LARGE BULBOUS STARDUST TRACKS: IMPACTOR PARTICLES ANALOGOUS TO CLUSTER IDPS – MINERALOGY AND TEXTURES OF TRACK 41, A TYPE EXAMPLE

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Introduction: Large bulbous Stardust tracks (type B) were made by weak porous aggregate particles dominated by fine-grained materials in contrast to the thin carrot-shaped tracks which were produced solely by coarse-grained components [1]. Our studies of track 41, a 4 mm-long bulbous track, made by a ~40 um particle [1], has properties consistent with cluster IDPs which are the weakest of all IDPs. Track 41 contains a large variety of > 1 µm single mineral grains and rock fragments. Most of the mass in the track, however, is present in capture-melted silicate glass which mixed with ~chondritic submicron material that did not survive capture.

Mineralogy: We studied the mineralogy of track 41 using conventional TEM techniques. Our observations, on fragments from a portion of the bulb, show that the mineralogy is heterogeneous. A large compositional variety of olivine fragments ranging from $Fo_{69.2}$ to $Fo_{99.8}$ occurring as single mineral grains or in rock assemblages were found including a low-Fe LIME (Mn > Fe) olivine. LIME olivines have been reported in primitive IDPs, AOAs and chondrite matrix and may be nebular condensates [2,3]. A > 5 µm fragment of enstatite appears to have been shocked as indicated by a number of microtextures including cleavage delaminations, mosaicism, the presence of sub-10 nm Fe metal (Ni-free) inclusions and numerous internal edge dislocations. A crystalline SiO_2 phase > 3 µm in size, was observed in several microtome sections. Diffraction patterns indicate this phase is cristobalite. Its origin is uncertain but cristobalite has recently been reported in the disks of T Tauri stars [4]. Given its size, it is unlikely to have formed during capture heating.

The capture produced glass which dominates the mass of material in the track contains nanophase inclusions of Fe metal with sulfide (MSG = Metal with Sulfide in Glass) and is found in fragments up to ~15 µm in size. The MSG is ~chondritic for the nine elements (Na, Mg, Al, S, Ca, Cr, Mn, Fe and Ni) that we measured.

Pre-impact textures: Hypothetical reconstruction of the impacting grain that produced track 41 suggests that the original particle was composed of a loose unequilibrated assemblage of minerals and rock fragments dominated by fine-grained ~chondritic matrix. This implies the assembly of random components of > 1 µm in size and submicron grains that accreted to the comet. This material is directly analogous to cluster IDPs which are composed of weakly bound large fragments and fines.

Conclusions: Our results indicate that the diverse mineralogy of large > 1 µm fragments in track 41, the mass dominance of ~chondritic fine-grained matrix material and the original impactor size of ~40 µm are consistent with a cluster IDP analog and therefore provide a direct link between porous IDPs and aggregates originating from comet Wild 2.

References: [1] Burchell M. J., Fairey S. A. J., Wozniakiewicz P., Brownlee D. E., Hörz F., Kearsley A. T., See T. H., Tsou P., Westphal A., Green S. F., Trigo-Rodríguez J. M. and Domingúez G. *MAPS* 43: 23-40. [2] Klock W., Thomas K. L., McKay D. S. and Palme H. *Nature* 339: 126-128. [3] Weisberg M. K., Ebel D. S. and Connolly H. C., Jr. *MetSoc*, p. 5288, 2007. [4] Sargent B. A. et al. *ApJ* 690:1193-1207.