In situ Exploration Strategy of the 2011 Mars Science Laboratory to Investigate the Habitability of Ancient Mars

Paul Mahaffy (NASA Goddard, Code 699, Greenbelt, MD 20771, Paul.R.Mahaffy@nasa.gov) and the SAM technical and science teams.

The ten science investigations of the 2011 Mars Science Laboratory (MSL) Rover named "Curiosity" seek to provide a quantitative assessment of habitability through chemical and geological measurements from a highly capable robotic platform. This mission seeks to understand if the conditions for life on ancient Mars are preserved in the near-surface geochemical record. These substantial payload resources enabled by MSL's new entry descent and landing (EDL) system have allowed the inclusion of instrument types new to the Mars surface including those that can accept delivered sample from rocks and soils and perform a wide range of chemical, isotopic, and mineralogical analyses. The Chemistry and Mineralogy (CheMin) experiment that is located in the interior of the rover is a powder X-ray Diffraction (XRD) and X-ray Fluorescence (XRF) instrument that provides elemental and mineralogical information. The Sample Analysis at Mars (SAM) suite of instruments complements this experiment by analyzing the volatile component of identically processed samples and by analyzing atmospheric composition. Other MSL payload tools such as the Mast Camera (Mastcam) and the Chemistry & Camera (ChemCam) instruments are utilized to identify targets for interrogation first by the arm tools and subsequent ingestion into SAM and CheMin using the Sample Acquisition, Processing, and Handling (SA/SPaH) subsystem. The arm tools include the Mars Hand Lens Imager (MAHLI) and the Chemistry and Alpha Particle X-ray Spectrometer (APXX). The Dynamic Albedo of Neutrons (DAN) instrument provides subsurface identification of hydrogen such as that contained in hydrated minerals.

The SAM suite of instruments on the "Curiosity" Rover of (MSL) provides chemical and isotopic analysis of volatiles sampled either from the atmosphere or extracted from solid samples. SAM has the capability to sample both organic and inorganic volatiles. The instruments of SAM are a quadrupole mass spectrometer (QMS) that works either alone or in concert with a gas chromatograph (GC) to search for organic compounds and a tunable laser spectrometer (TLS) that provides precise isotope measurements for H, C, and O in CO_2, CH_4, and H_2O. Gaseous samples are directly sampled from the atmosphere, thermally evolved from solid samples, or solvent extracted and chemically derivatized.

Examples of SAM planned measurements that most directly address habitability are (1) a search for amino acids and carboxylic acids present rocks by chemical derivatization; (2) comparison of $^{13}C/^{12}C$, $^{18}O/^{17}O/^{16}O$, and D/H ratios in volatiles released from ancient rocks and in these same compounds in the present atmosphere; (3) examination of patterns molecular weight and chemical structure in organic compounds that might be thermally released from heated clays.