HELIUM AND NEON ISOTOPIC AND ELEMENTAL COMPOSITION IN DIFFERENT SOLAR WIND REGIME TARGETS FROM THE GENESIS MISSION. V. S. Heber[1], H. Baur[1], D. S. Burnett[2] and R. Wieler[1]; [1]Isotope Geology and Mineral Resources, ETH, 8092 Zürich, Switzerland, heber@erdw.ethz.ch; [2]CalTech, JPL, Pasadena, CA 91109 USA.

The Genesis mission was a solar wind (SW) sample return mission. SW samples the solar photosphere which serves as a proxy for the composition of the Sun and the solar nebula. The spacecraft carried five passive collector arrays, each equipped with 54 single hexagons of different materials. Two B/C-arrays were deployed during the entire collection period and sampled the bulk SW. The L-array collected the low speed and the H-array the high speed SW. The E-array was only deployed at transient states of SW, the coronal mass ejections (CME). Possible differences in the composition of the three SW regimes would be important to understand SW acceleration mechanisms and to rule on the extent of fractionation between solar photosphere and SW. Here, we present preliminary data on the He and Ne elemental and isotopic composition for different regime targets with a special emphasis on differences between the SW regimes.

Experimental: He and Ne were analysed in a set of DOS (diamond-like carbon on silicon) targets (sample pieces ~3 x 4 mm) representing the four different SW regimes: B/C (samples 60253, 60067), L (60256), H (60242), and E (60239). DOS is a very suitable material for analyses of He and Ne. Due to the low atomic mass of C backscatter losses are minor for He and negligible for Ne. Even more importantly, fractionation of the He isotopes due to backscattering is very minor (see below). Also, the diamond-like C is very hard and therefore DOS targets have very few "hard-landing" induced surface damages compared to other targets. The hard surface also allowed cleaning of the targets by rinsing in ultapure water in a megasonic device (J. Allton, Genesis sample curator, personal communication 2006). This efficiently removed particles.

Noble gases were released by rastering a 213nm UV laser over small target areas (0.02-0.05mm^2 for He and ^{4}He/^{20}Ne, and 0.1-0.3mm^2 for Ne analyses) and measured with a very sensitive mass spectrometer [1]. We extensively tested possible fractionation effects on isotopic and elemental ratios by measuring spots with different circumference/area ratios. The ablation process did not cause any edge effects, e.g. enrichment of ^{3}He over ^{4}He or ^{4}He over ^{20}Ne. All samples were corrected for blanks, measured on spare flight material. Blank corrections were insignificant.

In order to detect small differences between SW regimes, uncertainties had to be minimized and the drift of the mass spectrometer to be controlled. This was achieved by analyzing He isotopes, Ne isotopes and ^{4}He/^{20}Ne ratios in three separate runs each with the standard-sample-bracketing method. As "standard" we used the analyses of the B/C target 60253, "samples" were the L, E, H, and B/C (60067) targets. Ablated

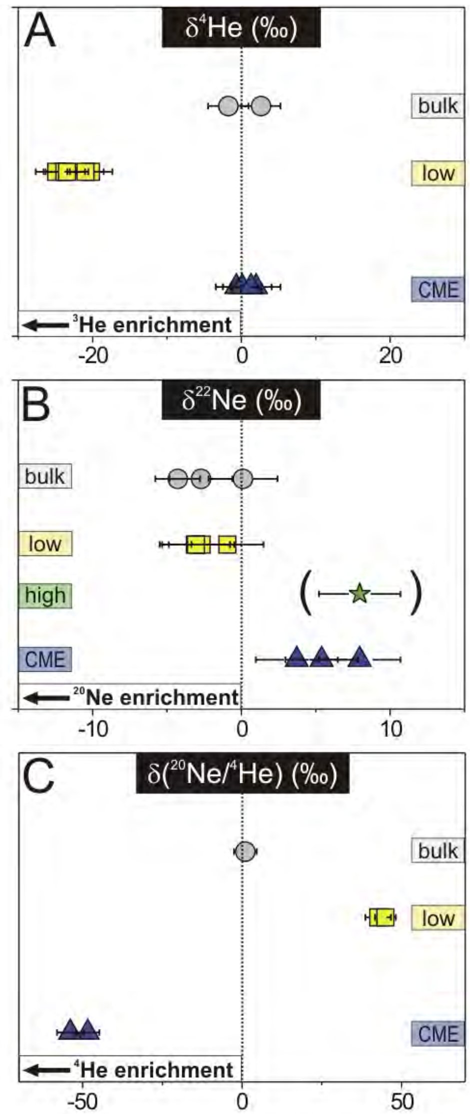

Fig. 1. Permil deviations relative to bulk SW of ^{4}He/^{3}He (A), ^{22}Ne/^{20}Ne (B) and ^{20}Ne/^{4}He (C) measured in low speed (yellow squares), high speed (green stars), and CME (blue triangles) SW regime targets. The high speed SW is shown in brackets only in B (see text). Grey circles represent a 2nd bulk SW DOS sample that serves to verify the analytical method.

areas were adjusted to match concentrations between different regimes. "Sample" error bars in Fig. 1 represent 1-σ uncertainties and include the errors of the bracketing "standards". The standard deviation of 22 ^{4}He/^{3}He ratios analysed in B/C is 1.9‰, of 15 ^{20}Ne/^{22}Ne ratios (B/C) 1.9‰ and of 9 ^{4}He/^{20}Ne ratios (B/C) 4.3‰. External calibrations for absolute isotope and elemental ratios were done with calibrated amounts of pure standard gases. However, absolute ^{4}He/^{3}He and ^{4}He/^{20}Ne ratios reported are preliminary since standard gas volumes need to be further cross-calibrated.

Ratios plotted in Fig. 1A and 1C are corrected for fractionation due to backscattering. The backscatter loss of ^{3}He, ^{4}He, and ^{20}Ne, ^{22}Ne was modelled for 13 and 5 different SW speeds, respectively, using the SRIM simulation [2]. Results were weighted by SW speed distributions for each regime measured during the Genesis collection period. Simulated loss fractions depend on the regime and range from ~1.3-2.8% for ^{3}He and ~0.8-1.7% for ^{4}He. A maximum backscatter loss of ^{20}Ne simulated for a very low SW speed (250km/s) is predicted to be 0.007, thus, loss of Ne in C targets due to backscattering is negligible. Correction of measured ^{3}He/^{4}He and ^{4}He/^{20}Ne ratios are only up to ~1.1% and 1.7%, respectively. These maximum corrections refer to the L-target with a high proportion of low speed SW. Ne isotopic ratios have not been corrected as the maximum correction of the ^{20}Ne/^{22}Ne ratio at 250km/s would be mere 0.005%.

No SW fluence data can be provided from our data so far, since laser raster areas have yet to be determined. Roughly, E and L targets each contain about one third of the He and Ne of the B/C collector, as expected. A problem occurred with the H target, however, which only contained ~10% of the expected He but ≥ 90% of expected Ne. ^{4}He/^{3}He ratio in this target was also ~2 times higher than the hypothetical SW values, though reproducible in four analyses. Possibly, an uppermost thin layer of very homogeneous thickness chipped off from the C coating removing most of the implanted He, whereas Ne remained in the target. However, according SRIM this would be unexpected since the implantation depths of He and Ne are similar. An alternative explanation is that our H target actually is not DOS but pure Si, which has high diffusivities for He and Ne [3], although ellipsometry data by the Genesis sample curation team appear to rule this out. At the conference we will present data on a second high speed SW DOS target.

Results: Our preliminary ^{4}He/^{3}He ratio for the bulk SW is 2074±15, the uncertainty reflecting the standard deviation of 22 B/C measurements. This is on the very low end of reported SW values [4,5]. More importantly, we observe a small but significant enrichment of ^{3}He in the low speed SW by 23±2‰ (Fig. 1A), whereas the ^{4}He/^{3}He ratio in CME and bulk targets are identical. It is very unlikely that the difference between low speed and bulk SW is an artifact due to erroneous backscatter correction. An enrichment of light species in the very slow SW is also observed in depth profiles of implanted noble gases in the Genesis bulk metallic glass by [6] and explained by fractionation due to inefficient Coulomb drag [4].

The average ^{20}Ne/^{22}Ne and ^{21}Ne/^{22}Ne ratios in the 2 bulk SW targets (total 18 analyses) are 13.81±0.03 and 0.0328±0.0001, respectively. Both values agree well with published SW Ne data [5,7,8]. In contrast to He, observed relative differences in Ne isotopic composition between the SW regimes and bulk SW are only marginally significant (Fig. 1B). The CME-SW seems to be somewhat enriched in ^{22}Ne compared to bulk SW (δ^{22}Ne= 6±2‰, 1-σ). Ne in the low speed SW may be slightly enriched in ^{20}Ne (δ^{22}Ne= -2.4±1‰). This potential enrichment is in accordance to the observed ^{3}He enrichment in low speed SW. However considering error bars and data from the second bulk SW sample also shown in Fig. 1B this difference is not significant. The data point for the high speed SW is shown in brackets since we cannot exclude a partial loss of Ne (see above). No differences in the ^{21}Ne/^{20}Ne were observed for different SW regimes.

The preliminary average ^{4}He/^{20}Ne ratio in the bulk SW target is 673±3. The stated error reflects only analytical uncertainties as further cross-calibrations of the standard gas reservoirs are pending. The two regimes for which data are available so far show clearly different He/Ne ratios (Fig. 1C). The CME-SW is enriched in ^{4}He by 51±4‰ whereas the low speed SW is depleted in ^{4}He by 44±4‰ relative to ^{20}Ne and bulk SW. The depletion of the light element relative to the heavier one in the low speed SW is in contrast to observations made for the isotope data and needs further investigations.

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