SCIENCE DEFINITION OF THE MARS SCIENCE LABORATORY SAMPLE CACHE. J. S. Karcz[1], D. W. Beaty[2], C. A. Conley[3], J. A. Crisp[2], D. J. Des Marais[4], J. P. Grotzinger[5], L. G. Lemke[4], C. P. McKay[4], S. W. Squyres[6], C. R. Stoker[4], and A. H. Treiman[7], [1]SETI Institute, 515 North Whisman Road, Mountain View, CA 94043. john.s.karcz@nasa.gov, [2]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, [3]NASA Headquarters, Science Mission Directorate, 3X63, 300 E Street Southwest, Washington, D.C. 20546, [4]NASA Ames Research Center, Moffett Field, CA 94035, [5]Division of Geological and Planetary Science, California Institute of Technology, Pasadena, California 91125, [6]Department of Astronomy, Cornell University, Ithaca, NY 14853, [7]Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston, TX 77058

Introduction: In June 2007 NASA proposed the addition of a container for caching samples to the 2009 Mars Science Laboratory (MSL) rover. The cache would provide a potential future Mars Sample Return (MSR) mission with the option of returning a diverse set of previously characterized samples. MSL's capabilities—particularly its broad suite of analytical instruments, traverse endurance of 20 km, and intended lifetime of at least one Martian year—are expected to exceed those of a potential future Mars Sample Return (MSR) rover. We were asked to recommend appropriate scientific objectives for the cache and a minimal set of requirements deemed necessary to reach them.

Constraints on the MSL cache: Factors which were found to have implications for the scientific scope of the cache included: 1) a directive that the cache be minimalist and that it employ MSL's previously planned capabilities without modification, 2) the need for cached samples to tolerate an extended stay on Mars, and 3) a desire that the cache be easily retrievable.

Use of MSL's existing capabilities: Due to the advanced state of MSL's development at the time of the cache's proposed addition, no modifications to the rover's systems to support the cache could be made other than those crucial to its inclusion. Thus, the cache will need to accept samples delivered by MSL's already-planned sample-acquisition systems—a pulverizing drill and a soil scoop. Both systems will be capable of providing powder samples, and the scoop is expected to be able to provide small intact rocks as well.

Tolerance of a long stay: If it is returned, the cache is expected to spend 6–10 years on Mars, well beyond the designed lifetime of MSL. Certain objectives, such as those which would require detailed analysis of volatile gas components of the samples, were thought by our team to be incompatible with such uncontrolled storage. Based on this and the expectation that MSR would retrieve fresh samples in addition to the cache, narrow objectives tolerant to the long stay were chosen. We expect that the cached samples will would nevertheless be more broadly valuable.

Ease of retrieval: Easy retrieval of the cache was considered to be important since this may increase the likelihood of its eventual return. As such, the team desired that the cache be compatible with the MSR Orbiting Sample (OS) container and that it only occupy a fraction of the capacity of the OS to leave room for samples that would be freshly obtained by a future MSR mission.

Recommendations:

Scientific Objectives: The cached samples are expected to contribute to each of the high-level goals for sample return identified by the Mars Exploration Program Analysis Group. However, given the constraints described above, our team thought the cached samples would be best suited for one particular objective: investigation of the evolution of the surface and interior of Mars. This aim is the least sensitive to the storage conditions of the samples, particularly to exposure to many years of diurnal thermal cycling.

Sample type: The science-definition team desired that the cache be capable of accommodating both rocks and powders but preferred rocks if accommodating both types was not feasible. (This was found to indeed be the case by the team implementing the cache.)

Cache requirements: We suggested a small set of requirements on the cache intended to—within the constraints above—maximize the attractiveness of the cached samples for later return. These included requirements applicable to the caching of both powder and intact rock samples; however, only those necessary for rocks will be described here. 1) Storage of each sample in separate containers is preferred, but storage of multiple intact rock samples in a common container is considered acceptable *if* 2) the samples are photo-documented using an appropriate MSL imager to aid their re-identification upon return to Earth. Further characterization and analysis is strongly desired whenever possible (using, *e.g.*, ChemCam) but not required. 3) The cache should accommodate at least five (preferably ten or more) independently collected samples. 4) Based on experience from lunar and meteoritic samples, it should accept rocks with masses of at least ~ 3 g to allow extensive petrological analysis. 5)

The materials that will be in direct contact with the samples should be chosen to minimize contamination and should be chosen in consultation with the Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM), and 6) samples of those materials should be curated to provide a later reference for understanding contamination of the returned samples, should NASA decide to collect them during a later mission.