Solar Wind Elemental Abundances from GENESIS Collectors

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Why Fe/Mg:

Background

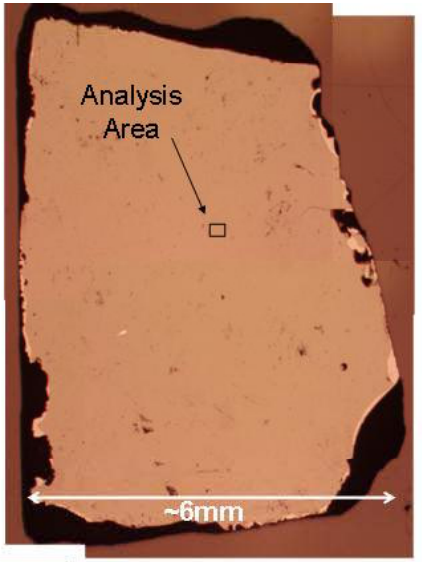
Solar wind elemental abundances are a major Genesis Science Objective. Spacecraft studies have shown that elements with first ionization potential (FIP) > 9 eV are fractionated relative to those with lower FIP compared with the solar photosphere; however, among elements with FIP<9eV (which make up most of the terrestrial planets) there is no evidence of fractionation. A major goal of Genesis is to provide a higher precision test of the lack of fractionation for FIP<9eV.

Bulk solar wind analyses were made by SIMS on silicon (Si), Sandia diamond-like-carbon (DoS), and epitaxial silicon-on-sapphire (SoS) using the ASU 6f and UCLA 1270 instruments. Fluences are calculated relative to implant standards.

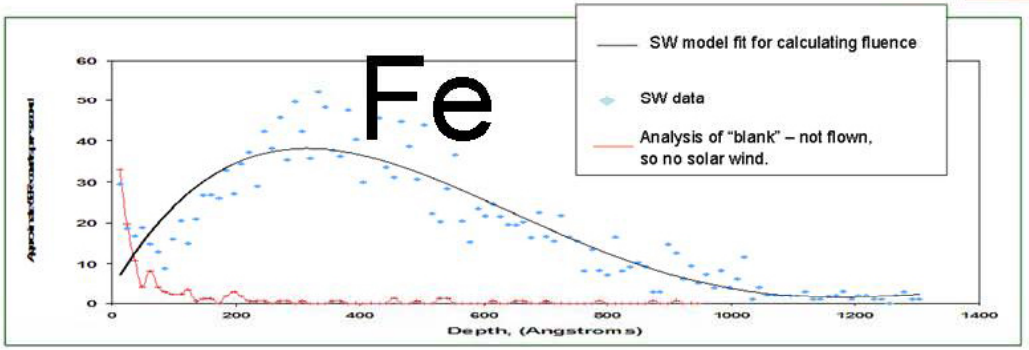
Technique:

Quantification of Solar Wind

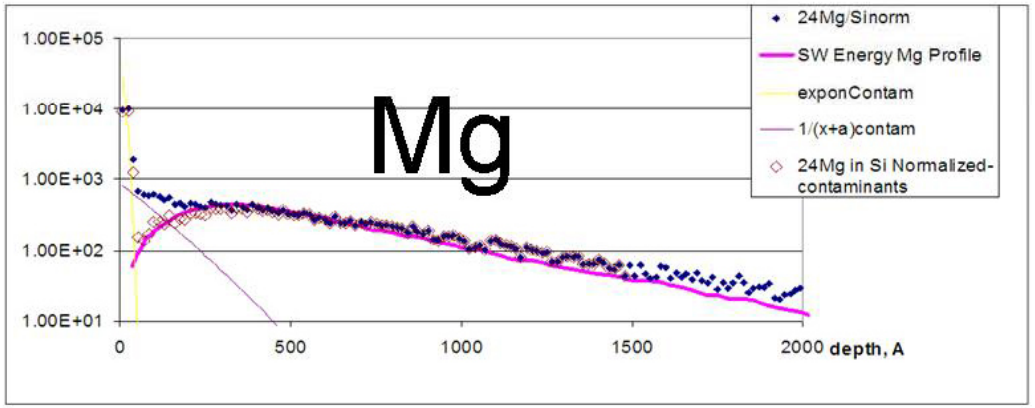
- n(x) = atoms/cc = RSF (cpsMg/cpsSi)(x) (1)
- Fluence = RSF ∫ (cps Mg/cps Si) dx (2)
- Measure RSF from known implant fluence from (2).
- Calculate solar wind fluence from (2) with RSF



A clean collector surface makes fluence calculations straight-forward.



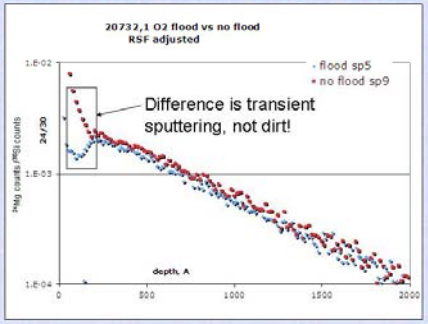
A dirty collector surface requires taking the deeo portion of the solar-wind profile and extrapolating it to the surface. Surface contamination is approximated.

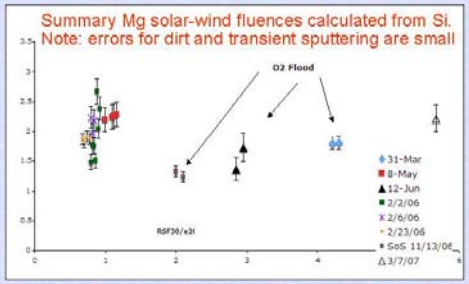


Complications to the basic technique:

Mg Fluence Summary and Analytical Issues

A. Transient sputtering effects

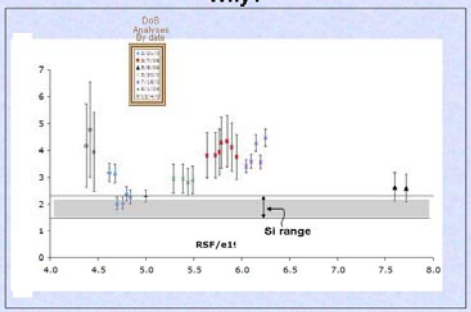




- Normalized flood/no flood profiles agree greater than 400A, but disagree below.
- Range of fluences overlap for flood *vs* no-flood.
- No-flood surface contribution is only about 25% of total so differences not expected.
- Accepting only flood data, Mg fluence is 1.65e^{12}/cm^2. An uncertainty of ±0.35 (20%) covers total range.
- Since there is really no good reason to not accept no-flood data, we can only say that the total observed range is from 1.3 to 2.4e^{12}/cm^2 with a midrange value of 1.8e^{12}/cm^2.
- Run-to-run variations (previous slide) outside of expected errors are unacceptable. Origins unknown.
- Agreement with theoretical depth profile from ACE Mg velocity distribution not good for either Si or DoS. Origins of differences not clear.

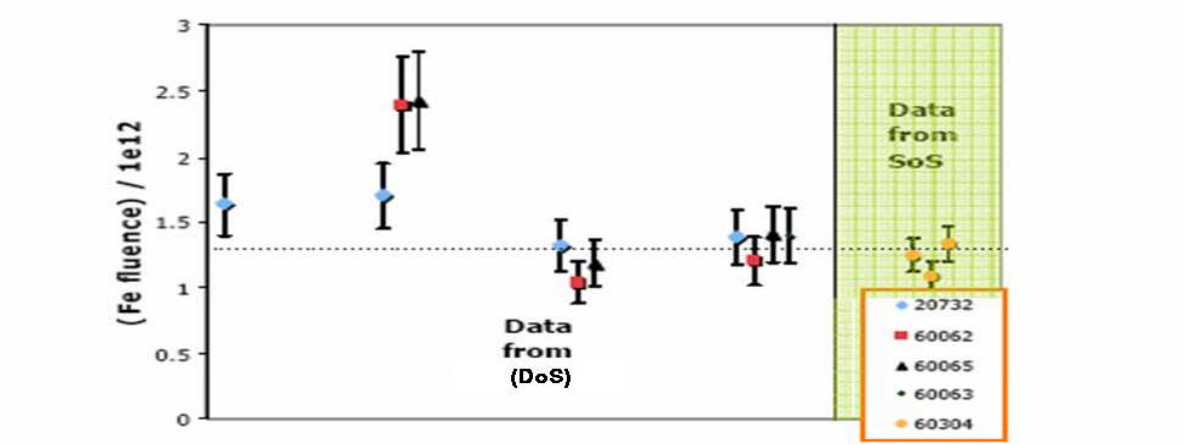
B. Discrepancy of Calculated Mg solar-wind fluence between Si and DoS collectors

Summary Mg solar-wind fluences measured in DoS are significantly different from those in Si. Why?

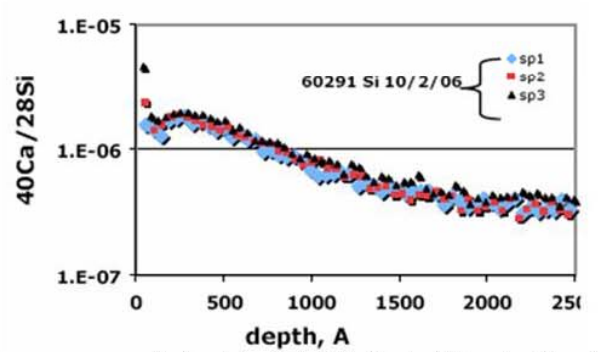


- Data points from individual profiles. Error bars represent % range of RSF derived from implants run on same day as sample.
- Beautiful depth profiles, but more scatter in derived fluences than for Si. Almost no overlap with range of Si fluences.
- Unlike Si, implant variability is significant. However, much of the range in RSF comes from deliberate variations in analytical conditions.
- When samples are sorted by date of analysis, in 4 of 6 cases, consistent SW fluences are obtained for that run. Variations among dates of analyses are larger, in many cases with deliberate variation of conditions, ***but never get fluence in Si range.***
- Since systematic errors are involved, we don't know whether the lowest or the highest fluences are most accurate. Range is from 2.3e^{12}/cm^2 to 4.4e^{12}/cm^2. Midrange is 3.35e^{12} ± 30%

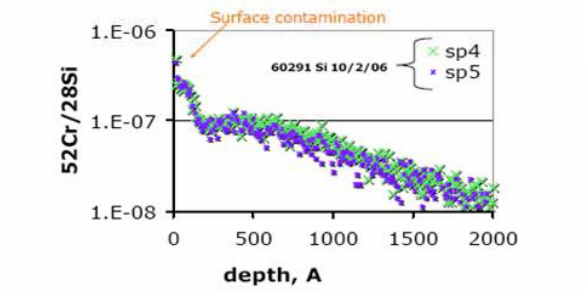
Fe, Ca, Cr, and Na fluence Summaries



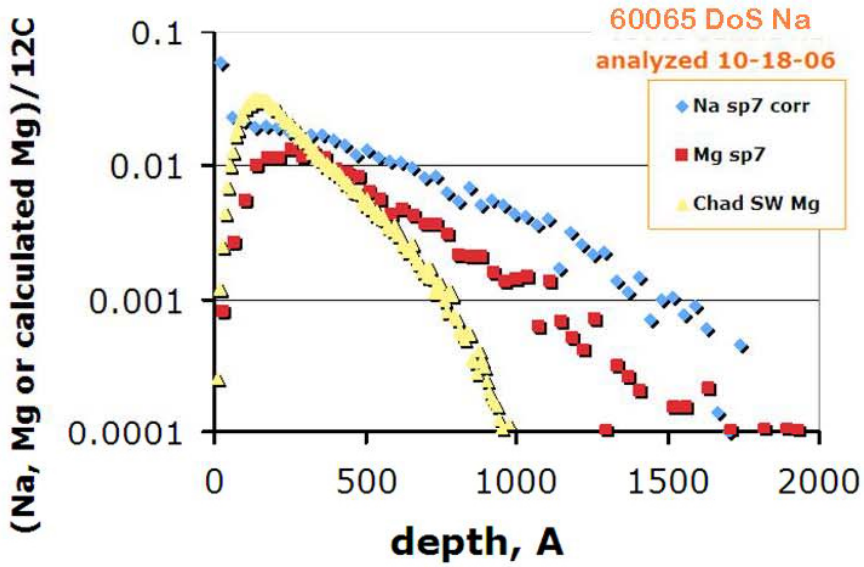
Summary of Fe from multiple analytical dates and collector materials



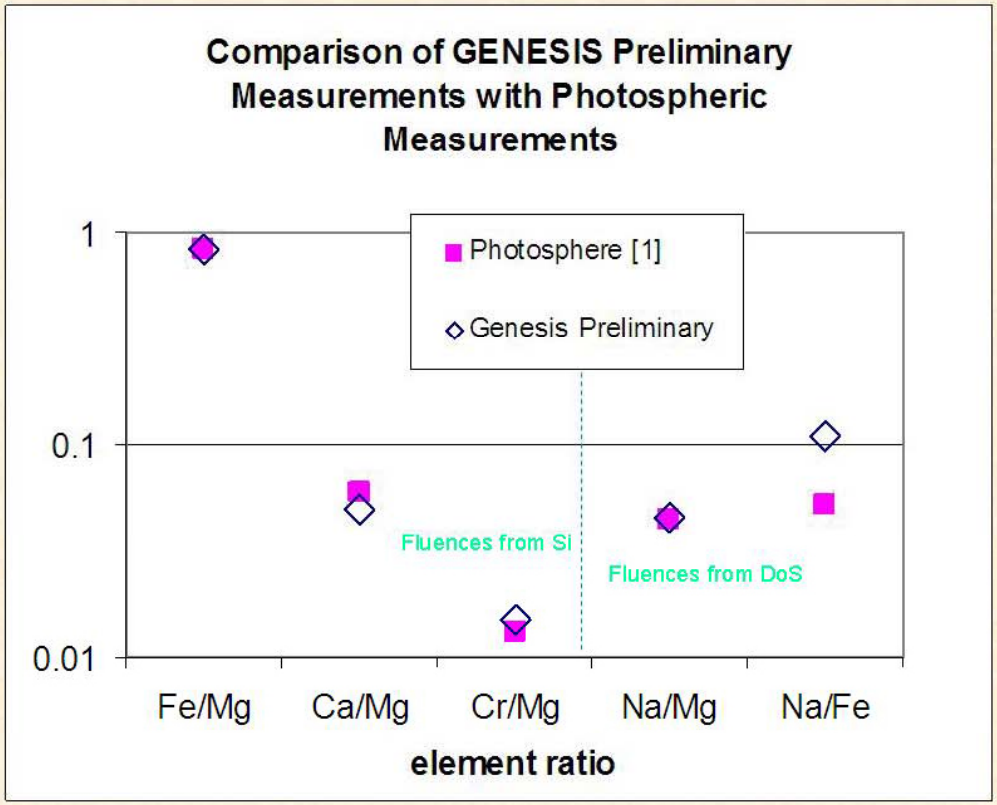
Ca measurements to date (3 in Si). Ca in Si is significant.



Two depth profiles for Cr. This is the first real attempt at Cr analyses; no special cleaning was tried for the removal of Cr surface contamination.



Cleaning has reduced surface contamination by over a factor of 100x. Although some contamination remains, 3 of 6 profiles agree at depths greater than 300Å. *Implant* profiles show no evidence for beam-induced Na migration. The Mg profile measured in the same sample differs from Na for reasons not yet known. Neither curve agrees with theoretical solar-wind depth profiles (e.g., Chad).



Preliminary Ratios are Close to Photospheric

- Future work will target understanding analytical issues (thereby refining measurements).
- Mg issues will be addressed by (1) measuring different materials and (2) implanting flight samples directly for internal standards.
- Work on other elements will be addressed at least in part by developing element-specific techniques for cleaning collector surfaces.