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Identification of the Ca-sulfate bassanite in Mawrth Vallis, Mars

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ABSTRACT

The region surrounding the Mawrth Vallis outflow channel on Mars hosts thick layered deposits containing diverse phyllosilicate minerals. Here we report detection of the Ca-sulfate bassanite on the outflow channel floor, requiring a more complex aqueous chemistry than previously inferred for this region. The sulfate-bearing materials underlie phyllosilicate-bearing strata, and provide an opportunity for testing proposed models of martian geochemical evolution with a future landed mission.

1. Introduction

Hydrated minerals on the surface of Mars including sulfates and phyllosilicates attest to a rich planetary history of water–rock interactions (e.g., Squyres et al., 2004; Bibring et al., 2006). There is increasing evidence for diverse conditions of aqueous alteration, which likely varied over time and space (e.g., Mustard et al., 2008; Murchie et al., 2009a; Ehlmann et al., 2009). From the perspective of planetary habitability, perhaps the most intriguing are the Noachian-aged exposures of phyllosilicates, which are inferred to have formed through alteration at weakly acidic to alkaline pH (Chevrier et al., 2007).

The region surrounding Mawrth Vallis contains one of the largest exposures of phyllosilicates on the martian surface (Poulet et al., 2005; Bibring et al., 2006). The phyllosilicates occur in light-toned layered deposits of possible sedimentary or pyroclastic origin (Loizeau et al., 2007, 2010; Michalski and Noe Dobrea, 2007), and exhibit a ubiquitous stratigraphic pattern of Al-rich phyllosilicates including kaolinite and montmorillonite overlying Fe-rich nontronite (Wray et al., 2008; Bishop et al., 2008; McKeown et al., 2009). Exposures are scattered across a region ~1000 × 1000 km in size (Noe Dobrea et al., 2010). Formation of these phyllosilicates must have produced excess cations that were accommodated in complementary salts or oxides (Milliken et al., 2009), yet to date only ferric oxides/hydroxides (Wray et al., 2008; Poulet et al., 2008b; McKeown et al., 2009) and highly localized jarosite ($KFe_3[SO_4]_2[OH]_6$; Farrand et al., 2009) have been identified in the region. Weak absorptions at ~2.4–2.5 μm in spectra dominated by phyllosilicates may be consistent with other secondary minerals as a lesser constituent of these rocks (Bishop et al., 2009b), but these spectral features are not yet assigned to specific minerals.

Here we report on a search for locations in the Mawrth Vallis region in which hydrated salts are the spectrally dominant component, for which we used data from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM; Murchie et al., 2007) supplemented by images from the High Resolution Imaging Science Experiment (HiRISE; McEwen et al., 2007), both on NASA's Mars Reconnaissance Orbiter.

2. Methods

We examined browse products (Seelos et al., 2008) for CRISM targeted observations distributed across the region surrounding Mawrth Vallis (Fig. 1). In particular, we searched for spatially contiguous areas highlighted by the BD1900 parameter, which tracks hydrated minerals, but not highlighted by the BD2210 or D2300 parameters that track Al- or Fe/Mg-phyllosilicates, respectively (Pelkey et al., 2007). We took special note of locations highlighted by the SINDEX parameter used to map hydrated sulfates (Roach et al., 2009).

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