NONDESTRUCTIVE THREE–DIMENSIONAL CONFOCAL IMAGING AND SXRF OF WHOLE STARDUST TRACKS IN AEROGEL. A. J. White[1,3], D. S. Ebel[1], M. Greenberg[1,2]. [1]Dept. of Earth and Planetary Sciences, American Museum of Natural History, New York, NY 10024. [2]Northwestern University, Evanston, IL 60208. [3](awhite@amnh.org).

Introduction: The NASA Stardust mission to comet Wild 2 returned to Earth in 2006 with cometary and interstellar material captured in aerogel. Cometary particles impacted with an aerogel collector at a relative velocity of 6.1 km/s, creating three-dimensional (3D) impact tracks of melted and crushed aerogel, void space, and fragmented cometary material [1]. Each track represents the history of a unique hypervelocity capture event. The nature of each impact, including the original state of the impactor, is recorded in track morphology and material distribution. Using a combination of 3D morphological data, chemical data, and microphysical models, it is possible to reconstruct track formation events and a model of the original impactor [2, 3].

Imaging: The focus of this work is to fully characterize whole tracks both morphologically and chemically using solely non-destructive methods. To achieve this, we combine high-resolution optical confocal 3D imaging with synchrotron X-ray fluorescence (SXRF) chemical mapping. To obtain the optical data, we use a Zeiss LSM 710 laser scanning confocal microscope (LSCM), located at the Microscopy and Imaging Facility of the American Museum of Natural History. LSCM data yields high-resolution (<80nm/pixel in XY) 3D imagery of track morphology and is preferable to other methods of imaging because it quickly produces 3D image sets of the distribution of compressed aerogel and particles larger than 100nm along the entirety of a track without disturbing the sample. Additionally, the spectroscopic capabilities of the LSM 710 also allows for the preliminary distinction between deposited cometary material and melted aerogel by taking advantage of natural aerogel fluorescence at discrete wavelengths [4]. A full description of the LSCM imaging technique can be found in [3, 5]. Complementary chemical data is acquired using the GSECARS X-ray microbe on beamline 13-IDE at the Advance Photon Source (APS) of Argonne National Laboratory. X-ray fluorescence maps of each track were collected 100ms/pixel at a resolution of 1 micron/pixel. Additionally, tracks are tilted and mapped a second time for stereo measurements [2].

It is important to realize that the richness of LSCM data cannot be conveyed in media such as an LPSC abstract. With 34 spectral bins and 16-bit data range, track morphology can be recorded in exceptional detail. Image stacks were acquired at a resolution of 74 nm x 74 nm in XY and 360 nm in Z for Tracks 131 and Tracks 169. Track 143 was acquired at a resolution of 173 nm x 173 nm in XY and 2 microns in Z. The final images presented here are a composite image stacks taken along the length of the track, stitched together, and flattened into maximum intensity projections.

Tracks: A thorough understanding of how cometary material and aerogel is distributed along tracks is required to understand the events which occurred after impact and to back-calculate properties of the original impactor using hydrodynamic simulations of hypervelocity impacts in aerogel. Here we present map data for Track 131 (C2012,7,131,0,0), Track 143 (C2013,10,143,0,0), and Track 169 (C2088,1,169,0,0). Track 131 is a small type A carrot shaped track [6] of length 560 microns with three terminal particles emanating from the bulb in three separate styli. The edge of the keystone can be seen on the left edge of both images of Track 131. Track 143 is a large bulbous track (type C) which has been dissected. LSCM and SXRF mapping of the dissected portion has also been done in addition to the parent body shown here. The SXRF map of Track 143 shows very few Fe-bearing grains. Track 169 has a bulb 420 microns long and a 750 micron stylus with one large terminal particle. Highlighted points in the SXRF map of Track 169 correspond to locations where XRD was also done.

In the figures below, upper images are 2D projections of 3D LSCM data sets; and lower images are synchrotron-XRF Fe Kα maps.

A detailed morphological and chemical analysis of these tracks as well as Tracks 68 and 166 will be presented at LPSC XLV.

References: [1] Brownlee D. et al. (2006) *Science, 314*, 1711-1716. [2] Greenberg M. et al. (2012) *Meteor. Planet. Sci., 47*, 634-648. [3] Ebel D.S. et al. (2009) *Meteor. Planet. Sci., 44*, 1554-1463. [4] Greenberg M. et al. (2011) *LPS XLII* Abstract #2640. [5] Greenberg M. et al. (2010) *Geosphere, 6,* 515-523. [6] Burchell M.J. et al. (2008) *Meteor. Planet. Sci., 43*, 23-40.

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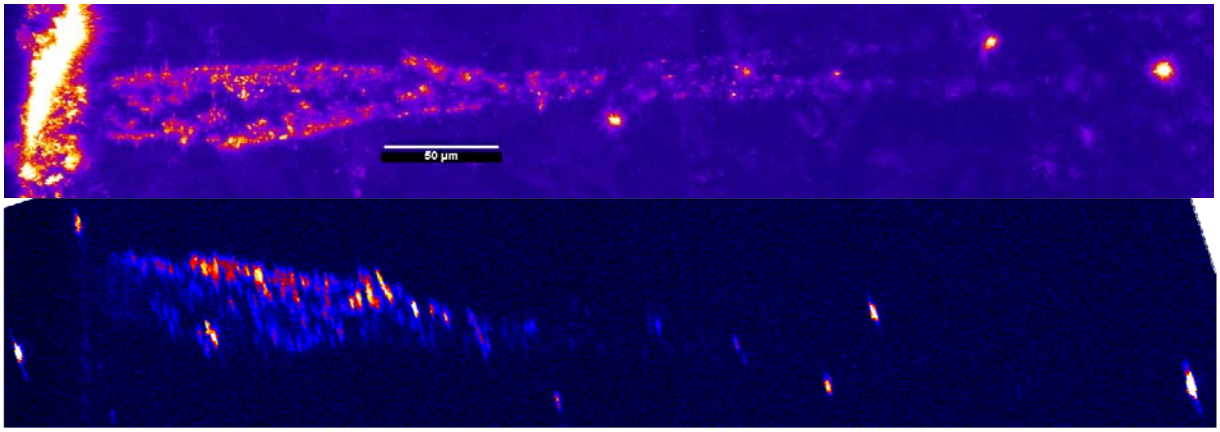
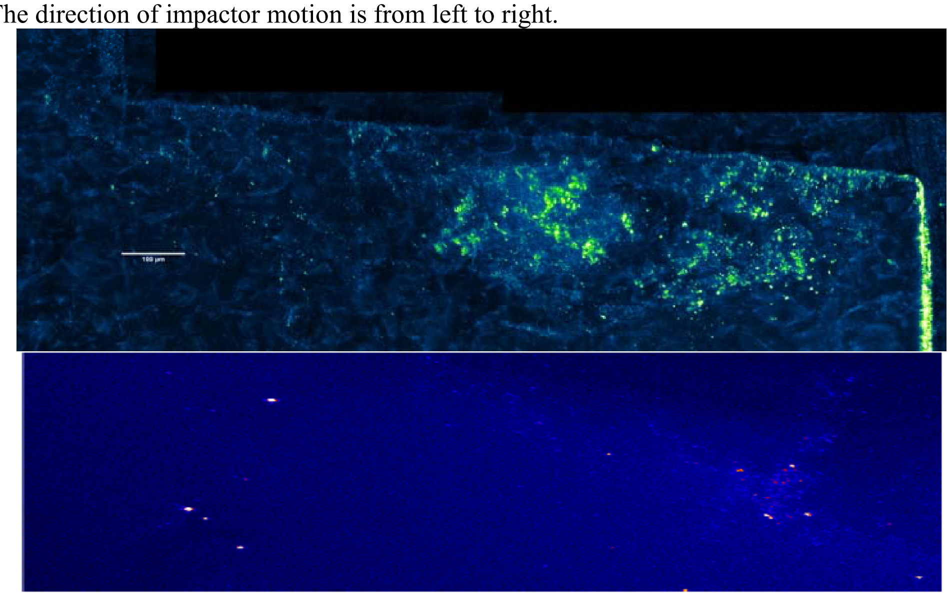
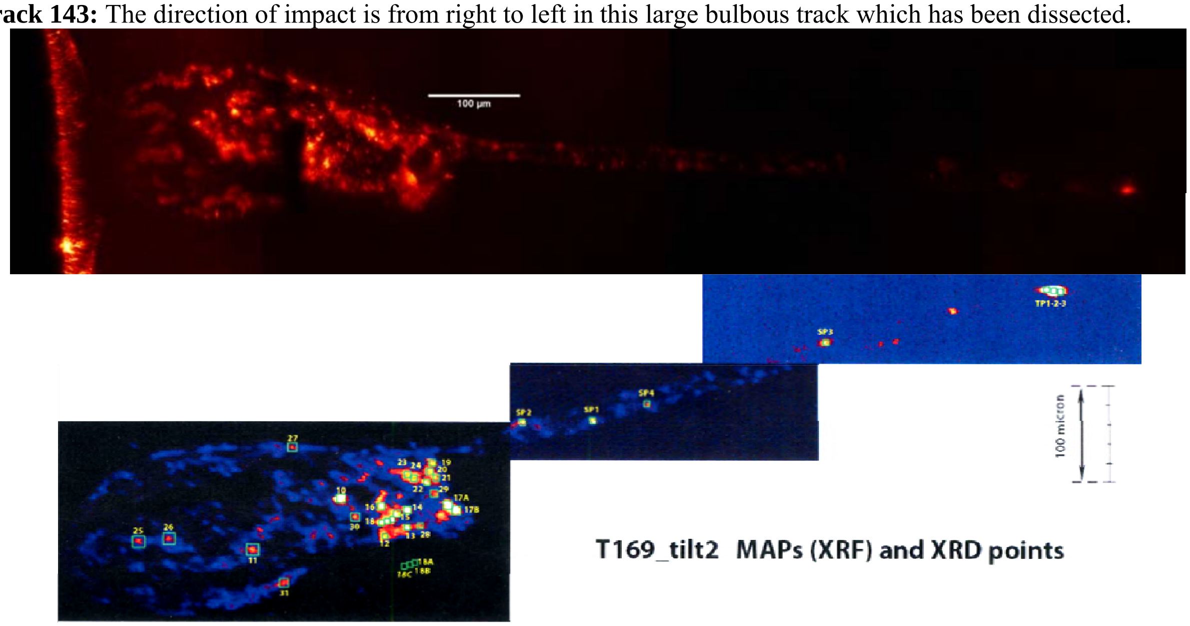


Track 131: The direction of impactor motion is from left to right.



Track 143: The direction of impact is from right to left in this large bulbous track which has been dissected.



Track 169: The direction of impact is left to right.