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IR-spectroscopic investigation of the kieserite-szomolnokite solid solution series under ambient and low temperature conditions with relevance to Mars

Dominik Talla and Manfred Wildner
Universität Wien, Institut für Mineralogie und Kristallographie, Natural Sciences, Austria (sutrar@volny.cz)

The investigation of hydrous sulfate deposits and sulfate-cemented soils on the surface of Mars is one of the important topics in the recent scientific endeavour to retrieve detailed knowledge about the planetary water budget and surface weathering processes on our neigh-bour planet. Orbiter IR spectra of the Martian surface indicate that kieserite, $MgSO_4{\cdot}H_2O$, is a dominant sulfate species at lower latitudes (CLARK et al., 2005). However, given its presumed formation by weathering of Fe-rich olivines and pyroxenes (CLARK & VAN HART, 1981), it is very probable that the actual composition of Martian kieserite lies at an intermediate value between the Mg- and Fe-kieserite (szomolnokite) endmembers. Although it is known that lattice parameters and spectral band positions differ significantly between these two endmembers, no detailed spectroscopic investigation on synthetic reference material along the entire $(Mg,Fe)SO_4{\cdot}H_2O$ binary solid solution series was done so far, despite its importance in the interpretation of spectral data acquired during Mars orbital reconnaissance missions.

We hereby present the results of FTIR measurements on hydrothermally synthesized samples with a variable Mg/Fe ratio. The FTIR spectra reveal changes in the wavenumber positions of prominent bands, as the Fe/Mg ratio progresses towards Fe-dominant compositions. The spectra acquired along the entire kieserite-szomolnokite solid solution series show Vegard-type behaviour, i.e. the spectral band positions change linearly between the two endmembers. Given the somewhat lower spectral resolution and stronger signal-to-noise ratio in the orbital spectra from Mars, only some absorption features may be used to reliably reflect upon the Mg/Fe ratio in kieserite found on the Martian surface. Such phenomena are the $\nu1$ vibration of the H_2O molecule, the H_2O bending vibration ($\nu2$) and a well-resolved band at around 850 cm^{-1} (LANE et al., 2015). The $\nu1(H_2O)$ symmetric stretching mode of H_2O increases in wavenumber with increasing Fe content, while the $\nu2(H_2O)$ stretching mode as well as the $\sim$ 850 cm^{-1} band decrease in energy. Apart from the band at 850 cm^{-1}, the well-resolved $\nu2(H_2O)$ bending vibration and the $\nu1$ symmetric stretching mode of the H_2O molecule, the changes in band position are too small to be effectively interpreted from orbital remote sensing measurements.

However, noticeable changes in wavenumber position are observed under decreasing temperature for the above mentioned IR absorption phenomena. Despite these deviations (which can in addition be compensated by the knowledge of the measurement temperature), one can roughly determine the chemistry of Martian kieserite along the Mg/Fe binary join from IR spectra acquired by orbital reconnaissance missions and the Mars rovers.

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