ANALYSIS OF POTENTIAL SUBSURFACE REFLECTORS & INTEGRATION WITH EXPOSED SURFACE MINERALOGY IN THE MAWRTH VALLIS AND OXIA PLANUM REGIONS.

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Introduction: The phyllosilicate-bearing layered deposits of the Mawrth Vallis and Oxia Planum regions of Mars may contain buried clues about the history of water on the planet. In addition, some researchers report evidence of pedogenesis and other potential markers of habitability during the Noachian era [1]. Due to these exciting possibilities, both Mawrth Vallis and Oxia Planum are potential landing sites for the European Space Agency's ExoMars2020 mission and have excellent data coverage from several instruments including the Shallow Radar (SHARAD) sounder, the High Resolution Science Experiment (HiRISE) camera, and the Compact Reconnaissance Imaging Spectrometer (CRISM).

As a sounding instrument, SHARAD may be able to offer insight into subsurface stratigraphy, revealing additional geologic history in the Mawrth Vallis and Oxia Planum regions. These prospects are enhanced by recent detections of sub-surface-reflectors (SSRs) in the plateau surrounding Valles Marineris [2]. We aimed to build on these findings and support research into future landing sites through analysis of potential SSRs corroborated by optical and spectral observations.

Objectives: Over the course of our investigation, we sought to detect potential sub-surface-reflectors (SSRs) in the phyllosilicate-rich Mawrth Vallis and Oxia Planum regions. In doing so, we correlated SSR candidates with surface features and changes in composition, providing additional insight into the area's unique stratigraphy and geological history while testing SHARAD's ability to detect SSRs in this region. Additionally, we used our research to refine methods of verifying potential SSRs against clutter simulations and evidence from other instruments.

Methodology: We employed a multi-instrument approach that included data from SHARAD, CRISM and HiRISE. By analyzing dozens of SHARAD radargrams across the Mawrth Vallis and Oxia Planum regions and comparing against topographical features to avoid misinterpreting surface clutter as sub-surface reflections, we created a list of potential SSRs. Our study focused on areas where CRISM spectra reflected the stratigraphic layering of phyllosilicates reported by other researchers and whose HiRISE images suggested erosion or impact features, optimally allowing us to corroborate our SSR candidates with surface evidence [1,3]. Additionally, we paid special attention to the predicted ExoMars 2020 landing ellipses and nearby areas with similar compositional and geomorphological features [4]. Working with the SHARAD Science Team, we incorporated simulated "cluttergrams" for our most promising candidates. These cluttergrams illustrated the surface clutter expected in a SHARAD radargram based on its corresponding topography, allowing us to compare potential SSRs in each radargram with features resulting from surface returns. We accomplished this comparison by overlaying a section of a radargram and its cluttergram to find differences between the two.

Observations: Although to date, we have analyzed dozens of radargrams, we narrowed our list of possible SSRs to our two most likely candidates and had cluttergrams made for them. These possible SSRs were best displayed in SHARAD radargrams 02560402 and 02312502, located south of the Mawrth Vallis outflow channel and the ExoMars landing ellipse, and were corroborated in adjacent radargrams. The first potential SSR consisted of a series of horizontal linear features that appeared to correspond with both compositional boundaries and visible layering (Figures 1 and 3). However, after comparison with the cluttergrams, we concluded that many, if not all, of these features were actually surface clutter, and therefore false positives (Figure 2). These false positives will help us improve our methodology, but do not mean that the surface features shown in Figure 1 do not have corresponding subsurface reflectors that could be detected with fur-

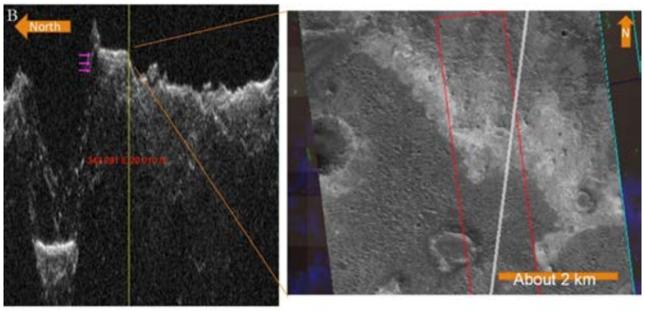

Figure 1: *SHARAD radargram 02560402 with SSR marked (left panel). Surface detail from HiRISE image ESP_030490_2000_RED showing an area of decreasing elevation corresponding to the southern edge of the potential SSR. The bright horizontal linear feature may be related to the potential SSR.*

ther analysis or another sounding instrument.

Discussion: Our investigation identified several candidate locations where subsurface stratigraphy may be reflected in surface lithology exposures, like that shown in Figure 1. As we continue our research, we may be able to utilize CRISM reflectance and other SHARAD data products to further test these and other SSR candidates beyond radargram observations. We may also utilize compositional data to model and constrain permittivity values for our regions of interest. Given SHARAD's vertical resolution of $15/\sqrt{\mathcal{E}}$ in a medium with relative permittivity $\mathcal{E}$ (~10 m depending on the permittivity of the substrate), we may then be able to scale radargrams and accurately measure subsurface features [5]. We will continue to refine our methodology to better analyze potential SSRs in Mawrth Vallis, Oxia Planum, and in other areas with phyllosilicate-bearing layered deposits. Although our research to date has most likely yielded false positives, we will continue to survey SHARAD profiles that may provide additional insight into the Mawrth Vallis and Oxia Planum landing site regions in order to help discern these areas' past habitability potential.

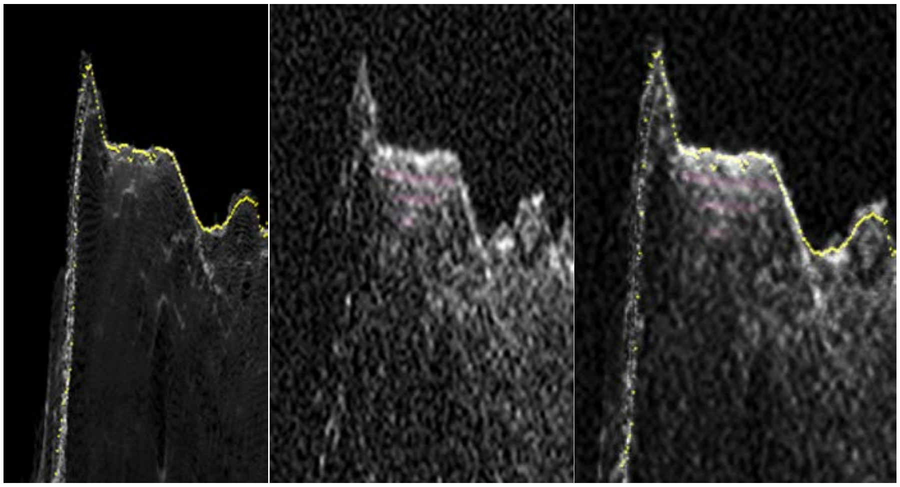

Figure 2: *Close-up from the cluttergram simulation for 02560402 (left); close-up from the radargram for 02560402 with the potential SSR group marked in pink (center); close-up of radargram overlaid on cluttergram (right). The overlay shows that the pink highlighted SSR candidates seem to correspond with predicted surface clutter.*

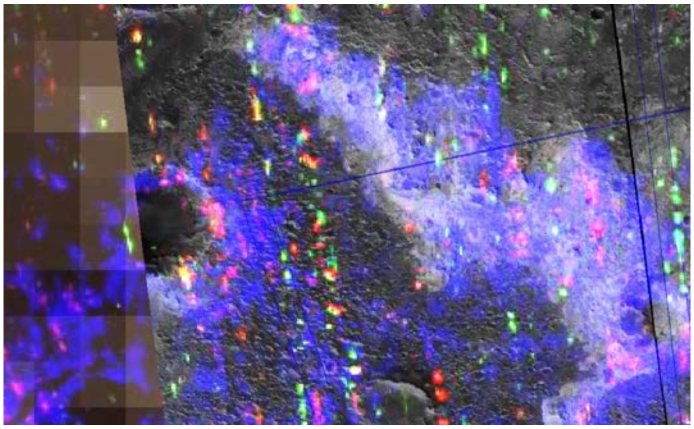

Figure 3: *Same area as Figure 1B, but with FRT0001D803 overlaid on top of ESP_030490_2000_RED. The color scheme is the standard PHY with red = BD2300 (Fe/Mg phyllosilicate) green = BD2210 (Al phyllosilicate or hydrated glass) blue=BD1900 (hydrated sulfates, clays, glass, or water ice). The figue appears to show changes in composition with magenta Fe/Mg phyllosilicate deposits possibly aligning with the light-colored feature in the HiRISE image. According to analysis of nearby FRT00008838, these deposits are consistent with Fe-smectite, but may include a mixture of other Fe/Mg-phyllosilicates including chlorite and serpentine [6].*

References: [1] Bishop J. L. et al (2013) *Planetary and Space Science Vol. 86,* 130-149. [2] Smith I. B. (2016) *LPS XXXXVII,* Abstract #2725. [3] Wray J. J. et al (2008) *Geophysical Research Letters, Vol. 35, L12202* [4] Tanaka K. L. et al. (2014) *USGS Scientific Investigations Map 3292*. [5] Seu R. et al (2007) *Geophysical Research Letters, Vol. 112, E05S05* [6] Noe Dobrea E. Z. et al (2010) *Journal of Geophysical Research, Vol. 115, E00D19*.