Sample Integrity for the Proposed Mars Sample Return Campaign. C. J. Budney, Jet Propulsion Laboratory / California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109-8099, Charles.J.Budney@jpl.nasa.gov.

Introduction: "Sample integrity" has been defined as preserving the scientific value on the samples returned during the proposed Mars Sample Return (MSR). Sample integrity includes contamination control, sample selection, sample documentation, sample preservation, and any other items needed to make sure the samples have the highest science value.

It is important to note, however, that sample integrity needs to be performed within the constraints of the mission, so the potential requirements are often traded with the engineering capabilities of the mission to come up with a reasonable and implementable requirement. This paper will discuss the current thinking as to the sample integrity capabilities for the proposed first MSR.

Previous work: Considerable previous work has been done for sample preservation requirements of samples to be returned from Mars. The philosophy of sample integrity is well described in Gooding [1] and Neal [2]. However, these mission concepts had different constraints than the current set of missions being proposed. Therefore, they are not directly applicable to the current MSR campaign concept, but they provide a useful basis for comparison. The differences from these previous studies and the current approach, along with the reasons for these differences, will be discussed.

Current Science Goals: The Mars Exploration Program Analysis Group (MEPAG) End-to-End International Science Assessment Group (E2E-iSAG) [3] has developed proposed science objectives for MSR. The E2E-iSAG extensively discussed the sample types that would be needed to achieve the science objectives. Returned samples would include sedimentary and igneous rock cores, regolith, and atmospheric gas.

Sample integrity: Based on the E2E-iSAG objectives, to meet the science goals with the samples the E2E-iSAG led to certain requirements on the mission elements for collecting and protecting the samples. These are discussed briefly in the sections below.

Size of the sample set. The E2E-iSAG derived the needed mass of the samples based on expected analysis and curation on Earth. How this would be translated into a volume will be discussed.

Sample encapsulation. Each sample would be individually stored in a sealed Sample Capsule. Derivation of requirements for the seals will be discussed.

Temperature control. Temperature requirements would be needed to protect the samples from alteration. However, the cache would be passively thermal controlled and left on the surface for a decade. Implications for the thermal environments will be discussed.

Magnetic fields and Radiation. Potential needs for these requirements will be discussed.

Physical integrity of the samples. Sedimentary rock cores would contain significant information in the geologic structure preserved in the cores. Preventing the cores from shattering would be important. Approaches to this will be discussed.

Inorganic contamination. The Apollo experience has shown us that preventing inorganic contamination of the samples would be important for preserving the validity of scientific measurements. Some potential approaches for MSR will be discussed.

Organic contamination. One of the key scientific objectives would be looking for evidence of current life in the samples. Organic materials may be a key to determining the presence of life. Therefore, the requirements for limits on organic contamination would likely be considerable more stringent than for a previous Mars missions. However, the Mars Science Laboratory experience showed that there are certain limits on cleaning and preventing recontamination that may have significant implications for the science that could be done with the samples.

Test materials and verification. The materials used to test the sampling system would be important for ensuring the sampling rover could collect and preserve the samples.

Conclusion: Preserving the scientific value of the samples to be collected by MSR would be challenging, but approaches exist to return scientifically valuable samples. The ultimate approach would depend on a compromise between the scientific desires of the Mars community and the ability of the engineers to implement those desires. Discussion based on this presentation would help guide the development of the requirements for the proposed Mars Sample Return campaign.

References:

[1] Gooding, J. (1990) NASA Tech. Memo, TM-4184, 32 pp. [2] Neal, C. R. (2000) JGR, 105, E9, pp. 22,487-22,506. [3] MEPAG E2E-iSAG (2011) posted at: *http://mepag.jpl.nasa.gov/reports/.*