NEW CONSTRAINTS ON SW Mg ISOTOPES FROM UNDERSTANDING GENESIS DoS COLLECTORS, WITH IMPLICATIONS. A. J. G. Jurewicz[1], K. D Rieck[1,2], M. Wadhwa[1], D. S. Burnett[3], R. Hervig[1] , P. Williams[4], Y. Guan[3], R. Wiens[2] and G. R. Huss[5], [1]ASU (CMS / SESE, Tempe AZ 85287-1404, Amy.Jurewicz@asu.edu), [2]LANL (SSA, ISR-1, m/s D-466 Los Alamos, NM), [3]Caltech (GPS, m/c 100-10, Pasadena, CA), [4]ASU (SMC, Tempe AZ), [5]University of Hawaii at Manoa (HIGP, Honolulu, HI).

SW Mg isotope data from Genesis DoS (diamond-like carbon on silicon) from 2010 gives a plausible, non-zero fractionation when the diamond-like carbon (DLC) film is assumed chemically and structurally inhomogeneous. These results can be used to interpret other Genesis isotope data; e.g. O [1].

Introduction: In 2009-2010, an attempt was made to measure Mg isotopes in solar wind (SW) using Genesis DoS [2]. Mg isotopes are quite uniform in planetary materials: we can presume that they represent the solar value. Accordingly, accurate values for SW Mg isotopes quantify isotopic fractionation due to SW formation, thus allowing more precise interpretations of other Genesis isotope data of exceptional interest.

DoS is a unique, artisan, amorphous material, which, in 2010, seemed ideal for SW isotope analysis: low Z matrix, chemically resistant (contamination relatively easy to remove) and suppressed hydride formation during SIMS analysis using an O_2+ primary beam (no MgH+, lower MRP, more Mg cps).

In 2010 the derived Mg isotopes were extremely scattered, the measured SW Mg profiles had inconsistent shapes as well as both variable depths of implant and intensity of Mg cps (even when normalized to C cps: Fig. 1). The anomalies did not seem instrument related but were otherwise inexplicable if the DLC were uniform. Investigating the analytical effects of these variations has allowed us to rework the 2010 data, giving plausible explanations for the anomalies and constraining fractionation in SW Mg isotopes.

Experimental: SW Mg isotopes and C_2 and C matrix data, were collected by SIMS at ASU on (1) flight DoS and (2) an implant into flight-spare DoS. The $^{25}Mg/^{26}Mg$ ratio of the implant (determined by ICPMS) calibrated instrumental mass fractionation (IMF). Procedures included front-side depth profile using an O_2^+ primary beam, a 250µ raster, 60% DTOS, and a field aperture. Details are given in [2].

New Data reduction: Two alternate assumptions were used: (1) non-uniformities in SW profiles reflect inhomogenieties in DLC significant for SIMS measurements; (2) variations in (a) relative sensitivity factors (RSFs) for Mg/C and (b) IMF reflect local variations structure and chemical bonding in both the standard and flown DoS. Local anomalies in Genesis DLC include variable Si background (cf. Fig.1 inset), embedded particulates (rare), density variations, and departures in carbon sp2-sp3 ratios (graphite-diamond) resulting from annealing during fabrication [3].

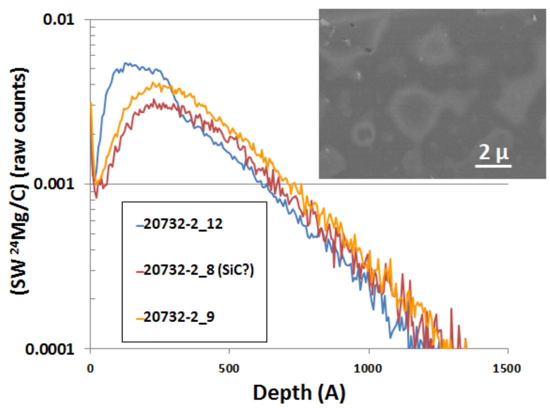

Fig. 1. Portions of 2010 SW ^{24}Mg depth profiles illustrating variable shape and intensity. Inset is backscattered electron image displaying unusually large-scale patchy texture. Only Si and C was visible in EDS.

To understand these inhomogenieties, we looked at multiple parameters which might reflect variations in local structure in hope of finding correlations. Unfortunately, Si was not included in the 2010 SIMS data. However, SW peak depth and shape parameters; sputtering rates; C cps and C_2 cps (normalized to primary beam intensity); etc., were tested for correlations. C_2/C is used here.

Results: Figure 2 shows the entire 2010 data set sorted by the C_2/C of the DLC. The error is included in the marker size. SW ($^{25}Mg/^{24}Mg$) and SW ($^{26}Mg/^{24}Mg$) pairs are connected by tie lines. The data pair in the oval averaged 3200 C-cps vs. 7700 C-cps. Since Si is an intrinsic, variable contaminant in DLC, and SiC grains have been seen in non-Genesis DLC, this data pair may represent an SiC composition. Perhaps the lower relative C_2/C reflects a higher SiC component in the matrix. Data pairs with open markers have variable, unexpectedly shallow SW ^{24}Mg peak depths consistent with the presence of Si. Note: Si could aid sintering in the DLC, making it more dense. The $^{26}Mg/^{24}Mg$ of open markers increase with decreasing C_2. This 26 excess is not explained by any existing model. However, the only plausible experimental explanation is an unresolved interference (*i*) at mass 26. *i* = $(^{28}Si^{12}C_2)^{++}$ seem the most likely, but it remains to be determined whether $(SiC_2)^{++}$ is sufficient in both

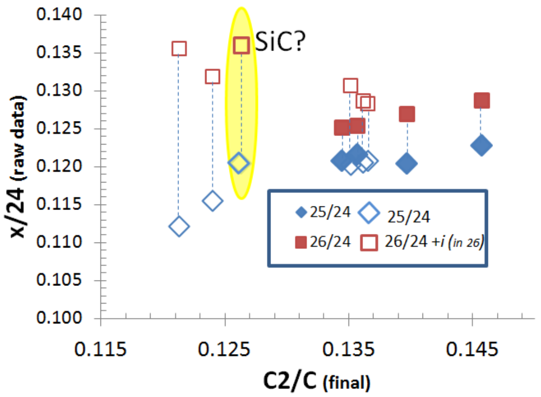

Fig. 2. All SW results vs. C_2/C. Squares and diamonds as indicated; 1σ analytical error size of marker. Tie lines connect pair from same analysis. Pairs with open markers have exess " ^{26}Mg", likely a Si-based molecular interference (i). SW Pair highlighted by oval had half the C cps, consistent with being an SiC grain.

stablity and abundance to explain the observed discrepancy. The open diamonds with lowest C_2/C have anomalously low $^{25}Mg/^{24}Mg$: at high matrix Si (SiC), an interference at mass 24 could exist, or there may be non-linear sputtering through carbide grains.

Figure 3 illustrates the data reduction of SW (solid markers, Fig. 2). The brown line in Figure 3a is a regression fit of SW $^{26}Mg/^{24}Mg$ vs. C_2/C (R^2=0.996); the blue line is half the slope of the regression (the correlation expected from IMF). The fit to SW $^{25}Mg/^{24}Mg$ data is estimated. The C_2/C of the IMF vs. that of the SW is shown.

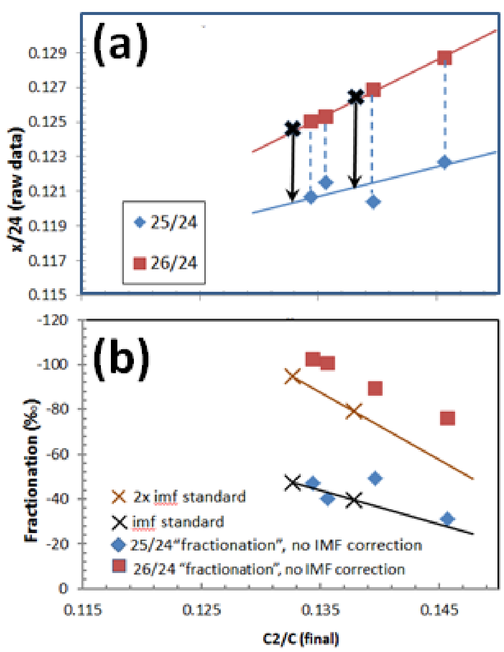

Fig. 3(a,b). Data reduction technique. SW vs. C_2/C as per Fig. 2. (a) *Lines: brown = regression of raw SW $^{26}Mg/^{24}Mg$; blue = visual fit of raw SW $^{25}Mg/^{24}Mg$ at 1/2 brown slope. Heavy black crosses are C_2/C of IMF implant standards(two of four SW pairs are bracketed). (b) X and lines = IMF implied by standard (brown $^{26}Mg/^{24}$;black $^{25}Mg/^{24}$). SW 1σ error = marker size.*

Figure 3b plots the apparent fractionation of SW from solar (no IMF) and compares it to the extrapolateed IMF calculated from the standard (all vs. C_2/C).

Figure 4 gives the data after IMF subtraction; i.e. fractionation of each ($^{26}Mg/^{24}Mg$, $^{25}Mg/^{24}Mg$) relative to assumed solar (0,0). The red dot is what might be expected from solar physics [after 4].

Synopsis: A new reduction of previously-reported Genesis SW Mg-isotope data gives a (25, 26) fractionation of (-4±8‰, -16±8‰) from assumed solar, where 8‰ is the 2σ error of mean plus 2‰, 4‰ (to compensate for error in IMFs of $^{25}Mg/^{24}Mg$ and $^{25}Mg/^{24}Mg$, respectively). This value is consistent with both that calculated from theory [4] and estimated previously from Genesis data [5]. A non-zero isotopic fractionation less than theoretical was assumed in order to interpret Genesis solar oxygen isotopes [1].

Features of Genesis DoS make it tempting for isotopic analyses by SIMS. However, data from both standard-implants and flown collectors also suggest significant issues: e.g., spatial variation in IMF, variable Si concentrations, occasional Mg contamination at periodic annealing layers and small Mg-bearing embedded particulates. These variabilities in the DoS must be accounted for during data reduction.

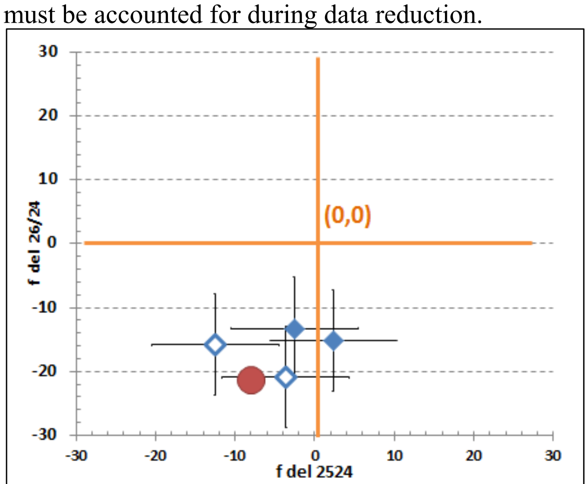

Fig. 4. SW Mg isotopes relative to assumed solar (0,0). Open markers: data not bracketed by IMF standard Red circle: theoretical fractionation after [4].

References: [1] McKeegan K. D. et al. (2011) Sci. 1528-1532. [2] Rieck K. D. (2010) LPS IVI,Abs#2391 [3] Alam T. M. et al. (2001) Proc. Amer. Chem. Soc., Thin Film Colloidal Sect., San Diego, CA 4/1-5/2001. [4] Bochsler P. (2000) Rev.Geophys. **38**, 247-266 [5] Humayan M. et al. (2011) *LPS IVII abs#1211*