THE 2007 PHOENIX MARS SCOUT WET CHEMISTRY LABORATORY: STUDYING THE CHEMISTRY OF THE POLAR SOIL/ICE.
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Introduction. The vast northern polar lowlands of Mars, known as Vastitas Borealis, could contain a chronological record of what may have an ocean, its remnant evaporitic stratigraphy, deposits of volcanic eruptions, or the advances and retreats of the polar ice cap. Recently, the Mars Odyssey orbiter has shown the existence of large amounts of subsurface water ice in the northern latitudes, buried under several to a few tens of centimeters of dry regolith [1]. The interactions between atmosphere, water, dust, and subsurface ice, in conjunction with the periodic changes of the ice/soil boundary, have no doubt produced unique chemical signatures in the regolith.

The *2007 Phoenix Mars Scout* lander is designed to touch down at the high northern latitudes of Mars, between 65-72°N. It will acquire and analyze samples of soil and ice, and monitor atmospheric conditions. Its major goal is to unravel the history of water in all its phases and the record left in the geochemistry of the regolith. In addition, the Phoenix will address bio-habitability by, identifying potential chemical energy sources available to support life, determining whether the subsurface geochemistry is hostile to life, and identifying the potential of the geochemical environment to preserve paleontological evidence.

The Wet Chemistry Lab. To help analyze and interpret the chemical record, the *Phoenix* carries with it a variety of analytical instruments [2,3]. Foremost in helping us to understand the chemical record will be four single-use independent wet chemistry labs. The *Wet Chemistry Labs* (WCL) [4], originally developed as part of the *Mars Environmental Compatibility Assessment* (MECA) package for the cancelled *2001 Mars Surveyor Program* lander, were rebuilt for the 2007 *Phoenix* mission. Each WCL (shown below) consists of a lower "beaker" containing a set of chemical sensors (inset image) designed to analyze the chemical properties of the regolith, and an upper "actuator", for adding the soil, reagents, and stirring.

The beaker assembly contains an array of sensors consisting of solid state and PVC (polyvinyl chloride) membrane based *ion selective electrodes* (ISE). These sensors will analyze for inorganic anions and cations, including calcium, sodium, potassium, magnesium, chloride, bromide, ammonium, nitrate, lithium, and sulfate. The array also includes special electrodes for pH, conductivity, oxidation-reduction potential (Eh), *anodic stripping voltammetry* (ASV) for heavy metals such as Cu^{2+}, Cd^{2+}, Pb^{2+}, Hg^{2+}, *chronopotentiometry* (CP) for independent determination of chloride, bromide & iodide, and *cyclic voltammetry* (CV) for identifying and analyzing possible reversible and irreversible redox couples.

The upper actuator assembly consists of a sealed Teflon-coated titanium water tank with a puncture valve, a sample loading drawer, a screened funnel, a stirrer motor with impeller, a pressure sensor, and a five-crucible reagent dispenser. The pressurized tank holds 25 mL of solution that serves to leach the soluble components from the soil and also contains the first calibration standards for the ion selective electrodes and, in three of the WLCs, the background electrolyte ($LiNO_3$) for the lithium reference electrodes. The first of the five crucibles contains a second addition of calibration standards, the second contains 2-nitrobenzoic acid, and other three contain barium nitrate for use in determining sulfate. The sample loading "drawer", containing a compartment which holds approximately 1 cm^3 of soil, is designed to receive the soil from the robotic arm, remove excess soil, and deposit it into the beaker. A funnel with a wire screen allows only particles < 2 mm to fall into the drawer.

The data provided by the WCLs from each sample analysis will provide a variety of chemical and physical parameters to help us understand the geochemistry of Mars' polar environment and its history.

References. [1] Boynton, W. V. et al. (2002) *Science, 297*, 81-88. [2] Smith P.H. (2004) *LPS XXXV*, Abstract #2050. [3] http://phoenix.lpl.arizona.edu/ [4] Kounaves S.P. et al. (2003) *JGR, 108-E7*, 5077-89.