SPALLOGENIC NEON IN THE EXPOSED LAYER OF STARDUST AEROGEL – SUBMICRON DUST OR SURFACE ARTIFACT? A. P. Meshik, C. M. Hohenberg and O. V. Pravdivtseva, Washington University, St. Louis, MO 63130, USA (am@physics.wustl.edu).

Introduction: The purpose of this work is to evaluate the possibility of studying gas-rich submicron particles in the aerogel collectors flown on the Stardust Mission. Such small particles have a very large surface-to-volume ratio and presumably were exposed to the solar wind before being incorporated into Wild-2. Depending upon their size, they would either be pushed out of the solar system by radiation pressure or spiraled into the sun by the Pointer-Robisson effect. They would consequently have a limited lifetime for incorporation into the comet, and to acquire solar wind or spallation products from an active early Sun. However, they might well acquire enough to represent a new type of interesting material returned by the Stardust Mission, a sample of the ancient solar wind and/or spallation from the naked T-Tauri phase of the Sun. The best place to look for submicron dust is in near-surface areas of the aerogel free of visible tracks. We cannot, of course, observe or analyze individual submicron particles; we can study them collectively as a component of the near-surface region of the aerogel. Noble gases are similarly studied in the invisible meteoritic nanodiamonds and the elusive phase-Q.

Recently we observed small ^{21}Ne enrichments in the surface layer of particle- and track-free aerogel block C2101– 7.0.0.0 [1]. To verify that this was a real effect, we obtained another sample of track-free aerogel flown on the mission. Here we report Ne results obtained from the new aerogel sample from block C2017–4.0.0.0.

Experimental: The new aerogel was a 7×6 mm area from block C2017–4.0.0.0, cut into several 0.4 mm thick slices, twice as thick as in our previous experiment from Block C2101. The 0.4 mm aerogel slices are easier to see and handle, and they do not shed small fragments as the thinner slices did. Moreover, small ^{21}Ne enrichments were found in both of the two outermost 0.2 mm slices of C2101. Therefore by doubling the thickness (and, therefore, the signal) we hoped to improve the statistics. Finally, the laser beam couples better with thicker slices, requiring less IR-power which, in turn, may decrease the blank. The aerogel slices were placed between fused quartz plates and mounted into a laser extraction cell equipped with two sapphire viewports allowing any unabsorbed laser beam to leave the cell (only ~7% of IR power is adsorbed by aerogel). The cell was first degassed for two weeks at ~175°C to remove contamination and as much adsorbed atmospheric Ne as possible, although the blank was still significant. Each aerogel slice was rastered with a slightly defocused 1064 nm beam generated by a Q-switched Nd-YAG laser, and the He and Ne analyzed in a standard manner. No significant He was found, within experimental errors, but we cannot exclude the possibility of He loss during the baking.

Results: Neon data from this work and that previously reported [1] are shown together in Figure 1. The outermost 0.4 mm of aerogel from each of these two studies shows small but statistically significant excesses of ^{21}Ne in qualitative agreement with independent study [2]. All of the deeper slices (except possibly slice 2) do not show this excess ^{21}Ne. Therefore our new Ne analysis confirm the ^{21}Ne excess in the outermost 0.4 mm suggesting that this effect is characteristic for all track-free aerogel blocks flown on Stardust. There is no detectible contribution from the solar wind in the aerogel from either of these studies. In Figure 2 we show the excess ^{21}Ne, calculated with the two 0.2 mm slices combined, so the results are normalized to 0.4 mm thick aerogel slices.

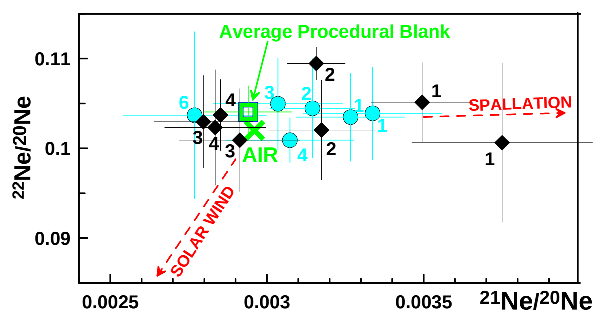

Fig. 1. Isotopic composition of Ne released from particle- and track-free aerogel blocks C2101–7.0.0.0 [1] and C2017–4.0.0.0 (this work). Numbers indicate the distance from the surface: 1 – exposed surface, 2 – second from the surface and so on. Also shown average procedural blank which is close to atmospheric neon. Errors are 1σ.

Discussion: The ^{21}Ne is the least abundant neon isotope and the most free from artifacts, suffering neither from CO_2^{++} or $^{40}Ar^{++}$, nor other interferences. In addition, for typical targets, the spallation yield for ^{21}Ne is similar to that for the major isotopes ^{20}Ne and ^{22}Ne, making ^{21}Ne the most sensitive and pure isotope for the quantitative measurement of spallation reactions. We can therefore attribute the ^{21}Ne excesses in these uppermost Stardust aerogel slices to spallation in the sub-micron particles. This interpretation puts strict constrains on the irradiation conditions. The submicron grains could not have been irradiated by the GCR as isolated individual grains since the recoil range is only 2-3 microns [3] so isolated sub-micron particles should retain little, if any, spallogenic ^{21}Ne. However, a lower energy SCR irradiation from an early active Sun could possible be retained. In either case, the grains may have been incorporated into larger objects, thus retaining spallation products. A recent study of the surface features of visible Stardust grains suggests that they were parts of "agglomerate of gas-laden amorphous ice particles" [4]. In any event, the measured, presumably spallogenic, ^{21}Ne seems to be carried by the sub-micron solids of Wild-2. Whether they were irradiated long ago before incorporation, or as part of the comet itself, remains to be seen. However, if GCR is the source, and ice surrounds the grains, spallation products would still recoil out of these particles if irradiated in place.

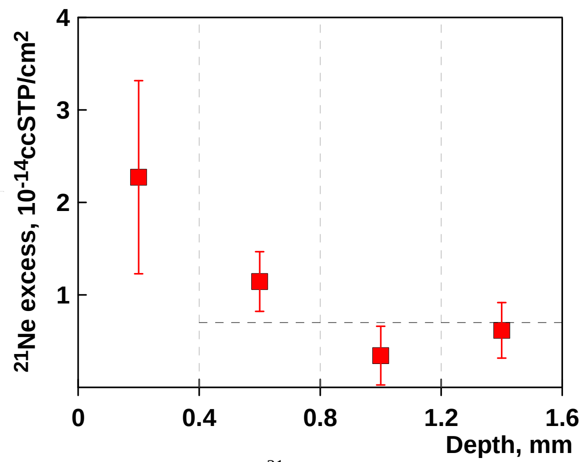

Fig. 2. The excess of ^{21}Ne calculated from all Ne data and normalized to 0.4 mm thick aerogel layers. The dashed horizontal line represents average ^{21}Ne content of ~7×10^{-15} ccSTP/cm^2 at 0.4–1.6 mm depth.

Before any further speculation on the origin of excess ^{21}Ne in the aerogel, we must consider the possibility that the observed excess is an artifact related to some contaminant of the aerogel surface. While this may seem remote due to the "clean" nature of mass 21, there is one preliminary and unconfirmed observation of unusual organics (could be thruster/rocket propellant residues?) on the flown aerogel surface [5].

To evaluate the possibility of aerogel contamination we plan to analyze a special kind of aerogel flown on Stardust, but not exposed to the comet, the "witness tile". We requested sliced of the "witness tile" aerogel and this critical sample is on the way to our lab. We hope to analyze it soon and may report our final interpretation at the conference.

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References: [1] Meshik A., Hohenberg C., Pravdivtseva O., Frank, D. and Zolensky M. (2009) *Meteoritical Society Meeting*, Nancy, Abstract #5285, [2] Palma R. L., Pepin R. O. and Schlutter D., (2009) *Meteoritical Society Meeting*, Nancy, Abstract #5319. [3] Ott U. and Begemann F. (2000) *Meteoriics and Planeary Science* 35, 53-63. [4] Pat-El I., Laufer D., Notesco G. and Bar-Nun A. (2009), *Icarus* 201, 406-411, [5] George Flynn, personal communication, July 2009.