TRANSMISSION ELECTRON MICROSCOPY ADVANCES REVEAL SUBTLE COMET DUST DIFFERENCES.

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Introduction: Comet dust returned by NASA's Stardust mission to comet 81P/Wild 2 was expected to resemble chondritic porous interplanetary dust particles (CP IDPs), a unique class of meteoritic material consistent with cometary origins: anhydrous, fine-grained, highly porous, inherited presolar isotope anomalies and ~chondritic composition [A]. An abundant CP IDP component is glass embedded with metal and sulfides (GEMS), typically 50-250 nm diameter low-Fe glass matrices with Fe(Ni) metal and sulfide inclusions down to sub-nanometer dimensions. The deceleration process (ablation, abrasion, recondensation and solidification) experienced by Wild 2 dust in braking from 6 to 0 km/s during capture in silica aerogel resulted in GEMS-like objects, an unfortunate product of finely-intermixed comet dust and silica that superficially resembles GEMS [B]. Some terminal particles in aerogel impact tracks have fine-grained (fg) material associated with large mineral(s). Researchers debate whether this fg-material is indigenous to Wild 2 and shielded by the terminal particle during passage through the aerogel or whether it results from the deceleration process. We applied transmission electron microscopy (TEM) advances in rapid, multi-SDD-detector, high S/N EDX mapping to Wild 2 dust and likely-cometary CP IDPs for detailed comparison of Wild 2 fg-material and GEMS.

Samples and Methods: We examined ultramicrotomed sections of GEMS-rich CP IDPs U217B19 (8 μm) and U220A19 (10 μm) and the terminal particle (8 μm) of Stardust track "Febo" (NASA C2009,2,57,2,28), comprised of a large (~4 μm) Fe(Ni) sulfide, smaller Mg-rich pyroxene and associated fg-material. TEM-EDX mapping was performed on two FEI Titan 80-200 kV (S)TEMs (NCEM, Oregon State U), each with 4 Bruker SDD detectors at 200 kV with pixel size as small as 3 nm.

Results and Discussion: EDX maps reveals subtle differences between GEMS in CP IDPs and fg-material in Febo: GEMS are discrete and rounded, whereas discrete boundaries are difficult to define in the fg-material. Previous analysis reported Febo fg-material as chondritic (excepting Si due to aerogel) [C], but in most of this section, it is variably depleted in Mg (~25-35x) and Ca (~15-98x), in contrast to GEMS (within ~2-3x chondritic). Of 4 regions deemed GEMS-like in HAADF images, 2 are within ~2-3x chondritic; however, their element distributions are unlike GEMS in CP IDPs. Within one ~500 nm object, 150-200 nm subgrains of partially reduced sulfide, melted enstatite and a Ca-bearing pyroxene produce a chondritic composition. Thus, Febo fg-material is consistent with deceleration debris from an incident particle comprised of sulfide and at least 2 pyroxenes. Indigenous GEMS in the Wild 2 sample, if they were present, are exceedingly hard to identify and likely destroyed by capture or diluted beyond recognition.

References: [1] Bradley J.P. 2013. in Treatise on Geochemistry, ed. Holland & Turekian, 2nd ed. Vol. 1, pp 287-308. [2] Ishii H.A. et al. 2008. *Science* 319:447-50. [3] Matrajt G. et al. 2008. *Meteoritics & Planetary Science* 43:315-334.

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