AQUEOUS MINERALOGY AND STRATIGRAPHY AT AND AROUND THE PROPOSED MAWRTH VALLIS LANDING SITE: NEW INSIGHTS INTO THE AQUEOUS HISTORY OF THE REGION. E.Z. Noe Dobrea1; Michalski1, J.; and G. Swayze2, 3Planetary Science Institute, 1700 E Ft Lowell Suite 106, Tucson, AZ – 85719; eldar@psi.edu, 2 U.S. Geological Survey, MS 964, Box 25046, Denver Federal Center, Denver, CO 80225

Introduction: The Mawrth Vallis region is one of the four finalist landing site candidates for the Mars Science Laboratory (MSL). It is of particular interest as a site for exobiological studies of Mars because it presents a well-exposed and intact stratigraphic column of altered Noachian crust ([11], [2]). Past spectroscopic studies using CRISM and OMEGA have revealed large (~10’s – 100 km) continuous exposures of unconformably layered phyllosilicate-bearing rocks [3]. Stratigraphy is not only defined by lithologic contacts, but also by mineralogy, with Al-phyllosilicate-bearing units (e.g., Al-smectite and kaolinite-group minerals) and hydrated silica overlying Fe/Mg-phyllosilicate-bearing units ([1], [4], [5]). The proposed landing ellipse covers a large, continuous stratigraphic section of this eroded and altered crust. However, the mineralogical diversity, stratigraphy, and morphology observed there is also observed in outcrops throughout the western Arabia Terra region at length scales of over 1000 km. This suggests that whatever processes were responsible for the formation of these rock units operated on regional scales. Proposed processes for the deposition of the rock units include deposition of ejecta by multiple impacts, sedimentation in fluviolacustrine or marine settings, and airfall of dust, volcaniclastic material, or impact produced fines [3]. Additional proposed processes for the formation of the observed hydrated minerals and their stratigraphy include climate-driven top-down alteration, fluviolacustrine deposition, and diageneric of volcanic materials (e.g., [3], [4], [5]).

In this work, we show that the terrain within and around the landing ellipse displays a broader range of hydrous mineralogy than previously realized, including the presence of acid-leaching products, sulfates, and dehydrated Mg-smectites.

Datasets and Methods: We have used calibrated (calibration level TRR2) 1/F data from Full Resolution Targeted (FRT) CRISM observations acquired inside and outside the ellipse (Fig. 1). Atmospheric opacity-correction was performed using volcano scan [7] and a newly derived EPF-based technique. Subsequent data processing includes destripping and despiking [8]. Parameterization (e.g. [9], [10]) is used to identify and map spectrally interesting units. In some cases, we took ratios of the spectra of interest to the spectra of known spectrally neutral units in the same detector column in order to remove uncertainties that may be introduced by potential column-dependent systematic errors, and to develop confidence in our detections.

Results: Spectroscopic and morphological studies of the walls of the craters in FRT00094F6 have allowed us to identify a stratigraphic section consisting of at least four primary compositional units: two Fe/Mg-smectite-bearing units at the bottom of the stratigraphy, an Al-phyllosilicate-bearing unit above that, and in some instances, an Mg-phyllosilicate-bearing unit above that. The Fe/Mg-smectite-bearing units typically show clear evidence for layering in the un-brecciated portions of the crater walls. The layering is not always flat and may exhibit truncations, ripple-like bedding and synclinal forms reminiscent of buried channels or craters. The layers under the synclinal forms are not deformed, supporting the hypothesis that these synclinal forms are cross-sections of buried channels. The Al-phyllosilicate-bearing unit often shows spectral evidence for an enhanced concentration of ferrous material at its base, as well as mineralogical evidence for limited exposure to acidic fluids (Fig. 2A). This unit typically presents fracture patterns near the top, and layering near the base. In the context of an impact crater wall, it is difficult to determine whether this pattern is caused by the impact itself or by some other depositional or pedogenic process.

We have also identified material with the spectral signature of the sulfate bassanite or the zeolite analcime just east of the proposed landing ellipse (Fig 2B). This material is associated to a unit that has a pitted and etched morphology and underlies the layered Fe/Mg-smectite-bearing units (although Fe/Mg-smectites are also prevalent throughout the rest of this unit). The specific mineralogy of the material cannot
be uniquely constrained at this time based on spectral studies alone. However, bassanite has been identified further north within Mawrth Vallis [11], and some additional constraints can be placed in this case by the morphology of the unit that it is associated with.

The pitted-and-etched terrain in which this material is found is interpreted to result from volume loss by dissolution. Sulfates have a much higher solubility than zeolites, and their dissolution could create major subsurface volume loss. Hence, the pitted-and-etched morphology supports the potential identification of sulfates, immediately east of the ellipse.

**Discussion:** The observed data indicate that the proposed MSL landing ellipse retains a record of temporal variations in the environmental conditions of the region. Fe/Mg smectites are very susceptible to alteration by acidic water (e.g., [12]), and their presence records alkaline to neutral conditions during the period of their formation, and their subsequent preservation. On the other hand, Al-smectites tend to be a little more resistant to acid-alteration than Fe/Mg smectites. However, absorptions observed at 2.20 and 2.27 μm in the spectra of portions of the Al-phyllosilicate bearing unit (Fig. 2A) are consistent with absorptions observed in the evaporitic residue of solutions formed from low-grade leaching of phyllosilicates by mild acidic solutions (e.g., [13], [14]). Hence, the presence of these alteration products suggests that at least part of the Al-phyllosilicate-bearing unit was exposed to acidic conditions at some point after its formation.

This observation is intriguing because it could potentially help explain TES spectral results. TES spectra of the phyllosilicate-bearing surfaces are dominated by aluminous or ferric silica [15]. If weathering of the clays has resulted in silica-rich coatings, it could result in a dominant thermal IR spectral component, even if the coatings are thin (<5 microns) [16].

Finally, the tentative identification of bassanite in the pitted-and-etched unit is of particular interest because in order for pitting to occur upon their dissolution, the sulfates must have been playing a structural role in the unit: they must have been deposited as part of the original unit rather than as pore fill within the unit, suggesting the deposition of a sulfate-bearing unit that either predates or occurred in association with the deposition of the clay-bearing materials.

**References:**

![Figure 2](image-url)