THE MSP '01 MARS ENVIRONMENTAL COMPATIBILITY ASSESSMENT (MECA). M. H. Hecht[1], T. P. Meloy[2], M. S. Anderson[1], M. G. Buehler[1], M. A. Frant[3], S. M. Grannan[1], S. D. Fuerstenau[1], H. U. Keller[4], W. J. Markiewicz[4], J. Marshall[5], W. T. Pike[1], W. W. Schubert[1], P. Smith[6], U. Stauffer[7], S. West[3], and J. Rademacher[1], 1. Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena, CA 91109 USA, 2. W. Virginia University, 338 COMER, P.O. Box 6070, Morgantown, WV 26506 USA, 3. Orion Research, Inc., 500 Cummings Center, Beverly, MA 01915 USA, 4. Max Planck Institut fur Aeronomie, Max-Planck-Str. 2, 37189 Katlenburg-Lindau, Germany, 5. SETI Institute, NASA ARC, M/S 239-12, Moffett Field, CA 94035-1000 USA, 6. University of Arizona, Lunar and Planetary Laboratory, Tucson AZ 85721 USA, 7. University of Neuchatel, Neuchatel, Switzerland.

A chemical analysis of soil-water mixtures and the first microscopic images of martian soil will be among the results to be returned by the Mars Environmental Compatibility Assessment (MECA) payload on the Mars Surveyor Program 2001 Lander. Sponsored by the Human Exploration and Development of Space (HEDS) enterprise, MECA's primary goal is to evaluate potential geochemical and environmental hazards that may confront future martian explorers, and to guide HEDS scientists in the development of high fidelity Mars soil simulants. As a survey of soil properties, the MECA data set will also be rich in information relevant to basic geology, paleoclimate, and exobiology. The integrated MECA payload contains a wet-chemistry laboratory, a microscopy station, an electrometer to characterize the electrostatics of the soil and its environment, and arrays of material patches to study the abrasive and adhesive properties of soil grains. MECA is allocated a mass of 10 kg and a peak power usage of 15 W within an enclosure of 35 x 25 x 15 cm (figure 1).

The Wet Chemistry Laboratory (WCL) consists of four identical cells that will accept samples from surface and subsurface regions accessible to the Lander's robotic arm, mix them with water, and perform extensive analysis of the solution. Ion-selective electrodes and related sensors will evaluate total dissolved solids, redox potential, pH, and the concentration of many soluble ions and gases. Cyclic voltammetry will address oxidants, and anodic stripping voltammetry will probe potentially hazardous trace metals.

MECA's microscopy station combines optical and atomic-force microscopy (AFM) in a controlled illumination environment to image dust and soil particles from millimeters to nanometers in size. Careful selection of substrates and an abrasion tool allows experimental study of size distribution, adhesion, abrasion, hardness, color, shape, aggregation, magnetic and other properties.

Mounted on the end of the robot arm, MECA's electrometer consists of four types of sensors: an electric field meter, several triboelectricity monitors, an ion gauge, and a thermometer. Tempered only by ultraviolet-light-induced ions and a low-voltage breakdown threshold, the dry, cold, dusty martian environment presents an imposing electrostatic hazard to both robots and humans. In addition, the electrostatic environment is key to transport of dust and, consequently, martian meteorology.

MECA will also observe natural dust accumulation on engineering materials. Viewed with the robot arm camera, the abrasion and adhesion plates are strategically placed to allow direct observation of the interaction between materials and soils on a macroscopic scale. Materials of graded hardness are placed directly under the robot arm scoop to sense wear and soil hardness. A second array, placed on the lander deck, is deployed after the dust plume of landing has settled. It can be manipulated in a primitive fashion by the arm, first having dirt deposited on it from the scoop and subsequently shaken clean. Dust accumulation as a function of conductivity, magnetic field strength, and other parameters will be explored.

The MECA instruments described above will assess potential hazards that the Martian soil might present to human explorers and their equipment. In addition, MECA will provide information on the composition of ancient surface water environments, observing microscopic evidence of geological (and biological?) processes, inferring soil and dust transport, comminution and weathering mechanisms, and characterizing soil horizons that might be encountered during excavation.

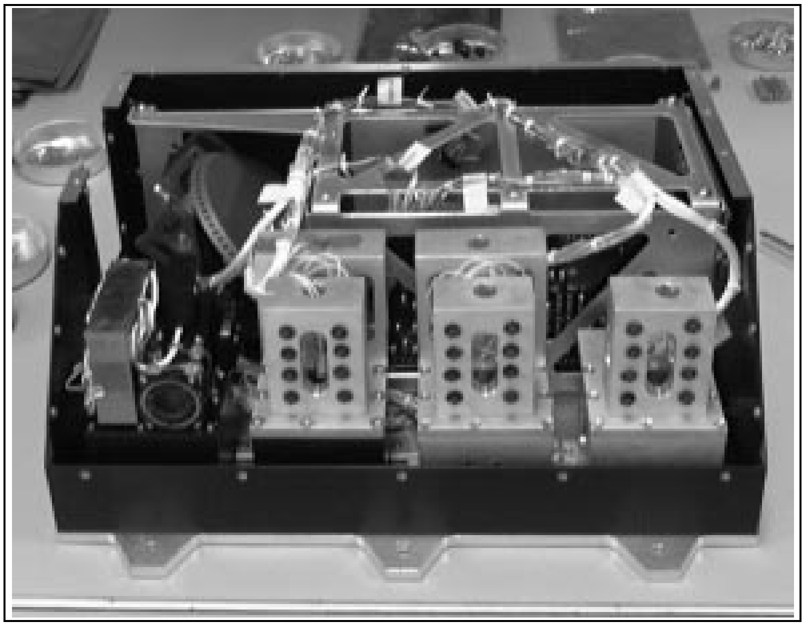

Fig. 1: The MECA engineering model, minus cover. In the foreground, left, is a wet chemistry cell. The rectangular element above it is the water tank, and the horizontal cylinder next to it is the sample drawer. The three adjacent units are mass and electronic simulators of the other three cells. The sample wheel can be seen in the rear left. The microscopes are hidden under the electronics cage, rear right.