

**AQUEOUS CHEMISTRY OF THE MARTIAN SOIL: RECENT RESULTS FROM THE PHOENIX MARS LANDER WET CHEMISTRY LABORATORY (WCL).** S. P. Kounaves<sup>1</sup>, M. H. Hecht<sup>2</sup>, R. Anderson<sup>1</sup>, K. Gospodinova<sup>1</sup>, P. Hredzak<sup>1</sup>, J. Kapit<sup>1</sup>, J. Maisano<sup>1</sup>, K. McElhoney<sup>1</sup>, Q. Moore<sup>1</sup>, G. O'Neil<sup>1</sup>, J. Shusterman<sup>1</sup>, S. Stroble<sup>1</sup>, J. Wage<sup>1</sup>, <sup>1</sup>Department of Chemistry, Tufts University, Medford, MA, 02155, <sup>2</sup>Jet Propulsion Laboratory, Pasadena, CA, 91109. (samuel.kounaves@tufts.edu)

An important goal of the 2007 Mars Phoenix Lander [1, 2] was to analyze the chemistry of the soils, at the surface and at depth, to provide a better understand the history of the water, the bihabitability of the soil, the availability of chemical energy sources, and the general geochemistry of the site. To this end, the Phoenix included four wet chemistry laboratories as part of the MECA instrument package.

Each of the four identical WCLs (Figure 1) consisted of an upper assembly for adding soil, water, reagents, and stirring, and a lower beaker containing an array of sensors for determining the concentrations of  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{K}^+$ ,  $\text{Na}^+$ ,  $\text{NH}_4^+$ ,  $\text{H}^+$  (pH),  $\text{SO}_4^{2-}$ ,  $\text{NO}_3^-$ ,  $\text{ClO}_4^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ , and  $\text{I}^-$ . It also included electrodes for electrical conductivity, chronopotentiometric determination of  $\text{Cl}^-$ ,  $\text{Br}^-$ , and  $\text{I}^-$ , and cyclic voltammetry[3].

The concentrations of the measured ionic species for one of the soil samples (Rosy Red) are shown in Table 1. The results were similar for all three soil samples analyzed, with soil-solution mixture dominated by  $\text{ClO}_4^-$ ,  $\text{Mg}^{2+}$ , and  $\text{Na}^+$  at mM levels, with sub-mM concentrations of  $\text{Ca}^{2+}$ ,  $\text{Cl}^-$ , and  $\text{K}^+$ .

Equilibrium modeling, using MINEQL, GWB, and FrezChem, has been used to predict and verify possible starting mixtures of minerals and salts. Even though multiple possibilities exist, a limited number have been selected as most plausible and used to formulate both simulant solutions and soil samples. The simulants have been analyzed using a WCL flight spare unit and results compared to those obtained on Mars. The models indicate a very complex system with the final species distribution sensitive to several variables, including ionic strength, pH,  $\text{P}_{\text{CO}_2}$ ,  $[\text{SO}_4^{2-}]$ , and the minerals assumed to be in the sample. Results to date point to a solution most likely saturated in respect to both  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$ , from calcite and magnesite. Models and laboratory experiments also confirm the likely presence of sulfate in solution and its potential titration by both intentional and unintentional addition of barium chloride.

**References:** [1] Arvidson et al. (2009) *LPSC XL*, [2] Arvidson et al. (2008) *JGR*, 113, E00A03 doi: 10.1029/2007JE003021. [3] Kounaves et al. (2009) *JGR*, 114, E00A19, doi: 10.1029/2008JE003084. [4] Hecht et al. (2009) *LPCS XL*. [5] W. Boynton et al. (2009) *LPCS XL*. [6] B. Sutter. (2009) *LPSC XL*.

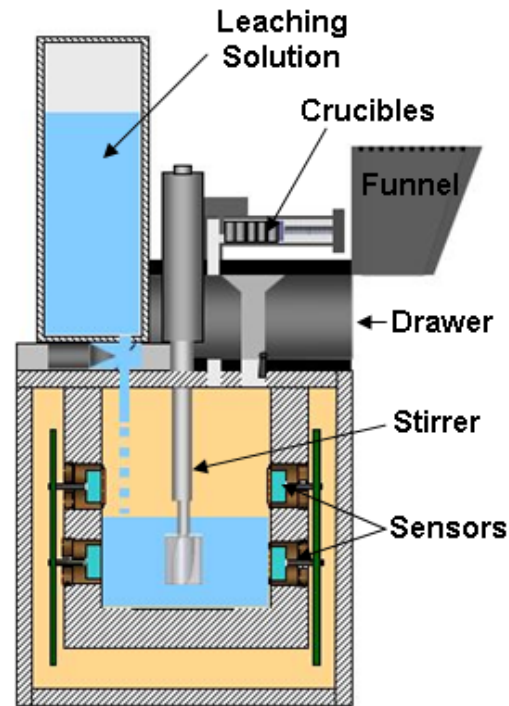


Figure 1. Diagrammatic cross-section representation of a single-use Wet Chemistry Laboratory (WCL)

Table 1 - Measured concentrations of ionic species in Rosy Red soil sample. Assumes delivery of a  $1\text{cm}^3$  sample with density of  $1\text{g/cm}^3$ .

Ionic Species	Concentration in Cell, mM	Est. %wt
$\text{Mg}^{2+}$	2.9 ( $\pm 1$ )	?
$\text{Ca}^{2+}$	0.6 ( $\pm 0.3$ )	3-5*
$\text{Na}^+$	1.4 ( $\pm 0.5$ )	0.10
$\text{K}^+$	0.4 ( $\pm 0.2$ )	0.03
$\text{ClO}_4^-$	2.6 ( $\pm 1$ )	0.75
$\text{Cl}^-$	0.6 ( $\pm 0.2$ )	0.04
pH	7.7 ( $\pm 0.3$ )	
* From TEGA Analysis [5]		