

THE COMMON ION EFFECT IN DEPOSITION OF MARTIAN (e.g., ALH84001) CARBONATES. P. H. Warren, Institute of Geophysics and Planetary Physics, University of California, Los Angeles CA 90095-1567, USA (pwarren@ucla.edu).

The most plausible model for origin of the carbonates in the ALH 84001 meteorite involves deposition from a playa lake or zone of groundwater that underwent evaporative concentration at or near the surface of Mars [1,2]. A key constraint for such a model is the virtual absence of sulfate in ALH 84001. In a simple closed system evaporation sequence, abundant sulfate would be expected to form from any plausible martian lake or shallow groundwater. However, several factors would potentially alter the course of the evaporation-deposition sequence enough to engender extremes of sulfate/carbonate fractionation, including the extremely low sulfate/carbonate ratio of ALH 84001. Assuming the evaporating water body was of transient in nature (i.e., the product of a flood), the water level could easily have been receding during the evaporation-deposition process, and we need only assume that carbonate deposition occurred, but not sulfate deposition, before the water level receded below the level where ALH 84001 was perched [1]. Occlusion of pores by incipient sulfate precipitation, in the outer fringes of the rock that ultimately became ALH 8001 and/or in overlying solid materials, might also have reduced the yield of sulfate deposition in ALH 84001 [1,2]. Another factor that probably played a key role is the common ion effect.

When two salts sharing a common ion are present in an aqueous solution, the dissolved ions of the more soluble salt act to substantially decrease the solubility of the less soluble salt. For application to Mars and ALH 84001, relevant sulfates have much greater solubilities than relevant carbonates. Assuming, for example, that the main ions in solution are Mg^{2+} , CO_3^{2-} , and SO_4^{2-} , then by the time the solution could be evaporatively concentrated to the point of $MgSO_4 \cdot 7H_2O$ saturation, the solubility of $MgCO_3$ would be diminished by a factor of 400, compared to its solubility in the absence of SO_4^{2-} (Fig. 1).

The actual solution chemistry would not be so simple, but given the magnitude of the common ion effect, potentially operating in conjunction with the water level drawdown and pore occlusion effects, it hardly seems surprising that the evaporitic carbonates in ALH 84001 are unaccompanied by significant sulfates.

In general, evaporitic martian sulfates probably formed only from extremely concentrated waters, whereas evaporitic carbonates probably formed as more diffuse deposits, filling pores in rocks (e.g., ALH 84001) and the megaregolith. Extremely concentrated waters, and thus sulfates, probably developed

mainly in places where floods (surface and groundwater) terminated in playas. In contrast, carbonates developed as diffuse deposits in the megaregolith along the routes followed by the waters on their way to the playas. Evaporitic sulfates are notoriously fragile, and tend to easily disintegrate upon exposure to eolian erosion. This model helps explain the extremely high abundance of SO_3 (~6 wt%) in the surface global regolith [3], and the virtual absence of carbonate signals among spectral measurements of the martian surface.

References: [1] Warren P. H. (1998) *JGR-Planets* 103, 16,759-16,773. [2] McSween H. Y., Jr. & Harvey R. P. (1998) *M&PS* 33, A103. [3] Rieder R. et al. (1997) *Science* 278, 1771-1774.

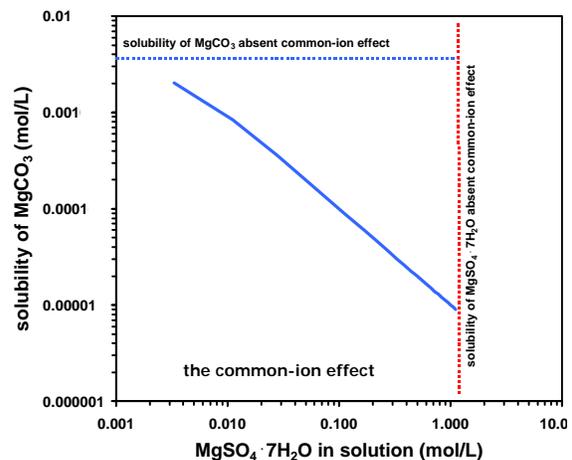


Fig. 1. Common ion effect on solubility of $MgCO_3$ in presence of dissolved sulfate.