HELIUM AND NEON ISOTOPIC COMPOSITIONS FROM STARDUST AEROGEL PARTICLE TRACKS.
R. L. Palma[1,2], R. O. Pepin[2], D. Schlutter[2] and J. Simones[1]. [1]Dept. of Physics and Astronomy, Minnesota State Univ., 141 Trafton N., Mankato, MN 56001 (russell.palma@mnsu.edu); [2]Dept. of Physics, Univ. of Minnesota, 116 Church St. S.E., Minneapolis, MN 55455.

Introduction: Aerogel impacted by cometary particles during the Stardust Mission resulted in bubbles and fragments along the incoming tracks. We have investigated the possibility that noble gases degassed from particles during their impact might still be trapped within the aerogel. Helium and neon isotopic compositions were determined in a) flight spare aerogel; b) flight aerogel without any apparent cometary material; and c) three aerogel fragments from the same melted aerogel bulbous "turnip" wall analyzed by Marty et al. and reported in [1].

Results: Flight spare material was analyzed to determine the feasibility of noble gas measurements in bulk aerogel. A 0.5cm^2 sample of flight spare block E226-5B was heated from 50°C to about 1000°C in eleven one hour steps. During each step a residual gas analyzer scanned from 1 to 50u. The ^{4}He, ^{20}Ne and ^{40}Ar peaks were orders of magnitude smaller than the primary gas constituents, H_2, H_2O, CO, and CO_2. The partial pressures of He, Ne, and Ar in the system never exceeded 10^{-8} Torr at any time.

To more accurately investigate He and Ne release, all other samples were analyzed in a static noble gas mass spectrometer with detection limits of approximately 1 x 10^{-14}, 6 x 10^{-13}, and 2 x 10^{-13} ccSTP for ^{3}He, ^{4}He, and ^{20}Ne, respectively. Samples were mounted in small platinum packets and pyrolized by step heating in a technique similar to that used for lunar grains [2] and IDPs [3]. Aerogel volatiles may be separated into two categories: gas from the Stardust encounter, and gas from all other sources. Gas may have been trapped within bubbles formed as cometary particles melted aerogel along the particle's entry path, or may still be trapped within the small debris that survived the encounter with the Stardust collector intact. Gases intrinsic to the aerogel may lie on surfaces and/or be trapped within the aerogel.

To examine possible intrinsic sources, a 1.5mm^2 sample from flight spare block E226-5B was heated in nine 15 second steps from 300 to 1330°C and then reheated using the same procedures. The reheated values determined the sytem blank. In the initial heating, the ^{4}He abundance was 1.6 x 10^{-11} ccSTP below 1000°C, increasing at 1330°C to 2.9 x 10^{-11} ccSTP. In the reheat, the ^{4}He abundance was 2.1 x 10^{-11} ccSTP, whereas ^{3}He and ^{20}Ne were indistinguishable in the initial and reheat runs (at ~1.3 x 10^{-14} and ~2.1 x 10^{-13} ccSTP, respectively). These data suggest that a small intrinsic ^{4}He component may be present in the aerogel, but show no evidence for intrinsic ^{3}He or ^{20}Ne. Blank analyses were repeated for keystone CO44, a ~1.5mm^3 sample excised from a flight aerogel cell containing no visible cometary material. It was initially heated to 200°C for 20 seconds to release contamination loosely trapped in the sample or sample holder, then heated in three 15 second steps at 1140, 1250, and 1330°C, with cumulative gas measurements taken after the final heating step. ^{3}He, ^{4}He and ^{20}Ne concentrations were indistinguishable between cold blanks, the 200°C heating, the 1330°C initial heating, and a 1330°C reheating (system blank). These blank levels were similar to those found in E226-5B, but in this case with no evidence for any ^{4}He intrinsic to the aerogel.

Marty et al. (reported in [1]) measured ^{4}He, ^{20}Ne, and neon isotopic compositions from particle track samples contained within two Stardust aerogel pieces 0.26 and 0.30 mm^2 in area. Andrew Westphal (Space Sciences Lab, U. C. Berkeley), under the auspices of the Isotope Preliminary Examination Team led by Kevin McKeegan, provided three samples (Figures 1-3) from the same material (c2044,0,41; tile 44, track "7", "Thera") left over from that provided to Marty et al.

Discussion: Results from the three Stardust particle track samples are shown in the table below, along with those of Marty et al. (reported in [1]). A major surprise of all three pyrolyses was that helium and neon did not evolve from the samples below approximately 1000°C, suggesting that either the gas was held in very retentive sites within the aerogel, or that the gas evolved from very fine refractory particles along the molten track(s). The similarity between the helium and neon results of this report's Stardust 1 and Thera

2 [1] is striking, particularly the neon isotopic composition. Both samples show a slightly elevated $^{20}Ne/^{22}Ne$ ratio, compared to earth's atmosphere, and similar $^{4}He/^{20}Ne$ values that are far less than the solar value of 650 [4].

The extremely low neon concentrations observed in Stardust 2 and 3 made accurate isotopic determinations difficult, although both were clearly distinct from sample 1. The $^{3}He/^{4}He$ values from 1 and 2 are consistent within error and lie between the solar wind (4.57×10^{-4}) and Jupiter (1.66×10^{-4}) [4] or He-Q (1.23×10^{-4}) [5] values. Figure 3 shows a greater number of tracks in sample 3, so that may be one possibility for the tenfold increase in ^{4}He concentration in that sample. However, although ^{3}He concentrations were similar in all three samples (with highly reproducible blanks of ~1.2×10^{-14} ccSTP), the variability of ^{4}He blanks at the high temperatures required for gas release means that ^{4}He contamination cannot be ruled out for this sample.

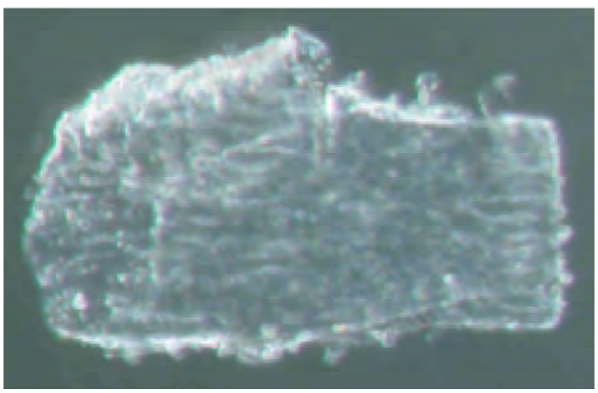

Figure 1. Stardust 1

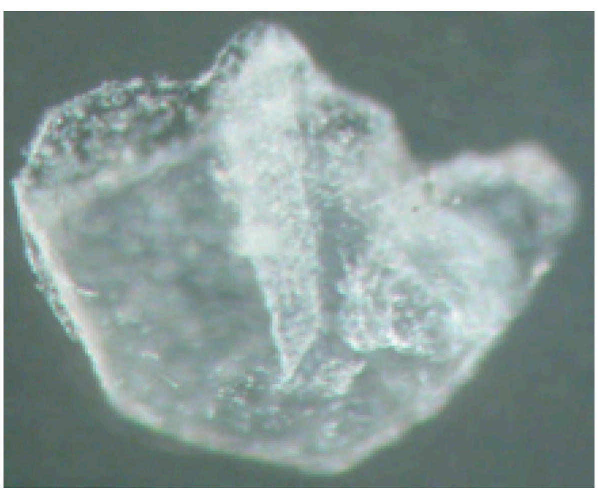

Figure 2. Stardust 2

References: [1] McKeegan K. D. et al. (2006) *Science, 314*, 1724-1728. [2] Palma R. L. et al. (2002) *GCA, 66*, 2929-2958. [3] Palma R. L. et al. (2005) *Meteoritics & Planet. Sci., 40*, A120. [4] Wieler R. (2002) *Rev. Mineral. Geochem., 47*, 21-70. [5] Ott U. (2002) *Rev. Mineral. Geochem., 47*, 71-100.

sample	^{4}He ($\times 10^{-11}$ ccSTP)	$^{3}He/^{4}He$ ($\times 10^{-4}$)	$^{4}He/^{20}Ne$
Stardust 1	6.02 ± .30	3.51 ± 0.37	1.30 ± 0.10
Stardust 2	4.00 ± .20	3.21 ± 0.54	16.5 ± 1.7
Stardust 3	≤60.8 ± 2.6	≥0.427 ± 0.038	≤181 ± 19
Thera 1[1]	53 ± 17		21.4 ± 4.9
Thera 2[1]	17.5 ± 3.8		3.0 ± 1.3

sample	^{20}Ne ($\times 10^{-11}$ ccSTP)	$^{20}Ne/^{22}Ne$	$^{21}Ne/^{22}Ne$
Stardust 1	4.64 ± .23	10.55 ± 0.21	0.0271 ± 0.0024
Stardust 2	0.243 ± .022	5.6 ± 1.6	0.053 ± 0.015
Stardust 3	1.03 ± .054	8.7 ± 1.4	0.042 ± 0.014
Thera 1[1]	2.47 ± 0.65	12.9 ± 3.2	0.0245 ± 0.0029
Thera 2[1]	5.80 ± 0.43	10.49 ± .24	0.0279 ± 0.0017

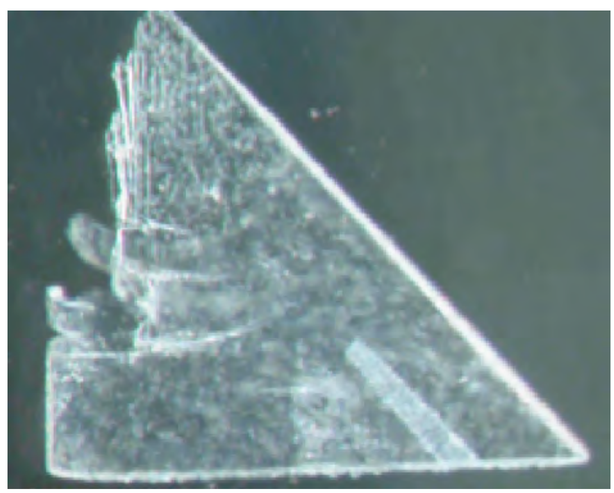

Figure 3. Stardust 3