MARS SCIENCE LABORATORY: LOOKING AHEAD TO 2011. A. R. Vasavada[1] and the MSL Science Team, [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109 USA.

Introduction: The launch of NASA's Mars Science Laboratory (MSL), the next rover mission to Mars, has been delayed until late 2011, with surface science operations commencing in mid 2012. In spite of this delay and its various causes and implications, the mission will retain the next-generation scientific and technological capabilities that have made it a critical element in NASA's Mars Exploration Program (MEP). The MSL mission is a key link between previous missions focused on the role of water and any future missions dedicated to sample return or life detection. MSL fills a scientific niche that the MEP describes as understanding Mars' potential as a habitable planet.

Mission Status: At the time of the December 2008 decision to delay the launch, the MSL spacecraft was undergoing assembly and testing at the Jet Propulsion Laboratory. Major elements of the flight system, including the cruise stage, aeroshell, descent stage, and rover, had completed assembly and begun testing (Figure 1). Four of the ten scientific instruments had been delivered to JPL; the rest were in the final stages of testing and calibration at their home institutions. The sample acquisition and processing hardware was nearing the end of development. A core team at JPL will devote much of 2009 to addressing critical issues noted in testing. The PI-led teams will complete instrument development and testing at a reduced pace. System-level integration and testing activities will resume in fiscal year 2010.

Science Objectives: The core objective of the MSL mission is to characterize ancient surface (or near-surface) environments and processes. In particular, MSL will examine that subset of environments that may have been habitable by microorganisms, also including that sub-subset of environments that may have been favorable for the preservation of microbial biosignatures and/or abiotic organic compounds. The pursuit of this hierarchal set of objectives (i.e., environments > habitability > preservation) is what will distinguish MSL from previous surface missions.

The detection of possible biosignatures or abiotic organic compounds is not a requirement for mission science success, or even a reasonable expectation. The recognition of how difficult it is to discover evidence of compelling biosignatures/carbon compounds on the early Earth, a planet that teems with life, tempers our expectations for Mars. But within this context comes an equally compelling reminder that in the investigation of early biosignatures on Earth, the loss of insight regarding biology is almost always compensated by the gain of insight into the history and range of processes that characterized early surface environments. So by pursuing a similar strategy with MSL we couple a clear strategic vision for MEP with the promise of important discoveries regarding the early environmental evolution of Mars.

Operationally, the MSL mission will assess the biological potential of at least one target environment by determining the nature and inventory of organic carbon compounds, searching for the chemical building blocks of life, and identifying features that may record the actions of biologically relevant processes. Another focus is to characterize the geology of the landing region at all appropriate spatial scales by investigating the chemical, isotopic, and mineralogical composition of surface and near-surface materials, and interpreting the processes that have formed rocks and soils. MSL also will investigate planetary processes of relevance to past habitability (including the role of water) by assessing the long timescale atmospheric evolution and determining the present state, distribution, and cycling of water and CO_2. A further objective is to characterize the broad spectrum of surface radiation, including galactic cosmic radiation, solar proton events, and secondary neutrons.

Scientific Payload: There are ten PI-led scientific instruments. They are classified into the following groups:

Mast-based remote sensing: Mounted on a mast are Mastcam, a color medium- and narrow-angle imaging system provided by Malin Space Science Systems (PI: Michael Malin), and ChemCam, a laser-induced breakdown spectrometer and remote micro-imager provided by Los Alamos National Laboratory (PI: Roger Wiens).

Contact science: On the end of the robotic arm are APXS, an alpha particle and X-ray spectrometer provided by the Canadian Space Agency (PI: Ralf Gellert, U. Guelph), and MAHLI, a color hand lens imager provided by Malin Space Science Systems (PI: Kenneth Edgett).

Analytical lab instruments: Located within the rover chassis are CheMin, which analyzes delivered samples with X-ray diffraction, provided by the Jet Propulsion Laboratory (PI: David Blake, NASA Ames Research Center), and the SAM instrument suite, which contains a gas chromatograph, mass spectrometer, and tunable laser spectrometer, provided by NASA Goddard Space Flight Center (PI: Paul Mahaffy).

Environmental measurements: RAD is a radiation detector provided by Southwest Research Institute (PI: Don Hassler). REMS is a meteorology package and UV sensor provided by the Spanish Ministry of Science (PI: Javier Gómez-Elvira, Centro de Astrobiología/INTA-CSIC). DAN is an active neutron spectrometer provided by the Federal Space Agency of Russia (PI: Igor Mitrofanov, Space Research Institute). MARDI is a color, high frame rate descent imager provided by Malin Space Science Systems (PI: Michael Malin).

The sample acquisition, processing, and distribution system consists of a five degree-of-freedom robotic arm, a drill and powder collection system, a scoop, a tool for brushing rock surfaces, and devices that sort, sieve, and deliver collected rock and soil samples to the analytical lab instruments. Detailed information on the mission and its scientific payload may be found at: http://msl-scicorner.jpl.nasa.gov

Landing Site Selection Update: The MSL Project has performed preliminary analyses of the launch/arrival conditions associated with a 2011 launch. The four candidate landing sites presently under consideration remain accessible and are considered the finalists for 2011. They are i) Eberswalde Crater, containing a clay-bearing delta formed when an ancient river deposited sediment, possibly into a lake; ii) Gale Crater, whose central mound is a 5-km thick sequence of layers that vary from clay-rich matierials near the bottom to sulfates at higher elevation; iii) Holden Crater, with alluvial fans, flood deposits, possible lake beds, and clay-bearing sediment; and iv) Mawrth Vallis, exposing layers within Mars' surface with differing mineralogies, including at least two kinds of clays. Some flexibility will be maintained to respond to new discoveries from ongoing missions at Mars. A new plan for community workshops is being developed.

Information on the candidate sites and community workshops may be found at:

http://marsoweb.nas.nasa.gov/landingsites
http://webgis.wr.usgs.gov/msl

Figure 1. The Mars Science Laboratory cruise stage (top), aeroshell (middle), and heat shield (bottom, not flight model) in assembly and testing at JPL. Inside the aeroshell are the completed descent stage ("sky crane") and rover body.