STARDUST FOIL CRATERS REVEAL THE FINE STRUCTURE OF DUST FROM COMET WILD 2.

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Introduction: The flight of the Stardust spacecraft through the coma of comet 81P/Wild 2 yielded a harvest of dust, captured in low density silica aerogel, and impacted onto surrounding aluminium (Al) foil sheets [1,2]. Although the relatively low peak pressure experienced by particles ploughing into aerogel allowed survival of diverse original grain compositions [3] and crystalline structure [4], abrasion and sub-grain disaggregation disrupted fragile components, making it difficult to interpret the original particle structure. The complexity of particle interaction with aerogel is now being revealed in laboratory experiments [5].

Impact upon Al foils inevitably creates higher shock pressures, and more extreme structural processing of the impactor. However, due to a long history of experimental studies e.g. [6,7], the relationship between impactor characteristics and metal crater shape is currently better understood than the processes responsible for aerogel track morphology, for which systematic experimentation is still in progress [8,9]. Using sophisticated image analysis methods, we can now describe the three dimensional shape of Stardust foil craters, and interpret the properties of dust grains responsible by comparison to impact features created under analogous laboratory conditions [10].

Materials and Methods of study: Stardust foils from the cometary side of the collector were examined as part of the Preliminary Examination (PE) [2,11] with additional stereo imagery of smaller craters from subsequent sample allocations. Scanning electron microscopy and stereo pair analysis used the protocols described in [11,12]. Flight spare Al1100 foils supplied by NASA were used as targets in light gas gun (LGG) shots with mineral powders and synthetic dust aggregate particles [12] using the technique of [13].

Results: Small Stardust impact structures exhibit great complexity in stereo-pair images and digital elevation models (Figure 1). Few have simple bowl-shaped depth profiles, most show overlapping and mutually interfering depressions. Where energy dispersive X-ray microanalysis has been performed, residues of several different compositions are often found together, implying complex impactors [11]. LGG impacts by single mineral grain projectiles, unless with very high shape factor, usually yield craters with a simple near circular bowl profile. However, artificial mafic silicate aggregates (porosity and binding polymer volume of ~50%) generate compound features similar to the majority of small Stardust craters.

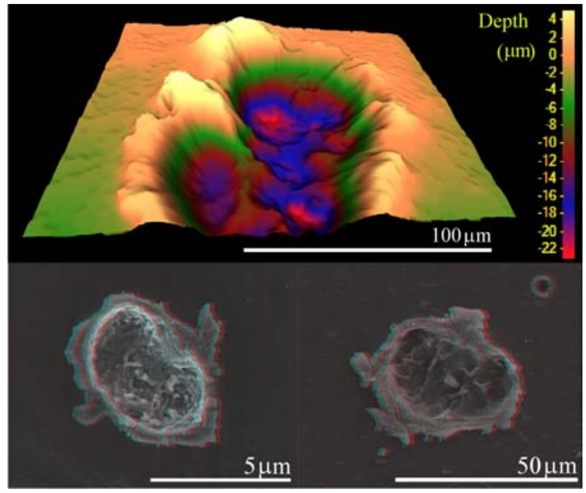

Figure 1. False colour depth model (top); and stereo anaglyphs (left) of Wild 2 dust craters compared to laboratory impact (right) produced by artificial aggregate particle on Al foil. Left eye red, right eye green.

Discussion: Complex crater morphology shows the majority of Wild 2 dust to be porous aggregates of µm to nm grains. Although only a very small fraction of the collected mass (~3%, [11]), these numerous tiny particles are important. Does their relatively poor preservation, in both aerogel and Al foil impacts, conceal a population of amorphous, non-crystalline materials?

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