HYDROUS PERCHLORATES AND THEIR RELATION TO HUMIDITY AT THE PHOENIX LANDING SITE. J. Hanley and V. F. Chevrier, W.M. Keck Laboratory for Space Simulation, Arkansas Center for Space and Planetary Science, MUSE 202, University of Arkansas, Fayetteville, AR 72701, jhanley@uark.edu, vchevrie@uark.edu.

Introduction: Phoenix showed the presence of ~1% perchlorate in the landing site regolith [1]. This ion is associated to sodium and magnesium [2], making these compounds ideal candidates for liquid brines on the surface. In addition, hydration-dehydration cycles may control the humidity. We study the stability of perchlorates (liquids and salts) under Martian conditions using a combination of experiments and models, which is then applied to Phoenix observations [3].

The previously determined phase diagrams [3] for $NaClO_4$ and $Mg(ClO_4)_2$ show that the eutectic temperature is 236 K for 52 wt% $NaClO_4$ and 206 K for 44 wt% $Mg(ClO_4)_2$. Using a combination of thermodynamic (Pitzer) and water evaporation kinetic models [3], we calculated evaporation rates for the Phoenix landing site conditions.

Liquid Stability*:* While temperatures are more favorable for liquid solutions on the warmest day, equilibrium vapor pressure values are also higher, so liquid perchlorate solutions are evaporating (Fig. 1). Paradoxically, on the coldest days, the atmospheric water vapor pressure is above the saturation value of eutectic $Mg(ClO_4)_2$ solutions, making the liquid thermodynamically stable for a few hours (Fig. 1A). This is not the case for $NaClO_4$ where a higher eutectic makes it evaporating or frozen, but never stable.

We obtained the cumulated evaporated thickness over time (Fig. 1B). Although, the main control on the evaporation rate is the temperature, liquid once formed remains metastable for several days.

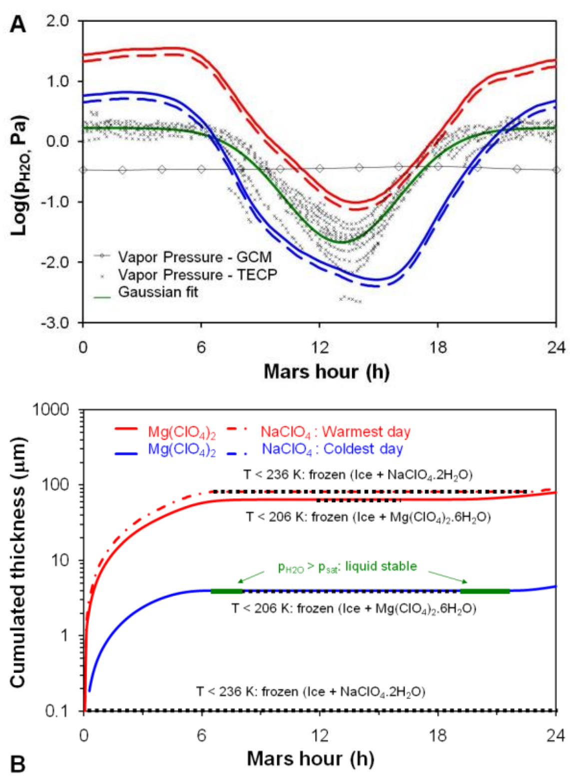

Figure 1. (A) Atmospheric water vapor from TECP (crosses) compared to modelled values from GCM (diamonds) and equilibrium values above eutectic solutions of $NaClO_4$ (dahed) and $Mg(ClO_4)_2$ (plain) for the coldest (blue) and warmest (red) days. (B) Integrated evaporation curves over time after noon for $Mg(ClO_4)_2$ and $NaClO_4$. Thick dotted black lines represent frozen periods. Green areas represent stable periods for liquid $Mg(ClO_4)_2$ eutectic solutions.

Humidity Control: Water vapor pressure exhibits strong diurnal changes associated with temperature fluctuations, suggesting coupling with the regolith, such as changes in the hydration state of perchlorates. At low temperatures, $Mg(ClO_4)_2$ has only one hydrate: 6 H_2O, which is stable up to 409 K, where it converts to $Mg(ClO_4)_2.4H_2O$ [3]. Although no evidence supports hydration higher than 6 H_2O, we suggest a transition to 5 H_2O at low humidity (Fig. 2).

When looking at the activity of water versus temperature in the soil (Fig. 2), we notice a clear trend along the MP6-MP5 curve. Almost all the values are in the stability field of $Mg(ClO_4)_2.5H_2O$. Another boundary is the solidus line, confirming control of humidity by Mg-perchlorates and the presence of liquid brines..

Further investigation into the effects of perchlorate hydration on atmospheric humidity is necessary. The next step will be determining the perchlorates hydratioin states at low-p_{H2O} and low-T.

References: [1] Hecht, M. H. et al (2009) *LPS XL*, Abstract #2420. [2] Kounaves, S. P. et al (2009) *LPS XL*, Abstract #2489. [3] Chevrier, V. F. et al. (2009) *GRL*, doi:10.1029/2009GL037497. [4] Besley and Bottomley (1969) *J. Chem. Therm.*, *1*, 13-19.

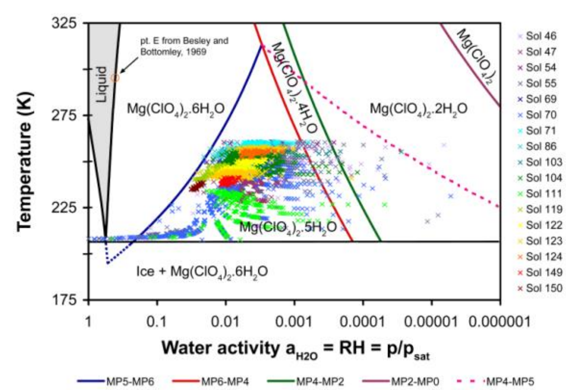

Figure 2. Temperature versus water activity in the soil, plotted with the stability diagram for $Mg(ClO_4)_2$. Solid lines are from Besley and Bottomley [4] and data points are from TECP's humidity sensor.