ISOTOPIC AND ELEMENTAL COMPOSITIONS OF AR, KR, AND XE IN BULK, SLOW, AND FAST SOLAR WIND TARGETS FROM GENESIS N. Vogel[1], H. Baur[1], D.S. Burnett[2], V.S. Heber[3], and R. Wieler[1]. [1]Institute for Geochemistry and Petrology, ETH Zurich, Switzerland. nadia.vogel@erdw.ethz.ch. [2]CalTech, JPL, Pasadena, USA. [3]Earth and Planetary Sciences, UCLA, Los Angeles, USA.

Introduction: A major objective of the GENESIS mission is to determine the noble gas composition of the bulk, slow, and fast solar wind (SW) [1]. Bulk collector arrays were exposed to the SW over a total of ~853 days, “regime” targets collecting ions of the slow interstream wind and the fast wind emerging from coronal holes were exposed for ~334 and ~313 days, respecticely [2]. A third regime collector array was exposed to SW related to coronal mass ejections (CME) for ~193 days [2]. We present bulk SW heavy noble gas isotopic and elemental compositions. A part of these results was published as preliminary data by [3]. Bulk data will be compared to our first heavy noble gas results from regime targets sampling fast and slow SW. We anticipate to present also data from the CME collector array at the conference.

The ultimate goal of Genesis is to infer the solar composition from that of the SW. Therefore one needs to correct for fractionation effects that many elements and isotopes experienced on their way from the photosphere into the SW. Such effects are, e.g., fractionation according to the first ionization potential (FIP) or by inefficient Coulomb drag (see, e.g., [4] and references therein). No independent measurements of the heavy noble gas composition of the solar photosphere exist to quantify element fractionation. Thus, element fractionations for heavy noble gases have to be indirectly inferred by comparing analyses of SW of different regimes, which may reveal systematically different degrees of deviation from the solar photospheric composition.

Experimental: We performed 14 analyses of ^{36,38}Ar, ^{84,86}Kr, and ^{129,132}Xe on CZ-Si exposed to the bulk SW. Additionally, we separately measured ^{82,83,84,86}Kr and ^{132,134,136}Xe, respectively, on three bulk collector CZ-Si targets each. Assuming that the isotopic composition in the different SW regimes does not differ, so far we only measured ^{36}Ar, ^{84}Kr, and ^{132}Xe on two CZ-Si targets exposed to the slow and fast SW, respectively. Regime data given here are preliminary. Noble gases were extracted by UV laser ablation from areas of 10-50 mm^2 releasing noble gas concentrations of usually at least 10 times above the blank limits for Xe and several 10 times for Kr. Blanks were determined by analyzing cold procedural blanks, lasering pieces of non-flown CZ-Si, and re-extracting already ablated areas of flown CZ-Si. Material and re-extraction blanks are for ^{36}Ar, ^{84}Kr, and ^{132}Xe in atoms/cm^2 in the range of 1-2x10^7, 1-3x10^5, and 0.3-1.3x10^5. As for the sample measurements, also the data regression of the material and re-extraction blanks is not trivial and sometimes represents a major source of uncertainty of our final noble gas results.

Results: Bulk SW fluxes of ^{36}Ar, ^{84}Kr, and ^{132}Xe in ions/(cm^{2}s) are 402 ± 20 (identical to the ^{36}Ar flux deduced from DOS targets [3]), 0.167 ± 0.01 and 0.0166 ± 0.0015. Preliminary fluxes of ^{36}Ar, ^{84}Kr, and ^{132}Xe in the slow and fast SW are very similar and amount to about 415, 0.188, and 0.019 ions/cm^2 s (slow wind) and 387, 0.175, and 0.016 (fast wind) ions/(cm^{2}s), respectively. Element ratios ^{36}Ar/^{84}Kr and ^{84}Kr/^{132}Xe in the bulk, fast and slow SW are plotted in Fig. 1.

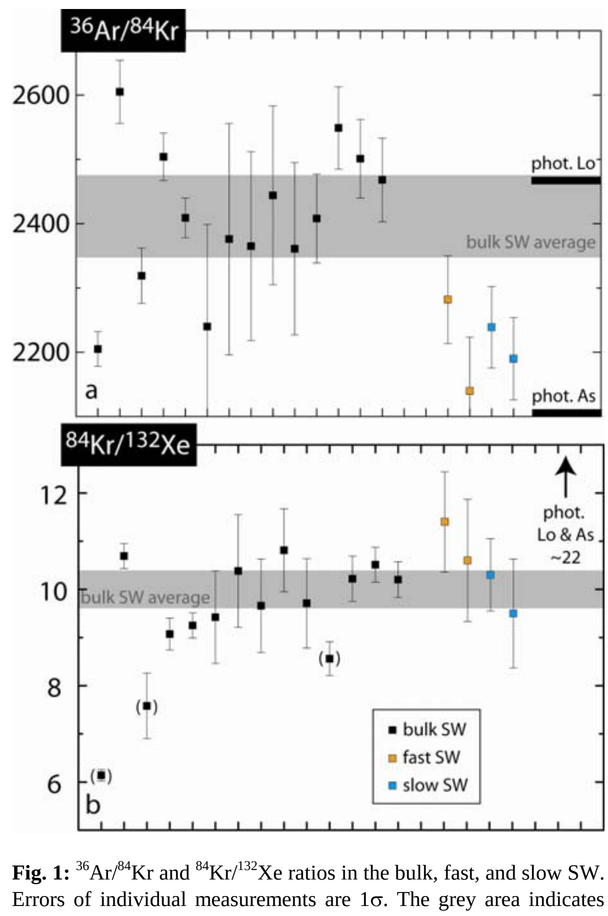

Fig. 1: ^{36}Ar/^{84}Kr and ^{84}Kr/^{132}Xe ratios in the bulk, fast, and slow SW. Errors of individual measurements are 1σ. The grey area indicates the average bulk SW with the 2σ standard error of the mean. Due to technical problems, data points in brackets are excluded from the average. Photospheric values are from [5] and [6].

Within uncertainties, fast and slow SW ^{84}Kr/^{132}Xe ratios are identical to those in the bulk SW (Fig. 1b). All regime ^{36}Ar/^{84}Kr ratios are slightly lower than the average bulk SW value, though still in the range of the individual bulk SW measurements.

The goal of the isotope analyses of Kr- or Xe-only in three bulk SW CZ-Si targets each was to reduce as much as possible analysis time and thus the uncertainty emerging from regression of individual peak readings to gas inlet time. The resulting ^{82}Kr/^{84}Kr, ^{83}Kr/^{84}Kr, and ^{86}Kr/^{84}Kr ratios (not shown) are within their rather large uncertainties identical to bulk SW data from lunar regolith samples [7] and to the terrestrial atmosphere [8]. Genesis bulk SW ^{129}Xe/^{132}Xe, ^{134}Xe/^{132}Xe, and ^{136}Xe/^{132}Xe ratios are shown in Fig. 2 relative to terrestrial atmospheric composition.

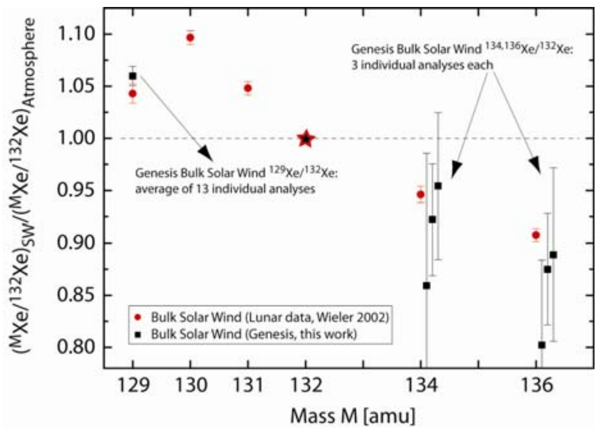

Fig. 2: Xe isotopic ratios of Genesis bulk SW relative to terrestrial atmospheric composition [8] and ^{132}Xe. Also shown are bulk SW data from lunar samples [7]. See text for further information.

Also shown are lunar bulk SW data of [7]. Within uncertainties, Genesis Xe isotopic ratios are identical to lunar bulk SW data and show the well known fractionation pattern relative to Earth's atmospheric composition [9]. The large error bars of the Genesis ^{134}Xe/^{132}Xe and $^{136/132}$Xe ratios represent 1σ errors of the individual measurements. In contrast, the ^{129}Xe/^{132}Xe ratio has a precision comparable to that of the lunar data, as it represents an average of 13 individual analyses with the 2σ standard error of the mean. This illustrates that performing more analyses of the other Xe (and also Kr) isotopes will certainly reduce the uncertainties of these ratios as well.

Discussion & Outlook: There is by now a good data base on the heavy noble gas elemental and (for some isotopes) isotopic composition of the bulk SW as collected by Genesis. The data generally agree well (cf. [10]) with bulk SW data from lunar samples [7, 11, 12], which until now have been the only source of heavy noble gas compositions in the SW.

According to Fig. 3 Xe in the SW is enriched compared to the solar photosphere [5], while the lighter noble gases including Kr are depleted. The nominal Kr/O ratios of both SW regimes are few % higher than the Genesis bulk value, however all values are identical within uncertainties. Similarly, Fig. 3 shows that the Xe/O in the slow SW is slightly higher than in the fast SW, which would be in line with the general observation that at least low FIP elements in the slow SW are more fractionated relative to the photosphere than in the fast wind (cf. Fig. 3). However, only a larger regime dataset will show if such differences really exisit beyond the limits of uncertainty. We hope to enlarge the regime dataset (including CME targets) until the time of the conference, which should ultimately help us to better understand and quantify the fractionation effects between the Sun and the SW.

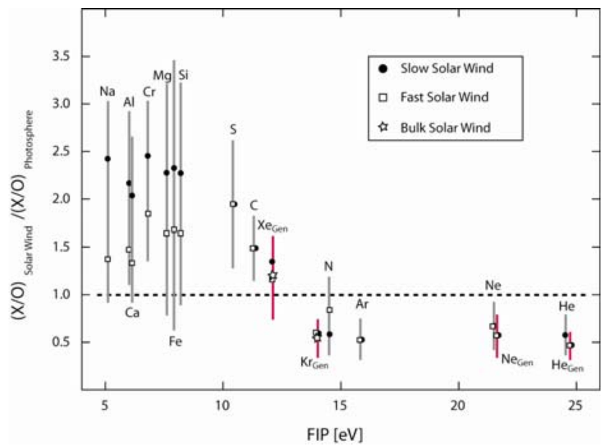

Fig. 3: Element/O ratios in the fast and slow SW compared to photospheric compositions as a function of the first ionization potential of the elements. Genesis He and Ne ratios are from [3], photospheric and SW abundances are from [5] and [4], respectively. Our noble gas data are anchored to oxygen via the Ar/O ratios of the fast and the slow SW provided by [4].

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