CURATORIAL DATA NEEDS FOR RETURNED VOLATILE-RICH EXTRATERRESTRIAL SAMPLES.

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Introduction: The Astromaterials Acquisition and Curation Office (hereafter referred to as the Curation Office) is responsible for preserving astromaterials for the long term, and for enabling the scientific analysis of returned samples. As new missions returning volatile-rich samples are flown, new curatorial techniques are needed to maximize the utility of these materials. In particular, preliminary examination (PE) is used to develop a sample catalog whereby scientists can request samples from the Curation Office. This abstract summarizes the ongoing work to develop new PE processes for volatile-rich returned samples.

Background: For existing sample collections dominated by rock/particle samples, the PE process consists of four primary steps: weighing, photographing, general classification, and assignment of sample numbers. This information is provided by the Curation Office at http://curator.jsc.nasa.gov in the form of a catalog, and has been successfully used by researchers for existing sample collection identification and requests. It is the goal for volatile sample return to fit into this effective and proven paradigm **[1, 2]**.

Future missions to the lunar poles, comets, icy moons, and other volatile-bearing planets like Mercury and Mars, are either planned or being evaluated for flight in the next few decades **[e.g., 3, 4]**. Compounds expected to be sampled include numerous volatiles and hypervolatiles which are in the gas phase at temperatures of -80°C or below. In addition, the presence of salts in some samples will depress their freezing points, increasing the likelihood of aqueous-phase sample return for some volatile-rich materials. Coupled with the presence of solid-phase components (i.e., rocks/particles), the potential for up to three phases in a single sample exists. While the capability for conditioned sample return (i.e., cold/cryogenic stowage) is being developed for lunar and comet sample return, it may not be employed for all volatile-targeting sample return missions. Cold curation will also be implemented as required to support the science goals for volatile-rich returned samples **[5]**.

Volatile Sample PE and Data Products: The details of PE versus sample analysis will likely need to be finalized by each mission's science team in collaboration with the Curation office since the science requirements will vary by mission. In addition, time-sensitive samples may require immediate sample analysis prior to PE operations. However, the development of a framework for volatile sample PE will facilitate the development and integration of those capabilities for future sample curation facilities.

Notional techniques for volatile PE are shown in **Table 1** below. The PE techniques for volatile samples are prioritized by those that are rapid and do not damage or consume any sample. Consequently, an emphasis is made on spectroscopic techniques since they do not consume sample. A major challenge in PE of a gas-phase volatile sample is that photographs do not provide the necessary data to characterize a sample aliquot. While photographs could be used to document condensed samples, spectroscopic techniques could also be used for condensed and gas-phase species. Similarly, general classification of samples could be accomplished with appropriately designed spectroscopic instruments, with samples categorized by their dominant volatile (e.g., H_2O, CO_2, etc.).

Table 1. Rock/particle versus volatile sample PE.

	Documentation	Quantification	Classification	Identification
Rock/Particle	*Technique:* Photographs *Hardware:* Camera, microscope	*Technique:* Weighing, counting clasts and particles *Hardware:* Scale, microscope	*General rock type:* Basalt, breccia, crustal/anorthosite, soil, etc. *Method:* Visual observation	*Sample and subsample numbers*
Volatiles	*Technique:* Photographs, spectroscopy *Hardware:* Camera, CRDS (gas only), FTIR	*Technique:* Total/partial P (gas), weighing (solid) *Hardware:* P gauge, scale	*Specific volatiles:* E.g., H_2O-bearing, CO_2-bearing, NH_3-bearing, etc. *Method:* Spectral features	*Original sample container and aliquot subsample numbers*

The quantity of sample could be measured by using appropriately calibrated pressure sensors. In this case, a unique interface to the flight storage container would be necessary to make this measurement; it would therefore need to be defined as a requirement prior to the design of the flight sample container.

Conclusion: Here we present a notional concept for volatile sample PE that could be used to enable the development of a volatile sample catalog, and subsequent sample request/allocation to facilitate sample analysis of these unique materials.

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