CLASSIFYING LANDSCAPES AND CONSTRUCTING SEDIMENTARY SUCCESSIONS IN ELYSIUM PLANITIA USING CTX AND HiRISE. V. Vescu[1, 2] (vvescu@caltech.edu), X. Tan[2], and S. Karunatillake[2], [1]Seismological Laboratory, Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA [2]Department of Geology and Geophysics, Louisiana State University, Baton Rouge, LA.

Introduction: As the second largest volcanic complex on Mars [1], Elysium Planitia is particularly important for understanding the geochemical composition of Martian mantle melts [2] [3]. However, landscape evolution may overprint volcanic resurfacing [4], causing uncertainties in the representativeness of bulk regional soils for igneous (primary) processes.

Here we use CTX and HiRISE images to map landscapes along the border of two geochemically distinct regions of Elysium Planitia. We aim to constrain better the degree to which landscape processes influence regional geochemical differences between the two regions.

In the same general area, we also use exposed outcrops of Cerberus Fossae [5] to map geologic units and construct geologic logs. We aim to assess the degree to which HiRISE images of outcrops can be effectively used for this purpose, particularly for stratigraphic variations in lithic-sediment units.

Methods: Starting from the geologic maps of Tanaka et al. [6], several regions had previously been delineated based on broad differences in chemical composition (Figure 1).

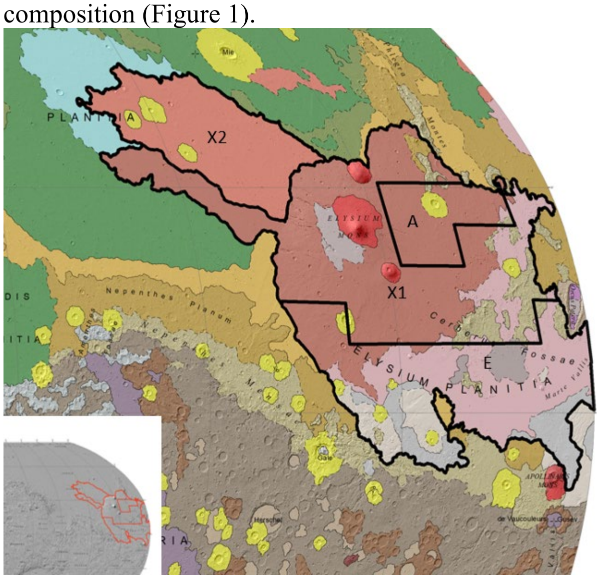

Figure 1: Map of previously delineated Elysium Planitia regions.

The Elysium quadrangle is divided into 30 rows and 30 columns using a fishnet in ArcGIS Pro. When available, the fishnet cells falling inside the delineated Elysium boundary (Figure 2) were examined to identify prominent landscape characteristics using CTX and HiRISE images. Landscapes are categorized into six types: volcanic, fluvial, aeolian, glacial, tectonic and impact.

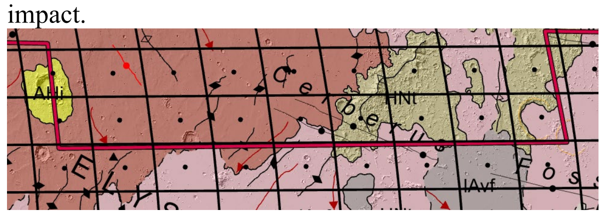

Figure 2: Detailed view of the boundary area which was mapped.

One of the most prominent features along this boundary is the Cerberus Fossae. We have used a pixel-counting method along outcrops of roughly constant slope to semi-quantify thickness variations in sediment and lithic strata of the region (Figure 3).

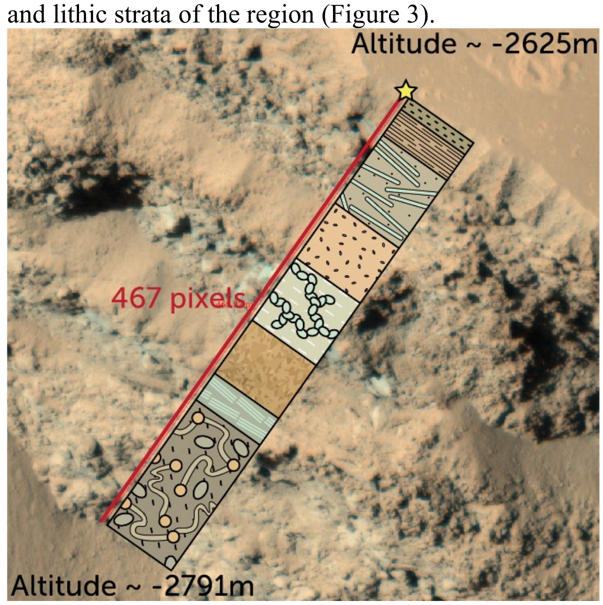

Figure 3: Depiction of the basic principle behind the pixel counting method.

Results: We find that the geochemical transition between the E and X1 regions has various landscapes on a broad range of scales. The region has many features that create elevation differences, influencing the general directions of flow-based processes.

Broadly, the prominent features of volcanic, tectonic, or impact origin that dominate the landscape induce elevation into the landscape. This irregularity brings about secondary landscape features, which appear mainly aeolian, gravitational, and fluvial, suggesting widespread mixed-layer homogenization between regions E and X1. For example, Figure 4 depicts an aeolian landscape of suspected katabatic origin near a crater wall.

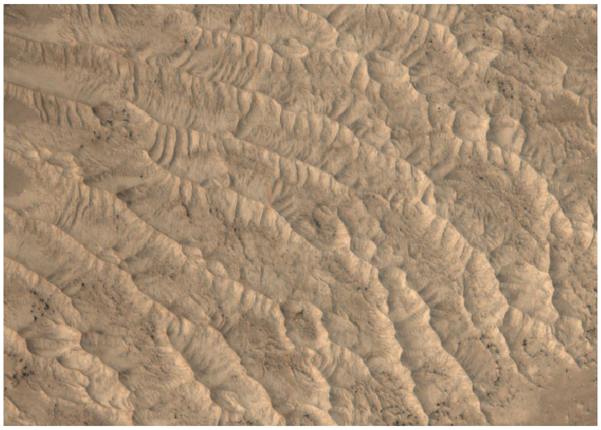

Figure 4: Example of the pronounced aeolian landscape surrounding altitude elevation seen on HiRISE observation PSP_002437_1875. (7.185°N, 151.904°E)

Figures 5-7 show geologic log-equivalents constructed using three very well-exposed outcrops. We use characteristics that emerge from the HiRISE observations, such as reflected frequencies and perceived cohesiveness, to categorize units into sedimentary or volcanic.

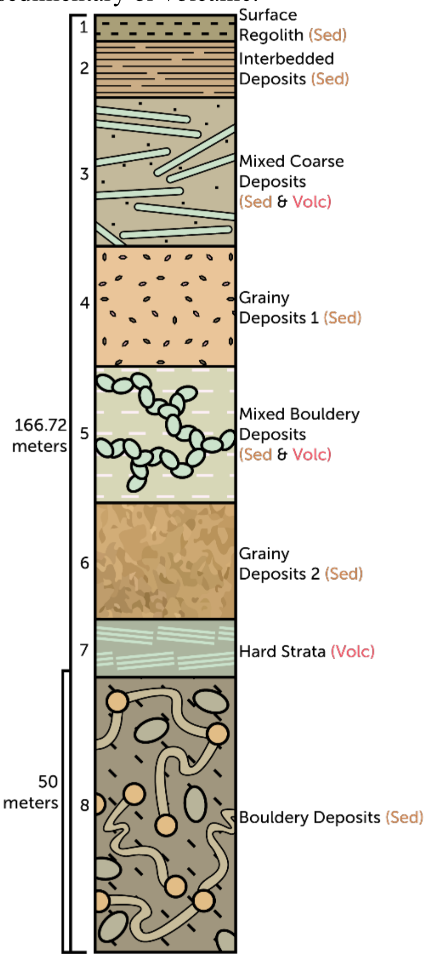

Figure 5: Geologic log based on outcrop seen on HiRISE observation ESP_024866_1900 (9.899°N, 160.459°E).

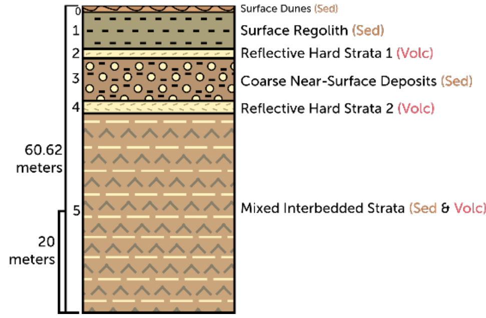

Figure 6: Geologic log based on outcrop seen on HiRISE observation ESP_055353_1905 (10.286°N, 159.586°E).

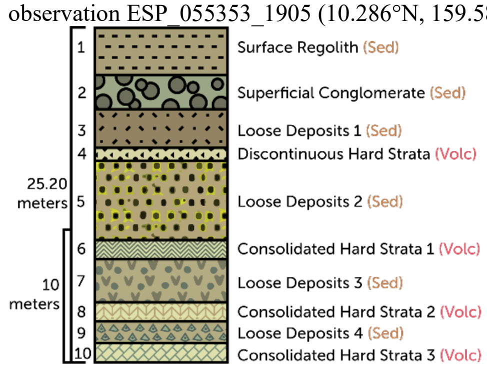

Figure 7: Geologic log based on outcrop seen on HiRISE observation ESP_012537_1915 (11.252°N, 157.509°E).

Discussion: Our mapping suggests categories of processes displacing and mixing soil and regolith along the Martian surface. Our semi-quantitative thickness estimates of strata, particularly on the relative influence of aeolian versus other types of processes, provides depth context for the geochemical trends in Elysium Planitia, especially on the spatial significance of compositional boundaries.

Geomorphological processes acting on strata identified in our geological cross-sections may obscure the apparent compositional contact between regions E and X1. HiRISE-level resolution images remain an effective method of logging exposed outcrops. They also give insights into the depth of the mixed layers and the recent history of deposition of volcanic material. Capturing images of Mars at shallower elevation angles may further improve the effectiveness of such methods in the future.

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References: [1] Mouginis-Mark, P. J. et al. (1984) *Earth, Moon, and Planets, 30,* 149-173. [2] El-Maarry, M. R. et al. (2009) *Journal of Volc. and Geothermal Research, 108(1-2),* 116–122. [3] Horvath, D. G.et al. (2021) *Icarus, 365,* 114499. [4] Karunatillake, S. et al. (2009) *JGR: Planets, 114,* E12001. [5] Stähler, S. C. et al. (2022) *Nature Astronomy*, *6*, 1376–1386 [6] Tanaka, K.L. et al. (2014) *U.S. Geological Survey Scientific Investigations Map 3292,* pamphlet 43 p.