

THREE PROPOSED COMPENDIA FOR GENESIS SOLAR WIND SAMPLES: SCIENCE RESULTS, COLLECTOR MATERIALS CHARACTERIZATION AND CLEANING TECHNIQUES. J. H. Allton¹, M. J. Calaway², L. E. Nyquist³, A. J. G. Jurewicz⁴, D. S. Burnett⁵, ¹NASA Johnson Space Center, Astromaterials Acquisition and Curation Office, Houston, TX, Judith.h.allton@nasa.gov; ²Jacobs, NASA Johnson Space Center, Houston, TX, ³XI/NASA-JSC, Houston, TX, ⁴Arizona State University, Tempe, AZ, ⁵Caltech, Pasadena, CA.

Introduction: Planetary material and cosmochemistry research using Genesis solar wind samples (including the development and implementation of cleaning and analytical techniques) has matured sufficiently that compilations on several topics, if made publically accessible, would be beneficial for researchers and reviewers. We propose here three compendia based on content, organization and source of documents (e.g. published peer-reviewed, published, internal memos, archives). For planning purposes, suggestions are solicited from potential users of Genesis solar wind samples for the type of science content and/or organizational style that would be most useful to them. These compendia are proposed as living documents, periodically updated. Similar to the existing compendia described below, the curation compendia are like library or archival finding aids – they are guides to published or archival documents and should not be cited as primary sources.

Background on curation compendia: The Astromaterials Acquisition and Curation Office at Johnson Space Center has the responsibility to provide to the planetary and cosmochemistry communities information about the 8 collections curated by the office: Apollo lunar samples, Antarctic meteorite samples, Stardust Wild-2 comet samples, Stardust interstellar dust samples, Genesis solar wind samples, interplanetary dust samples collected by high altitude aircraft, microparticle impact samples, Hayabusa mission asteroid Itokawa samples. Curatorial information to assist in appropriate sample selection can be found online.

<https://curator.jsc.nasa.gov/curation.cfm>

One useful tool for those planning to request samples has been the lunar compendium, originally maintained by C. Meyer as a living document until his retirement in 2012. The introduction to the lunar sample compendium contains a broad overview of the science consensus on lunar history and the questions being debated. Detailed information on each sample can be accessed by sample number or petrographic type, along with a few special categories: soil, core, cosmic ray profiles, educational thin sections, and public display. A typical information sheet for a rock sample will include selected petrography, mineralogy, chemistry, radiogenic dating, cosmogenic isotopes and exposure ages. A short history of curation sample handling and family tree of subsamples created is also provided.

The meteorite compendia, currently updated under Kevin Righter's direction, are specialized. There is a Martian Meteorite Compendium, Lunar Meteorite Compendium (2013), HED Compendium (2011). The information sheets for each sample display information similar to that for the lunar rocks.

Genesis Solar Wind Sample Compendia: The compendia for lunar samples and meteorites are organized by sample number with groupings by sample type. This is useful for unknown rocky materials, but not for Genesis solar wind samples as sample numbers do not encompass unique genetic information. The planetary science objective of the Genesis mission was to determine precisely the elemental and isotopic composition of the solar nebula via direct laboratory measurements of solar wind. These measurements are extremely difficult to make, even with the best conditions. The hard landing on re-entry reduced the size of most collectors and contributed contamination which must be removed. Variables include analytical technique and correction factors, cleaning protocol, and choice of collector substrate. We propose three compendia. The first, a compendium of science results has the same objective as the existing compendia for the other collections. The second and third compendia are required because precise, accurate measurement requires the exact knowledge of the collector substrate and the effects from surface cleaning applied to samples to be analyzed.

Compendium of science results: The results to be reviewed/compiled will include peer-reviewed publications, as well as other published reports such as LPSC abstracts. What should be included? Possibilities for content are given in Table 1. How should it be organized so users can easily find information? Possibilities for organization of this content and cross-referencing are given in Table 2.

Table 1. Possibilities for type of science content.

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| <ul style="list-style-type: none"> • Element fluence results, precision • Isotope ratios results, precision • Analytical technique details, fractionation & blank corrections (e.g. internal standards via implantation) • Cleaning technique and validation that cleaning did not alter solar wind • Comparison to theoretical models • Comparison to measurements by others |
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Cross-referencing the variables that affect results is adaptable to online searching and data correlation by users; thus, making the information more accessible. [Note: a bibliography is currently maintained online in pdf format [1]. It could be beneficial to convert this to a searchable database, cross-linked to the compendium.].

Table 2. Possibilities for science organization and cross-referencing.

By element or element group
By solar wind regime (bulk, coronal mass ejection, high speed, interstream low speed)
By analysis technique (e.g. depth profiling, bulk dissolution or pyrolysis, backside profiling)
By collector material (silicon, sapphire, diamond-like carbon, gold, aluminum, germanium, concentrator targets)
By broad science objective <ul style="list-style-type: none"> • Solar nebula composition • Interactions between Sun and planetary materials • Solar physics
By detailed science objective [2] <ul style="list-style-type: none"> • Mg isotope • Fe isotope • C, N, O isotope, including regimes • Low FIP, high FIP • Isotopic composition non-volatile elements >Ar • Nebular gases or dust preferentially accreted to Sun (Se, Br, Kr, Rb, Sr) • Chondrites as proxy (Mn, Rb, Ga) • Ion-neutral induced chemical fractionation, sun-nebula (K, Na, Rb) • Chondrite volatile depletion (B, F, Cl, S, Zn, Se, Br) • Flux of late accreting planetesimals (Li, Be, B) • Modification of planetary materials by solar wind (radioactive, F) • Solar gravitational settling (siderophile heavy and light)

Compendium of collector material characterization: Because the solar wind measurements are exacting, accurate characterization of reference materials are crucial for valid results. The variety of collector materials has allowed measurement of solar wind in materials of differing matrix effects and differing ability to retain ions. While the 15 different collector materials used to capture solar wind are carefully described in [3], additional and more detailed information about material fabrication, characterization, bulk chemistry and surface cleanliness resides in archival documents. Proposed material characterization content is given in Table 3.

Table 3. Proposed material characterization content.

<ul style="list-style-type: none"> • Rationale for selection (early testing results) • Fabrication method, batch • Bulk composition • Surface cleanliness assessment
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Compendium of cleaning techniques and cleanliness assessment: In many cases, the collector surface needs to be cleaned before analysis of the solar wind. The variety of collector materials characterized in the second compendium has allowed application of several cleaning techniques, some quite harsh. At this time upon request, the curatorial staff can provide cleaning using ultrapure water (UPW) and IPA. Other sample cleaning efforts and the results have been undertaken by researchers.

Tracking the ongoing cleaning studies is difficult, as they are comprised of complex information from which few conclusions have yet been drawn. Much of this information resides in LPSC abstracts, internal reports and emails. Creative organizational skills can make this information more easily accessible. Proposed cleaning technique and cleanliness assessment content is given in Table 4.

Table 4. Proposed cleaning and cleanliness assessment content – both chemical and physical.

<ul style="list-style-type: none"> • Technique (e.g. ultrapure water, HF, nitric acid, RCA1 semiconductor method) • Cleanliness assessment (e.g. optical imaging, SEM imaging and elemental analysis, TRXRF, ToF-SIMS) • Validation that cleaning technique did not alter solar wind (e.g. implanted reference ions)

Summary: A compendium of Genesis science results is proposed, along with type of content and ways to organize the content for easy public access. Potential users for Genesis sample information are invited to suggest type of content and organization that would be beneficial to them. Companion compendia, for collector material characterization and sample cleaning techniques, are also proposed. These latter two compendia are crucial to accuracy and precision of measurements. Type of content and organization for these is also invited. Please contact the Genesis Solar Wind Sample Curator with suggestions: Judith.h.allton@nasa.gov

References:

- [1] Calaway M. J. [2] Burnett D. S. and Jurewicz A. J. G. (2016) *The Future of Genesis Science: a special report to NASA 1/15/2016*. [3] Jurewicz A. J. G et al. (2003) *Space Sci. Rev.* **105**, 535-560.