THE MARS SURVEYOR PROGRAM - PLANNED ORBITER AND LANDER FOR 2001. R. S. Saunders, Jet Propulsion Laboratory, 180-701, 4800 Oak Grove Drive, Pasadena, CA 91109, saunders@jpl.nasa.gov.

Introduction: Following the loss of the Mars Climate Orbiter and the Mars Polar Lander, the Mars Surveyor Program is undergoing a replanning effort. There is currently no anticipated change to the 2001 orbiter science payload, which is scheduled for launch on March 30, 2001. If launched on schedule, the orbiter will arrive at Mars on Oct. 20, 2001. The 2001 orbiter carries the Gamma Ray Spectrometer (GRS) (based on science objectives lost with Mars Observer) and the Thermal Emission Imaging System (THEMIS). The Mars Surveyor 2001 Lander is scheduled to launch on April 10, 2001 and will land on Mars on January 22, 2002, about three months after the orbiter arrives and about two weeks after the orbiter achieves its mapping orbit following a 76 day aerobraking sequence. If the 2001 lander is approved for launch, it will be modified to address problems that may have contributed to the loss of the Mars Polar Lander and the science payload will be sent to a safe landing site in either 2001 or 2003. The '01 payload is ideally suited for characterizing martian soils.

Orbiter payload: THEMIS will determine the mineralogy of the martian surface using multispectral, thermal infrared images in 10 spectral bands between 6.5 and 14.5 micrometers, selected to map expected minerals. The entire planet will be mapped in the infrared at 100 meters per pixel resolution. THEMIS will also acquire visible images with 20 meters per pixel resolution with 5 visible wavelength bands selectable for any given image. 15,000 visible images will obtained; each covering 20 by 20 km. In addition to supporting the science objectives of the THEMIS team, many of the vis images will be devoted to future landing site selection and plans are being developed by the PI for other scientists to request specific targets for their research.

The Mars 2001 Orbiter Gamma Ray Spectrometer (GRS) will map gamma rays emitted from the surface of Mars and from the energy spectrum determine the elements present at the martian surface. These measurements will be used to determine the elemental abundances of the martian surface material including composition of the permanent polar caps. The distribution of near-surface water will be inferred by mapping hydrogen abundance. The spatial resolution of the GRS is approximately equal to the orbital altitude of 300 km. The precision of the elemental abundances varies with elements and depends on total observation time. For example the uncertainty in Si at the equator by the end of the mission would be about 3%, improving progressively at higher latitudes.

An additional experiment, the Martian Radiation Environment Experiment (MARIE) is an energetic particle spectrometer designed to measure the near space radiation environment as related to the radiation hazard to human explorers. This is one of the Human Exploration and Development of Space Enterprise (HEDS) experiments that was selected for the 2001 mission to acquire data needed before planning human missions to Mars. MARIE will determine the radiation energy spectrum, separate the contribution from various particles, and measure the accumulated absorbed dose and dose rate that would occur in human tissue.

Lander Site Selection: During the past year, the planetary science community was engaged in selecting a landing site for the 2001 lander that meets all the engineering constraints for elevation, rock abundance, latitude (for thermal and power), etc. Two sites were identified as highest priority. The preferred site is the Isidis Rim at 3N-1S, 270-280W. This potential landing zone is located on the rim of a Noachian impact basin (Isidis) This would be an opportunity to sample Noachian rocks. The site contains morphologic evidence for valley networks and channels that indicate past water; of fundamental interest for exobiology. Deep crustal or mantle rocks should be present. Mars Global Surveyor Thermal Emission Spectrometer (MGS TES) data indicate that feldspar is more abundant than pyroxene. This could indicate that these rocks have been altered in some way to destroy the pyroxene signature, or the impact has exposed rocks from a higher alumina layer. The site selection process identified a second landing zone that is believed to be safer, that is, to have fewer rocks. This is a region of hematite, identified by the TES experiment and reported by Christensen at LPSC 30. The region is level, relatively rock-free and scientifically exciting because it may represent the site of an ancient lake once filled with iron-bearing water. Evaporation may have left behind an enormous deposit of iron oxide. Such, deposits occur on Earth and can seal in evidence of ancient life in a secure mineral envelope. Alternatively, the hematite may be the product of hydrothermal activity. In either case, the presence of water is strongly indicated. The lander payload has a moessbauer spectrometer that will be able to distinguish among the various iron bearing minerals and confirm the presence of hematite.

Mars Surveyor 2001 Lander Payload: The following four of the lander instruments comprise the Athena Precursor Experiment (APEX) (Steve Squyres, PI), a package of instruments that will be included on the Athena rover in a future sample return mission.

The Mars 2001 Lander Panoramic Camera (PanCam) is a mast mounted high-resolution stereo multispectral panoramic imager which is designed to image the landing area and aid in rover maneuvers. The camera will provide support imaging for the Mossbauer, APXS, and MECA experiments and will be used to take images of a small sundial. PanCam has an angular resolution of 0.28 mrad/pixel and 16 color spectral bands covering the range 0.4 to 1.1 micrometers with a nominal signal-to-noise ratio of 200:1 in all bands.

The Miniature Thermal Infrared Spectrometer (Mini-TES) is designed to measure the infrared spectrum of martian surface materials and characterize the martian atmospheric temperature profile. The infrared spectrum can be used to determine composition and other properties of minerals on the martian surface. The spatial resolution is 8 and 20 mrad (8 and 20 cm at 10 m distance). The spectrometer covers the wavelength range from 5 to 28 microns.

The Mossbauer Spectrometer is designed to study iron (Fe) on Mars. The principal scientific objectives of the experiment are to identify iron-bearing minerals in rocks, determine the oxidation state of iron, identify the iron oxides and the magnetic phase in the martian soil, and search for Fe-sulfates, Fe-nitrates, and Fe-carbonates. The data will provide tests for hypotheses about weathering, the evolution of the martian atmosphere, and the history of water.

The Mars Surveyor 2001 Rover Alpha Proton X-ray Spectrometer (APXS) is an upgraded, calibrated version of the APXS deployed by the Mars Pathfinder Rover. It is designed to measure the elemental chemistry of martian surface material.

The Mars Descent Imager (MARDI) (Mike Malin, PI) is a camera mounted on the bottom of the Mars Surveyor 2001 Lander designed to obtain images of the martian terrain as the Lander descends. MARDI is essentially the same design as the MARDI on the Mars Polar Lander. MARDI will acquire about 10 images of the surface as the lander descends, with the last image taken just before touchdown from an altitude of roughly 6 meters.

The Robotic Arm Camera is attached just above the scoop on the Mars Surveyor 2001 Lander Robotic Arm. The camera is slightly modified version of the Robotic Arm Camera on the Mars Polar Lander. It is designed to provide close-up images of the surface in the vicinity of the lander, assist Robotic Arm operations by imaging prospective surface samples in-situ and in the tip of the scoop, and obtain close-up images of the floor and side-walls of the trench dug by the robotic arm.

The Mars In-situ Propellant Production Precursor Experiment (MIP) (David Kaplan, PI) consists of five investigations that will assess various technologies for use in future Mars missions. The primary objective of the experiment is to acquire and compress martian atmospheric carbon dioxide and produce pure oxygen from that carbon dioxide. Other objectives are to: identify optimal solar arrays for future power systems on Mars, design radiators for future long-term operation on Mars, mitigate long-term deposition of airborne dust onto solar array surfaces, and conduct long-term operations on Mars.

The Martian Radiation Environment Experiment (MARIE) (Gautam Badwhar, PI) is an energetic particle spectrometer designed to measure the near space radiation environment as related to the radiation hazard to human explorers. MARIE will operate with the orbiting Marie experiment to assess the mitigating properties of the martian environment to radiation coming in from space.

The Mars Environmental Compatibility Assessment (MECA) (Tom Meloy, PI) consists of four experiments designed to study potential hazards to human exploration of Mars. MECA includes a Wet Chemistry Laboratory to analyze chemical components, such as peroxides, acids, bases, and heavy metals, in the martian soil, a Microscopy Station to study properties of small grains of martian dust and soil, including morphology, hardness, adhesion, and abrasion. The system can image particles from millimeters to nanometers in size, Patch Plates to study the interaction of martian dust with various surfaces, and an Electrometer to measure the amount of electrostatic charge generated by the interaction of the robot arm and scoop with the martian soil.

In addition to the APXS, the Mars Surveyor 2001 Rover, Marie Curie, is equipped with two sets of imaging cameras. Mounted on front of the rover are stereo black and white cameras for hazard detection and terrain imaging. Near the APXS are cameras for terrain and APXS target imaging. The rover cameras are geometrically calibrated.