

National Aeronautics and Space Administration

Antarctic Meteorite Sample **INVESTIGATOR'S GUIDEBOOK**

Astromaterials Research and Exploration Science
Directorate/XI

Astromaterials Acquisition and Curation Office/XI2

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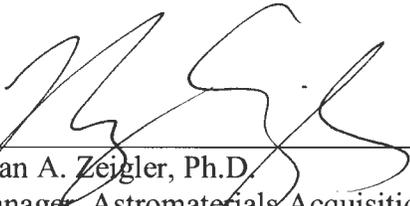
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1. Introduction - US Antarctic Meteorite Program

The US funded collection and curation of Antarctic meteorites, or the US Antarctic Meteorite program, is a cooperative effort among NASA, the National Science Foundation (NSF) and ANSMET, and the Smithsonian Institution (SI). The NSF, with decades of experience in exploring this harsh environment, provides support for field research and collection, and NASA and the Smithsonian Institution, as experts in curation of lunar samples and geologic specimens, respectively, provide for the classification, storage and distribution of Antarctic meteorites (Cassidy, 2003; Cassidy et al., 1992; Harvey, 2003; Graham and Annexstad, 1989; McCoy et al., 2008; Marvin and Mason, 1980; Allen et al., 2011; Righter et al. 2015; Corrigan et al., 2015; Harvey et al., 2015). As of 2016, the total number of samples recovered is ~22,000, and JSC curators have sent over 19,000 meteorite samples to roughly 600 scientists worldwide. The collection is among the largest in the world, and features samples from the Moon, Mars, and asteroids (Fig. 1).

2. Antarctic Meteorite Sample Collection and Curation

2.1 Collection and naming of meteorites

The US Antarctic meteorite program has recovered meteorites from many different geographic regions in the Transantarctic Mountains (Fig. 2). All samples found are collected, rather than high grading of samples in the field, in order to minimize bias. Samples are collected in the field and assigned a temporary five digit number upon collection. When samples are returned to NASA-JSC they are assigned an official name and number according to the guidelines set by the Nomenclature Committee of the Meteoritical Society; a three letter prefix abbreviates the geographic location (e.g., MIL = Miller Range), followed by either a 5 or 6 digit number. The first two numbers are from the year that the field season began (e.g. 2007-2008 samples have 07 as the first two digits. The remaining three or four digits are assigned to samples within that year's collection. In some years, more than 999 samples were collected in the same geographic location, so a fourth digit is used. In years where >999 samples are collected, but from different regions, it is usually possible to maintain five digit rather than six digit numbering, but there are exceptions to this. The official numbers are not assigned in the field, so they have no relation to the sequence in which the samples were collected, nor do they reflect size or importance.

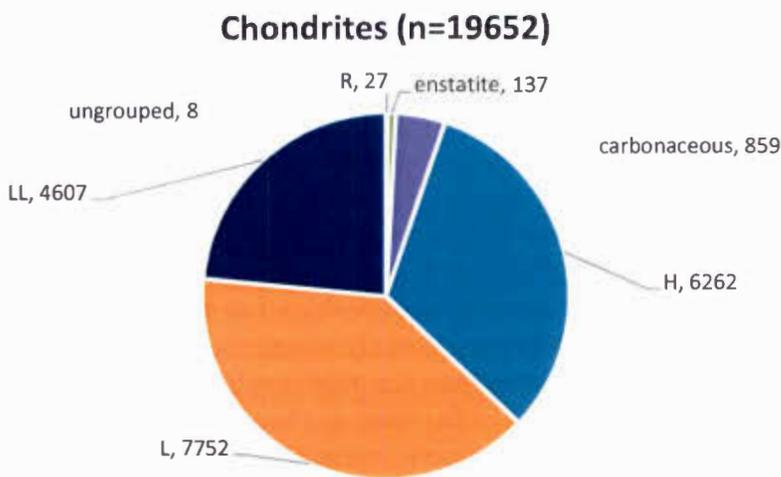
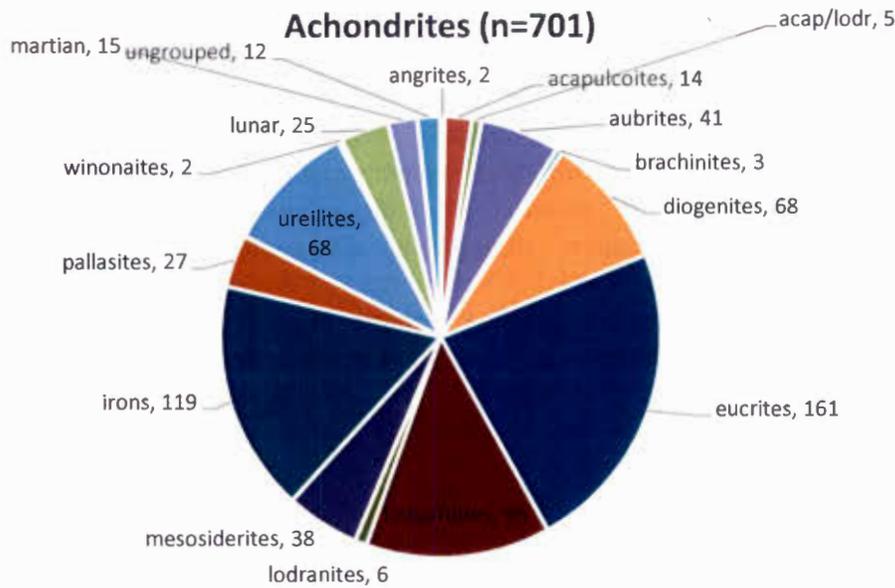


Figure 1: Pie chart showing distribution of meteorite types in the US Antarctic meteorite collection, as of January 2017.

2.2 Initial characterization of samples

Samples are kept frozen until they are ready for initial characterization and classification, upon which they are thawed in a cleanroom cabinet with continuously flowing nitrogen. Initial characterization at JSC includes weighing, photographing, and macroscopic description of interior and exterior. Samples chips are then prepared to send to the Smithsonian either as a thin section, chip for a thin section to be made at the Smithsonian (depending on the demand in the respective thin section labs), or for oil immersion or SEM classification of equilibrated ordinary chondrites. The minimum amount of information is obtained to make a reasonable classification of each meteorite. For example, oxygen isotopic measurements are only done in cases where the curators are truly stumped, or where the data can help distinguish between multiple possibilities. Subsequently, oxygen isotope analysis is rare and is only done on a handful of samples each year.

Similarly, only the minimum electron microprobe data are collected; the philosophy is that the samples will be characterized enough so that the community can recognize samples of importance or relevance to their research interests.

2.3 Announcements of sample availability

Since June 1978, the US Antarctic Meteorite Program has published a semi-annual newsletter reporting new meteorites and information about the US Antarctic meteorite program (*Antarctic Meteorite Newsletter*). In some years, the newsletter has had three issues instead of two, and there have been special editions of the newsletter reporting the availability of an unusual or rare new meteorite. The newsletter was originally prepared in hard copy form and mailed to PIs. Newsletters became available in an online version in 1993, and also had a PDF version. From that point until approximately 2003, there were online, PDF, and hard copy versions all available at the same time. In 2003, the Meteorite Working Group (MWG; see Section 4) decided that the hard copy version would only be sent to libraries and meteorite-related institutions, keeping the PDF and online versions available for all PIs. In 2005, the printed version was completely discontinued. Scanned versions of the early newsletters are available online, as well as the more recent web and PDF version: <http://curator.jsc.nasa.gov/antmet/amn/amn.cfm>

| Code | Site Name | Code | Site Name |
|-------------|---------------------|-------------|-------------------|
| ALH | Allan Hills | MAC | Macalpine Hills |
| BEC | Beckett Nunatak | MBR | Mount Baldr |
| BOW | Bowden Neve | MCY | McKay Glacier |
| BTN | Bates Nunataks | MET | Meteorite Hills |
| BUC | Buckley Island | MIL | Miller Range |
| CMS | Cumulus Hills | ODE | Odell Glacier |
| CRA | Mt. Cranfield | OTT | Outpost Nunatak |
| CRE | Mt. Crean | PAT | Patuxent Range |
| DAV | David Glacier | PCA | Pecora Escarpment |
| DNG | D'Angelo Bluff | PGP | Purgatory Peak |
| DEW | Mt. DeWitt | PRA | Mount Pratt |
| DOM | Dominion Range | PRE | Mount Prestrud |
| DRP | Derrick Peak | QUE | Queen Alexandra |
| EET | Elephant Moraine | RBT | Roberts Massif |
| FIN | Finger Ridge | RKP | Reckling Peak |
| GDR | Gardner Ridge | SAN | Sanford Cliffs |
| GEO | Geologists Range | SCO | Scott Glacier |
| GRA | Graves Nunataks | STE | Stewart Hills |
| GRO | Grosvenor Mountains | SZA | Szabo Bluff |
| HOW | Mt. Howe | TEN | Tentacle Ridge |
| ILD | Inland Forts | TIL | Thiel Mountains |
| KLE | Klein Ice Field | TYR | Taylor Glacier |
| LAP | LaPaz Ice Field | WIS | Wisconsin Range |
| LAR | Larkman Nunatak | WSG | Mount Wisting |
| LEW | Lewis Cliff | | |
| LON | Lonewolf Nunatak | | |

2.4 The collection at Johnson Space Center

2.4.1 Main collection

Newly arrived samples are temporarily stored in freezers which are set at -10 to -4 F. Once thawed, all other samples are kept at room temperature. Samples at JSC are stored in several different types of cabinets. Martian and lunar meteorites, a subset of more rare achondrites and chondrites, and all carbonaceous chondrites are stored in dedicated nitrogen cabinets. The remaining samples (mostly equilibrated ordinary chondrites) are stored in three different settings: large (> 500 g) samples are stored in large volume GN2 cabinets, medium-sized (20 to 500 g) samples are stored in two large GN2 cabinets with multiple trays, and small samples (< 20 g) are stored in air, bagged in nylon. Some exceptionally large samples are

triple bagged in air and kept in open shelves in the lab. One exceptional sample is LEW 85320, collected in the Lewis Cliffs Ice Tongue in 1985; a specialized nitrogen storage box was constructed for this sample and it resides in the meteorite lab where any personnel and visitor can observe it clearly in its plexiglass container.

2.4.2 Thin section library

A library of thin sections of all non-EOC (and some EOC; equilibrated ordinary chondrites) specimens with original mass >10 g is maintained at NASA-JSC. All enstatite meteorites thin sections are stored in electronic desiccators to avoid breakdown of water soluble minerals such as oldhamite. The library sections are not generally loaned out to PIs for research purposes, except in rare cases but for no more than 3 months. PIs are free to visit the facilities to examine thin sections at any time after their announcement in AMN.

2.4.3 Special samples

Because the collection is large, yet contains some very unusual, scientifically unique and important samples, a subset of samples have been placed on a special protected list. Requests for these samples can only be evaluated by the full MWG committee (see section 4). This list is re-assessed at every MWG meeting and thus has changed over the years. Some samples that were added many years ago may have been removed from the list as the collection has been augmented with similar samples. Some samples have moved onto the list as their remaining mass has become much smaller than the original mass yet scientific interest in the sample continues. A current listing of the special protected samples is too long to list here, but can be found on the NASA-JSC webpage: <https://curator.jsc.nasa.gov/antmet/forms/specialspring16.pdf>

2.5 The collection at the Smithsonian Institution

2.5.1 Irons and pallasites

Iron meteorites and pallasites are stored at the Smithsonian in the National Museum of Natural History. They are housed and maintained in dedicated auto-desiccators proximal to facilities uniquely equipped to cut and prepare irons and predominantly iron bearing samples.

2.5.2 Long-term storage facility

In the 1990s, storage space for Antarctic Meteorites at NASA-JSC became full and guidelines for managing the long-term storage of meteorites at the Smithsonian were developed. Because scientific interest in EOC is lower than other groups, and because there are so many EOC (~90%) in the US Antarctic meteorite collection, procedures were developed to transfer such specimens to the Smithsonian Institution for permanent long-term storage. Currently, if an EOC specimen at JSC has not been requested or allocated for ~4 to 5 years, it is a candidate for transfer. However, a small percentage of meteorites from each icefield are kept at JSC for long-term storage.

Long-term storage of all meteorites at the Smithsonian (except irons and pallasites) is located at the Museum Support Center in Suitland, MD. Meteorites

are stored in a class 10,000 cleanroom (completed in 2011) with 14 stainless steel nitrogen atmosphere glove-boxes. Meteorites are segregated into cabinets and pans by class. Samples, which are only removed for allocations, are enclosed in the same style and materials used at JSC. Sampling takes place on a cleanroom laminar flow bench. Tools, sample containers, and bags are made of stainless steel, aluminum, Teflon, or nylon. Polyvials are also used as sample containers - polystyrene vials with polyethylene lids.

Samples transferred to the Smithsonian become the property of the Institution and are not managed by or governed by NASA policies and procedures.

2.5.3 Thin section libraries SI

A library of thin sections of all non-EOC (and some EOC), including small ones with masses below 10 g, is maintained at the Smithsonian Institution. MWG does not in general advocate the loan of Smithsonian Institution (SI) library sections, in order to maintain one relatively complete library. However, in special cases, the SI library section may be loaned for a brief period (up to 2 weeks) by the SI curator with the consent of one other member of MWG.

2.5.4 Meteorite powder library

For many large meteorites collected during the early years of the ANSMET program, homogenized powders were prepared and archived at the Smithsonian. A full listing is reported in Jarosewich (1990).

3. Antarctic Meteorite Sample preparation

3.1 Materials used to process and store meteorites

At JSC, the meteorite samples are prepared several different ways and can be requested accordingly. Most samples are prepared as chips, obtained either by use of stainless steel chisels in a chipping bowl or using rock splitters. Tools, sample containers, and bags are made of stainless steel, aluminum, Teflon, or nylon. Polyvials are also used as sample containers - polystyrene vials with polyethylene lids. In cases where a meteorite will be subdivided into many pieces for scientific studies, the samples are cut dry on a bandsaw, producing a 1- to 2-cm thick slab. A listing of meteorites that have been cut or slabbed at JSC, along with details about sawing and possible effects on samples, is available at <http://curator.jsc.nasa.gov/antmet/bandsaws.cfm>.

3.2 Cabinet processing: carbonaceous chondrites and martian meteorites

Since 1978, carbonaceous chondrites have had a dedicated cabinet for processing due to the possibility that these samples contain unique organic compounds. Since 1997, martian meteorites have been processed in a dedicated cabinet, again due to the possibility that there are organic or other compounds that are specific to these samples, and to minimize the effects of handling under less clean conditions. On occasion, an additional cabinet will be cleaned for targeted processing of specific meteorites, such as lunar meteorites.

3.3 Flow bench processing

Cleanroom laminar flowbenches are used to process all other samples, and also for initial processing of new meteorites.

3.4 Thin and thick section preparation

The meteorite thin section lab at JSC can prepare standard 30-micrometer thin sections, thick sections of variable thickness (100 to 150 micrometers are common for LA-ICP-MS or microdrilling), or demountable sections using superglue for use in TEM studies. Water is not used in any part of the thin sectioning process, and instead light mineral oil and alcohol are used for the cutting grinding and polishing stages. Diamond grinding wheels are used on some samples, as well as a SiC slurry for lapping. Polishing compounds are typically diamond paste or diamond fluids, but alumina can be used as a final polish as well. Pure silica slides are available as a substitute for standard petrographic glass slides if necessary.

3.5 Iron meteorite and pallasite preparation at Smithsonian

Iron meteorites and pallasites are stored and processed at the Smithsonian. These meteorites, unlike other meteorite types, are stored at the National Museum of Natural History. The majority of these are stored in humidity controlled cabinets to reduce oxidation. Sample preparation facilities are specially equipped for cutting, polishing and sectioning irons and predominantly iron bearing meteorites. Iron meteorites and pallasites are cut using specialized composite (a hardened rubberized compound impregnated with abrasives) blades. Blade composition and sources can be provided upon request. Polished sections are made with standard epoxy and polished with diamond paste and aluminum oxide.

4. Antarctic Meteorite Sample Requests, request review, loan agreements and loans, and Allocations

Requests for US Antarctic Meteorite samples are welcomed from research scientists from around the world, regardless of their current state of funding for meteorite studies. Requests will be handled according to applicable US laws and regulations. Samples can be requested from any meteorite that has been made available through announcement in any issue of the **Antarctic Meteorite Newsletter** (beginning with 1(1) in June, 1978). Student requests should have a supervising scientist listed to confirm access to facilities for analysis. All sample requests will be reviewed in a timely manner (Fig 3). Requests are divided into two categories for evaluation:

1) Many requests for equilibrated ordinary chondrites and other more common or large meteorites can be reviewed by the NASA Antarctic Meteorite Curator and the Meteorite Steering Group, and if accepted, allocated within several months.

2) Requests which are not eligible for review solely by the NASA Curator are evaluated by the Meteorite Working Group (MWG). Such requests are divided into seven categories:

- a) Requests for samples announced in the most recent Antarctic Meteorite Newsletter.
- b) Requests for samples on the protected (or special) list.
- c) Requests for samples that are small (< 30 g) or rare.
- d) Requests made by new PIs.
- e) Requests for samples that are > 5 g of material.
- f) Requests for non-destructive analysis of large portions (>25% of an equilibrated ordinary chondrite, or >10% of any other meteorite) of the remaining mass of a sample.
- g) Requests for destructive analysis on a thin section of a sample for which there are <6 thin sections existing.

The Meteorite Working Group (MWG) is a panel of experts convened to advise the curators on sample allocation. The MWG meets twice a year, in late September and mid-

March. In addition to evaluating meteorite sample requests, MWG maintains and updates the Antarctic meteorite "special list": see section 2.4.3.

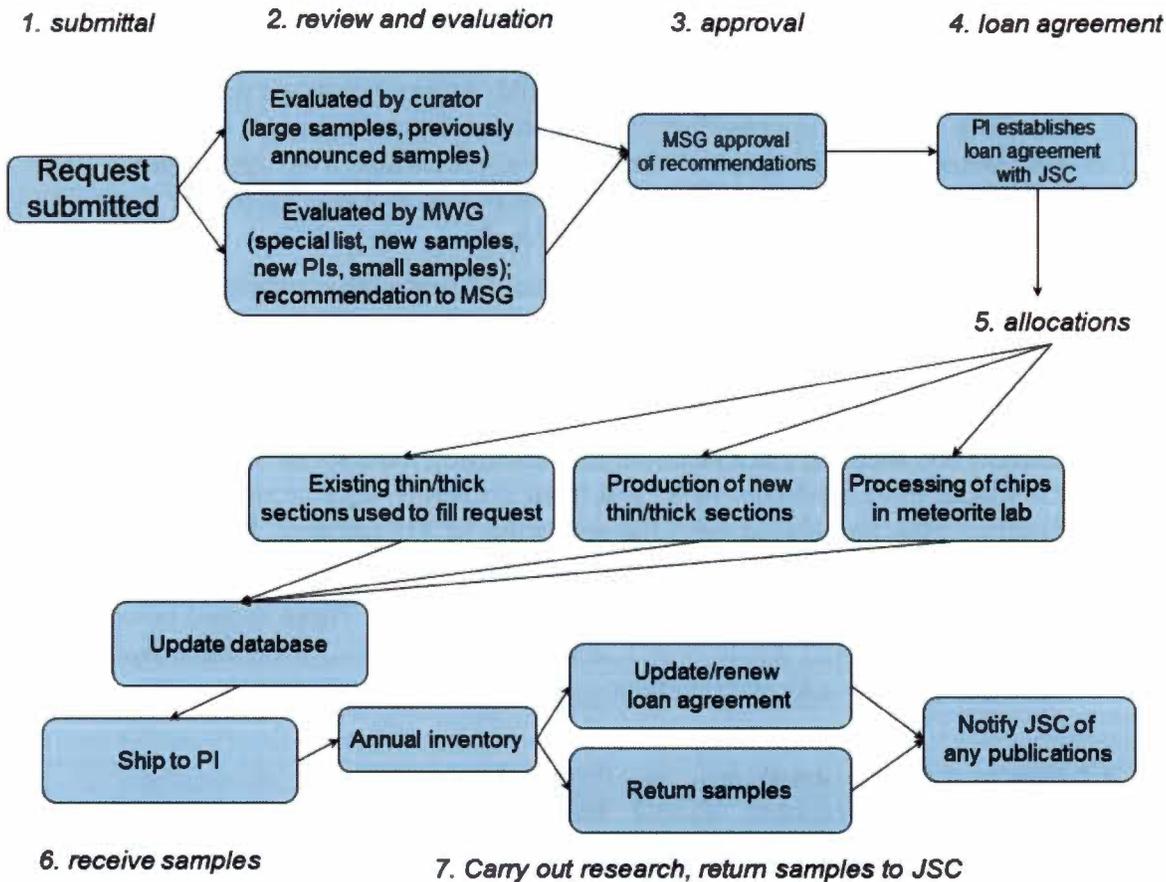


Figure 3: summary of steps involved in requesting samples, evaluating requests, receiving Antarctic meteorite samples, and returning them to JSC. Details are explained in sections 4 to 6.

Allocation recommendations from MWG must be approved by the Meteorite Steering Group, which consists of a representative of each of the agencies involved in ANSMET program – NSF, NASA, and the Smithsonian Institution.

4.1 General Proposal Guidelines - How to prepare a sample request

An electronic request form must be filled out for any Antarctic meteorite samples [<http://curator.jsc.nasa.gov/antmet/requests.cfm>]. All necessary information should be typed on the electronic form, although attachments that provide essential information that cannot be easily incorporated in the form are welcome (examples: Reprints of publication that explain rationale, flow diagrams for analyses, etc.).

Information required for making a sample request:

- a. Each request should accurately refer to meteorite samples by their respective identification numbers. The sample identification numbers are provided in the most current full sample listing [<http://curator.jsc.nasa.gov/antmet/statistics.cfm>], the Classification Database [<http://curator.jsc.nasa.gov/antmet/classdb.cfm#AdvSearch>],

or can be found in the Antarctic Meteorite Newsletters [<http://curator.jsc.nasa.gov/antmet/amn/amn.cfm>].

- b. Each request should provide detailed scientific justification for the proposed research.
- c. Each request should explain the specific requirements for the samples, such as sizes or weights, particular locations (if applicable) within individual specimens, or special handling or shipping procedures. For meteorites that are small, of rare type, or are considered special because of their unusual properties, it is very important that all requests specify both the optimum amount of material needed for the study and the minimum amount of material that can be used.
- d. Each request must explicitly state all planned destructive procedures. For thin and thick sections, this includes ion probe, laser ablation, etching, and repolishing (see §4.5).
- e. Consortium requests should list all members of the consortium, and explain their roles.
- f. Each MWG meeting has a deadline for submitting requests so that the committee has the information needed to make informed decisions. Any request received after the deadline may be delayed until the following MWG meeting. For the latest sample request deadline, see <http://curator.jsc.nasa.gov/antmet/requestdates.cfm>
- g. Please note that the request form has signature blocks. These should be used only if the form is sent via FAX or postal service to us. See *How to submit sample requests* (next section) for information about submitting sample requests.

4.2 How to submit a sample request - Proposal Submission

All sample requests should be made using the form (Appendix A) at: <http://curator.jsc.nasa.gov/curator/antmet/requests.cfm>

The preferred method of request transmittal is via e-mail to: JSC-ARES-MeteoriteRequest@nasa.gov

The subject line of the message needs to be "MWG Request."

If unable to e-mail the completed form above, make sample requests by mail or fax to:

Secretary, MWG

Mail Code XI2

National Aeronautics and Space Administration

Lyndon B. Johnson Space Center

2101 NASA Parkway

Houston, TX 77058-3696

FAX: (281) 483-5347

4.3 Proposal review

Sample request proposals are reviewed by the NASA Curator and the Meteorite Working Group (MWG), who presents their findings to the Meteorite Steering Group (MSG). In considering allocation requests, MWG assesses the scientific content of the proposal, capability of the proposers, availability of requested samples, and the realism of the investigation. MWG also weighs the overall merit of the proposal against the required

amount of sample. The MWG consists of nine scientists with diverse expertise within meteoritics. The membership term on MWG is three years, with systematic rotation of members to provide new points of view while maintaining continuity. The findings of the MWG must then be approved by the MSG, which is a three-person committee with representatives from NSF, NASA and the Smithsonian Institution.

4.4 Sample Allocation

Once a sample request is approved, allocation of materials can generally be made within several months following the MWG meeting. Chips from the meteorite processing lab can be prepared within 2 to 4 months. Thin sections that are already available in the collection can be sent within a few months. New thin sections may take up to 6 months to prepare, depending on demand.

4.5 Loans

Before any samples are allocated to a PI, a loan agreement between NASA and the PI must be established. This loan agreement is valid for 5 years, and is an umbrella agreement that covers loans of any meteorite materials during that period. At the end of the loan period, the PI must either renew the agreement or return the samples.

4.5.1 Categories of sample loans/allocations:

Loans fall into 5 categories. The category of loan for each specimen will be noted on the original loan paperwork.

Category A: Thin or thick section – non-destructive analysis. This category is for research using non-destructive techniques, “including, but not limited to” optical microscopy, scanning electron microscopy (SEM), standard electron microprobe analysis (EMPA), Fourier transform infrared (FTIR) spectroscopy, X-ray absorption near-edge structure (XANES) spectroscopy, and Raman spectroscopy. These samples are expected to be returned at the completion of the research.

Category B: Thin or thick section – destructive analysis. This category is for research using destructive analytical techniques, such as secondary ion mass spectrometry (SIMS), focused ion beam (FIB) extraction, laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), and microdrilling. High-current X-ray mapping by electron beam methods may result in damage to a variety of minerals, and is considered to be destructive analysis. These samples are also expected to be returned at the completion of the research. The investigator is expected to return some documentation of what damage was done to the section, using the destructive analysis form (Appendix D).

Category C: Chip – non-destructive analysis. This category is for research using a small piece or chip of a meteorite and a non-destructive technique, such as magnetic spectroscopy, UV-Vis, FTIR, Raman spectroscopy, or SEM analysis. These samples are also expected to be returned at the completion of the research. If a sample is approved to be powdered, for example for a spectroscopy study, we expect powders to be returned. Powders can be used for additional studies, and can be allocated by MWG and JSC. This category also includes educational sample loans.

Category D: Chip – destructive analysis. This category is for research utilizing sample preparation techniques involving digestion of samples in acid or other dissolution, heating, or melting procedures. These samples are not expected to be returned at the completion of the research, but *if material is remaining, it must be returned at the end of the loan period*. In such cases, the investigator is expected to return some documentation of what damage was done to the sample.

Category E: Chip – irradiation analysis. This category is for research utilizing sample analysis techniques involving irradiation of samples. These samples are not expected to be returned at the completion of the research, but *specific arrangements for such material should be made with the JSC curation group*.

4.5.2 Loan periods

Sample loans are generally for five years, although a sample of a rare or popular meteorite, or one with limited material available, may be loaned for a shorter period, such as one year, three months, or even one month. PIs wishing to retain material for study more than 5 years may apply to extend their loan by writing a justification to the JSC curator.

4.5.3 Destructive analysis of thin or thick sections

Any procedure that is likely to result in destructive change to a thin or thick section must be approved in advance. Usually this is part of the original sample request. In this case, approval will be noted on the original loan paperwork. If a PI determines after sample allocation that he/she wishes to do destructive analysis, a formal request must be made to the NASA curator, who will refer the request to MWG for review, when appropriate. Decisions on such requests will be expedited, so as to not hold up research efforts – they usually can be made within several weeks. In such cases the request will be handled as an addendum to the original request for those samples.

4.6 Return of loaned material

Samples loaned under categories A-C, and any material remaining from a category D loan, must be returned to the NASA Curator. PIs holding samples under category E should make special arrangements with the NASA Curator. Samples should be returned by the end of the loan period. PIs should coordinate with NASA-JSC Astromaterials Curation office for the shipping address and method.

All destructive analyses and other procedures that may have compromised a returned sample's usefulness for future study should be documented. For thin and thick sections, PIs may use the brief form (MF 76 – see Appendix D) to document destructive analyses. Along with the form, we request images of the destroyed areas – they can be back scattered electron (BSE), secondary electron (SE), or reflected light images.

5. Sample Security and Accountability

Antarctic meteorite samples collected by the ANSMET program are the property of the United States Government, are considered irreplaceable, and are therefore made available to investigators only under a carefully controlled and monitored program.

5.1 Antarctic Meteorite Investigators

All investigators must sign an Antarctic Meteorite Sample Loan agreement, which is an umbrella agreement that remains valid for no more than five years; both the PI and the NASA-JSC Astromaterials Curation office will maintain copies of this agreement. The agreement outlines the responsibilities for the PI to provide a secure storage location for the sample, annual or regular inventory updates, and responsibility to return samples (if applicable) when the research has been completed. Samples will not be allocated to any PI without the Sample Loan Agreement completed.

5.2 Sample Receipt

For individual samples, an Antarctic Meteorite Sample Assignment form will be issued with the sample, for each PI to sign for that specific sample (Appendix C). There is no additional paperwork, other than the annual inventory process.

5.3 Sample Security and Storage

An Antarctic Meteorite sample PI is responsible for the control and safeguarding of all Antarctic Meteorite samples consigned to his/her custody. The elements of an appropriate security plan for Antarctic Meteorites include maintenance of an inventory log, keeping Antarctic Meteorite samples under supervision, keeping Antarctic Meteorite samples under the control of the PI and/or his designee. In no case may Astromaterials on loan from NASA, including Antarctic Meteorite samples, be stored with money, precious stones or minerals, classified material, or any other item that is considered to be of high theft value.

5.4 Sample Transfer between Investigators

Sample transfers between approved investigators are permitted in the following situations: (1) if this has been pre-approved, i.e. was part of the original approved sample allocation request; and (2) if the sample transfer is part a new investigation/request that has been reviewed and approved by the MSG. The PI remains responsible for the security and prompt return of samples (to the PI) after the collaborator is done with the measurements and samples.

5.5 Lost Samples

In the event that a sample is lost, the PI must report the loss to the Antarctic Meteorite Curator immediately. NASA reserves the right to ask questions of the PI to understand and document the circumstances under which the sample was lost. The NASA-JSC Curator requests that in the case of a sample loss, PIs complete and fax/mail/email a Sample Loss or Consumption form which can be downloaded from the web at: <http://curator.jsc.nasa.gov/antmet/forms.cfm> (Appendix E).

5.6 Sample Accountability and inventory

Annual inventories will be requested of all PIs by the NASA-JSC Astromaterials Curation office. Each PI will receive a listing of samples in his/her name to verify. Samples with expired/expiring loans should be returned. The inventory must be signed by the PI and witnesses by a security representative or a representative of the Institution. Use of the collection for research purposes is the highest priority, and cooperation of PIs in use

and return, and accounting for samples is critical. *PIs that do not respond to inventory queries by the NASA Curator will not continue to receive samples from the collection.*

6. Publication of results

6.1 Acknowledgements

When publishing results of your research, please include the split numbers used in the research.

We also request that scientists use the following acknowledgement statement when reporting the results of their research in peer reviewed journals: “US Antarctic meteorite samples are recovered by the Antarctic Search for Meteorites (ANSMET) program which has been funded by NSF and NASA, and characterized and curated by the Department of Mineral Sciences of the Smithsonian Institution and Astromaterials Curation Office at NASA Johnson Space Center.” Such an acknowledgement will broaden the awareness of the funding mechanisms that make this program and these samples possible.

6.2 Reprints

Please provide journal reprints in PDF form, reporting results of your research on the Antarctic meteorite samples, to the NASA-JSC Antarctic Meteorite Curation staff (Cecilia Satterwhite or Kevin Righter). The information in your publications can be used to support sample compendium, and help define the unique properties of any particular meteorite.

7. References

- Allen, C.C, Allton, J.A, Lofgren, G.E., Righter, K., and Zolesnky, M.E. (2011) Curating NASA’s extraterrestrial samples—Past, present, and future. *Chemie der Erde* 71, 1–20.
- Cassidy, W.A. (2003) *Meteorite, Ice, and Antarctica: a personal account*. Cambridge University Press, Cambridge, UK, 349 pp.
- Cassidy, W., Harvey, R.P., Schutt, J., Delisle, G., Yanai, K. (1992) The meteorite collection sites of Antarctica. *Meteoritics* 27, 490–525.
- Corrigan, C.M., Welzenbach, L.C., McBride, K.M., Righter, K., Satterwhite, C.E., Harvey, R.P., McCoy, T.J., and Singerling, S.A. (2015) A Statistical Look at the US Antarctic meteorite collection. In Righter, K., Corrigan C.M., Harvey, R.P., and McCoy, T.J. eds., *35 seasons of U.S. Antarctic Meteorites: A pictorial guide to the Collection*. AGU Special Publication 68, 173-187.
- Graham, A.L. and Annexstad, J.O. (1989) Antarctic Meteorites. *Antarctic Science* 1, 3-14.
- Harvey, R.P. (2003) The origin and significance of Antarctic meteorites. *Chemie der Erde – Geochemistry* 63, 93–147.
- Harvey, R.P., Schutt, J., and Karner, J. (2015) Fieldwork methods of the US Antarctic Search for Meteorites Program. In Righter, K., Corrigan C.M., Harvey, R.P., and McCoy, T.J. eds., *35 seasons of U.S. Antarctic Meteorites: A pictorial guide to the Collection*. AGU Special Publication 68, 23-42.

Jarosewich, E. (1990) Chemical analyses of meteorites - A compilation of stony and iron meteorite analyses. *Meteoritics* 25, 323-337.

McCoy, T.J., Welzenbach, L.C., Corrigan, C.M. (2008) Antarctic meteorites: exploring the solar system from the Ice. In: *Smithsonian at the Poles* , pp. 387–394.

Marvin, U.B. and Mason, B. (eds.) (1980) *Catalog of Antarctic Meteorites, 1977-1978*. Smithsonian Contributions to the Earth Sciences No. 23, 50 pp.

Righter, K., Corrigan, C. M., McCoy, T. J. and Harvey, R. P. (eds) (2015) *35 Seasons of U.S. Antarctic Meteorites (1976-2010): A Pictorial Guide to the Collection*, John Wiley & Sons, Inc, Hoboken, NJ, 336 pp; doi: 10.1002/9781118798478.fmatter

Appendix A: Antarctic Meteorite Sample Request Form

Please take these steps to ensure a smooth request process:

- 1) read the instructions
- 2) look at the example form
- 3) fill out all relevant fields, especially if you have collaborators
- 4) delete the instructions and example form before saving your final version
- 5) return the sample request form (preferably as email attachment) to:

E-mail: **JSC-ARES-MeteoriteRequest@nasa.gov**

If mailing form, use address below:

Secretary, Meteorite Working Group
Mailcode XI2
NASA Johnson Space Center
2101 NASA Parkway
Houston, Texas, 77058
FAX: 281-483-5347

Instructions

Requests for meteorites are considered by the Meteorite Working Group (MWG), a committee that reports to NASA, the National Science Foundation, and the Smithsonian Institution. MWG makes every effort to provide samples for legitimate scientific study in a timely way. In considering requests, however, MWG needs certain basic information.

Explanation

- 1) Name of requester. We ask that one person be made responsible for the samples, even when several people work on a project. The person who signs the request must be the person who will be authorized by their institution to sign the sample loan paperwork. In the case of students (undergraduate or graduate), he or she should also obtain the signature of his/her research advisor, **(electronic signature is acceptable)**; the advisor will become responsible for the secure handling of the samples.
- 2) Professional title. Indicate here how you would like your mail to be addressed. Examples of professional titles are Mr., Ms., Dr., Prof.
- 8) Meteorite. List in this column the names of all meteorites requested.
- 9) Class. List in this column the type of each meteorite requested. Much experience shows that this information serves as a helpful check of consistency that avoids confusion and delay. You can obtain a complete listing of Antarctic meteorites from the web site of the Meteorite Bulletin:

<http://curator.jsc.nasa.gov/antmet/statistics.cfm>

10) Form. Indicate in this column the form in which you would like to have the sample. We list below three examples of forms often requested along with the abbreviations for them used at the Meteorite Processing Laboratory. MWG also considers requests for non-standard preparations (See item 11, below).

Chip (CP). A fragment up to 5 g in mass

Polished thin section (PM). Polished thin sections are typically 30 μm thick, vary in area, and are mounted on glass with epoxy (Buehler Epoxide at this time).

Polished thick section (PS). A chip that has been polished on one side.

11) Number of samples. List in this column the number of samples requested from each meteorite.

12) List the amount of sample you or your consortium members would like (ideally) for analysis or study.

13) List the minimum amount of sample you or your consortium members could use to still complete a measurement for your study.

14) Remarks and notes. In this column

a) use the footnote 19 to indicate that special considerations apply to sample preparation and explain under item (19);

b) use the footnote 20 to indicate that the measurements are destructive or partially destructive and explain under item (20).

c) include any other information that you think MWG will need to process your request.

15) Title of study. Give a brief title of your study (in ten words or less).

16) Purpose of study. In a short paragraph, explain the purpose of your work. If you are requesting meteorites from MWG for the first time it would be helpful to include a line or two describing your background and to send along one reprint or other document relevant to the proposed work.

17) Planned measurements. Indicate the instrumental methods to be used (e.g., optical microscopy, electron microprobe, ion microprobe, SEM, TEM, spectroscopy, NMR, Mossbauer, XRF), who will do the analyses, and where the measurements will be made. If this is a consortium study, please make sure that any samples requested independently by your collaborators are for other distinct purposes (i.e., MWG will not recommend for approval samples for a consortium that have also been requested separately by consortium members).

18) Reasons for choosing the particular samples requested. For a significant fraction of requests, MWG finds that samples different from the ones requested would be better suited to the stated purposes of the investigator. When the investigator explains the sample selection criteria, MWG is in a better position to use its detailed knowledge of the meteorite collection to fill the requests in a satisfactory way. For example, it may be possible to provide a chip from a large-mass member of a pairing group but not one from a small-mass member of that same pairing group.

19) Sample mass required. Give a detailed explanation for the mass required for analysis by you or your consortium, and give a breakdown of the mass required for each technique being used. Any differences between amount needed and amount requested must be explained in detail.

20) Special preparations. Indicate any types of materials or special handling considerations personnel in the Meteorite Processing Lab need to be aware of in order to provide material that will meet your analytical needs. A few examples of special preparations are listed below:

Carbon coating (CC)

Gold coating (GC)

Crazy Glue mount for TEM sections (CAM)

No fusion crust

Distance from fusion crust

Chips from specific locations

Chips of clasts/chondrules/inclusions

NOTE that in some cases it is beyond the capabilities of the JSC Meteorite Processing Lab to provide specimens in highly specialized forms (e.g., crushed in agate without any history of contact with metal). When in doubt, please contact the curator in advance of submitting your request.

21) Effects on samples. Indicate how your work will affect the samples that you have requested. Some measurements destroy samples completely; others do not destroy samples completely but may alter them in significant ways. Examples of the latter type include laser and ion microprobing, heating, coating with gold, etching, mixing powders with diluents, removing material for TEM work. Sample handling procedures should also be detailed if you intend to return portions to the MPL.

SAMPLE OF Antarctic Meteorite Sample Request Form

| | |
|---|---|
| 1a) Name of person requesting samples: <u>A.L. Hollol</u> | 1b) Signature: <u>Alphonse Hollol</u> |
| 2) Professional Title: <u>Mr.</u> | 3) Date: <u>September 1, 2001</u> <u>84001 Moraine Drive</u> <u>Wellington,</u> |
| 4) Institution: <u>Antarctic Meteorite Consortium</u> | 5) Address: <u>New Zealand</u> |
| 6) Telephone: <u>011 64 476 88001</u> | 7) E-mail: <u>ALH@MAC.nz</u> |

| (8) | (9) | (10) | (11) | (12) | (13) | (14) |
|-----------|-------|------|--------|-----------|-------------------|-------------------|
| Meteorite | Class | Form | Number | Mass/Size | Minimum mass/size | Remarks and notes |
| ALH 81000 | CM | Chip | 1 | 10 mg | 10 mg | 20 |
| | | PM | 1 | -- | -- | |

- 15) Title of study : Tin isotopic study in CM chondrites.
- 16) Purpose of Study/Scientific rationale (can be a few paragraphs)
 As part of a doctoral thesis project, I have begun a survey of tin isotopes in meteorites to test for the possibility of isotopic fractionation of tin during aqueous processes. Small effects are seen in terrestrial samples. The comparison with extraterrestrial materials should be interesting.
- 17) Planned measurements
 Methods - Measurements of tin isotopes are made by using a newly acquired ion microprobe here at Consortium Laboratories in Wellington (Hollol et al., 2001, J. Mass Spec., **72**, 637-645, attached). In separate, destructive experiments, we will measure the bulk tin content of the sample by ICP-MS. To make the ICP-MS measurements we collaborate with Prof. Shackleton's group at the University of Auckland.
 Location of instruments – see above
- 18) Reason(s) for choosing the particular samples requested (can be a few paragraphs)
 CMs are known to show signs of extensive aqueous alteration. We are aware that many Antarctic meteorites have been weathered and for this reason have selected a sample from the *most* weathered group as a kind of control. In separate studies, we will also be analyzing a recent, non-Antarctic CM fall. The CM that we have requested from the US Antarctic collection is part of a large pairing group; we would be glad to have a sample from any member of this group.
- 19) Basis for estimating mass requested
 Please see Hollol et al. (2001)

- 20) Special preparations No special preparation required.
- 21) Effect on sample – Ion microprobing will leave numerous pits, about 50 μm in diameter, in the section.

Antarctic Meteorite Sample Request Form

1a) Name of person requesting samples: _____ 1b) Signature: _____

2) Professional Title: _____ 3) Date: _____

4) Institution: _____ 5) Address _____

6) Telephone: _____ 7) E-mail: _____

| (8) | (9) | (10) | (11) | (12) | (13) | (14) |
|-----------|-------|------|--------|-----------|-------------------|-------------------|
| Meteorite | Class | Form | Number | Mass/Size | Minimum mass/size | Remarks and notes |
| | | | | | | |
| | | | | | | |
| | | | | | | |

15) Title of Research

16) Purpose of Study/Scientific rationale

17) Planned measurements and collaborators

| Collaborator | Institute | Method | Mass required |
|--------------|-----------|--------|---------------|
| | | | |
| | | | |
| | | | |

18) Reason(s) for choosing the particular samples requested

19) Basis for estimating mass requested

20) Special preparations

21) Effects on samples

22) Certification of research advisor (required only when requester has not yet received an undergraduate or graduate degree).

I certify that the student submitting this request has access to the laboratories required to complete the research.

Name: _____ Signature: _____

Institution: _____ Address _____

Telephone: _____ E-mail: _____

Appendix B1: Domestic Loan agreement

Nonreimbursable Agreement between the National Aeronautics and Space Administration Johnson Space Center and [Principal Investigator Name] and [Institution Name] for the Loan of Antarctic Meteorite Samples

AUTHORITY AND PARTIES

In accordance with the National Aeronautics and Space Act (51 U.S.C. § 20113), this Loan Agreement is entered into by the National Aeronautics and Space Administration Johnson Space Center, located at Houston, Texas (hereinafter referred to as “NASA” or “JSC”) and [Principal Investigator Name] the Principal Investigator (hereafter referred to as “PI”) located at [Institution Name, Institution Location] and [Institution Name] (herein referred to as “the Institution”). NASA, the PI and the Institution may be individually referred to as a “Party” and collectively referred to as the “Parties.”

PURPOSE

Antarctic meteorite samples distributed by Johnson Space Center of the National Aeronautics and Space Administration, hereinafter referred to as JSC, are jointly managed by JSC, the Smithsonian Institution and the National Science Foundation, as part of the US Antarctic Meteorite Program. The samples are property of the US Government and are under the custody and curatorial control of JSC.

The Johnson Space Center of the National Aeronautics and Space Administration, a Federal Agency, desires to enter into a Loan Agreement and to make certain Antarctic meteorite samples available to the PI. The PI proposes to use the said Antarctic meteorite samples to undertake, at his / her own direction, scientific investigations. These investigations are described in a sample request submitted by the PI to the Antarctic Meteorite Curator. Approval of a sample request is a prerequisite to this Loan Agreement and subsequent loan of the Antarctic meteorite samples.

The use of the Antarctic meteorite samples will permit beneficial contact among representatives of JSC, the PI and the Institution; will provide opportunities for discovery and dissemination of information to the scientific community and to the general public; will promote the maximum utilization of Antarctic meteorite samples by JSC; and will provide opportunities for dissemination of information concerning the activities of NASA.

RESPONSIBILITIES:

The Parties Agree to the Following:

1. The Antarctic meteorite samples made subject to this Loan Agreement shall be assigned to the PI on sample assignment forms signed by the JSC Antarctic Meteorite Curator and the PI.

2. The Antarctic meteorite samples are the property of the United States Government, and are therefore made available to investigators only under a carefully controlled and monitored program. It is therefore essential that rigorous security and accountability procedures be followed by all persons who have access to the Antarctic meteorite samples. The PI and the Institution shall be responsible for the receipt, use (including security during use), and accountability of the Antarctic meteorite samples, as follows:
 - a. As determined by NASA, the Antarctic meteorite samples shall be either hand-carried, at the expense of the Institution, by an authorized official of the Institution, or mailed at JSC's expense, to the PI via registered mail or by a shipping service approved by JSC. JSC reserves the right, at the expense of the Institution, to direct the mode of transportation for the return of the Antarctic meteorite samples.
 - b. Only the PI or the PI's Designee may receive and open the package. The PI or Designee shall record all of the Antarctic meteorite samples promptly upon receipt, and a record of receipt shall be maintained while the meteorites are in the custody, possession or control of the PI.

- c. During the use for research purposes, the Antarctic meteorite samples must be under the constant control of the PI or Designee. At the end of each use of the Antarctic meteorite samples, an inventory of the investigated samples shall be made.
 - d. When not being actively investigated, the Antarctic meteorite samples must be locked in a safe or secure storage cabinet equipped with a combination padlock or equivalent. The combination to the storage safe or cabinet shall be under the exclusive control of the PI and, if appropriate, the Institution security organization. If a controlled environment is required for scientific purposes, samples not being actively investigated must be stored in a locked laboratory.
 - e. In no case may astromaterials on loan from NASA be stored with money, precious stones or minerals, classified material or any other item that is considered to be of high theft value.
 - f. To insure that appropriate security arrangements are followed, the storage space holding the Antarctic meteorite samples shall be subject to inspection by NASA representatives upon request.
 - g. The PI shall report immediately the loss or damage of the Antarctic meteorite samples to the JSC Antarctic Meteorite Curator.
3. The PI shall be responsible for accurate accounting of all Antarctic meteorite samples by sample name / number and location. The PI shall perform an inventory of the Antarctic meteorite samples on an annual basis using the sample inventory form provided by the JSC Antarctic Meteorite Curator, and submit this form to the JSC Antarctic Meteorite Curator in a timely manner. This inventory includes any samples consumed or destroyed in the course of the research. This inventory shall be signed by the PI and certified by an official or security representative of the Institution. At the termination of this Loan Agreement, unless an extension of the loan has been granted, the Antarctic meteorite samples shall be returned to JSC with a full accounting of such Antarctic meteorite samples, using the sample return form provided by the JSC Antarctic Meteorite Curator.
4. The PI may use the Antarctic meteorite samples at his/her own Institution, or may carry the samples to use them at other locations consistent with the approved sample request. If the approved sample request entails collaborative work at another institution, the Antarctic meteorite samples shall be either hand-carried, at the expense of the Institution, by an authorized official of the Institution, or mailed at the Institution's expense, via registered mail or by a shipping service approved by JSC. The PI shall keep a record of all

such transfers, inform the JSC Antarctic Meteorite Curator when such transfers occur, and note them in the annual inventory. When the samples are in use by a collaborator, the original PI is responsible for extending the security requirements set forth in this agreement and shall retain responsibility for the Antarctic meteorite samples. When the collaborator has finished planned work on the samples, they must be immediately returned to the PI.

5. This Loan Agreement is not transferable to another institution or investigator. If the PI relocates to another institution and wishes to continue research on the meteorite samples, a new Loan Agreement must be completed among the PI, the new Institution and NASA before Antarctic Meteorite samples can be transferred. If the PI is finished with a sample, but another investigator is interested in studying this sample, a new sample request must be submitted to the Antarctic Meteorite Curator, and if approved a new Loan Agreement must be completed by the new Investigator.

6. Return of samples to JSC may arise from several circumstances. If the PI completes or terminates research on Antarctic meteorite samples, the samples must be returned to the JSC Antarctic Meteorite Curator. If the PI relocates to a new institution without executing a new loan agreement, the samples must be returned. Upon the circumstances of death or incapacitation of the PI, the Institution will be responsible for returning the Antarctic Meteorite samples. Finally, if this agreement expires without renewal or is terminated by any of the Parties, the Antarctic Meteorite samples must be returned.

7. The use of Antarctic meteorite samples shall be solely for the purposes set forth in the approved sample request. This Loan Agreement does / or does not allow the PI to use destructive analytical procedures, as specified in the approved sample request. The PI may request from the Antarctic Meteorite Curator an amendment to the sample request in order to perform additional research on the samples.

8. When requested to do so during the period of the use, the PI or the Institution shall provide to representatives of JSC a copy of any publication(s) resulting from the research and confer any scientific knowledge acquired as a result of such use, provided that no proprietary knowledge shall be disclosed involuntarily in the discharge of this obligation.

9. Title to the Antarctic meteorite samples shall remain with the US Government and shall not be affected by the incorporation, attachment, or mixture thereof to or with property not owned by NASA.

10. NASA, the PI or the Institution may, consistent with Federal law and this Loan Agreement, release general information regarding their own participation in this Loan Agreement as desired.

LIABILITY AND RISK OF LOSS

1. Notwithstanding any other provision of this Agreement, the PI and / or the Institution shall not be liable for loss of or damage to the Antarctic meteorite samples, except that the PI and / or the Institution shall be responsible for any such loss or damage:

a. which results from willful misconduct, lack of good faith, or negligence on the part of the PI and / or the Institution's directors or officers, or on the part of any of the Institution's superintendents or any other equivalent representatives, who have supervision or direction of all or substantially all of the Institution's business; or

b. which results from a failure on the part of the PI and / or the Institution due to the willful misconduct, lack of good faith, or negligence on the part of any of the Institution's directors, officers, or other representatives mentioned in (a) above (i) to maintain and administer, in accordance with the provisions of this Loan Agreement the program for delivery, protection, and preservation of Government property, or (ii) to take all reasonable steps to comply with any written directions from JSC with respect to the delivery, protection, and preservation of Government property.

Loss or damage to the Antarctic meteorite samples caused by failure to follow proper safeguarding standards as set forth in this Loan Agreement shall be considered in selecting recipients for future Antarctic meteorite sample loans.

2. NASA, its officers, and employees shall not be liable for any loss, damage, expense, or liability of whatsoever nature or kind arising out of, or as a result of, or in connection with the possession or use of the samples during the term of the loan or any extension thereof.

3. The PI and the Institution hereby waive any claims against NASA, its employees, its related entities, (including, but not limited to, contractors and subcontractors at any tier, grantees, investigators, customers, users, and their contractors and subcontractors, at any tier) and employees of NASA's related entities for any injury to, or death of, Institution employees or the employees of the Institution's related entities, or for

damage to, or loss of, the Institution's property or the property of its related entities arising from or related to activities conducted under this Loan Agreement, whether such injury, death, damage, or loss arises through negligence or otherwise, except in the case of willful misconduct. The Institution further agrees to extend this unilateral waiver to its related entities by requiring them, by contract or otherwise, to waive all claims against NASA, its related entities, and employees of NASA and employees of NASA's related entities for injury, death, damage, or loss arising from or related to activities conducted under this Loan Agreement.

FINANCIAL OBLIGATIONS

There shall be no transfer of funds between the Parties under this Agreement and each Party shall fund its own participation. All activities under or pursuant to this Agreement are subject to the availability of funds, and no provision of this Agreement shall be interpreted to require obligation or payment of funds in violation of the Anti-Deficiency Act, (31 U.S.C. § 1341).

PRIORITY OF USE

Any schedule or milestone in this Agreement is estimated based upon the Parties' current understanding of the projected availability of NASA goods, services, facilities, or equipment. In the event that NASA's projected availability changes, the PI shall be given reasonable notice of that change, so that the schedule and milestones may be adjusted accordingly. The Parties agree that NASA's use of the goods, services, facilities, or equipment shall have priority over the use planned in this Agreement. Should a conflict arise, NASA in its sole discretion shall determine whether to exercise that priority. Likewise, should a conflict arise as between two or more non-NASA Parties, NASA, in its sole discretion, shall determine the priority as between those Parties. This Agreement does not obligate NASA to seek alternative government property or services under the jurisdiction of NASA at other locations.

NONEXCLUSIVITY

This Agreement is not exclusive; accordingly, NASA may enter into similar agreements for the same or similar purpose with other private or public entities.

USE OF NASA NAME, INITIALS, AND EMBLEM

The PI or the Institution shall not use “National Aeronautics and Space Administration” or “NASA” in a way that creates the impression that a product or service has the authorization, support, sponsorship, or endorsement of NASA, which does not, in fact, exist. The PI or the Institution must submit any proposed public use of the NASA name or initials (including press releases and all promotional and advertising use) to the NASA Assistant Administrator for the Office of Communication or designee (“NASA Communications”) for review and approval. Approval by NASA Communications shall be based on applicable law and policy governing the use of the NASA name and initials.

Use of NASA emblems (*i.e.*, NASA Seal, NASA Insignia, NASA logotype, NASA Program Identifiers, and the NASA Flag) is governed by 14 C.F.R. Part 1221. The PI or the Institution must submit any proposed use of the emblems to NASA Communications for review and approval.

TERMS OF AGREEMENT -- DURATION, TERMINATION, AND MODIFICATION

This Loan Agreement becomes effective upon the date of the last signature below (“effective date”) and shall remain in effect until the completion of all obligations of the Parties hereto, or five years from the effective date. If the PI still holds Antarctic meteorite samples, a new or renewal Loan Agreement must be agreed upon by NASA and the PI or the samples must be returned to the JSC Antarctic Meteorite Curator. If the Antarctic meteorite samples are required for additional research the PI may request, in writing, a loan extension from the JSC Antarctic Meteorite Curator. If the request is approved, the loan period shall be extended by the amount of time agreed to by the JSC Antarctic Meteorite Curator.

The Parties may unilaterally terminate this Loan Agreement by providing thirty (30) calendar days written notice to the other Parties. Upon termination the PI or the Institution must return the Antarctic Meteorite samples held to the JSC Antarctic Meteorite Curator within thirty (30) days. However, if any provision of this Loan Agreement is violated, NASA may request the return of all the Antarctic Meteorite samples and the PI or the Institution shall return the Antarctic Meteorite samples immediately. Any modification to this Agreement shall be executed, in writing, and signed by the PI and an authorized representative of the Institution and of NASA.

POINTS OF CONTACT

The following personnel are designated as the Points of Contact among the Parties in the performance of this Agreement:

NASA JSC Curator

Name

Title

Email

Telephone

Fax

Address

Institution Official

Name

Title

Email

Telephone

Fax

Address

Principal Investigator

Name

Email

Telephone

Fax

Address

DISPUTE RESOLUTION

All disputes concerning questions of fact or law arising under this Loan Agreement shall be referred by the claimant in writing to the appropriate persons identified in this Agreement as the "Points of Contact." The persons identified as the "Point of Contact" for NASA, the PI and the Institution shall consult and attempt to resolve all issues arising from the implementation of this Loan Agreement. If the Parties are unable to resolve the dispute, then the NASA signatory or that person's Designee, as applicable, shall issue a written decision that shall be the final agency decision for the purpose of judicial review. Nothing in this article limits or prevents any of the Parties from pursuing any other right or remedy available by law upon the issuance of the final NASA decision.

APPLICABLE LAW

U.S. Federal law governs this Loan Agreement for all purposes, including, but not limited to, determining the validity of the Loan Agreement, the meaning of its provisions, and the rights, obligations and remedies of the Parties.

SIGNATORY AUTHORITY

The signatories to this Loan Agreement covenant and warrant that they have authority to execute this Loan Agreement. By signing below, the undersigned agrees to the above terms and conditions.

NASA JSC Curator

Institution Official

Name

Name

Date

Date

Principal Investigator

Name

Date

Appendix B2: International Loan agreement

Agreement between the National Aeronautics and Space Administration Johnson Space Center and [Principal Investigator Name] and [Institution Name] for the Loan of Antarctic Meteorite Samples

AUTHORITY AND PARTIES

In accordance with the National Aeronautics and Space Act (51 U.S.C. § 20113), this Loan Agreement is entered into by the National Aeronautics and Space Administration Johnson Space Center, located at Houston, Texas (hereinafter referred to as “NASA” or “JSC”) and [Principal Investigator Name] the Principal Investigator (hereafter referred to as “PI”) located at [Institution Name, Institution Location] and [Institution Name] (herein referred to as “the Institution”). NASA, the PI and the Institution may be individually referred to as a “Party” and collectively referred to as the “Parties.”

PURPOSE

Antarctic meteorite samples distributed by Johnson Space Center of the National Aeronautics and Space Administration, hereinafter referred to as JSC, are jointly managed by JSC, the Smithsonian Institution and the National Science Foundation, as part of the US Antarctic Meteorite Program. The samples are property of the US Government and are under the custody and curatorial control of JSC.

The Johnson Space Center of the National Aeronautics and Space Administration, a Federal Agency, desires to enter into a Loan Agreement and to make certain Antarctic meteorite samples available to the PI. The PI proposes to use the said Antarctic meteorite samples to undertake, at his / her own direction, scientific investigations. These investigations are described in a sample request submitted by the PI to the Antarctic Meteorite Curator. Approval of a sample request is a prerequisite to this Loan Agreement and subsequent loan of the Antarctic meteorite samples.

The use of the Antarctic meteorite samples will permit beneficial contact among representatives of JSC, the PI and the Institution; will provide opportunities for discovery and dissemination of information to the scientific community and to the general public; will promote the maximum utilization of Antarctic meteorite samples by JSC; and will provide opportunities for dissemination of information concerning the activities of NASA.

RESPONSIBILITIES:

The Parties Agree to the Following:

11. The Antarctic meteorite samples made subject to this Loan Agreement shall be assigned to the PI on sample assignment forms signed by the JSC Antarctic Meteorite Curator and the PI.

12. The Antarctic meteorite samples are the property of the United States Government, and are therefore made available to investigators only under a carefully controlled and monitored program. It is therefore essential that rigorous security and accountability procedures be followed by all persons who have access to the Antarctic meteorite samples. The PI and the Institution shall be responsible for the receipt, use (including security during use), and accountability of the Antarctic meteorite samples, as follows:

- h. As determined by NASA, the Antarctic meteorite samples shall be either hand-carried, at the expense of the Institution, by an authorized official of the Institution, or mailed at JSC's expense, to the PI via registered mail or by a shipping service approved by JSC. JSC reserves the right, at the expense of the Institution, to direct the mode of transportation for the return of the Antarctic meteorite samples.
- i. Only the PI or the PI's Designee may receive and open the package. The PI or Designee shall record all of the Antarctic meteorite samples promptly upon receipt, and a record of receipt shall be maintained while the meteorites are in the custody, possession or control of the PI.

- j. During the use for research purposes, the Antarctic meteorite samples must be under the constant control of the PI or Designee. At the end of each use of the Antarctic meteorite samples, an inventory of the investigated samples shall be made.
- k. When not being actively investigated, the Antarctic meteorite samples must be locked in a safe or secure storage cabinet equipped with a combination padlock or equivalent. The combination to the storage safe or cabinet shall be under the exclusive control of the PI and, if appropriate, the Institution security organization. If a controlled environment is required for scientific purposes, samples not being actively investigated must be stored in a locked laboratory.
- l. In no case may astromaterials on loan from NASA be stored with money, precious stones or minerals, classified material or any other item that is considered to be of high theft value.
- m. To insure that appropriate security arrangements are followed, the storage space holding the Antarctic meteorite samples shall be subject to inspection by NASA representatives upon request.
- n. The PI shall report immediately the loss or damage of the Antarctic meteorite samples to the JSC Antarctic Meteorite Curator.

13. The PI shall be responsible for accurate accounting of all Antarctic meteorite samples by sample name / number and location. The PI shall perform an inventory of the Antarctic meteorite samples on an annual basis using the sample inventory form provided by the JSC Antarctic Meteorite Curator, and submit this form to the JSC Antarctic Meteorite Curator in a timely manner. This inventory includes any samples consumed or destroyed in the course of the research. This inventory shall be signed by the PI and certified by an official or security representative of the Institution. At the termination of this Loan Agreement, unless an extension of the loan has been granted, the Antarctic meteorite samples shall be returned to JSC with a full accounting of such Antarctic meteorite samples, using the sample return form provided by the JSC Antarctic Meteorite Curator.

14. The PI may use the Antarctic meteorite samples at his/her own Institution, or may carry the samples to use them at other locations consistent with the approved sample request. If the approved sample request entails collaborative work at another institution, the Antarctic meteorite samples shall be either hand-carried, at the expense of the Institution, by an authorized official of the Institution, or mailed at the Institution's expense, via registered mail or by a shipping service approved by JSC. The PI shall keep a record of all

such transfers, inform the JSC Antarctic Meteorite Curator when such transfers occur, and note them in the annual inventory. When the samples are in use by a collaborator, the original PI is responsible for extending the security requirements set forth in this agreement and shall retain responsibility for the Antarctic meteorite samples. When the collaborator has finished planned work on the samples, they must be immediately returned to the PI.

15. This Loan Agreement is not transferable to another institution or investigator. If the PI relocates to another institution and wishes to continue research on the meteorite samples, a new Loan Agreement must be completed among the PI, the new Institution and NASA before Antarctic Meteorite samples can be transferred. If the PI is finished with a sample, but another investigator is interested in studying this sample, a new sample request must be submitted to the Antarctic Meteorite Curator, and if approved a new Loan Agreement must be completed by the new Investigator.

16. Return of samples to JSC may arise from several circumstances. If the PI completes or terminates research on Antarctic meteorite samples, the samples must be returned to the JSC Antarctic Meteorite Curator. If the PI relocates to a new institution without executing a new loan agreement, the samples must be returned. Upon the circumstances of death or incapacitation of the PI, the Institution will be responsible for returning the Antarctic Meteorite samples. Finally, if this agreement expires without renewal or is terminated by any of the Parties, the Antarctic Meteorite samples must be returned.

17. The use of Antarctic meteorite samples shall be solely for the purposes set forth in the approved sample request. This Loan Agreement does / or does not allow the PI to use destructive analytical procedures, as specified in the approved sample request. The PI may request from the Antarctic Meteorite Curator an amendment to the sample request in order to perform additional research on the samples.

18. When requested to do so during the period of the use, the PI or the Institution shall provide to representatives of JSC a copy of any publication(s) resulting from the research and confer any scientific knowledge acquired as a result of such use, provided that no proprietary knowledge shall be disclosed involuntarily in the discharge of this obligation.

19. Title to the Antarctic meteorite samples shall remain with the US Government and shall not be affected by the incorporation, attachment, or mixture thereof to or with property not owned by NASA.

20. NASA, the PI or the Institution may, consistent with Federal law and this Loan Agreement, release general information regarding their own participation in this Loan Agreement as desired.

LIABILITY AND RISK OF LOSS

1. Notwithstanding any other provision of this Agreement, the PI and / or the Institution shall not be liable for loss of or damage to the Antarctic meteorite samples, except that the PI and / or the Institution shall be responsible for any such loss or damage:

a. which results from willful misconduct, lack of good faith, or negligence on the part of the PI and / or the Institution's directors or officers, or on the part of any of the Institution's superintendents or any other equivalent representatives, who have supervision or direction of all or substantially all of the Institution's business; or

b. which results from a failure on the part of the PI and / or the Institution due to the willful misconduct, lack of good faith, or negligence on the part of any of the Institution's directors, officers, or other representatives mentioned in (a) above (i) to maintain and administer, in accordance with the provisions of this Loan Agreement the program for delivery, protection, and preservation of Government property, or (ii) to take all reasonable steps to comply with any written directions from JSC with respect to the delivery, protection, and preservation of Government property.

Loss or damage to the Antarctic meteorite samples caused by failure to follow proper safeguarding standards as set forth in this Loan Agreement shall be considered in selecting recipients for future Antarctic meteorite sample loans.

2. NASA, its officers, and employees shall not be liable for any loss, damage, expense, or liability of whatsoever nature or kind arising out of, or as a result of, or in connection with the possession or use of the samples during the term of the loan or any extension thereof.

3. The PI and the Institution hereby waive any claims against NASA, its employees, its related entities, (including, but not limited to, contractors and subcontractors at any tier, grantees, investigators, customers, users, and their contractors and subcontractors, at any tier) and employees of NASA's related entities for any injury to, or death of, Institution employees or the employees of the Institution's related entities, or for

damage to, or loss of, the Institution's property or the property of its related entities arising from or related to activities conducted under this Loan Agreement, whether such injury, death, damage, or loss arises through negligence or otherwise, except in the case of willful misconduct. The Institution further agrees to extend this unilateral waiver to its related entities by requiring them, by contract or otherwise, to waive all claims against NASA, its related entities, and employees of NASA and employees of NASA's related entities for injury, death, damage, or loss arising from or related to activities conducted under this Loan Agreement.

FINANCIAL OBLIGATIONS

There shall be no transfer of funds between the Parties under this Agreement and each Party shall fund its own participation. All activities under or pursuant to this Agreement are subject to the availability of funds, and no provision of this Agreement shall be interpreted to require obligation or payment of funds in violation of the Anti-Deficiency Act, (31 U.S.C. § 1341).

PRIORITY OF USE

Any schedule or milestone in this Agreement is estimated based upon the Parties' current understanding of the projected availability of NASA goods, services, facilities, or equipment. In the event that NASA's projected availability changes, the PI shall be given reasonable notice of that change, so that the schedule and milestones may be adjusted accordingly. The Parties agree that NASA's use of the goods, services, facilities, or equipment shall have priority over the use planned in this Agreement. Should a conflict arise, NASA in its sole discretion shall determine whether to exercise that priority. Likewise, should a conflict arise as between two or more non-NASA Parties, NASA, in its sole discretion, shall determine the priority as between those Parties. This Agreement does not obligate NASA to seek alternative government property or services under the jurisdiction of NASA at other locations.

NONEXCLUSIVITY

This Agreement is not exclusive; accordingly, NASA may enter into similar agreements for the same or similar purpose with other private or public entities.

USE OF NASA NAME, INITIALS, AND EMBLEM

The PI or the Institution shall not use “National Aeronautics and Space Administration” or “NASA” in a way that creates the impression that a product or service has the authorization, support, sponsorship, or endorsement of NASA, which does not, in fact, exist. The PI or the Institution must submit any proposed public use of the NASA name or initials (including press releases and all promotional and advertising use) to the NASA Assistant Administrator for the Office of Communication or designee (“NASA Communications”) for review and approval. Approval by NASA Communications shall be based on applicable law and policy governing the use of the NASA name and initials.

Use of NASA emblems (*i.e.*, NASA Seal, NASA Insignia, NASA logotype, NASA Program Identifiers, and the NASA Flag) is governed by 14 C.F.R. Part 1221. The PI or the Institution must submit any proposed use of the emblems to NASA Communications for review and approval.

TERMS OF AGREEMENT -- DURATION, TERMINATION, AND MODIFICATION

This Loan Agreement becomes effective upon the date of the last signature below (“effective date”) and shall remain in effect until the completion of all obligations of the Parties hereto, or five years from the effective date. If the PI still holds Antarctic meteorite samples, a new or renewal Loan Agreement must be agreed upon by NASA and the PI or the samples must be returned to the JSC Antarctic Meteorite Curator. If the Antarctic meteorite samples are required for additional research the PI may request, in writing, a loan extension from the JSC Antarctic Meteorite Curator. If the request is approved, the loan period shall be extended by the amount of time agreed to by the JSC Antarctic Meteorite Curator.

The Parties may unilaterally terminate this Loan Agreement by providing thirty (30) calendar days written notice to the other Parties. Upon termination the PI or the Institution must return the Antarctic Meteorite samples held to the JSC Antarctic Meteorite Curator within thirty (30) days. However, if any provision of this Loan Agreement is violated, NASA may request the return of all the Antarctic Meteorite samples and the PI or the Institution shall return the Antarctic Meteorite samples immediately. Any modification to this Agreement shall be executed, in writing, and signed by the PI and an authorized representative of the Institution and of NASA.

POINTS OF CONTACT

The following personnel are designated as the Points of Contact among the Parties in the performance of this Agreement:

NASA Headquarters, Office of International
and Interagency Relations

Name

Title

Email

Telephone

Fax

Address

NASA JSC Curator

Name

Title

Email

Telephone

Fax

Address

Institution Official

Name

Email

Telephone

Fax

Principal Investigator

Name

Email

Telephone

Fax

Address

Address

DISPUTE RESOLUTION

All disputes concerning questions of fact or law arising under this Loan Agreement shall be referred by the claimant in writing to the appropriate persons identified in this Agreement as the “Points of Contact.” The persons identified as the “Point of Contact” for NASA, the PI and the Institution shall consult and attempt to resolve all issues arising from the implementation of this Loan Agreement. If the Parties are unable to resolve the dispute, then the NASA signatory or that person’s Designee, as applicable, shall issue a written decision that shall be the final agency decision for the purpose of judicial review. Nothing in this article limits or prevents any of the Parties from pursuing any other right or remedy available by law upon the issuance of the final NASA decision.

APPLICABLE LAW

U.S. Federal law governs this Loan Agreement for all purposes, including, but not limited to, determining the validity of the Loan Agreement, the meaning of its provisions, and the rights, obligations and remedies of the Parties.

SIGNATORY AUTHORITY

The signatories to this Loan Agreement covenant and warrant that they have authority to execute this Loan Agreement. By signing below, the undersigned agrees to the above terms and conditions.

**NASA HEADQUARTERS, OFFICE OF
INTERNATIONAL AND INTERAGENCY
RELATIONS**

NASA JSC Curator

Name

Name

Date

Institution Official

Name

Date

Date

Principal Investigator

Name

Date

Appendix C: Antarctic Meteorite Sample Assignment Form

METEORITE SAMPLE ASSIGNMENT

RIGHTER, K has been assigned the following sample(s):

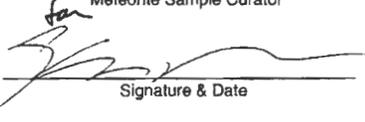
| <u>Generic</u> | <u>Specific</u> | <u>Parent</u> | <u>Weight (grams)</u> | <u>Classification</u> |
|----------------|-----------------|---------------|---------------------------|-----------------------|
| EET 87 527 | 4 | 1 | 0.010 | CK5 CHONDRITE |
| EET 90 026 | 7 | 1 | 0.010 | CK5 CHONDRITE |
| LAP 03 632 | 17 | 1 | 0.010 | LUNAR-BASALT |
| MET 01 149 | 11 | 1 | 0.010 | CK3 CHONDRITE |
| QUE 99 680 | 8 | 1 | 0.010 | CK5 CHONDRITE |



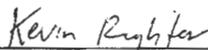
Meteorite Sample Curator

Issue Date: 01/19/2005

Return Date: One Year



Signature & Date



Recipient's Name, Printed or Typed

By accepting custody of the above sample(s), the recipient understands that it is furnished pursuant to, and is fully subject to, the terms and conditions of the agreement under which the related meteorite sample analysis is to be performed. All Antarctic meteorite samples remain the property of the National Science Foundation and are subject to recall.

**UPON RECEIPT OF THE SAMPLE(S), PLEASE SIGN THIS FORM
AND RETURN IT TO THE METEORITE SAMPLE CURATOR,
CODE ST, JOHNSON SPACE CENTER, HOUSTON, TEXAS 77058.**

Appendix D: Form MF76 for destructive analysis of meteorite thin/thick sections

Curatorial Form MF-76 Meteorite Sample Analysis Record

Please complete one form for each sample on your inventory listing that you are returning. Refer to the instructions for returning samples for more complete details.

Date:

Name:

Meteorite:

Section Nos:

What if any conductive coat was used?

- C
 Au
 Other (please specify)

Were any destructive analyses carried out on this sample? Yes No

If Yes, were they by: Ion microprobe
 Laser microprobe
 Other (please specify)

Please give details, e.g. UV/IR laser, size and shape of pits etc.?

Ion microprobe users: What primary beam was used?

- Cs
 O
 Other (please specify)

What phases were analyzed, how many analyses were made and, to the best of your knowledge, do any unanalyzed areas of these phases remain?

Appendix E: Sample Loss or Consumption Form
METEORITE SAMPLE LOSS OR CONSUMPTION FORM

Sample Number: _____

Consumption: (How Consumed)

Loss: (Give all known details, including place, date, and circumstances)

Signature and Date

Printed Name

Affiliation

Meteorite Sample Curator Signature and Date

