GEOLOGIC CHARACTERIZATION OF OXIA PLANUM WITH MARS ODYSSSEY THEMIS DATA.

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Introduction: ESA's ExoMars 2020 team has conducted a rigorous process of selection for a location to send their rover Rosalind Franklin to the surface of Mars. Oxia Planum (Fig. 1) was selected for its extensive distribution of phyllosilicate bearing units of likely Noachian age, and its relatively smooth and lower elevation terrain compared to a similar candidate site, Mawrth Vallis [1]. It is important to conduct mineralogical and thermophysical assessments of the region for context and to serve as comparative studies when the rover investigates the surface. Remotely sensed mineralogical assessments have been conducted using Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) and Observatoire pour la Mineralogie, l'Eau, les Glaces et l'Activité (OMEGA) instruments. Such found an abundance of hydrated minerals in this region and were the drivers for Oxia Planum to be selected as a landing site [2]. However, to date, few efforts have provided Oxia surface characterization in the thermal infrared (TIR). The TIR provides complementary information to near-infrared (NIR) sensors CRISM/OMEGA because it is primarily sensitive to changes in bulk composition and also can be used to assess thermophysical properties. We propose to do an assessment of this region with an emphasis on bulk composition using the Thermal Emission Imaging System (THEMIS) onboard Mars Odyssey. Our objectives are to: 1) independently discriminate surface units in the region based on THEMIS spectral data, daytime/nighttime radiance characteristics, and textural/tonal characteristics (from CTX), 2) determine how these TIR-defined units relate to mapped phyllosilicate exposures, and 3) assess the bulk compositional characteristics of mapped surface units.

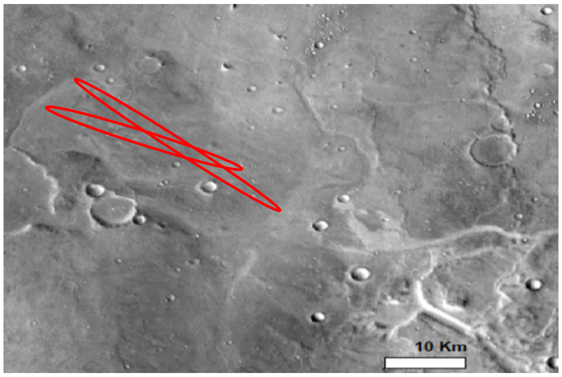


Figure 1: THEMIS daytime radiance of the Oxia Planum landing site. Notional 1-sigma landing ellipses from [2].

Datasets and Methodologies: We used level-1 thermal radiance data from THEMIS and conducted an atmospheric correction by using Thermal Emission Spectrometer (TES) data and an iterative model to obtain surface radiance [3]. From the surface radiance we extracted the spectral data. We also used THEMIS thermal inertia data to distinguish locations that have different surface compositions. Lastly, we used High Resolution Imaging Science Experiment (HiRISE) and Context Camera (CTX) data to distinguish significant surface morphology differences.

Unit Classification: We opted to designate geologic units based on four parameters: mineralogy, thermal inertia, tone, and texture. For mineralogy we used a decorrelation stretch technique with band numbers 8,7 and 5 to discriminate between surfaces of varying bulk SiO_2 content. For thermal inertia we used THEMIS thermal inertia stamps [4] to assess the difference of distributions on a unit to unit basis. For tonal differences we used CTX, where main distinctions were darker vs. brighter units. Lastly, we observed differences in surface textures with HiRISE data; this allowed us to designate five distinct units (Fig. 2).

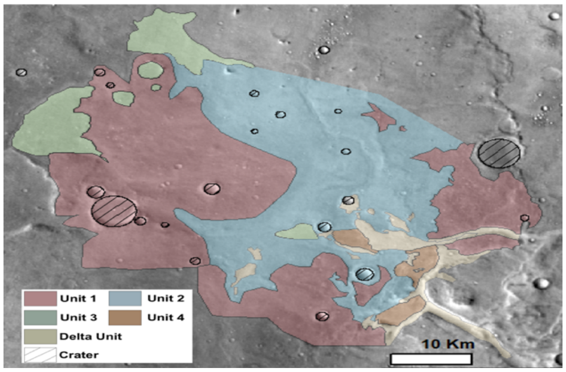


Figure 2: Units designated by thermal inertia, texture and mineralogy.

Unit Spectra and Modelling: We used two separate atmospherically corrected THEMIS stamps that together cover the entire region, I36292031 and I36604021. We extracted sample ROIs in both stamps and produced spectral plots (Fig. 3). Units 1, 3, 4, and Delta are spectrally similar to each other, with a narrow absorption centered at ~9 µm and a steep positive emissivity slope between ~9-11 µm. This shape is consistent with minimal contribution from mafic material. Even Unit 3, which is a dark-toned, resistant unit previously interpreted as younger volcanics [2], exhibits this spectral shape. Unit 2 exhibits the most distinctive shape among mapped units, with a broader absorption that is shifted towards longer wavelengths. The shift indicates likely greater contribution from mafic material and is

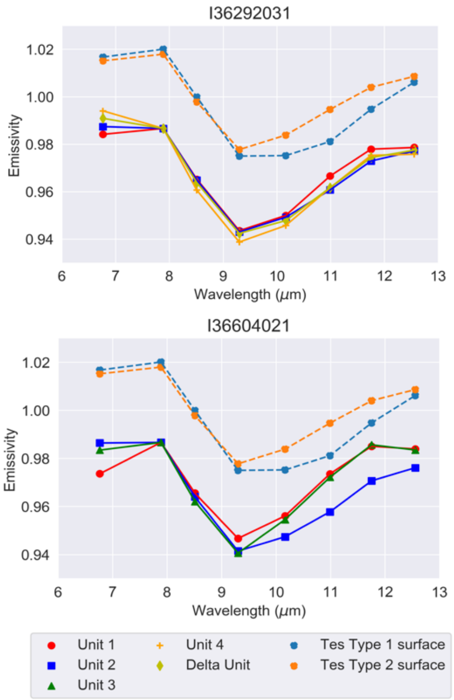


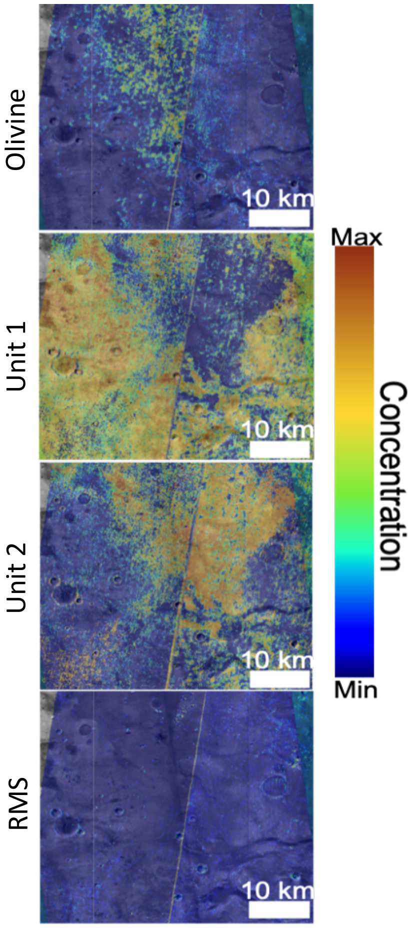
Figure 3:* *Spectra from units in Oxia Planum. Spectra vary by stamp but have similar trends. TES type surfaces displaced for clarity by 0.03.

potentially consistent with less alteration. Because the spectra for Unit 1 and Unit 2 had the biggest differences in spectral emissivity, we chose these as endmembers to model for spectral concentrations and produce THEMIS spectral concentration maps. We also added an Olivine endmember (Fo_{68}) based on small bluish spots observed in the DCS images that could be indicative of an even higher mafic content. A linear least-squares fitting algorithm was used to calculate the concentrations of the three endmembers (along with blackbody as a proxy for dust) on a pixel to pixel basis [5] (Fig. 4).

Fig. 4 shows that most surfaces in this region can be well-modeled using just olivine, Unit 1 and Unit 2. Though Units 3,4 and Delta are distinctive from Unit 1 in texture, tone or thermal inertia, they are spectrally similar. Small, isolated regions of olivine are modeled throughout geologic Unit 2; future work will examine CRISM data to determine if these isolated locations are consistent with concentrated olivine or simply lower SiO_2 content. The blackbody contribution was mainly located in the southern portion of the region. The last image in the figure is RMS error results. The majority of the higher RMS errors were located around crater rims, likely due to imperfect atmospheric emission correction over these surfaces with higher/lower-than-average radiance in the scene.

Conclusions: Oxia Planum is a region with a diverse set of surface morphologies and mineralogy. Though there is geological variability with the different classified units, bulk compositions do not vary significantly, with the exception of Unit 2. The similarity between Unit 1 and the delta unit might indicate that the host materials for the NIR-identified phyllosilicate minerals are similar to those found in the delta unit. THEMIS spectral shapes from Unit 1 (which hosts the phyllosilicate minerals) are consistent with substantial phyllosilicate abundance, but without knowing the composition of the host material (e.g. mafic, intermediate, silicic), it is difficult to model the absolute abundances from THEMIS spectra alone. The spectral differences between the delta and the underlying Unit 2 suggests that the later episode of aqueous activity associated with the delta [2] was not persistent enough to fully alter these units (e.g. original compositional differences are still recognizable and have not been converted to authigenic phyllosilicates). Future work will utilize post-sunset THEMIS spectral data (to be acquired in coming months) to better constrain the rock vs soil compositions of our mapped surface units.

Figure 4: Spectral units produced by linear least squares modelling using assigned endmembers superimposed over CTX imagery.



References: [1] Loizeau et al. (2019) *LPSC* abs. # 2132 [2] Quantin-Natafet al. (2019) *Mars 9th* abs. # 6317. [3] Bandfield et al. (2004) *JGR, Planets* 109 E10 [4] Christensen et al. (2013) *LPSC* abs. # 2822 [5] Bandfield et al. (2002) , *Planets* 107 E6

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