FLASH-HEATED WILD 2 PARTICLES IN THE STARDUST AEROGEL: ANATOMY OF AN Al-Ca-Mg-RICH IMPACT MELT.

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Introduction: Wild 2 particles returned to Earth by the Stardust mission were partially damaged by the hypervelocity capture at 6.1 km/s into aerogel [e.g., 1]. The large and dense mineral grains survived but the fine-grained material severely interacted with the aerogel. These fine-grained assemblages were fragmented, dispersed and flash heated in the aerogel walls of bulbous deceleration tracks [e.g., 2,3]. The resulting microstructure typically consists of a silica-rich glass, quenched from a melt, containing numerous Fe-Ni-S nano-inclusions and vesicles. Wild 2 silicates grains are found encased into this SiO_2-glass but a large fraction was also melted and partially mixed with melted aerogel during the capture.

Here we present the mineralogical reconstruction of an aggregate that suffered such melting event. This reconstruction is based on an analytical transmission electron microscopy study of an impact melted particle (allocation FC6,0,10,0,42). The particle was imaged by chemical mapping using EDS at a resolution of about 5 nm in order to study the silicate remnants enclosed into the silica-rich glass (melted aerogel).

Results: Chemical maps reveal numerous Mg, Ca and Al patches within a dense silica glass. The typical size of these domains range from 200 to a few tens of nm (the smallest were not resolved). The Mg-rich patches are the most abundant, with a Mg/Si ratio within the range 0.5-0.6. The concentrations of Al and Ca correlate together and with Mg, suggesting that spinel and Ca-Al-pyroxene are most probably the mineral precursors. The boundaries between regions of different compositions are not sharp, showing that cation interdiffusion occurred on a distance of at least 50 nm. The patches do not contain significant amount of iron. Iron and sulfur are rather found as nano-inclusions dispersed within the melted aerogel. The edges of the Al-Ca-Mg patches are sometimes enriched in Fe and S, possibly due to an interaction during the episode of high temperature impact.

Discussion: The studied sample is representative of an impact melt generated during the capture process of the Wild 2 particles. The amorphous state of the sample and the local compositions of the impact glass reveal that it results from the quench of two coexisting immiscible liquids, the first coming from the melted SiO_2 aerogel and the second from melted Al-Ca-Mg silicates and oxides grains. We show that the compositions of impact products are accurate probes to constrain the thermal parameters associated to the capture (peak temperature and cooling rate). Despite the dramatic changes associated with this thermal episode, we show that it is possible to reconstruct a part of the mineralogy of these fine-grained materials. Here, the particle was a fine-grained refractory assemblage dominated by low and high-Ca pyroxenes and Mg-Al-spinel.

References: [1] Zolensky et al. 2006. *Science* 314:1735-1739. [2] Roskosz et al. 2008. *Earth and Planetary Science Letters* 273:195-202. [3] Leroux H. et al. 2009. *Geochimica et Cosmochimica Acta* 73:767-777.