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Composition and Stratigraphy of Acidic or Salty Components at Mawrth Vallis, Mars

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Abstract

Small outcrops of materials characteristic of acidic or salty environments have been found at Mawrth Vallis. They are characterized by a spectral doublet (2.22-2.28 µm) and are generally associated with the upper Al/Si-rich phyllosilicate unit and may include acidified clays [1], bassanite [2], jarosite [3] or other materials. Here we are investigating these doublet units in more detail to constrain their likely formation conditions and determine how they are related to the phyllosilicate-rich units at Mawrth Vallis.

1. Introduction

The phyllosilicate-rich outcrops at Mawrth Vallis exhibit multiple spectral signatures in CRISM images due to a variety of phyllosilicates and other hydrated materials [e.g. 1]. Defining the composition of these hydrated outcrops provides information on the aqueous geochemistry of the region. In this study we are focusing on the components likely to have formed in acidic or salty environments [1-4] that are often found in portions of the upper Al/Si-rich units. These are identified by the presence of a doublet feature between 2.22-2.28 µm that is distinct from the bands characteristic of Al/Si-rich (~2.2 µm) and Fe/Mg-rich (~2.3 µm) phyllosilicates [e.g. 5].

2. Methods

CRISM TRR3 [6] and MTRDR [7] images have been evaluated for this study. In addition to the initial parameters generated to identify minerals of interest in CRISM images [6], newly developed parameters were used in this study that enable improved discrimination among the types of phyllosilicates and other hydrated and OH-bearing phases [8].

3. Results

The acidic type materials at Mawrth Vallis are found in some cases at the juncture of the lower Fe/Mg-rich smectite and the upper Al/Si-rich phyllosilicates [4]. This is observed in Figure 1 for a region north of Oyama crater and west of the main channel.

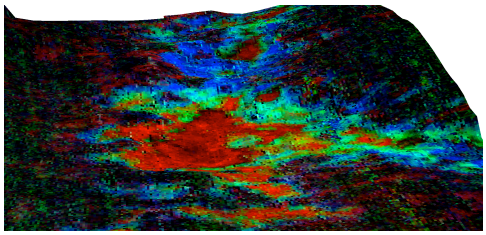

Figure 1: 3D view of MTR3 version of CRISM image HRL000043EC (R is D2300, G is BD2250, B is BD2190). The image is ~8 km across and S is up. Fe/Mg-smectite is shown in red and Al/Si-rich phyllosilicates in blue. The green regions indicate the unit associated with acidic or salty processes.

CRISM spectra from several locations in this image are shown in Figure 2 including several examples of the acidic materials. This acidic type unit is identified by a weak doublet or broad band near 2.22-2.28 µm. This can be asymmetric with a deeper band near 2.22-2.23 µm or near 2.26-2.28 µm, indicating this could be due to two components. It could be as simple as acid alteration of the Fe/Mg-smectite. Experiments with SWa-1 Fe(Al)-smectite in HCl observed a change in the 2.29 µm band in spectra of SWa-1 smectite to a broad doublet with centers near 2.23 and 2.27 µm as the sample was acidified [9, Figure 2). The observed features could also be

due to sulfate minerals like jarosite, gypsum or butlerite, but none of these is a perfect match to the CRISM spectra. The Al hydroxide gibbsite also has features in this region. Jarosite and butlerite typically form in acidic environments, while gypsum is more characteristic of neutral conditions and gibbsite indicates a highly leached environment.

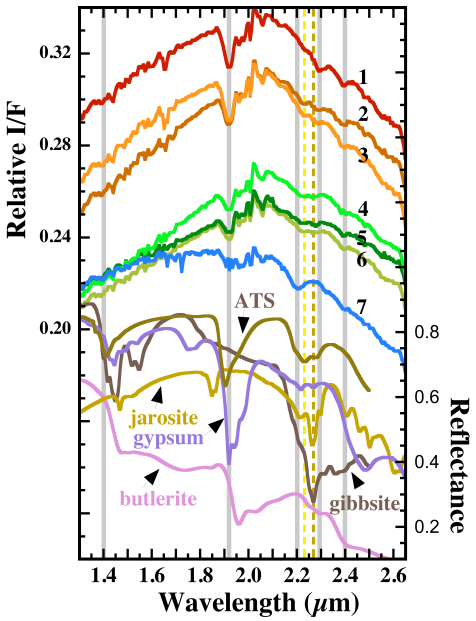

Figure 2: MTR3 spectra from CRISM image HRL000043EC compared with lab spectra. CRISM spectra 1 and 7 are examples of the nontronite and montmorillonite type units and spectra 2-6 are examples of the acidic materials. Lab spectra of acid-treated smectite (ATS) [9], jarosite, gypsum, gibbsite and butlerite all exhibit features near 2.22-2.28 µm.

4. Summary

We are working on characterizing the spectral properties and locations of these acidic type units in order to determine how widespread they are at Mawrth Vallis and constrain the geochemical conditions during their formation. The MTR3 calibration version of the images currently being tested and the newly developed spectral parameters are enabling improved analyses of this doublet feature. This acidic/salty unit with the doublet feature also partly overlaps with the ferrous material in between the lower Fe^{3+}/Mg-rich smectite unit and the upper Al/Si-rich upper unit. We are using the composite VNIR+IR nature of the new MTR3 files to further study how these units are related. We are using 3D views of CRISM images and overlaying these on HRSC stereo views in order to investigate the stratigraphy of the acidic or salty units. Our study is designed to determine what the types of minerals or alteration products likely are and how they are associated with each other and the dominant phyllosilicate units at Mawrth Vallis.

Acknowledgements

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