

Transformations of Mg- and Ca-sulfate hydrates in Mars regolith

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ABSTRACT

Salt hydrates have an active role in regolith development on Mars. The Mg-sulfate system, with highly variable values of n in the formula $\text{MgSO}_4 \cdot n\text{H}_2\text{O}$, is particularly subject to transformations among several crystalline and amorphous forms. The Ca-sulfate system, $\text{CaSO}_4 \cdot n\text{H}_2\text{O}$, is likely to be associated with the Mg-sulfates in most occurrences, but is less susceptible to transformations in n . Desiccation of $\text{MgSO}_4 \cdot n\text{H}_2\text{O}$ occurs in exposed soils at the martian equator in summer where higher daytime temperatures at low relative humidity prevail against sluggish nighttime rehydration at high relative humidity. Desiccation and rehydration are both accelerated in the finest size fractions, particularly in silt-size aeolian particles subject to global redistribution by dust storms. This redistribution and periodic excursions into long-term episodes of high obliquity work to rehydrate desiccated $\text{MgSO}_4 \cdot n\text{H}_2\text{O}$ to form epsomite, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, at higher latitudes in the first case and more globally in the latter. Kieserite, a monohydrate form of $\text{MgSO}_4 \cdot n\text{H}_2\text{O}$ resistant to desiccation, can survive equatorial summer conditions, but not protracted high relative humidity; preservation of kieserite at the surface may place limits on the equatorial distribution of ice during past episodes of high obliquity. Deeper horizons in equatorial regolith may preserve hydrated phases through repeated obliquity episodes, raising the possibility of an ancient regolith archive of past hydration. At shallower depths in the regolith, in situ determination of the hydration states of the Mg-sulfates, and possibly the Ca-sulfates, may be used to constrain regolith dynamics if rates and modes of transitions in n can be fully characterized.

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