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Analyzing CRISM Data from mound B in Juventae Chasma, Mars, with the Multiple-Endmember Linear Spectral Unmixing Model MELSUM

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Juventae Chasma, just north of Valles Marineris on Mars, contains several light-toned deposits (LTD), one of which is labelled mound B. Based on IR data from the imaging spectrometer OMEGA on Mars Express,[1] suggested kieserite for the lower part and gypsum for the upper part of the mound. In this study, we analyzed NIR data from the Compact Reconnaissance Imaging Spectrometer CRISM on MRO with the Multiple-Endmember Linear Spectral Unmixing Model MELSUM developed by Combe et al.[2].
We used CRISM data product FRT00009C0A from 1 to 2.6 μm. A novel, time-dependent volcano-scan technique [3] was applied to remove absorption bands related to CO_2 much more effectively than the volcano-scan technique [4] that has been applied to CRISM and OMEGA data so far.
In the classic SMA, a solution for the measured spectrum is calculated by a linear combination of all input spectra (which may come from a spectral library or from the image itself) at once. This can lead to negative coefficients, which have no physical meaning. MELSUM avoids this by calculating a solution for each possible combination of a subset of the reference spectra, with the maximum number of library spectra in the subset defined by the user. The solution with the lowest residual to the input spectrum is returned.
We used MELSUM in a first step as similarity measure within the image by using averaged spectra from the image itself as input to MELSUM. This showed that three spectral units are enough to describe the variability in the data to first order: A lower, light-toned unit, an upper light-toned unit and a dark-toned unit. We then chose 34 laboratory spectra of sulfates, mafic minerals and iron oxides plus a spectrum for H_2O ice as reference spectra for the unmixing of averaged spectra for each of these spectral regions.
The best fit for the dark material was a combination of olivine, pyroxene and ice (present as cloud in the atmosphere and not on the surface). In agreement with [5], The lower unit was best modeled by a mix of the monohydrated sulfates szomolnokite and kieserite plus olivine and ice. The upper unit fits best with a combination of romerite, rozenite, (two polyhydrated iron sulfates) olivine and ice. Gypsum is not present. The excellent fit between modeled and measured spectra demonstrates the effectiveness of MELSUM as a tool to analyze hyperspectral data from CRISM.

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