IDENTIFYING FRACTURE NETWORKS AT OXIA PLANUM AND MAWRTH VALLIS, MARS.

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Introduction: The selected landing site for the ExoMars rover mission, Oxia Planum, preserves a rich record of geological history from the red planet's warmer and wetter past, approximately four billion years ago. Oxia Planum is situated in a region with many channels cutting through from the southern highlands to the northern lowlands. Such locations are considered to be prone to include many prime targets to investigate for clues that could potentially reveal the presence of biosignatures of ancient life on Mars. Oxia Planum is dominated by Fe/Mg-smectite-bearing rocks that must have formed due to alteration by water, as well as physical signs of water flow like deltas and fluvial channels [1]. The clay strata at Oxia may be a continuation of thicker and more diverse clay strata observed at Mawrth Vallis [e.g.[2], a previous candidate landing site for ExoMars several hundred kilometers to the northeast.

Fractures filled with bright material have been previously identified at Mawrth Vallis [2][3][4][5][6], but their properties and distribution throughout the clay-bearing strata in the region is unknown. The ExoMars rover mission will be looking for biosignatures in Oxia Planum, and the mineral fills within filled fractures are a good target for biosignature preservation [7]. So, the main question covered in this research is: Where may such fractures be found on both sites and what are their possible origins? The proposed landing sites for both locations were carefully analyzed for possibility of fractures, their frequency, density, and any visible trends.

Methods: This research used data and observations from the Java Mission-Planning and Analysis for Remote Sensing (JMARS) program [8] and satellite images from the High-Resolution Imaging Science Experiment (HiRISE) [9] as tools for investigations. Firstly, the outlined landing ellipse was recorded, and all observations were mapped and fed into a fracture database. JMARS was utilized to view images, create maps, import relevant shape files, and build the comprehensive fracture database. The latitude/longitude grid layer was used to split the mapping area into 1 km grid squares upon the HiRISE images. Consequently, grids that showed possible bright fractures were logged as "present", "possible", and "not-present". Other bright features were also noted for later follow up. Fractures that extended to multiple grids were considered as "present" for all respective grids. Finally, green, yellow, and red box shapes correlating with present, possible, and not present fracture squares respectively was created to be analyzed for overall distribution trends. If a particular grid was denoted by present or possible, it was analyzed for morphology, including polygonal (rectangular) or irregular (linear/curvilinear) shape, size (short or long), color of clay unit (reddish-brown, blue), and density of fractures (high, moderate, low).

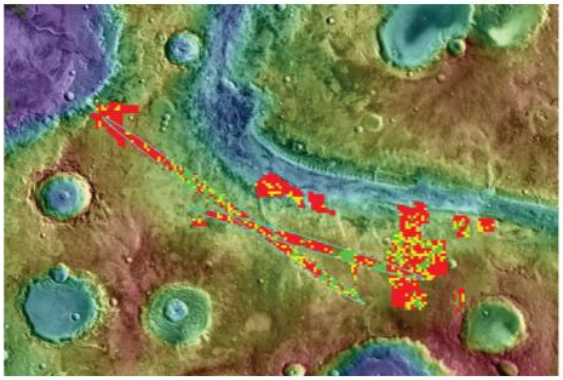

Figure 1: *Fracture distribution map for Mawrth Vallis. Grids with definite fractures are outlined in green, possible fractures in yellow, and no fractures in red.*

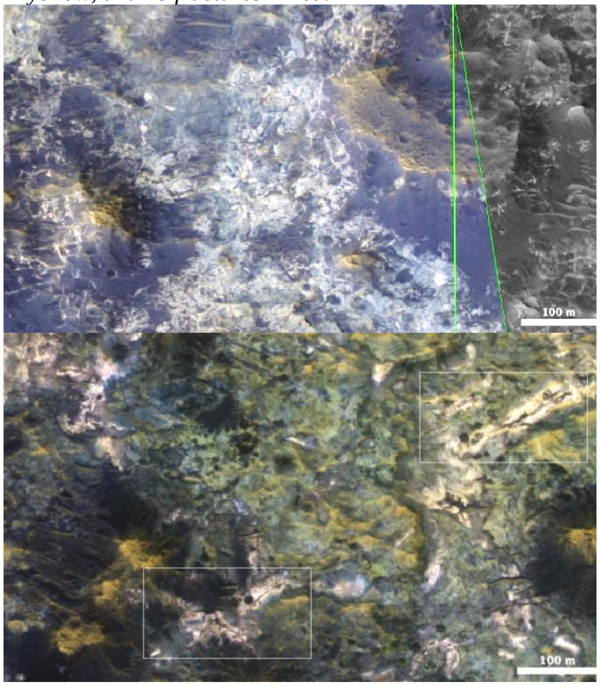

Figure 2: *(top) Typical Mawrth Vallis rectangular fracture networks emerging from beneath the regional capping unit and (bottom) possible halo-bounded irregular fractures*

Mawrth Vallis: Figure 1 shows the distribution of fractures in the ExoMars proposed landing site at Mawrth Vallis. Rectangular fractures were identified for their shape and classified under polygonal fractures as they most often appear in repeating patterns. By contrast, irregular fractures (Figure 2), are those that do not show any patterning. Finally, any of these fracture types could appear halo-bounded, partially surrounded by a bright halo-like ring as shown in Figure 2.

Distribution of fractures. Bright fractures, which were easier to identify using remote sensing methods due to their contrast with dark surface materials like sand, were abundant in the southern and central parts of the ellipses but were less concentrated in the far northern areas. The differences in types of fractures identified are most likely a result of their occurrence in different parts of the area's stratigraphy, with rectangular fractures embedded just below the mafic capping unit, bright fractures in the boundary between Al-phyllosilicates and Fe/Mg smectites, halo-bounded fractures in the Fe/Mg smectite layer, and thin fractures throughout.

Results. We hypothesize that rectangular fractures at the top of the layering sequence formed due to desiccation in a subaerial environment (similar to mudcracks), consistent with their location at the top of a proposed weathering sequence. We also hypothesize that curvilinear and irregular fractures in the Fe/Mg-smectites formed during burial of wet sediments, as observed on Earth during dewatering of subaqueous sediments [10]. If present, precipitated minerals in shallower rectangular fractures may preserve fluids and biosignatures from surface environments. Finally, precipitated minerals in deeper curvilinear fractures may preserve fluids and biosignatures from subsurface environments.

Oxia Planum: Following selection of Oxia Planum as the ExoMars landing site, we have now begun an investigation to determine whether or not similar fractures are present in the clay-bearing units of this region. Understanding the different formation environments is fundamental for our knowledge in the search for biosignatures on Mars. So far, 1 km^2 grids have been mapped in the central portion of the landing ellipse, however, obvious filled fractures appear to be more much rarer than at Mawrth Vallis. Figure 3 shows the best example so far of a possible filled fracture remnant. Other bright erosional remnant features are also present, such as sinuous ridges and other bright material like in Fig 4, but these features may be bright due to dust rather than precipitated minerals. Low albedo fractures are very common in Oxia, and typical fractured terrains have a subtle East to West orientation that is superposed on a muted erosional texture that creates a series of low hills.

*Origin of bright ridges in Oxia***.** The resistant sinuous bedrock ridges so commonly seen at Oxia could be caused by water activity in filled fractures, or through inverted river channels, a carved river channel that has allowed eroded gravel to settle which becomes cemented and resistant to create an inverted sinuous ridge. As Oxia Planum will be critically studied by the ExoMars rover, this analysis of the filled fracture distribution of the local and surrounding regions at Mawrth will undoubtedly prove beneficial and critical for deeper understanding of ancient fluvial processes, potential biosignatures and surrounding depositional environments.

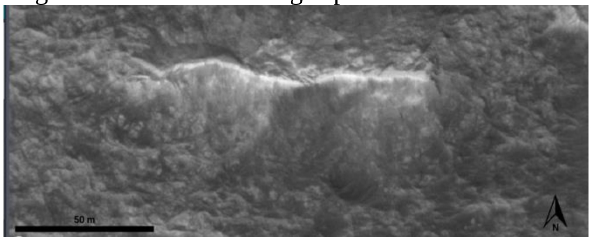

Figure 3: *Possible bright linear filled fracture or sinuous ridge in the Oxia Planum landing ellipse.*

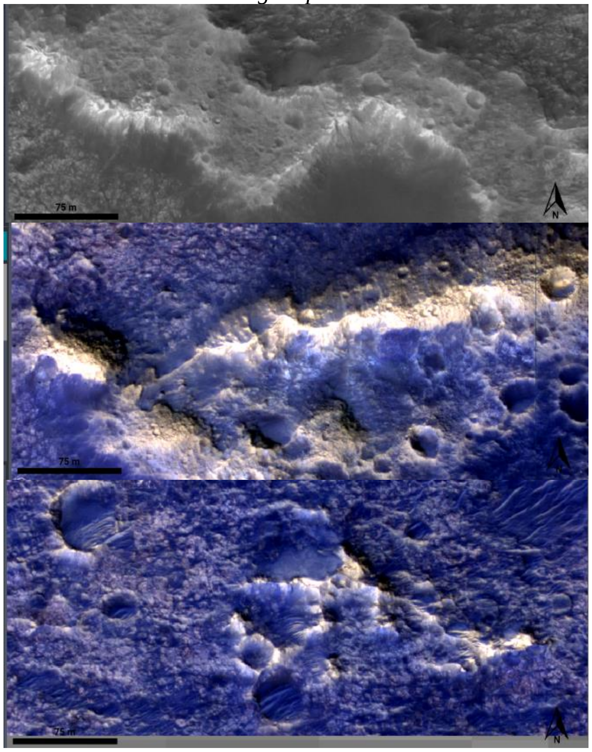

Figure 4: *Other bright materials observed in Oxia.*

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