Phoenix Mars Mission Wet Chemistry Laboratory Detection of Martian Soil Oxidants

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INTRODUCTION

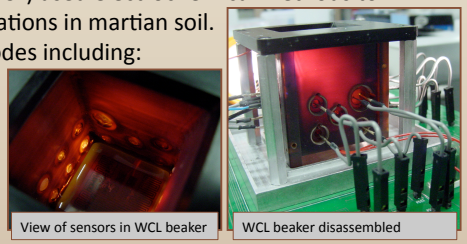
In the summer of 2008, the NASA Phoenix Mars Mission Wet Chemistry Laboratory (WCL) was used to measure soluble components in soil collected from the northern plains of Mars. Large amounts of perchlorate, a strong oxidant, were detected in the martian soil with the WCL.

Using a WCL laboratory testbed under Phoenix flight operating conditions, we are analyzing Mars soil analogs with chronopotentiometry, an electrochemical technique, to determine the soil concentration limits of other potential martian oxidants. The presence of these on Mars may have a significant impact on habitability and the preservation of biosignatures.

INSTRUMENTATION AND METHODS

The Wet Chemical Laboratory (WCL) used electrochemical methods to determine the soluble anions and cations in martian soil. The WCL beaker contains 26 electrodes including:

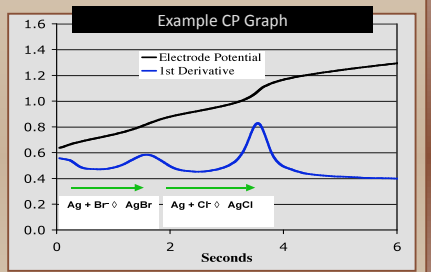
- Ion sensitive electrodes
- pH sensors
- Reference electrodes
- Chronopotentiometry electrodes
- Cyclic Voltammetry electrodes
- Conductivity analyzers

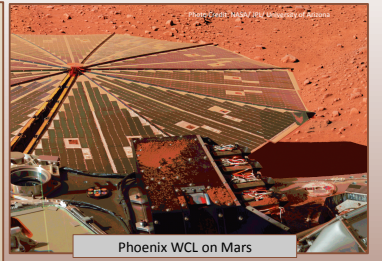

View of sensors in WCL beaker | WCL beaker disassembled

On Mars, chronopotentiometry was used to quantify halide concentrations (Cl^-, Br^-, I^-). The working electrodes were silver and platinum.

Chronopotentiometry (CP)

- A controlled current is applied across a working electrode and a counter electrode
- The potential of the working electrode relative to a reference electrode is measured as a function of time





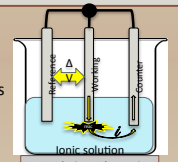
Phoenix WCL on Mars

THE SAND EQUATION

The Sand Equation is used to calculate concentrations of ions in solution based on the applied current and the transition time.

$$(i\tau^{1/2})/C_O^* = (1/2)(nFAD_O^{1/2}\pi^{1/2})$$

i = applied current
τ = transition time
C_O^* = concentration
n = number of electrons
F = Faraday's constant
A = electrode area
D_O = diffusion constant



CP Oxidation Schematic

RESULTS

Hypochlorite

The silver electrode could not detect separate transitions for hypochlorite and chloride; the platinum electrode could only detect hypochlorite.

The WCL Platinum electrode could detect hypochlorite at as low as ### ppm.

Figure 1

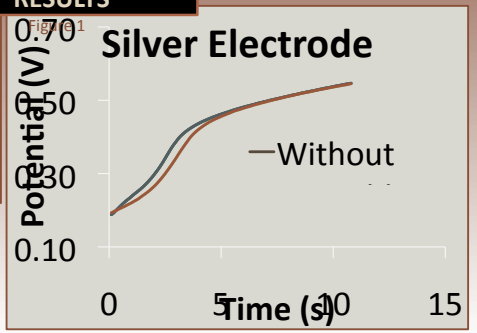
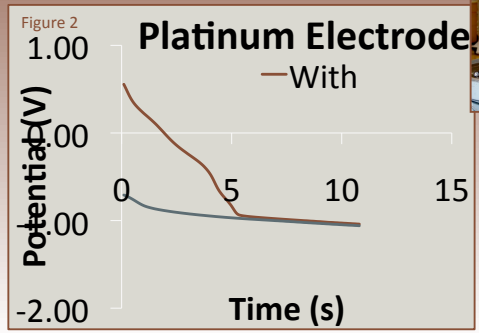
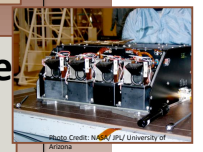


Figure 2



Figures 1 & 2 represent the chronopotentiometry scans of a Mars soil analog in solution before (blue) and after (red) hypochlorite was added.



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References