Freezing and Evaporation Modeling of WCL Solutions Using FREZCHEM Model and GWB Geochemical Work Bench. A. Elsenousy1, J. Hanley1, V. Chevier1. 1. Arkansas Center for Space and Planetary Sciences, 202 Old Museum Building, University of Arkansas, Fayetteville, AR, USA, 72701. amira@uark.edu

Introduction:
The WCL (Wet Chemistry Laboratory) onboard the NASA’s Phoenix lander identified the soluble ionic composition of Mars’s Northern region’s soil. The ions discovered at Phoenix landing site included Ca²⁺, Mg²⁺, K⁺, Na⁺, Cl⁻, SO₄²⁻, and the most unexpected ion ClO₄⁻ [1,3]. Although the soluble ionic composition of the soil at phoenix landing site is well known [1-4], this is not the case for the composition of the parent salts in the regolith. Recent studies have been done on modeling the WCL solutions using various thermodynamic codes to understand the salt assemblages at the Phoenix landing site [4, 5] using two different pathways: evaporation at 7°C or freezing of liquid brines [5]. In our study we compare the minerals formed by freezing (T < 0°C using FREZCHEM) with evaporation scenario (T > 0°C using both FREZCHEM and GWB). We also include the presence of chlorate compounds since chlorate is usually associated to perchlorate in natural environments [4, 6].

Experimental Methods:
The WCL solutions evaporation and freezing were modeled with FREZCHEM (modified to include chlorate salts) using initial conditions reported by [1], updated for sulfate (0.20 mmol/kg) and chlorate (6.20 mmol/kg). All evaporation runs started with 1000 g of solution and a water decrement of 0.1 g at constant temperature of 283.15 K. Freezing runs started at temperature of 273.15 K down to 173.15 K with temperature decrement of 1 K. Both evaporation and freezing runs were established with an initial pH of 7.7 and initial CO₂ of 3 mbar. The Geochemist’s Workbench® software package was also updated to include the Pitzer parameters for chlorate salts as reported in [4]. Evaporating 1 kg of water at 7°C took place with initial pH of 7.7 using the composition as defined in [1]. In this case, a fixed calcite concentration of 4.5 wt% [7] was added to the simulation to test for the presence of carbonate.

Results and Discussion:
As expected, the highly hydrated salts such as Meridianite (MgSO₄·11H₂O) and sodium perchlorate dihydrate (NaClO₄·2H₂O) are formed via freezing pathway (Fig. 1B). Potassium perchlorate is the least soluble perchlorate salt, therefore it was among the first precipitated salts through both evaporation and freezing runs (Fig. 1 A & B). Chlorates are the highly concentrated minerals at both evaporation and freezing pathways for FREZCHEM and GWB. Chlorate salts such as Mg (ClO₄)₂·6H₂O, Ca (ClO₄)₂·2H₂O and NaClO₄ are highly observed in the evaporation pathway of GWB (Fig. 2) and are dominated by Mg²⁺ and minors of Na⁺. Surprisingly, Calcium perchlorates are not observed at any of the models which is related to the presence of the two sinks KClO₄ for ClO₄⁻ and gypsum for Ca²⁺.

References: