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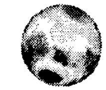

Mars Science Laboratory (MSL): The US 2009 Mars Rover Mission

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6th International Conference on Mars, July 21-25, 2003

1. INTRODUCTION

The Mars Science Laboratory mission is the 2009 United States Mars Exploration Program rover mission. The MSL Project expects to complete its pre-Phase A definition activity this fiscal year (FY2003), release an Announcement of Opportunity (AO) for the selection of scientific investigations in mid-March 2004, launch in 2009, arrive at Mars in 2010 during Northern hemisphere summer and then complete a full 687 day Mars year of surface exploration. MSL will assess the potential for habitability (past and present) of a carefully selected landing region on Mars by exploring for the chemical building blocks of life, and seeking to understand quantitatively the chemical and physical environment with which these components have interacted over the geologic history of the planet. Thus, MSL will advance substantially our understanding of the history of Mars and, potentially, its capacity to sustain life.

2. OVERARCHING SCIENTIFIC OBJECTIVE

To conduct a Mars Habitability investigation (to achieve breakthrough science in astrobiology).

- Habitability is defined as the potential of a given environment to support life at some time and should be equated to the phrase "capacity to sustain life".
- This assessment of habitability is to be made through multidisciplinary measurements related to biology, climatology, geology and geochemistry.

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3. INVESTIGATIONS TO SUPPORT OVERALL SCIENCE OBJECTIVE

1. Assess the biological potential of a least one target environment.
   - A. Determine the nature and inventory of organic carbon compounds.
   - B. Inventory the chemical building blocks of life (C, H, N, O, P, S).
   - C. Identify features that may represent the effects of biological processes.
2. Characterize the geology of the landing region at all appropriate spatial scales.
   - A. Investigate the chemical, isotopic, and mineralogical composition of Martian surface and near-surface geological materials.
   - B. Interpret the processes that have formed and modified rocks and regolith.
3. Investigate planetary processes of relevance to past habitability.
   - A. Assess long-timescale (i.e., 4-billion-year) atmospheric evolution processes.
   - B. Determine present state, distribution, and cycling of water and CO_2

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4. SCIENCE COMPLEMENT TO ADDRESS OBJECTIVES

1. **Remote Sensing Suite**

Imaging and complementary mineralogy

Reconnaissance and site geologic context

2. **Contact instrument Suite**

Complementary mineralogy, chemistry and microscopic imaging

Sample selection and supplemental target analysis

3. **Analytic Laboratory**

Definitive mineralogy, chemistry and high resolution textural information

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5. EXPERIMENT PLAN

The experiment plan for the mission involves coordinated cooperation between mast mounted instruments, contact instruments, and an analytic laboratory. The mast instruments, mounted ~ 4 m above the surface, provide the scientific basis for the path to be taken by the rover, as well as geologic context and initial mineralogical reconnaissance. The contact instruments will provide information on where and what to sample and analytic laboratory instruments will provide definitive mineralogy, chemistry and high resolution textural information from the acquired samples. Sampling tools will include a rock corer, a scoop for collection of regolith and small rocks, and a rock abrasion tool.

6. MSL SYSTEM AND CAPABILITIES

MSL will bring a new generation of rover into use with substantially more capability than has previously been possible (Figure 1). Sample acquisition tools and a sample processing and handling center will be available (Figure 1b). The MSL rover is to be able to land and operate for a Mars year within the latitude band ± 60 degrees where the elevation relative to the MOLA datum is less than 2.5 km (Figure 2). Using guided entry, the three sigma landing ellipse is to be 5 X 10 km (Figure 3) and the rover may be able to be operated day and night in any season, if the decision is made to power it via a pair of new generation radioactive power sources (RPS). The rover will be capable of significant mobility; the rover will have the ability to drive over 0.75 m obstacles and to drive a total of 6 km.

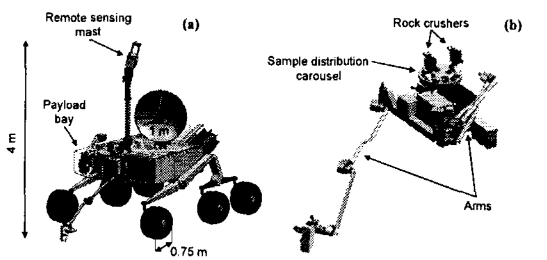

Figure 1. (a) Scale drawing of the current MSL rover concept. The sample acquisition (SA) system and Sample processing and handling (SPaH) systems are located in the payload bay on the front of the rover. The remote sensing mast will reach to 4 m above the surface. Other science instruments are envisioned to be housed on the ends of arms and in an analytical lab, within the payload bay. (b) The SA/SPaH system detail. At the end of one arm, we envision a rock abrasion tool, a mini-coring device, and on the other arm, a scoop.

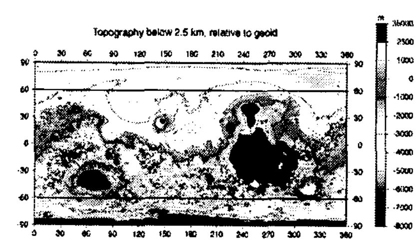

Figure 2. MSL will be able to access 76% of the Martian surface as it has the capability to land within ±60° latitude and below +2.5 km from the MOLA geoid. Black indicates area on Mars above +2.5 km.

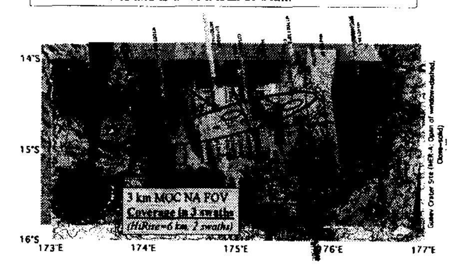

Figure 3. MSL will have thousands of potential landing sites available to it, given the latitude and altitude capabilities and the small size of the landing ellipse (5 x 10 km, 3 sigma).

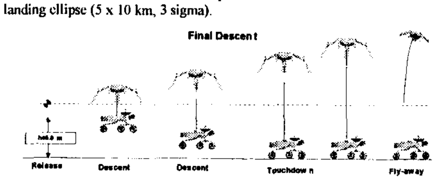

Figure 5. The "sky-crane" phase is the final phase and landing of the MSL Rover. It occurs in the last 5 seconds of the sequence. A tether lowers the Rover to the surface, detaches, and the entry stage flys away from the landing site. The Rover will touchdown at about 1 m/s.

7. MSL LANDING SEQUENCE

MSL will enter the Martian atmosphere directly, using guided entry, two parachutes (super and subsonic) and propulsion to slow down and land on the surface (Figure 4). Just before landing at about the 5 m level above the surface, the engines will have slowed MSL to a hover. At that time, the rover will be lowered from the entry stage to the surface of Mars (Figure 5), achieving a soft landing (<1 m/s). The Rover simply has to stand up and drive away. This landing method does not require a crushable or protective landing platform and the rover does not need to egress, simplifying initial operations.

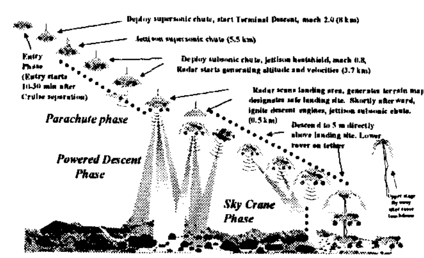

Figure 4. The MSL Landing sequence. MSL uses a 2-parachute approach, supersonic and subsonic. MSL will avoid 16+ m diameter craters during the powered descent phase using a scanning radar. The sky-crane phase lands the rover, enabling a very soft landing.

8. CONCLUSION

The small landing ellipse, wide latitude and altitude range should allow the full use of all the information gathered by Mars missions prior to and including the Mars Reconnaissance Orbiter (MRO) to be fully used in the site selection process. The combination of surface remote sensing, significant mobility, contact instruments, sampling tools, and long life should allow the analysis of dozens of intelligently selected samples over a large region of Mars, yielding a rich harvest of new information.