The Importance of Contamination Knowledge - Insights into Mars Sample Return

The Astromaterials Acquisition and Curation Office at NASA Johnson Space Center (JSC), in Houston, TX (henceforth Curation Office) manages the curation of all past, present, and future extraterrestrial samples returned by NASA missions and shared collections from international partners, preserving their integrity for future scientific study while providing the samples to the international community in a fair and unbiased way. The Curation Office also curates all reference and witness materials for each mission (e.g., flight and non-flight hardware coupons; lubricants; non-flight, flight-like, and flown witness plates). These reference and witness materials provide the scientific community with the fundamental ability to reconstruct the contamination/alteration history of the sample collection through the course of the mission, with the overall goal of strengthening the scientific conclusions drawn from the study of returned materials.

The information gained from characterizing the physical, biological, inorganic, and organic chemical properties of reference and witness materials is defined as the Contamination Knowledge (CK) of the sample collection. Unlike the data collected for Contamination Control (CC) and Planetary Protection (PP), CK is exclusively concerned with preserving reference and witness materials for study by future scientists upon sample return. Although CC and PP data collected for sample integrity and forward contamination purposes can be complementary to CK, they are two separate data sets with distinct objectives. A robust collection of samples for CK is necessary to allow the extraterrestrial material in a returned sample to be distinguished from terrestrial contamination. Traditionally CK is utilized by sample scientists in order to accomplish the mission's scientific objectives, however this information can also be utilized by the Office of Planetary Protection to help evaluate the presence of any back contamination.

Mars 2020, the first phase of a potential multipart Mars Sample Return (MSR) campaign, is expected to contribute to NASA's Mars Exploration Program Science Goals by filling in knowledge gaps concerning: 1) the existence of past or present life on Mars, 2) the past and present climate of Mars, 3) the geology of Mars, and 4) hazards associated with human exploration of Mars [1]. Although there is debate concerning which samples will best answer these questions, the necessity for proper sample blanks is well-understood. The CC and PP requirements, driven by the restricted Class V mission designation, are the most stringent of any sample return mission in recent history. The extremely low levels of allowable terrestrial contamination on the spacecraft and rover can complicate these analyses given the detection limits of current analytical instrumentation, especially in the case of biological contamination. By collecting and curating unanalyzed samples specifically for CK, future sample scientists will not be relegated to: 1) relying on data collected using possibly obsolete tools and techniques for return sample blanks, or 2) using remnants of extracted and/or cultured samples from ATLO, which could be incompatible with the desired experimental endpoints or state-of-the-art techniques available at the time of sample return.

The addition of biological experimental endpoints to a sample return campaign's objectives broadens the requisite range in preservation environments (e.g. inert ultra-pure nitrogen gaseous environment at 18°C versus ≤-80°C) and types of CK samples. As a result, the Curation Office will also curate the following CK samples at ≤ -80°C for the Mars 2020 mission: 1) unanalyzed swabs and wipes in sterile containers, 2) all recirculation filters from the clean rooms used for sample and caching subsystem assembly and all filters from the laminar flow benches used to assemble sample intimate hardware, and 3) witness plates collecting airborne contamination within the assembly cleanrooms.

It has been Curation Office policy since the Apollo missions to preserve as many pristine samples as possible for future scientific research [2, 3]. Although CK is required to be collected for all stages of the MSR campaign, the CK for the Mars 2020 mission is the most critical for understanding contamination in the returned samples given the intimacy between the martian samples and the Mars 2020 flight hardware. This presentation highlights the importance of CK for sample return missions as well as the traditional and novel types of CK samples required for a successful MSR campaign.

References: [1] https://mars.nasa.gov/mars2020/mission/science/goals/ [2]. NASA 1965 *Summer Conference on Lunar Exploration and Science, Falmouth, Massachusetts,* 421. [3] Allen C. et al. (2011), *Chemie der Erde – Geochemistry, 71,* 1–20.

THE IMPORTANCE OF CONTAMINATION KNOWLEDGE – INSIGHTS INTO MARS SAMPLE RETURN. A. D. Harrington[1], M. J. Calaway[2], A. B. Regberg[1], J. L. Mitchell[1], M. D. Fries[1], R. A. Zeigler[1], and F. M. McCubbin[1], [1]Astromaterials Research and Exploration Sciences (ARES) Division, NASA Johnson Space Center, 2101 NASA Parkway Mail Code XI2, Houston TX 77058, Andrea.D.Harrington@NASA.gov, [2]Jacobs, NASA Johnson Space Center.

The Importance of Contamination Knowledge – Insights into Mars Sample Return