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WHAT LURKS IN THE MARTIAN ROCKS AND SOIL? INVESTIGATIONS OF SULFATES, PHOSPHATES, AND PERCHLORATES

Optical constants of synthetic potassium, sodium, and hydronium jarosite†

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Abstract

The hydroxy sulfate jarosite [$(K,Na,H_3O)Fe_3(SO_4)_2(OH)_6$] has both been discovered on Mars, and is associated with areas of highly acidic runoff on Earth. Because jarosite is extremely sensitive to formation conditions, it is an important target mineral for remote sensing applications. Yet at visible and near infrared (VNIR) wavelengths, where many spacecraft spectrometers collect data, the spectral abundance of a mineral in a mixture is not linearly correlated with the surface abundance of that mineral. Radiative transfer modeling can be used to extract quantitative abundance estimates if the optical constants (the real and imaginary indices of refraction, n and k) for all minerals in the mixture are known. Unfortunately, optical constants for a wide variety of minerals, including sulfates like jarosite, are not available. This is due, in part, to the inherent difficulty in obtaining such data for minerals that tend to crystallize naturally as fine-grained (~10 μm) powders, like many sulfates including jarosite. However, the optical constants of powders can be obtained by inverting the equation of radiative transfer and using it to model laboratory spectra. In this paper, we provide robust n and k data for synthetic potassium, hydronium, and sodium jarosite in the VNIR. We also explicitly describe the calculation procedures (including access to our Matlab code) so that others may obtain optical constants of additional minerals. Expansion of the optical constants library in the VNIR will facilitate the extraction of quantitative mineral abundances, leading to more in-depth evaluations of remote sensing target locations.

Keywords: Jarosite, optical constants, radiative transfer, Hapke, index of refraction, sulfate, Mars, AMD