RELICT STRUCTURE OF A HYDROUS MINERAL IDENTIFIED IN WILD 2 DUST.

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Introduction: In January 2006, the Stardust spacecraft returned to Earth two unprecedented and independent types of extraterrestrial samples: bona fide samples of a comet, and the first grains of contemporary interstellar dust. Over a thousand dust particles from comet Wild 2 that have been collected by the Stardust spacecraft have been extensively investigated [1] – [5]. None of them ever yield compelling evidence for a hydrous phase. Here we present for the first time TEM data from a terminal particle (TP) (track 32) indicating the former existence of the phyllosilicate sepiolite or a Na-poor saponite.

Technique: A TEM grid from the terminal particle (TP) of Track 32 (C2027,3,32,3,8) was investigated in great detail using transmission electron microscopy. We performed high–resolution (HRTEM), bright field–(BF) imaging and selected area electron diffraction (SAED) to characterize the crystal structures. Additional energy dispersive X–ray (EDX) analyses were performed for determining the chemical composition. D–spacings were obtained from lattice fringe images and SAED patterns respectively.

Results: The complex TP of track 32 shows two clearly distinct mineral phases. The first, enstatite (Mg/Si 0.919; Fe/Si 0.026; Ca/Si 0.011; Al/Si 0.010; Cr/Si 0.011) shows high stacking disorder parallel (100) which includes alternating clinoenstatite (CLEN) and orthoenstatite (OREN) lamellae, (100) twins and pronounced stacking disorder. Attached and partly enclosed into the enstatite a structurally separated second phase (Mg/Si 0.694; Fe/Si 0.037; Ca/Si 0.026; Al/Si 0.032; Cr/Si 0.015; Mn/Si 0.015; Ti/Si 0.013) was discovered showing significantly different compositional and textural behaviour. Chemical characterization is consistent with sepiolite or Na-poor saponite, both are phyllosilicates. Detailed TEM studies reveal sigmoidal fractures in this second phase which are typically observed as the result of dehydration in smectites or similar hydrous phases under vacuum. Microstructural data (HRTEM, SAED) are partly consistent with a high temperature triclinic clinoenstatite structure. The structural deviation is most likely due to the lower Mg/Si ratio of the new phase. Collected EELS spectra didn´t show OH-related pre peaks indicating complete dehydration of the sample. Our data suggest that sepiolite or low Na saponite are the most likely candidates for the missing hydrous phase of comet Wild 2 samples, which transform to high temperature triclinic enstatite due to impact heating during capture into Aerogel.

References: [1] Brownlee et al. 2006. Science 314: 1711-1716. [2] Flynn et al. 2006. Science 314:1731–1735. [3] Zolensky et al. 2006. Science 314:1735-1739. [4] Schmitz S. and Brenker F.E. 2008. Astroph. J. Lett. 681:L105-108. [5] Schmitz et al. 2009. Geochim. Cosmochim. Ac. 73:5483-5492.