GEOLOGY OF THE EASTERN MARGIN OF TEMPE TERRA WITH IMPLICATIONS FOR MARS DICHOTOMY MODIFICATIONS. L. Pan[1] and B. L. Ehlmann[1,2], [1]California Institute of Technology (1200 E California Blvd, MC 150-21, Pasadena, CA, 91125. Email: lpan@caltech.edu), [2]Jet Propulsion Laboratory

Introduction: Tempe Terra is the northernmost exposure of ancient highland material and has a complex volcano-tectonic and resurfacing history [1-4]. Current understanding has been developed with the geomorphic features observed, lobate scarp, linear faults, etc.. Here we take advantage of hyperspectral data from Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) and made Fe/Mg phyllosilicate detections at the eastern margin of Tempe Terra, which are clearly exposed as a result of dichotomy erosional processes. These studies will shed light on the compositional constituents of Tempe Terra as well as the modification processes near dichotomy.

Geological setting: Tempe Terra is adjacent to several important features on Mars, bounded by Kasei Valles in the south and Tharsis to the west. The Terra grades into Acidalia Planitia to the east, connecting the old heavily-cratered Noachian terrain to the smooth northern plains (Figure 1a). From previous geological mapping, Tempe Terra is divided into heavily cratered terrain, the ridged plains and younger mottled plains and knobby plains [1], with striking grabens formed due to extensional stresses throughout Mars' history [2-4]. Our study region lies in close proximity to the knobby plains unit which is right at the boundary of dichotomy (Figure 1b), which is the transitional area from the highland material in Tempe Terra to the lowlands of Acidalia Planitia. In this region we have detected a dozen of occurrences of phyllosilicates in 9 CRISM images (some overlapping ones) as shown in Figure 1. These detections are strongly associated with how the dichotomy is modified.

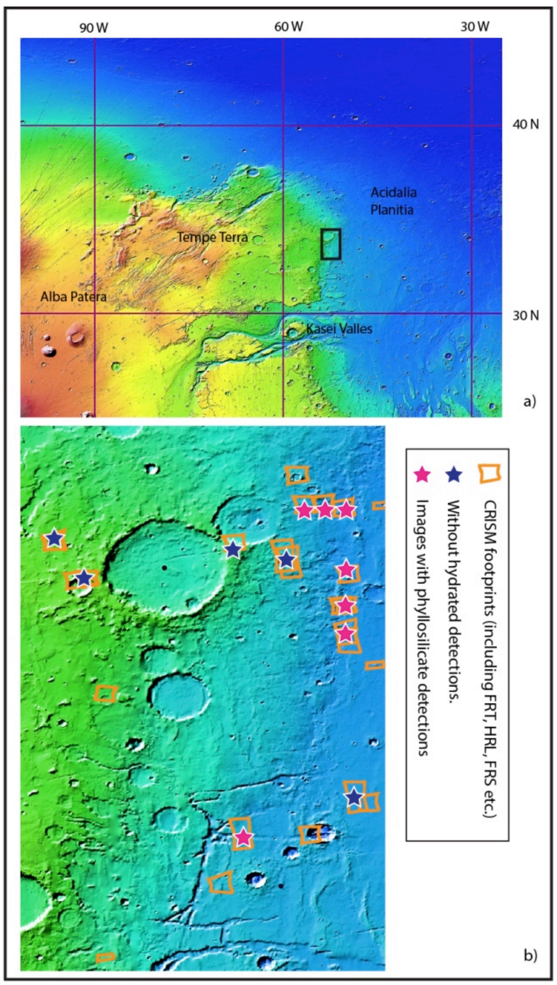

Figure 1: a) Geological Context of the eastern margin of Tempe Terra with respect to Kasei Valles, Acidalia Planitia and Alba Patera.

Spectral analysis: Hydrated silicate detections are identified by vibrational absorptions caused by overtones and combinations using visible, near-infrared

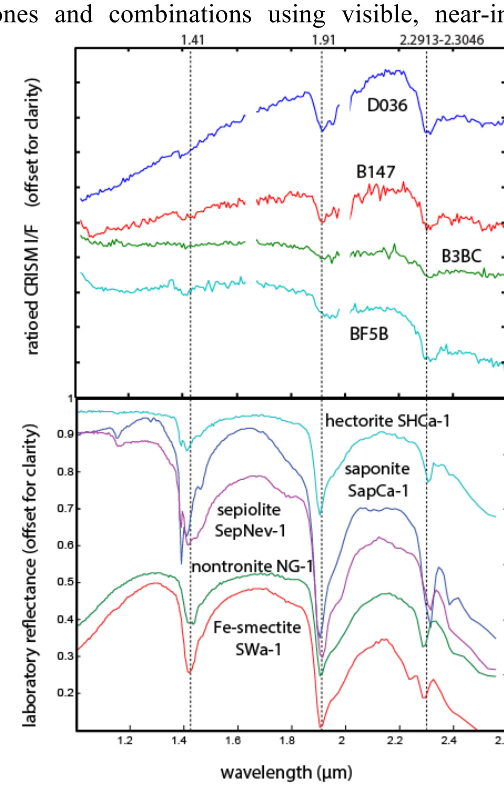

Figure 2: Spectral detections of Fe/Mg phyllosilicates in different CRISM images, compared with laboratory data of typical Fe/Mg smectite.

spectral data from CRISM.

Fe/Mg phyllosilicates are detected in multiple images in the region with a combination of a 1.4-μm feature due to water and metal-OH absorptions, a 1.9-μm absorption due to water, and an absorption at approximately 2.3 μm due to Fe/Mg-OH (Figure 2). Both Fe and Mg end members of the smectite group are consistent with CRISM spectral features with a slightly different band center around 1.4 and 2.3 μm [5]. The CRISM data are mostly centered at 1.39 and 2.31 μm, which indicates Mg-OH absorption, but there are some variations in the 1.9 μm band depth and width, indicating differences in H_2O content. Differences in the slope of the spectra shortward of 1.9 μm are possibly due to ferric and ferrous variation, similar to the phyllosilicates detected elsewhere in Acidalia [6] and Mawrth Vallis [7-8].

The spectral features of Fe/Mg phyllosilicate are quite consistent throughout the 9 images in approximately 70×40 km^2 area (4 showed in Figure 2). These detections are also consistent with previous Fe/Mg phyllosilicates detected in the highlands [5,7-9] and the northern plains [6, 10, 11]. However, no other hydrated or mafic signatures are detected in our survey.

Geomorphic setting of Clay Minerals: The detections are associated with features like inverted channels, craters, eroded textures in the region. The inverted channel morphology in CRISM images in Figure 3(a-c) is the most intriguing feature in the area. The inverted channel is 12.84 km long, 80-100 m wide with sinuous morphology. It's bounded by two wider channels on either sides. Here we can see the Fe/Mg phyllosilicates beneath a mantling crust are detected right at the flanks of the inverted channels, and within small craters on the smooth plains. The rather smooth unit to the south represents a relatively older resurfacing event that fills the previous topography with lavas/sediments.

Within the specific study region inverted topography is a common feature. Well-known in the context of lava flow fields and landscapes with duricrusts, inverted topography has been identified in many places on Mars. Here the topography is associated with phyllosilicate detections underneath, which could have been formed either as later alteration from original basalt lava fills or direct exposure of cemented altered sediments that are resistant to erosion.

However the phyllosilicate detections are also observed in places other than the inverted channel (e.g. in craters) and the spectral features detected region-wide are similar. Therefore it is more likely that the hydrated mineral formed before these erosional features and subsequently exposed in various settings as a continuous layer of phyllosilicates.

Conclusions and Future Work: The discovery of Fe/Mg phyllosilicates in the eastern margin of Tempe Terra confirms and may continue to shed light on the strong erosional processes at dichotomy, due to either aeolian, glacial or fluvial activities. With further investigation, one may connect these detections at the knobby plains unit with the bulk of Noachian Tempe Terra heavily cratered units to establish a more complete stratigraphy, constraints on the timing of clay mineral formation and surface water flow, and possibly identify the formation mechanisms for the phyllosilicates. We will continue investigate other parts of Tempe Terra with CRISM data and bring in digital elevation data to try to understand the geologic relationship between different units as well as the nature of erosional processes in the observations.

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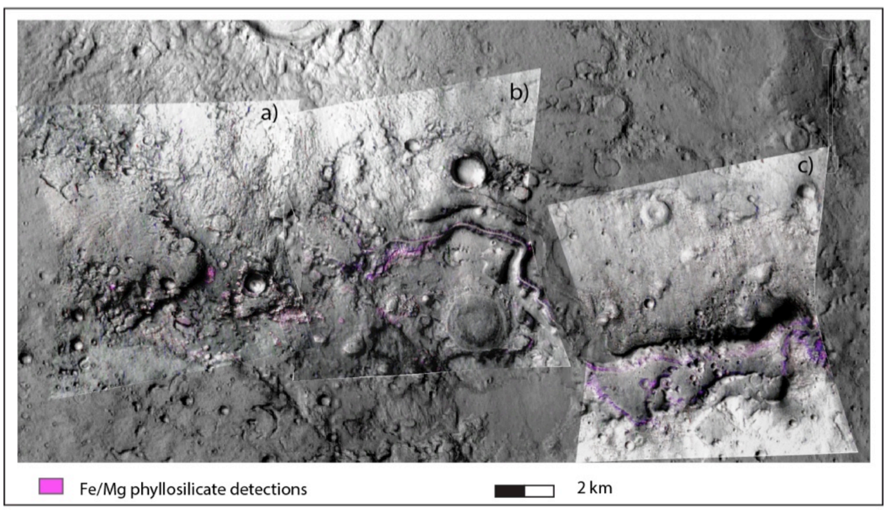

Figure 3: CRISM color composite map overlain with CTX mosaic from Google Mars showing the occurrences of phyllosilicate with respect to morphology