The “Mars Environmental Compatibility Assessment” (MECA) payload for MSP 2001 is comprised of a multifunctional laboratory equipped to assess martian soil properties with wet chemistry, camera imagery, optical microscopy (potentially with UV fluorescence capability), atomic force microscopy (AFM; potentially with mineral-discrimination capabilities), electrometry, active & passive external materials-test panels, mineral hardness testing, and electrostatic and magnetic materials testing. Additionally, evaluation of soil chemical and physical properties as a function of depth down to ~50 cm will be facilitated by the Lander/MECA robot arm on which the camera (RAC) and electrometer are mounted. MECA was designed as a NASA Human Exploration and Development of Space (HEDS) payload for determining the properties of martian soil that may be detrimental to human exploration. It is, however, well equipped to address exobiology questions in the following areas (Figure 1):

**Geochemical Clues To Aqueous Mineralogy and Oxidation Formation:** Using an array of ion-specific electrodes (ISEs), cyclic voltammetry, and electrochemical techniques, the chemistry cells will wet soil samples for measurement of basic soil properties of pH, redox potential, and conductivity. Total dissolved material, as well as targeted ions will be detected to the ppm level, including important geochemical ions such as Na⁺, K⁺, Ca²⁺, Mg²⁺, NH₄⁺, Cl, SO₄²⁻, HCO₃⁻, etc, as well as more toxic ions such as Cu²⁺, Pb²⁺, Cd²⁺, Hg²⁺, and ClO₄⁻. MECA will enable surface versus subsurface material to be compared for these quantities. The role of water in surface processes is of course, key to the exobiological study of Mars; MECA wet chemistry essentially “reactivates” ancient aqueous settings. Although solution-dissolution dynamics are not always reversible, MECA will help constrain water solubility species in the soil that may have derived from ancient hydrothermal mineralization, from chemical precipitation in lake beds and carbonate-rich ocean basins, from flood waters episodically disgorge from the upper crust, or from moisture-driven mineral differentiation in the pedogenic surface. Counterbalancing the preservation of organic biodetritus potentially derived from a more clement martian past, are the postulated soil oxidants. These must be studied as key to carbon/life preservation for both extinct and potentially extant life on Mars. The oxidant issue is addressed by MECA by electrochemical detection techniques, while the targeted detection of compounds such as carbonates may be realized if reagent addition to the cells becomes a technical reality (currently under investigation).

**Minerals And Rocks As Clues To Ancient Hydrology:** Additional compositional information that can be cross-referenced with the wet-chemistry is obtained under the microscope from grain features such as cleavage, crystal shape, fracture patterns, grain color, grain surface coatings, pitting/etching, as well as from UV-excited fluorescence (by LEDs). MECA microscopy has dual magnification, 2.5x and 25x, and data-processing algorithms and image sequencing/offsetting to provide confocal and stereomicroscopy. Of exobiological interest would be the detection of calcite, dolomite, silica, fibrous evaporitic minerals, etc. Microscopy will enable discrimination (for millimeter-size fragments) of lithological species of exobiological interest such as amygdaloidal vesicular clasts indicative of hydrothermal activity, clastic sediments indicative of fluvial, lacustrine, or littoral activity, microlayered evaporitic materials, and so forth. Many lithic species betray aqueous or hydrothermal processes.

**Grain Textures As Indicators Of Aqueous Activity And Weathering:** AFM provides imaging capabilities comparable to SEM, and has resolution
in the nanometer range. It will enable, along with microscopy, determination of microstructures such as those of the clay minerals (important indicators of water weathering), precise micro- and nano-scale mineral/grain shapes, and the surface textures of some of the larger grains. Sedimentologists routinely use mechanical grain-surface textures to evaluate transport history of sand grains, such as water or wind action [2]. Additionally, AFM enables imaging of chemical surface textures such as etch features, which are clues to weathering. MECA is hoping to use the AFM in a tapping mode so that phase-contrast imaging is available --this is an exciting new area of imaging with the potential for identification and mapping of mineral species, grain surface characteristics, and clast microfabrics.

MECA-APEX Synergism: Various instrument packages on the Lander and Rover will work harmoniously and synergistically towards common science goals for both HEDS and planetary science. In recent commentary [3], the potential has been noted for deriving soil mineralogy and geochemistry by interaction of the APEX (ATHENA) payload elements of panoramic imagery, infrared spectroscopy, Moessbauer spectroscopy, and APX, with the suite of MECA techniques described above.