CHARACTER OF $Mg(ClO_4)_2$ BRINES UNDER MARS REGOLITH CONDITIONS

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We recently reported on our investigation of the initiation and growth of ice lenses under Mars like conditions [1]. We assume that the soil-water-ice system is gas and solute free. We conclude that 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. Solute-free lens growth is thus favored in clay-sized soils over silt soils due to greater ΔT_f, yet segregated ice was observed at the Phoenix site, where soils were predominantly silt-sized.

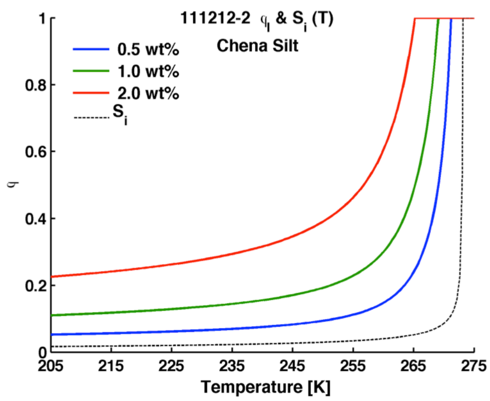

Figure 1. Unfrozen **f**raction of H_2O during brine cooling, compared to unfrozen H_2O in Chena Silt.

Perchlorate salts also occur at the Phoenix site, and strongly affect some properties associated with lens growth and habitability.

The phase diagram of $Mg(ClO_4)_2$ suggests eutectic temperatures on the order of 205 K [2]; some degree of unfrozen solution would be expected throughout much of the year in the shallow regolith. Comparison of unfrozen H_2O fraction *(ϕ_w)* in solute-free silt with ϕ_w in perchlorate brines (Fig. 1), shows salt addition substantially increases ϕ_w in silt; no such increase occurs for clays.

Density and viscosity (η) also increase during freezing. In a binary solution η increases by ~ 10^3, which may inhibit brine segregation and advection of heat (Fig. 2).

For the hexahydrite ($Mg(ClO_4)_2$•$6H_2O$) precipitating out of the brine, precipitation/solvation processes near the eutectic are very energetic; ~4*x* greater than for freezing pure H_2O. Thus, phase change near the

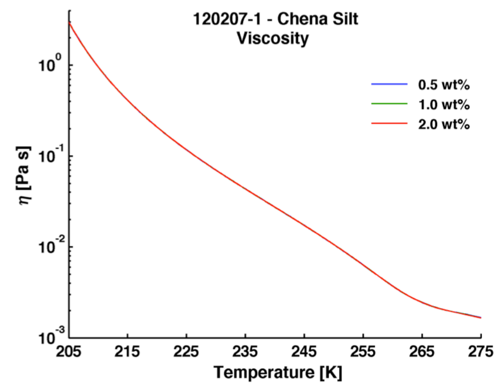

Figure 2. Viscosity increase by 3 orders of magnitude in the course of freezing.

eutectic will be substantially slowed as the energy associated with phase change must be conducted through the saturated regolith.

The nominal limits of H_2O activity (a_w) for metabolic activity is generally thought to be ~ a_w = 0.6. While eutectic perchlorate brines are unlikely to support metabolism, a_w > 0.6. for all $T \gtrsim$ 215K (Fig. 3), which should in principle permit metabolic activity for a significant fraction of the martian summer.

Observations of near IR absorptions at the Phoenix

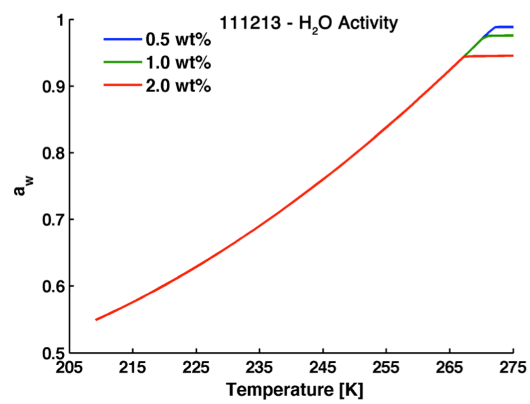

Figure 3. The brine H_2O activity coefficient as a function of *T* during freezing.

site may indeed reflect the persistence of detectable unfrozen H_2O throughout the mission [3].

References: [1] Sizemore, H. G., *et al., LPSC 44* (2013); [2] Chevrier, V. F *et al., Geophys. Res. Lett.*, 36, L10202, 2009; [3] Cull, S. C., *et al., Geophys. Res. Lett.*, 37, L22203, 2010