbide (Genesis sample # 60001 and 60003) and one chemical vapor deposited (CVD) ^{13}C concentrator target (60002) were imaged with optical microscopes. This resulted in mosaic scanned images and particle feature maps encompassing the entire target area. Particle morphologies were subsequently compared with non-flight, but flight-like, concentrator targets and sample return capsule (SRC) materials. Contamination of similar morphology on the acceleration grid was examined using a scanning electron microscope (SEM). Energy dispersive X-ray spectroscopy (EDS) for particle chemistry was subsequently compared with the optical images from the flown targets.

Figure 1 shows that all three targets imaged in this report are fully intact and do not show any signs of material fractures. However, due to the SRC hard landing, each target has experienced varying degrees of impacts, scratches, and particle debris from the spacecraft and Utah impact site. In addition, previous ellipsometry results and overview imaging of both flown SiC targets show a solar wind irradiation gradient from the center focal point to the outer edge [3, 4].

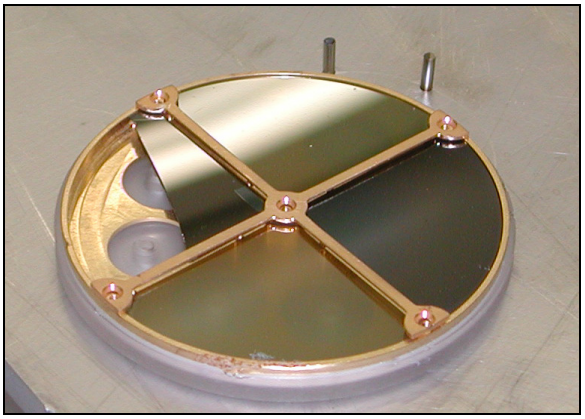

Fig. 1: Genesis Concentrator Target after Landing. In the above image, SiC target quadrants are on the top and bottom (60001 and 60003 respectively). The CVD target (60002) is on the right and the partial DOS target fragment is on the left.

Optical Imaging: The targets were first imaged with a Leica MZ9.5 stereoscope. This produced a good overview of the larger particles and impact features. Individual contamination features originating from the crash environment were imaged with a Leica DM6000M automated microscope using 5X, 10X, and 50X objective lens. Feature locations were then mapped to an overview mosaic image. Figure 2 shows an image example of a salt deposit on SiC target 60003. The salt deposit is probably a dried mixture of halite and other sediments from the lacustrine environment at the Utah Test and Training Range. Black carbon-carbon fibers, Al fragments, and other SRC materials can be visibly identified mixed within the salt matrix. Figure 3 shows an example of microsphere contamination, most likely from the super-light ablator (SLA) material from the SRC.

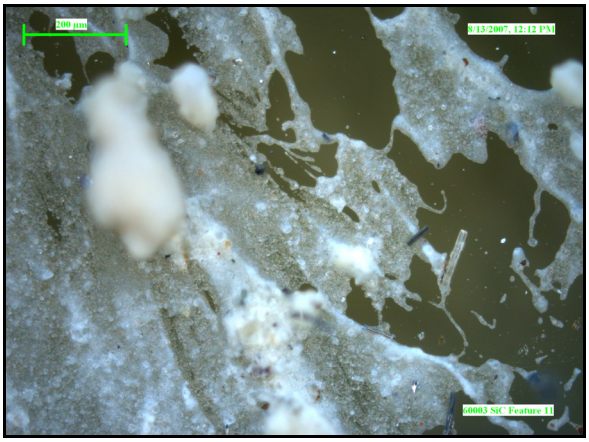

Fig. 2: SiC 60003 salt feature using a 10X objective lens. Scale bar is 200 µm.

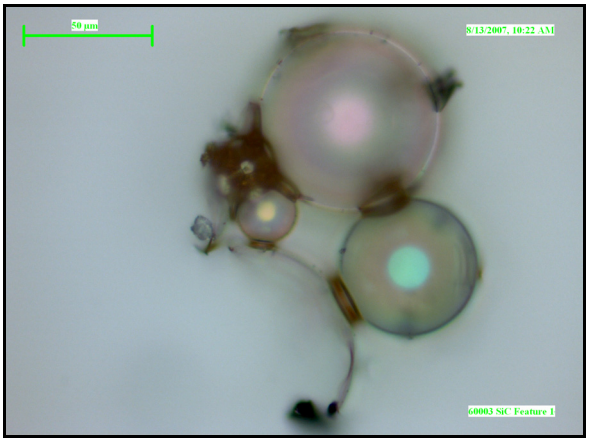

Fig. 3: SiC 60003 microsphere feature at 50X objective lens. Scale bar is 50 µm.

Mosaic Particle Mapping: Full mosaic images were constructed for each target using Surveyor software interfaced with ImageProPlus software on the Leica DM6000M microscope using a 5X

objective lens. In addition ~ 1 mm^2 areas were mosaic mapped with the 50X objective lens. ImageProPlus software was used to identify and count all particles > 0.3 µm in diameter within the ~ 1 mm^2 area. The following graphs show the particle distribution in the scanned area for each target material.

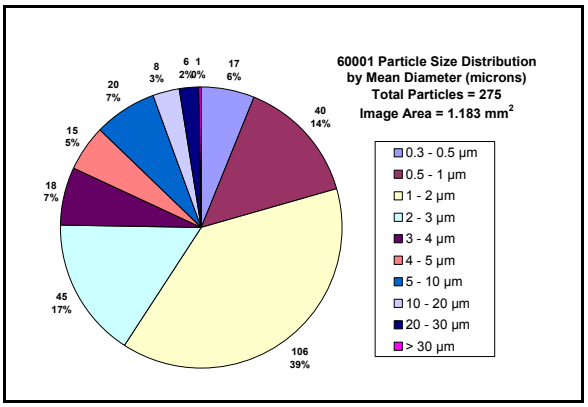

Fig. 4: SiC 60001 above target graph shows that 88% of the particles are < 5 µm in diameter and 59% are < 2 µm in diameter.

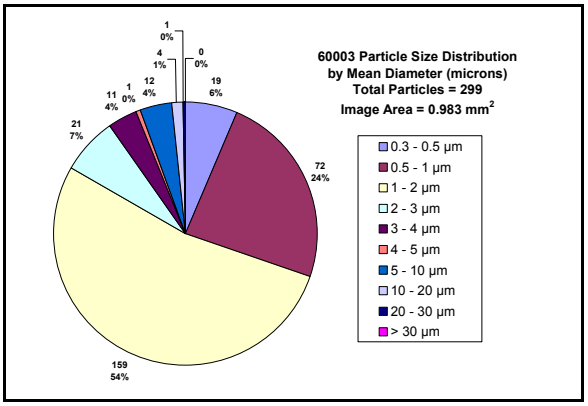

Fig. 5: SiC 60003 above target graph shows that 95% of the particles are < 5 µm in diameter and 84% are < 2 µm in diameter.

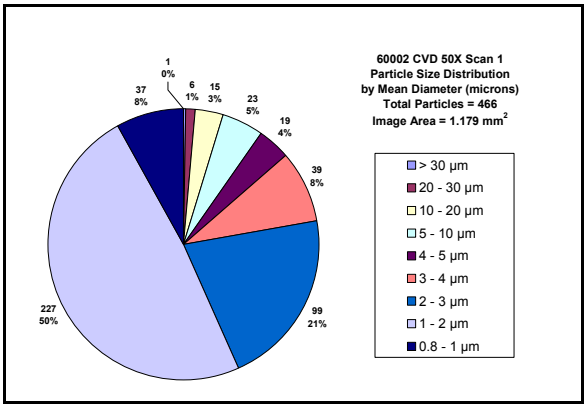

Fig. 6: CVD 60002 above target graph shows that 91% of the particles are < 5 µm in diameter and 58% are < 2 µm in diameter.

SEM Imaging and EDS Analysis: Since the flown targets could not be examined in a SEM due to instrument induced contamination, EDS analysis of surface particle contamination from the flown acceleration grid was studied and compared with particles on the flown targets. Figure 7 shows a backscatter image of microsphere fragments probably from the SLA material on the SRC.

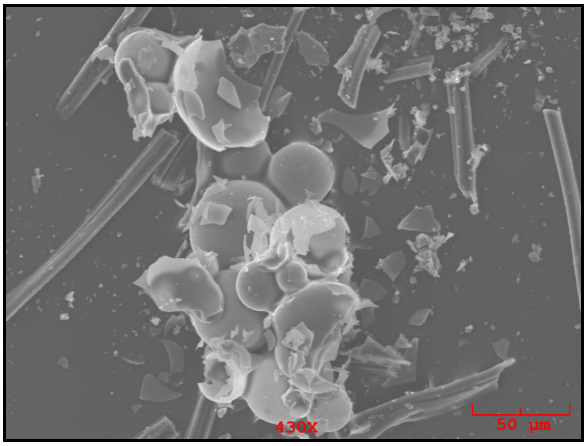

Fig. 7: SEM image of microsphere particle contamination as well as long carbon fibers on the acceleration grid. Scale bar is 50 µm.

Summary: The majority of surface particles were found to be < 5 µm in diameter with increasing numbers close to the optical resolution limit of 0.3 µm. Acceleration grid EDS results show that the majority of materials appear to be from the SRC shell and SLA materials which include carbon-carbon fibers and Si-rich microspheres in a possible silicone binder. Other major debris material from the SRC included white paint, kapton, collector array fragments, and Al. Image analysis also revealed that SRC materials were also found mixed with the Utah mud and salt deposits. The EDS analysis of the acceleration grid showed that particles < 1 µm where generally carbon based particles.

Chemical cleaning techniques with Xylene and HF in an ultrasonic bath are currently being investigated for removal of small particles by the Genesis science team as well as ultra-pure water megasonic cleaning by the JSC team [5]. Removal of organic contamination from target materials is also being investigated by the science team with the use of UV-ozone cleaning devices at JSC and Open University [6].

References: [1] Burnett, D.S. et al. (2003) Space Science Reviews 102 (1-2), 1-28; [2] Wiens, R.C et al. (2003) Space Science Reviews 102(1-2), 93-118; [3] Calaway, M.J., et al. (2007) LPSC XXXVIII, Abstract # 1632; [4] Allton, J.H., et al. (2008) LPSC XXXIX; [5] Allton, J.H., et al. (2007) LPSC XXXVIII, Abstract # 2138; [6] Calaway, M.J., et al. (2007) LPSC XXXVIII, Abstract # 1627.