THE SEARCH FOR MICROMETER-SIZED IMPACT CRATERS ON THE POLISHED ALUMINUM COLLECTOR FROM THE GENESIS SPACECRAFT.

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Introduction: The primary mission of the Genesis spacecraft was to capture solar wind in high-purity collector surfaces during an extended exposure near the Earth-Sun Lagrange point L1 [1]. However, this unique exposure location outside the heavily polluted low earth orbit makes the Genesis collector also an interesting object for the study of cosmic dust impact craters, e.g., for comparison with the dust population captured on the interstellar collector of the Stardust spacecraft [2]. Optical crater searches of the polished aluminum collector ("Al kidney") from Genesis have indicated the presence of at least 32 craters in the 11 – 195 μm size range [3, 4]. Here we report on a search for micrometer-sized craters on a portion of the same collector; this size range is more directly comparable to what is observed on the interstellar Stardust collector.

Experimental: We used a roughly centimeter-sized section of the polished aluminum collector for high resolution imaging by secondary electron microscopy (SEM). This sample has previously been used for (destructive) noble gas measurement by UV-laser ablation [5] and the area available for this study was therefore limited to portions outside the laser areas, largely along the edges of the sample. For the SEM imaging we followed the same analytical approach as for the Stardust interstellar collector crater search [6], acquiring three-megapixel images at a resolution of 52 nm/pixel. We initially acquired more than 15,000 such images during an automated scan of the entire surface of the sample. Following a first quick survey to remove images that only show areas that were hit by the laser during the noble gas measurement, 4942 images of relatively unaffected aluminum remained, representing a surface area of ~33 mm^2. These images were then examined for crater-like features. The most likely crater candidates were further investigated by SEM imaging at higher resolution.

Results and Discussion: Of the almost 100 crater-like features initially identified, a vast majority had to be dismissed upon closer inspection. Many micrometer-sized dust particles exhibit bright rims and dark centers when imaged by SEM, imitating the appearance of craters when the grains are roundish in shape. Only five features, ranging in size from 350 nm to 1.1 μm, could be confirmed as likely impact craters. Interestingly, four of these are tightly clustered in a 10 μm area. Clustered craters have also been observed on the cometary Stardust collector and several possible mechanisms for such clustering have been discussed [7]. In the case of Genesis, fragmentation of a projectile due to impact on another spacecraft component appears most likely, with the clustered craters representing secondary impacts. We will perform elemental analyses of the impact debris to constrain possible source materials.

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