CURATION OF FROZEN SAMPLES. L. A. Fletcher[1], C.C. Allen[1] and R. Bastien[2]. [1]ARES, Mail Code KT, NASA Johnson Space Center, Houston, TX 77058, [2]Jacobs Technologies, 2224 Bay Area Blvd, Houston, TX 77058 (lisa.a.fletcher@nasa.gov).

Introduction. NASA's Johnson Space Center (JSC) and the Astromaterials Curator are charged by NPD 7100.10D with the curation of all of NASA's extraterrestrial samples, including those from future missions. This responsibility includes the development of new sample handling and preparation techniques; therefore, the Astromaterials Curator must begin developing procedures to preserve, prepare and ship samples at sub-freezing temperatures in order to enable future sample return missions. Such missions might include the return of future frozen samples from permanently-shadowed lunar craters, the nuclei of comets, the surface of Mars, etc.

We are demonstrating the ability to curate samples under cold conditions by designing, installing and testing a cold curation glovebox. This glovebox will allow us to store, document, manipulate and subdivide frozen samples while quantifying and minimizing contamination throughout the curation process.

Background. The ability to collect and curate samples under cold conditions has been desired by the scientific community for years. It is apparent that warming samples to temperatures above what they have experienced in their past will destroy some scientific value.

JSC has experience with frozen astromaterial samples, specifically meteorites, moon rocks and cometary dust particles. Antarctic meteorites are routinely shipped to JSC frozen, then brought to room temperature and dried in a nitrogen glovebox. A few meteorites have been processed at subfreezing temperatures, and one specific example is the Tagish Lake meteorite (Canada) samples. Some of these samples were collected, stored and processed frozen at JSC to minimize contamination. Preserving the samples in this way was critical to the important research on prebiological organic compounds published in *Science* [1]. In addition to meteorites, selected Apollo samples from shadowed locations on the lunar surface have been stored untouched and frozen in the Lunar Laboratory since Earth return. Analysis of these samples may provide key information on the preservation of volatiles in permanently-shadowed craters at the lunar poles. Finally, a few selected Stardust cometary samples in aerogel are currently being held in frozen storage to preserve cometary organics.

In past and recent years, JSC has researched the technology and cost of cold curation in preparation for Mars sample return. Many of the most important martian samples currently exist at sub-freezing temperatures and are extremely temperature-sensitive. In 1990 James L. Gooding reported that "the maximum scientific value of the samples is retained when they are preserved in the conditions that applied prior to their collection. Any sample degradation equates to loss of information." Gooding also concluded that "excessive warming would mobilize adsorbed water and initiate irreversible chemical or isotope-exchange reactions. Temperatures substantially lower than 273K are required to arrest interfacial water in fine-grained porous samples. Heat-sensitive materials including unidentified oxidants discovered by the *Viking* Landers, would decompose if excessively warmed. Hydrate or carbonate minerals might undergo stable-isotopic re-equilibration, thereby erasing their records of ancient Mars climates. Uncontrolled temperature rise would also produce large head-space pressures, through gas desorption from samples, which would further stimulate undesirable reactions. Deliberate heat sterilization would not affect age-dating of igneous rocks but would profoundly degrade paleoclimate information in sediments and soils [2]."

Technical Requirements. Similar to traditional curation gloveboxes for current astromaterial samples, this glovebox was designed and built to meet the same cleanliness requirements to ensure compatibility with current contamination control protocols. The primary technical requirements for the box design include the ability to: (1) maintain a cold environment inside the box with continuous purge of high purity nitrogen gas; (2) continuously monitor and record the nitrogen quality and temperature; (3) store samples and tools in a freezer located within the box; and (4) manipulate samples on a cold plate in the center of box. Also in line with current curation protocols, this glovebox will be stored within a Class 1,000 (ISO Class 6) cleanroom and utilized by workers donned in cleanroom suits. See Figure 1 for glovebox system design drawing.

Project Plan. The glovebox system has been designed, built and delivered to JSC. After final installation in an existing curatorial laboratory, we plan to develop technologies and procedures to store, document, manipulate, subdivide, package and ship frozen samples. We will also minimize, quantify and document contamination levels throughout the curation process.

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References. [1] Nakamura-Messenger, K., S. Messenger, L. P. Keller, S. J. Clemett and M. E. Zolensky (2006) Organic globules in the Tagish Lake meteorite: Remnants of the protosolar disk. *Science* 314, 1439-1442. [2] Gooding, J.L., Scientific guidelines for the preservation of samples collected from Mars, *NASA Tech. Memo., TM-4184*, 1990.

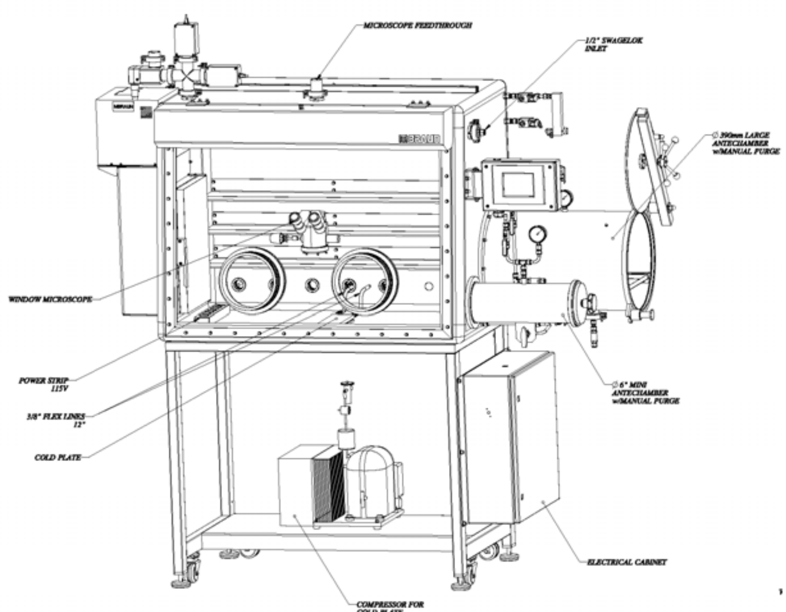

Figure 1: Glovebox design by MBraun, Inc. System includes -35°C freezer, -35°C cold plate, microscope, electrical connections, penetrations for gaseous nitrogen supply and exhaust, spare penetrations for future utilities and monitoring system to display and record nitrogen and temperature parameters.