BULK SOLAR WIND Na AND K MEASURED IN GENESIS COLLECTORS. K. D. Rieck[1] (krieck1@asu.edu), A. J. G. Jurewicz[1], D. S. Burnett[2], R. L. Hervig[1], P. Williams[3], and Y. Guan[2]. [1]SESE, ASU, Tempe, AZ, 85287-1404 USA; [2]Geological & Planetary Sciences, Caltech, Pasadena, CA 91125 USA; [3]School of Molecular Sciences, ASU, Tempe, AZ, 85287-1604 USA.

Introduction: Traditionally, solar abundances are estimated using spectroscopic or meteoritic data. The Genesis sample return mission collected solar wind (SW) as an alternative direct measurement. We studied bulk SW Na and K in returned Genesis collectors to compare with the above estimates. This work is intended to better define the baseline for solar-abundances as used in Cosmochemistry, and test a predicted process of SW formation.

Current Status: This study used SIMS analysis at ASU (Cameca ims 6f) and Caltech (Cameca ims 7f) to measure bulk SW Na and K in two different Genesis SW collector materials (diamond-like carbon (DlC) and silicon (Si)) for comparison with traditional solar abundance references. Analysis of two materials at two institutions is for validation of the SW values obtained. That is, if analytical techniques are appropriate, if SW has been retained in the collector and is not affected by wafer cleaning or other peripheral handling, then the SW values obtained from both collector materials should be statistically identical.

Data in Figures 1 and 2 were obtained using both SIMS instruments. Sample preparation for both front-side and backside depth profiles (FDP and BDP, respectively), analytical techniques, and the intricacies of calibrating the data, are described in great detail in [1] and [2].

Current Results: The Genesis SW K fluence is 5.1e09 (±8e08) atoms/cm^2, with significant scatter in measurements from both DlC and Si collectors. Scatter is commensurate with the low fluences, so further work using the techniques applied in this study is unlikely to change the value or the error.

Our current best value for SW Na is 1.01e11 (+9e09, -2e10) atoms/cm^2, an average of values from DlC and Si collectors. Unlike SW K, all but one of the SW Na measurements in DlC suggest that the SW Na fluence is 5($\pm$1)E10, or 50% of the combined (DlC and Si) value (Fig. 2), much lower than that measured in Si in both this study and previously [3].

Initially, we assumed that the discrepancy between SW Na data in DlC and Si was a DlC issue: DlC is a handmade material that can undergo changes in material properties when H (e.g., from SW) is introduced [1]. To date, we have excluded all reasonable hypotheses for an analytical discrepancy caused by the DlC. We now suspect that there may be unresolved mass interferences in the Si data. One DlC measurement resulted in a Si-like SW Na value. This may represent a Si contaminant causing a similar interference, or from an inaccuracy in the profile model used for separating the reference ion signal from that of the SW.

Two potential interferences are $^{29}Si^{16}O^{1}H^{2+}$ (MRP: 151,586) and $^{28}Si^{16}O^{1}H_2^{2+}$ (MRP: 5,781). Although these doubly-charged molecules would be produced in Si at very low levels, Genesis SW Na is only present at a very low level.

Planned Experiments: The plan is to check for interferences in SW Na data from Si using backside depth profiling in Si, as detailed in [1 - 3]. One sample will be a thinned Genesis fragment; the other will be a thinned, low-energy plasma source ion-implanted (PSII) sample [4] with H content and distribution similar to that acquired in flight by Genesis collectors. On the Genesis collector we will measure “SW ^{23}Na” as usual, as well as mass 22.5, which would indicate the presence of $^{28}Si^{16}O^{1}H^{2+}$. In the implant, which should contain absolutely no Na, we will simply measure “SW ^{23}Na” as usual. Obtaining mass 22.5 profiles in the Genesis sample and a correspondingly lower profile at “SW ^{23}Na” in the Na-free H-implant will indicate the presence of a high-MRP interference in Si- and Si-bearing DlC. If there is no indication of a signal at mass 22.5 or in the Na-free H-implant, we will conclude that the discrepancy between values in DlC and Si is unsolvable at present, and continue to use the average (DlC + Si) SW Na value.

Discussion and Conclusions: These measurements were primarily made to better define the baseline for solar-abundances used in Cosmochemistry by using pristine solar material instead of modeled spectra or analog meteorites. But, first the SW needs to be corrected for fractionation incurred during ionization and acceleration of the material from the Sun into the SW.

Spacecraft evidence suggests that any elemental fractionation from solar abundances occurring during SW formation is related to the ease of ionization of the element, as represented by the element’s first ionization potential (FIP). There are two competing hypotheses concerning FIP fractionation: Either (a) there is a FIP threshold (speculated to be 8-9 eV) below which all elements in the Photosphere go directly into the SW without fractionation [e.g., 5], or (b) there is no threshold and very low FIP elements are fractionated [6]. Figure 3 is a compilation of Genesis data (normalized to Genesis Mg [7]) for elements with < 8 eV FIP, designed to help distinguish between these hypotheses. K (K.R) and Na (K.R.) are from [1] (this study), Al and

Cr are estimates that still require precise calibration, Mg and Fe are from [7], and Ca is from [8]. Figure 4 shows how our Genesis K and Na data (normalized to Genesis SW Mg [7]) compare with CI chondrite data.

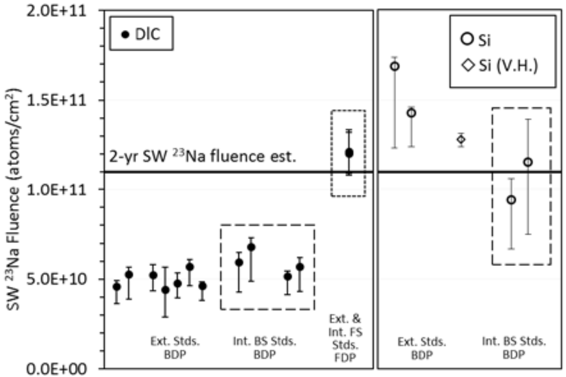

Fig. 1. SW ^{23}Na fluence data from Genesis DlC and Si. Ext. / Int. Stds. = calibrated by external/internal standards, respectively. BS/FS = Back-/Front-side reference ion implant. BDP/FDP = Back-/Front-side depth profile. Errors (this study) based on curve-fitting error. Technique details in [1, 2]. 2-year fluence estimate from [9].

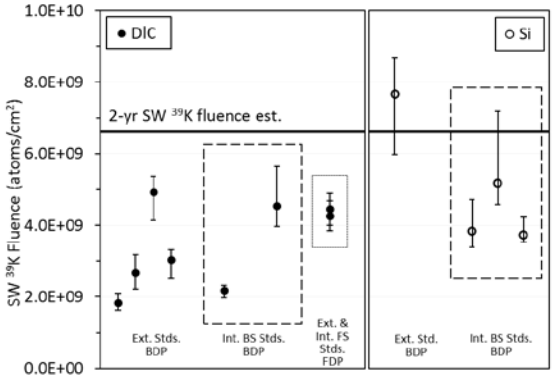

Fig. 1. SW ^{39}K measurements in Genesis DlC and Si. Same notation as in Fig. 1. Errors based on curve-fitting error. Technique details in [1, 2]. 2-year fluence estimate from [9].

Our averages (DlC + Si) have large errors, but are centered near the predicted abundances. Our average SW K abundance is reasonably consistent with solar data (Photosphere and chondrite data), albeit *slightly lower*. Only Na data from Si (e.g., Na (V.H.) [3], calibrated as part of the present study), suggest enrichment in the SW relative to Mg consistent with FIP fractionation. However, if a mass interference (e.g., ^{29}Si^{16}O^{1}H^{2+}, MRP: 151,586) is found for SW Na data from Si, and these data are excluded, the remaining SW Na data from DlC would suggest either 1) Na depletion (caused by factors unrelated to or more significant than FIP), or 2) spectroscopic measurement error and chemical mobility of Na in the early solar system.

Determining what these data mean depends on whether the cause of our DlC vs Si discrepancy can be determined. These data may reflect uncertainty in the spectroscopic measurement of Na and K, some unidentified solar process, chemical mobility of K in early solar system materials, and/or some unidentified systematic measurement error in the present study.

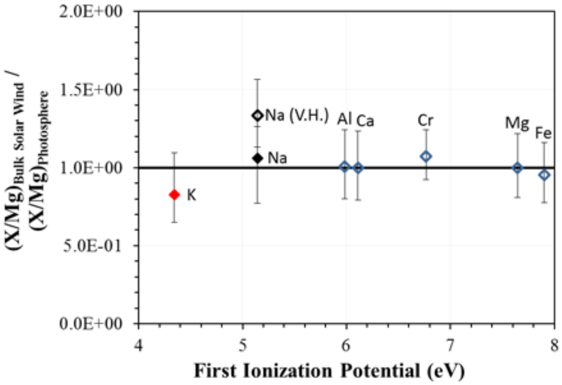

Fig. 2. Solar wind elemental fractionation from photospheric abundances. K.R. = this study. Other SW data from [3, 7, 8]. Photosphere data from [10].

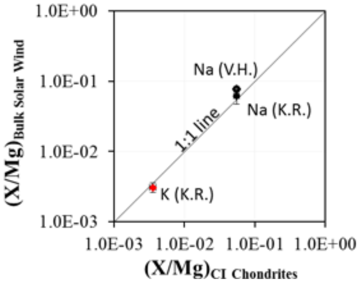

Fig. 3. Bulk solar wind Na/Mg and K/Mg abundances versus CI Chondrite abundances. K.R. = this study. V.H. from [3, 7]. Chondrite data from [10].

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