Characterization of Jarosite-Bearing Outcrops at Mawrth Vallis. J. M. Danielsen\textsuperscript{1,2}, J. L. Bishop\textsuperscript{2}, \textsuperscript{1}San Jose State University (San Jose, CA; jacob.danielsen@sjsu.edu), \textsuperscript{2}SETI Institute (Mountain View, CA).

**Introduction:** Compact reconnaissance imaging spectrometer for Mars (CRISM) images are analyzed and characterized for various materials including sulfates and smectites in the Mawrth Vallis region on Mars (Figure 1). Recent new MTRDR processing of two CRISM images, FRT0003BFB and FRT0000A425, allows for a better understanding of the materials on the Martian surface \cite{1}. Using spectral analysis of visible-near infrared data, we found the presence of smectites (nontronite & montmorillonite) and jarosite. We used the improved calibration currently available of these images to gain a better understanding of the jarosite-bearing units and their relationship to the associated phyllosilicate-bearing rocks. 

**Methods:** Multiple spectral parameters \cite{2} were tested to visually aid in identifying and characterizing specific mineral groups in the CRISM images. The spectral parameters R (SINDEX2), G (BD2100_2), B (BD1900_2) and R (BD350_2), G (BD920_2), B (BD1000VIS) were most helpful for identification of jarosite in these images, while the parameters R (BD2300, G (BD2190), B(BD2200) were used for detection of the Fe-rich smectite (nontronite) and Al-rich smectite (montmorillonite).

Spectra of areas of interest were collected using a spectra profile tool and a pixel average of either 3x3 or 5x5. To reduce the effects of atmospheric contributions and instrument effects, image FRT0003BFB was ratioed to a spectrally neutral 20x20 spot. This technique produced a cleaner spectral profile for analysis. Image FRT0000A425 exhibits spectral features due to aqueous components across most of the image. Therefore, a good location for ratioing the image is not present, and the spectral profiles were taken without being ratioed.

![Figure 1](image1.png)

Figure 1. (A) showing map of Mawrth Vallis region on Mars and locations of CRISM images. (B) Crism image FRT0003BFB. (C) Crism image FRT0000A425

**Results:** Phyllosilicates have been found in abundance in the Mawrth Vallis region and are well documented \cite{3-5}. Sulfates have also been identified in isolated, small outcrops \cite{6-9}. We extended these analyses with the recently available, improved CRISM images to characterize in more detail the types of sulfates present and their relationships to the phyllosilicate-bearing rocks.

FRT0003BFB: The spectrum of the phyllosilicate nontronite contains bands at 1.42, 1.91, and 2.29 – 2.30 μm \cite{10}. Our nontronite data contain a weak band at 1.42 μm and strong bands near 1.9 μm and at 2.29 μm (blue spectrum in Figure 2). The sulfate mineral jarosite [KFe\textsuperscript{3+}3(SO\textsubscript{4})\textsubscript{2}(OH)\textsubscript{6}] contains bands at 1.47, 1.86, and 2.26 μm \cite{11-12} that we used for identification of this mineral (Figure 2). It is also notable that jarosite spectra do not contain the water band near 1.9 μm that is found in smectite clays and other hydrated materials. While the 1.47 band is difficult to resolve in our data (red spectrum in Figure 2), the 1.86 and 2.26 μm bands were identified. Further, regions having these two characteristic jarosite bands, exhibited weaker water bands near 1.9 μm, strengthening the detection of this mineral.

![Figure 2](image2.png)

Figure 2. Spectra of the mixed “doublet” material (orange), jarosite (red) and nontronite(blue) in FRT0003BFB

The orange spectrum (Figure 2) contains bands at 1.42, 1.91, 2.22, 2.26, and 2.29 μm. This is characteristic of the “doublet” material identified recently \cite{9} that is likely a mixture of hydrous clays and sulfates, or may be an acidic alteration product of the nontronite. Montmorillonite and opal have spectral bands at 1.91 and 2.21 μm and could be mixed with altered nontronite or jarosite. Locations of outcrops are shown in figure 3.

The jarosite units we identified likely formed in situ, either in low pH water or in salty evaporate ponds.

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