



Water vapour interaction of hygroscopic salts with respect to formation of liquid phases at Martian surface conditions

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Here we present the H₂O sorption and deliquescence properties of hygroscopic salts such as halite, ferric sulphate and Mg-perchlorate which have been recently identified in deposits on the Martian surface. Because it has been shown that deliquescence of salts, such as sodium chloride, in the hyper-arid Atacama Desert provide a habitable environment, Martian hygroscopic salt deposits also might have an astrobiological potential. However, there is a shortage of thermodynamic data of the interaction of water vapor with relevant salts especially under the extreme conditions at the present Martian surface such as low temperature and very low water vapor pressure. Thus more experimental and theoretical work has to be done to support future missions on Mars in exploring geomorphologic developments and habitable environments.

The hydration/dehydration properties of halite, ferric sulfate and Mg-perchlorate were investigated quantitatively by means of isotherm measurements and thermogravimetry/ differential thermoanalysis (TG/DTA). The Sorption isotherms were measured gravimetrically from T=258-293 K and in the range of p_{H₂O}=10-4-10 mbar with a McBain quartz spring balance. TG/DTA measurements were performed on a Netzsch STA 409 apparatus with a heating rate of 3 K/min to 673 K. Over several weeks prior to the TG-experiment the samples have been stored in a controlled low pressure atmosphere of defined relative humidity (or water activity).

Exposure of the different salts to a low pressure atmosphere with controlled water activity results in different behavior of turning into liquid due to the characteristic deliquescence relative humidity (DRH). Liquefaction started with increasing RH in the order of Mg-perchlorate, ferric sulfate, and halite from about RH=80 to RH=40%. It is not surprising that Mg-perchlorate behave as the most hygroscopic salt of this selection. As seen from the isotherm measurements, the perchlorate starts hydration already at RH<0.01%, which is comparable with the behavior of zeolites but very different to the ferric sulfate and halite. Mg-perchlorate shows a two-step-hydration with increasing RH to form the hexahydrate at RH<1% already, followed by liquefaction at RH=40%. The perchlorate seems to become wet at some higher RH with decreasing temperature. The opposite has been found for halite. Halite has shown almost no uptake of water before approaching the DRH. Ferric sulfate shows a very unusual hydration/dehydration behavior with crossing hydration and dehydration isotherm branches. After liquefaction in hydration mode at about RH 50-60% desiccation of the sample stops with forming of the 9-hydrate (probably coquimbite) and seems to be stable for longer time at RH<1%. Kinetic measurements proof that hydration is faster than desiccation and that weight gain/loss of the liquefied sample is significant faster than those of the solid forms.

Taking into account the eutectic temperatures and the DRH values of the salts investigated, the results of this study support the existence of liquefied salt hydrates at present conditions on the Martian surface at least for the perchlorate and the ferric sulfate.