

STRUCTURAL VARIATION IN THE ANCIENT PHYLLOSILICATES AT MAWRTH VALLIS, MARS.

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Introduction: The stratigraphy of the Noachian phyllosilicates detected in the Mawrth Vallis region of Mars indicates a complex history of ancient aqueous alteration [e.g. 1-5]. There are four fundamental units detected by MRO/CRISM: the deepest unit is a light-toned Fe/Mg-smectite that is likely the aqueous alteration product of basalt, overlain by a transitional ferrous unit, then a hydrated silica / Al-phyllosilicate layer, and finally a layer of darker, anhydrous caprock at the top of the sequence [2,4]. These are each visible in crater wall exposures in Figure 1. These phyllosilicate-rich outcrops were likely formed by an expansive and long-duration aqueous event (or multiple events) including alteration of sediments or volcanic ash [2-5] that halted no later than 3.7-3.6 Ga ago [6]. The phyllosilicate-rich units are finely bedded at the meter scale, consistent with a sedimentary origin [e.g. 5,7]. The wide distribution of this phyllosilicate stratigraphy [8], the unusual strength of the spectral features (consistent with intense alteration) [9] and the ancient age of the rock units [6] make this site particularly interesting for understanding the history of aqueous activity on Mars [10].

We seek to investigate the strike and dip of strata in these key phyllosilicate-rich stratigraphic units to help constrain depositional processes; e.g. do we see cross-bedding as expected for aeolian dune strata, or rhythmic horizontal bedding as in deep subaqueous settings? Major structural variations (faults and/or folds) can also be characterized. Units sharing a common mineralogy as observed by CRISM were assessed for commonality in average layer strike and dip.

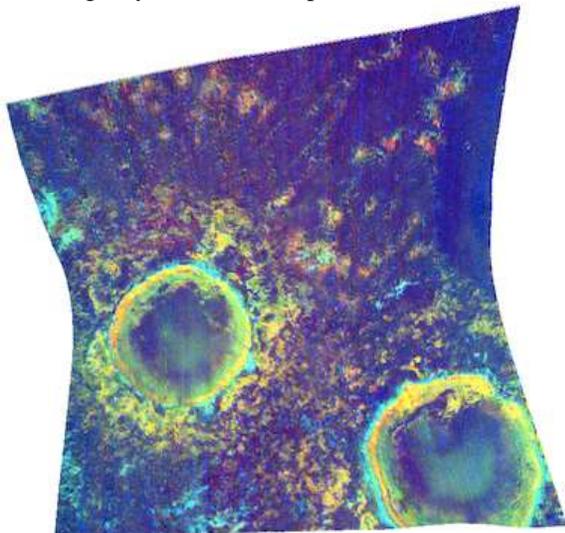


Figure 1: Mineral map of ~4 km wide impact craters located in the Mawrth Vallis region (CRISM image FRT000094F6). Colors are Red: Fe³⁺/Mg-smectite (2.3 μ m band), Green: Fe²⁺ material (1-1.8 μ m slope), and Blue: Al-phyllosilicate and/or Si-OH (2.21 μ m band).

Methods: Strike and dip measurements of strata using Digital Terrain Models (DTMs) made from HiRISE images (vertical accuracy <1 meter) were imported into OrionTM software. Strata were visually identified and representative points along the strata were selected to produce a planar best fit via multi-linear regression, an approach used widely in studies of Martian layered deposits [e.g., 5,11,12]. Planar measurements of identifiable layers were taken at \sim 50 m intervals. Measurements were excluded that had a standard error >1, a Goodness of Fit <98%, strike error >30 degrees, or dip error >10 degrees to ensure that all planes were representative of layer geometry (Figure 2). Planar measurements were then plotted in contour diagrams as the pole perpendicular to the bed in an equal-area projection, with horizontal beds plotting at the center of the stereonet (Figure 3).

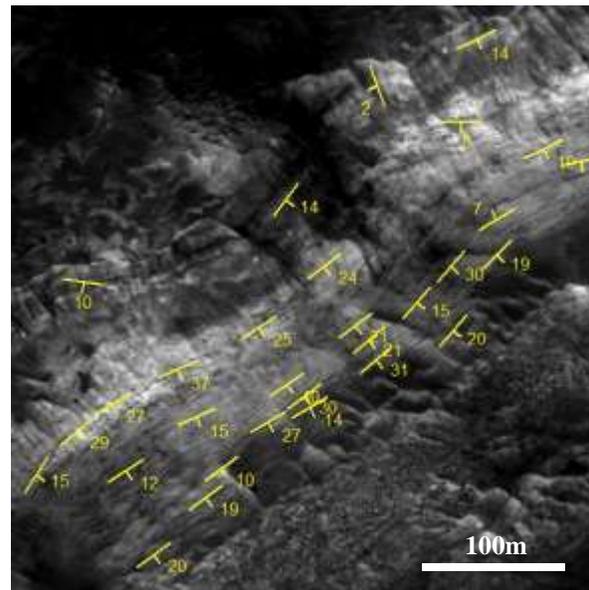


Figure 2: Strike and dip measurements taken of strata on the northwest crater wall in the leftmost crater of Figure 1 (from HiRISE image PSP_004052_2045).

Impact Excavation: Impact craters offer some of the best exposures of layer mineralogy in the Mawrth Vallis region and elsewhere on Mars [e.g. 13; Figure 1]. Unfortunately, the impact structure appears to dominate the planar measurements of layers, highly distorting layer geometries. Strike and dip measurements taken at a 4 km diameter impact crater located approximately 30 kilometers east of Oyama crater in the Mawrth Vallis region are consistent with structural measurements of terrestrial impact craters in sedimentary layers such as the Haughton impact structure in the Canadian High Arctic [14]. For example, our measurements of strata exposed by the crater's northern wall (Figure 3) show the same structural trend as the northern wall measurements presented in [14]. At the same crater's southern wall, the dip direction of the outermost exposed stratigraphic layers is again down toward the crater center, with ~30 degrees of variation in dip.

These measurements may be more representative of impact-generated structural deformation than of the pre-impact depositional bedding planes. Since the kinematics and mechanics of the modification stage in determining final crater morphology are not fully understood at present [14], it is difficult to interpret these measurements. Further data and analyses are required in order to deduce paleo-environmental conditions and subsequent tectonic stressors from measurements of strata taken at crater wall exposures.

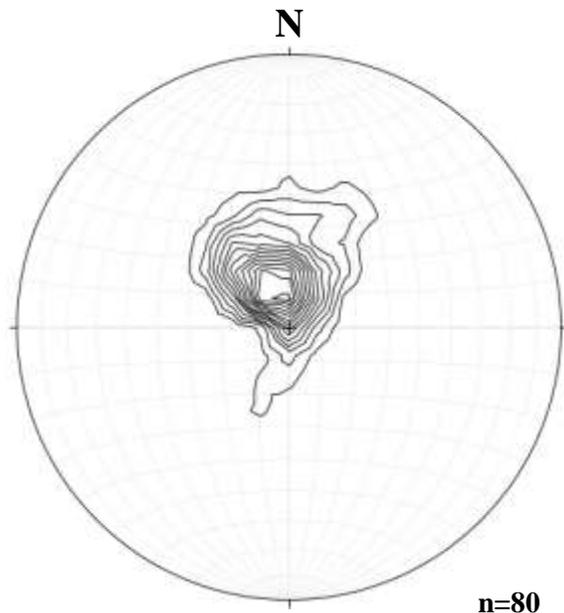


Figure 3: Contour diagrams (contour interval=2%) of pole perpendicular to the bed in equal-area projection of the northern crater wall of Figure 1.

Other Exposures: We can avoid the distorted structure that is produced as a result of impacts, because fluvial or aeolian carved canyons offer good exposures

for mineralogical analysis as well as undisturbed original structure that can be used for our analysis. For example, small valleys on the floor of the very large Oyama crater offer good exposures of mineralogy (Figure 4) as well as undisrupted strata. Planar measurements of visible strata will be measured in a DTM of HiRISE images ESP_022288_2035 and ESP_022354_2035.

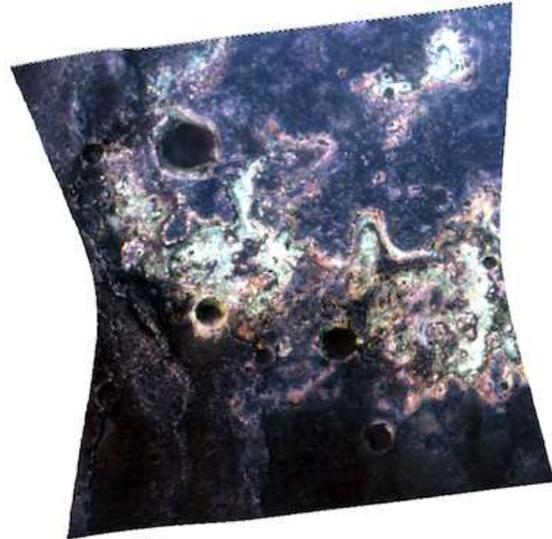


Figure 4: View of aqueous mineral exposures in valleys on the floor of Oyama crater in the Mawrth Vallis region (CRISM image FRT0001903B). Colors are Red: 2500 nm, Green: 1500 nm, Blue: 1208 nm.

Further Work: Additional planar measurements are underway from structurally undisturbed sites in the Mawrth Vallis region. Determination of the average strike and dip for each mineralogically distinct unit identified in CRISM data will provide more information about formation of the units as well as tectonic events that have punctuated deposition of the strata.

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