CHARACTER OF Mg(ClO₄)₂ BRINES UNDER MARS REGOLITH CONDITIONS A. P. Zent[1], H. G.

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Introduction: Elsewhere in this volume [1], we report on our investigation of the initiation and growth of ice lenses under Mars like conditions. In that work, we assume that the soil-water-ice system is gas and solute free. We conclude that initiation of lens initiation – the unloading of particle-particle contacts by thermomolecular forces at a given soil horizon – may be a common process in the shallow Martian regolith, and that the dominant property controlling the rate of lens growth is the freezing point depression (ΔT_f) associated with the interfacial forces of the soil. Lens growth is thus favored in clay-sized soils over silt soils due to the greater ΔT_f, but segregated ice was observed at the Phoenix site, where soils were predominantly silt-sized.

Perchlorate salts were also observed at the Phoenix site, and will strongly affect some of the properties associated with potential ice lens growth, over and above increases to ΔT_f. Here, we investigate the nature of Mg(ClO₄)₂ brines under Mars-like conditions, with particular emphasis on those aspects that might influence the *in situ* segregation of residual liquids during phase change, potentially leading to the formation of subsurface excess ice. We also discuss cyclic variations in the water activity (a_w) that might affect the habitability of solutions in the shallow regolith.

The phase diagram of Mg(ClO₄)₂ suggests eutectic temperatures on the order of 205 K, meaning that some degree of unfrozen solution would be expected throughout much of the year in a typical shallow martian regolith. In Figures 2 and 3, we compare the unfrozen fraction of H2O due to varying solution concentrations to that expected from interfacial forces in two of our standard soils, Chena Silt and Univik Clay. While salt addition substantially increases the unfrozen H₂O in silt, the large clay surface area is of roughly equal importance in the clays, and substantially different unfrozen amounts are not expected.

The density and viscosity of the solutions also increase during freezing. The viscosity of a binary solution increases by roughly three orders of magnitude, which will severely inhibit potential segregation of subsurface perchlorate brines to form discrete expressions of excess ice.

The precipitation/solvation process for a (Mg(ClO₄)₂•6H₂O) is very energetic, with roughly a factor of four times more energy released than for freezing pure H2O. Thus, phase change and precipitation of the hexahydrite salt will be substantially drawn out as the energy associated with phase change is conducted away.

Activity: The nominal limits for metabolic activity in solution is generally thought to be in the vicinity of aw = 0.6. While eutectic perchlorate brines are thus generally uninhabitable, these activity levels are not reached until the brine cools to ~ 215K. At higher temperatures, the unfrozen H₂O for a saturated pore space solution is well within the habitable range
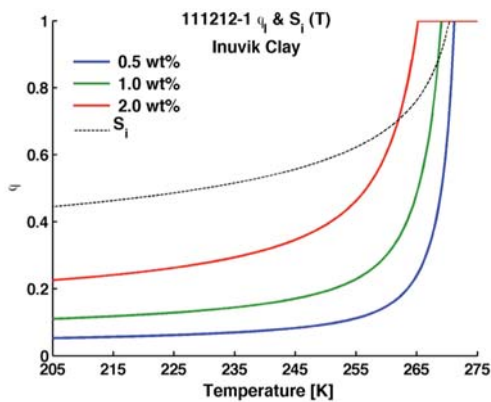
References
[1] Sizemore *et al., This Volume* (2013); [2]Pestrova *et al*.,(2005);
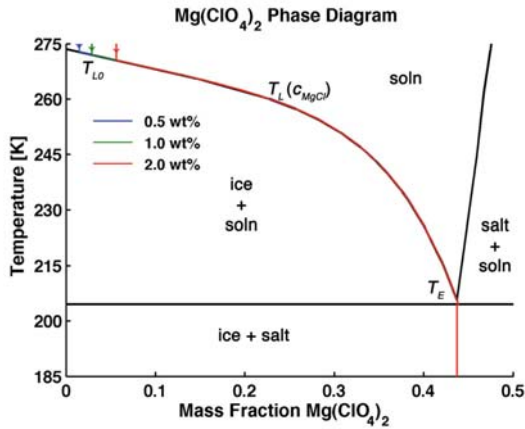
Figure 1. Binary phase diagram of $Mg(ClO_4)_2$ using the data of Pestrova *et a.,* 2005, and the path followed by cooling solutions. Weight percent refers to $Mg(ClO_4)_2$ in dry soil.
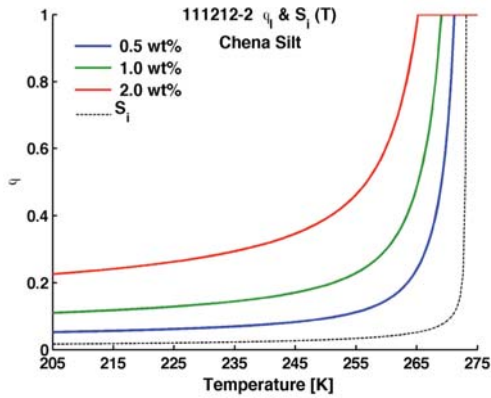
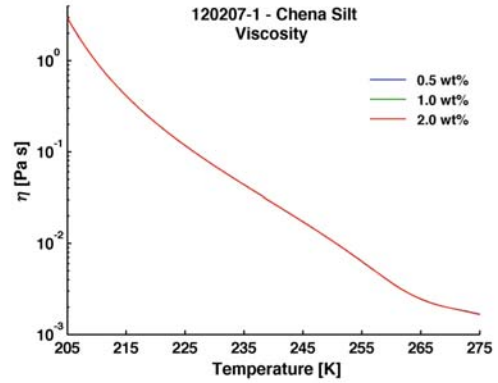**Figure 2.** Unfrozen fraction of H_2O during cooling, compared to unfrozen H_2O in Chena Silt due to interfacial forces.
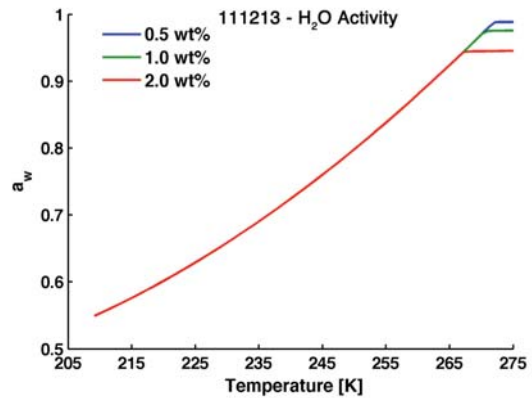

Figure 3. Same as above, for Inuvik Clay.
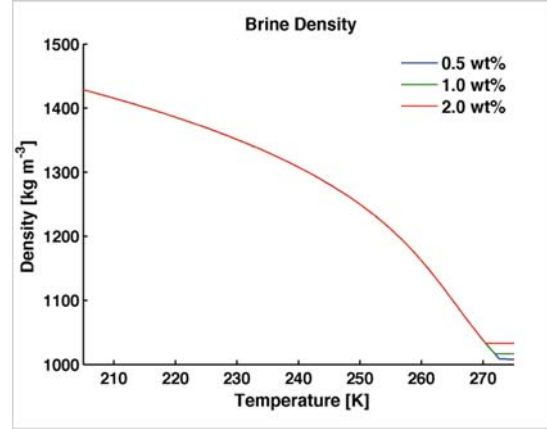
Figure 4. Solution density from freezing onset to the eutectic for 3 initial dry weight concentrations.

Figure 5. Viscosity increase by 3 orders of magnitude in the course of freezing, effectively immobilizing the unfrozen fraction at low *T*.

Figure 6. The H_2O activity coefficient as a function of *T* during freezing.