FORMATION OF CHLORIDE HYDRATES VIA VAPOR-SOLID REACTION AT LOW-T -- IMPLICATION FOR A H2O-RICH CRYOSPHERE IN MARS SUBSURFACE AND ON OTHER ICY PLANETARY BODIES. Alian Wang, Jie Wei, Lily Lu, and Kathryn Connor, Dept. Earth and Planetary Sciences and McDonnell Center for Space Sciences, Washington University in St. Louis (alianw@levee.wustl.edu, Rudolph Hall, One Brookings Drive, St. Louis, MO, 63130, USA).

A H2O-Rich Cryosphere: On Mars, ground ice was identified in Polar Region by Phoenix lander [1], and was implied at high latitude region by the color change of “white” impact ejecta through orbital imaging [2]. In equatorial region, a H2O-rich cryogenic environment in subsurface sulfate-rich layer was suggested through the observed color change of subsurface ferric sulfates (Tyrone site at Gusev Crater), which indicates dehydration happened after excavation and exposure to Mars current surface condition [3, 4].

Cl was found existing in every sample of every surface exploration mission to Mars [5]. Putative chlorides were suggested to exist in broad region of southern hemisphere on Mars [6]. Similar to sulfates, a thick layer of chlorides at subsurface could maintain a low-temperature environment because their high thermal inertia, on the basis of a thermal profile model [7]. Furthermore, chloride hydrates are the stable forms of chlorides at low temperature, such as CaCl2·6H2O (antarcticite) [8].

We would hypothesize a H2O-rich cryosphere within the subsurface of Mars, made of ground ice layer at polar and high latitude regions, and of salt- or salt-enriched-regolith-layers at low latitude regions. One piece of puzzle in this hypothesis is the source materials of Reoccurring Slope Lineae (RLS) that has been observed during local summer season with large quantity and broad spreading at low-latitude region and equatorial area on Mars [9, 10].

We report here the results from a set of experiments that has proved a critical concept in above RSL related study, i.e., the recharging of RSL source material at low-temperature (T) during local winter on Mars. These results have significant implication for the process that might happen on all low-T planetary bodies, i.e., Mars, Moon, icy satellites, asteroids, and comets.

RSL & 1st set of Experiments: Based on the observations made by HiRISE and CRISM, i.e., the tight correlation of RSL occurrence with temperature (T), the time duration of its occurrence and annually re-occurrences, the regional correlation with putative chloride deposits, and the lack of VIS-NIR spectral features at RSL sites [9, 10, 11], we hypothesized the source materials of RSL to be the subsurface chloride hydrates [12]. To test this hypothesis, we designed and conducted two sets of experiments. The results from first set of experiment was reported early [13], which demonstrated: (1) the deliquescence of Mg-, Ca-, Fe-, Al-chloride hydrates are heavily dependent on temperature; (2) under the T and partial water pressure (P_H2O) relevant to Mars subsurface, the rates of deliquescence of these chloride hydrates allow the process to begin and to accomplish (to exhaust the tested quantity of chloride hydrates) within hours and days. These results support that the deliquescence of chloride hydrates can generate RSL phenomena within the time duration of RSL observed on Mars [14].

This abstract reports the second set of experiments, that was designed to test if the rehydration of chlorides can happen through vapor-solid reaction at low-T relevant to Mars subsurface, i.e., if the recharging of RSL source materials can happen during a local winter period on Mars.

Vapor-solid reaction at -78 °C: The experimental setup is shown in Figure 1. MgCl2·6H2O was used as the starting material. It was baked in a 200 °C oven for 48 hours. Gravimetric measurements before and after baking confirmed the loss of 6.5 H2O per molecule (including adsorbed H2O). Raman spectroscopic measurements before and after baking confirmed the total transformation from MgCl2·6H2O to MgCl2, shown as the loss of Raman spectral features in 3000-4000 cm⁻¹ for hydrates. Visually, original transparent MgCl2·6H2O grains (Fig. 2a) all transformed to opaque-white grains of MgCl2 (Fig. 2b) after baking.

For the low-T experiment, a reaction vial containing about 100 mg of MgCl2 was buried in dry ice (-78 °C) in a foam box. This box-vial set was put into a...
Thus, the recharging of RSL source materials annually during local winter period is allowed by thermodynamics and kinetics. It means that the subsurface salt- or salt-rich-regolith layers could function like a “cold-trap”, to react with atmospheric H₂O vapor that is moving from polar region to middle latitude regions during local winter period on Mars. This vapor-solid reaction would rehydrate the chlorides, which were formed during the local summer period on Mars by dehydration. The chloride hydrates formed in such way will be the source materials for RSL to reoccurring in next local summer.

**Future works:** These two sets of experiments are proof-of-concept studies, which demonstrated the correctness of our hypothesis, and the feasibility of our experimental design. A detailed systematic experimental investigation is designed and will be proposed. It will concentrate on the thermodynamics and kinetics properties of specific chloride hydrates that are stable at lower T thus having even higher hydration degrees. The study on reaction rates (for deliquescence and rehydration) will be emphasized. Furthermore, experiments to reveal the P H₂O values (i.e., H₂O availability) at low-T within an environment filled with chloride hydrates and sulfate hydrates will be conducted, for the purpose to evaluate the habitable potentials of icy-salt environments, within Mars subsurface and on other icy planetary bodies as well.

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