COLLEGE OF SCIENCE
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MAPPING THE SUBSURFACE NEAR PAVONIS AND ARSIA MONS VOLCANOES, MARS, USING SHARAD RADAR SOUNDER DATA

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ABSTRACT

The Tharsis Province is one of the most volcanically prominent regions on Mars. The region, which covers about a quarter of the surface of Mars, is marked by the Tharsis Montes. They are—from northeast to southwest—Ascraeus Mons, Pavonis Mons, and Arsia Mons. The Tharsis Province is roughly 4 billion years old and has been active for most of its history. While there is a general understanding of the region's history, we believe that a relative timeline of events in the region can be built. This can be done in part by studying the subsurface stratigraphy of the region. We have selected two areas of interest seen in Figure 1. As preliminary work towards building this relative timeline, we used the SHARAD instrument on the Mars Reconnaissance Orbiter to construct a map of what could possibly be a series of lava flows, tephra, or other volcanic remnants that reside beneath the surface.

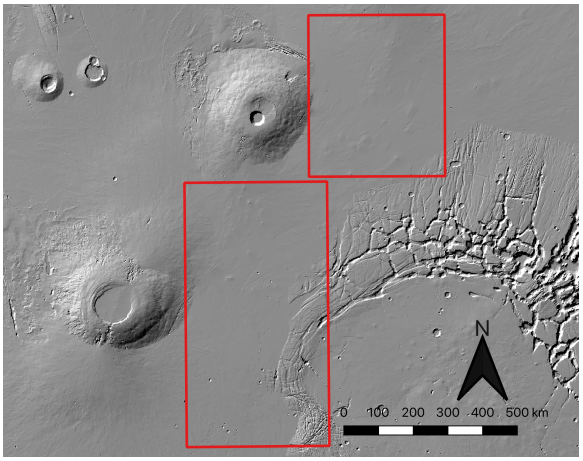

Figure 1: Areas of Interest, MOLA Hillshade Map

INTRODUCTION

The SHARAD instrument can be found on the Mars Reconnaissance Orbiter (MRO). SHARAD, standing for Shallow Radar, is a 20-meter dipole antenna that utilizes wavelengths between 15 to 25 megahertz. This wavelength is chosen for observations closer to the surface, whereas SHARAD's counterpart Marsis utilizes longer wavelengths to probe further beneath the surface. A SHARAD observation returns an image—known as a radargram—of a surface echo as well as any subsurface features (known as reflectors) that may be present as seen in Figure 2. However, not all features beneath the surface echo on a radargram is a reflector. We therefore also utilized clutter simulations which mimicked the surrounding terrain and its possible implications on the radargram. The clutter simulation for the provided radargram can be seen in Figure 3.

In the two areas of interest shown in Figure 1, there are 303 total radargrams to study. So far, we have analyzed 71 tracks. As the research continues,

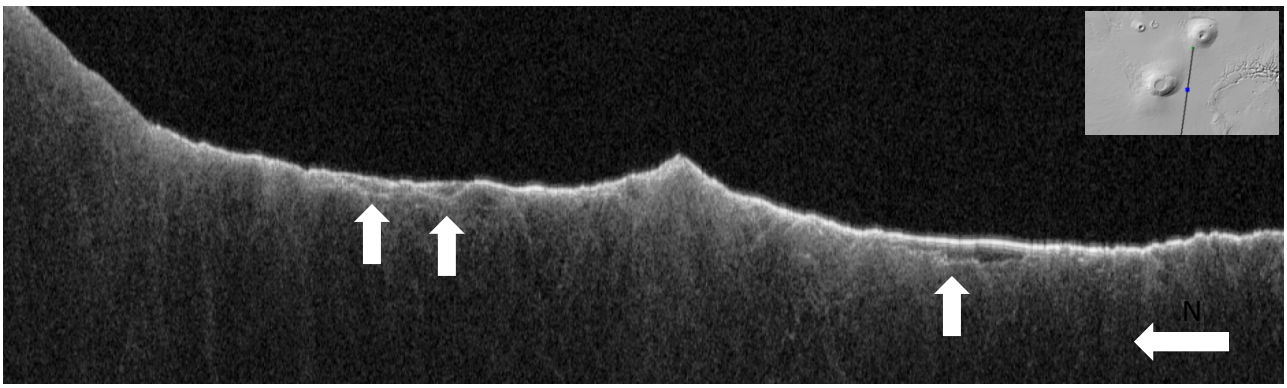

Figure 2: Radargram East of Arsia Mons with marked reflectors and map, s_02790301

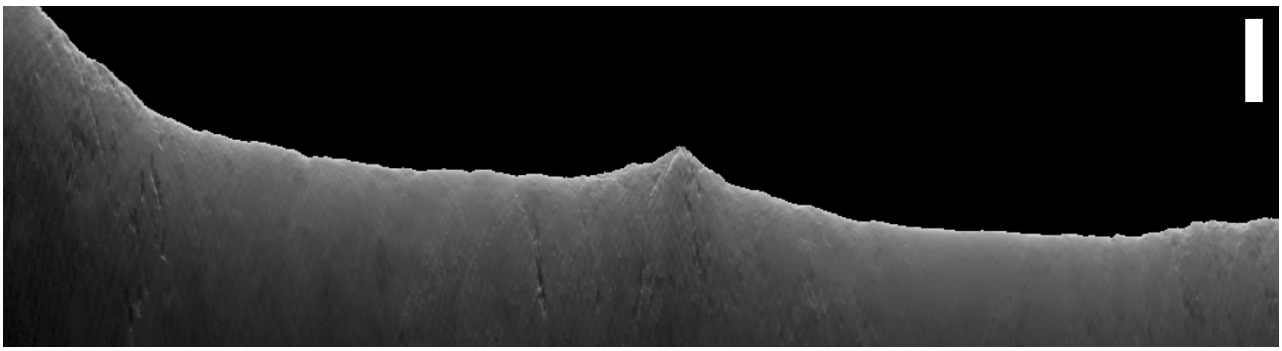

Figure 3: Clutter simulation for radargram in Figure 2

we hope to complete an analysis of all the radargrams and utilize tools such as the HiRise camera and Marsis to help draw conclusions about when subsurface features appeared relative to others.

METHODS AND DATA

An analysis of a radargram generally follows these steps: (1) identify a possible subsurface reflector. Possible reflectors can be a faint or bright line and are generally flat and thin as seen in Figure 2. (2) Consult the clutter simulation for possible interference. If a similar feature is found in the same place on the clutter simulation, the possible reflector is disregarded. If there is no such feature on the clutter simulation, (3) the reflector is put on a confidence scale from low to high. The reflector's placement on the confidence scale is to the discretion of the analyzer. Generally, the longer and brighter a reflector is, as well as how little inference there is in the corresponding region on the clutter simulation, the higher the confidence. These three steps are followed until all possible reflectors on the radargram have been analyzed. The radargram number, relative location, and number of reflectors for each confidence level is placed on an excel file for future reference.

Once a radargram or group of radargrams has been analyzed, their data files are placed on a QGIS project. A map can be built with the locations of the reflectors as well as their depth in microseconds. We used the MOLA Hillshade map and the CTX Overlay map by Murray Lab to construct a sufficiently detailed map of Mars in the regions of interest.

RESULTS AND CONCLUSION

The majority of the 71 tracks analyzed were in the northern region of interest from Figure 1. The high-confidence tracks in this region can be seen in Figure 4. In this region we can see a consistent pattern of reflectors spanning from northeastern Pavonis Mons towards the southeast. The time delay is another form of measuring depth—the whiter the reflector, the shorter the time delay. There are also some cases where a high confidence reflector is above another high confidence reflector. In Figure 4, these double reflectors are displayed with a darker line. The series of reflectors beneath the surface in Figure 4 are likely some remnants of volcanism such as a lava flows or tephra. Analysis of more radargrams and other instruments would need to be done to narrow down what these reflectors could be, and—because they are beneath the surface—we may never have a clear answer until we can observe the subsurface stratigraphy directly. Nonetheless, building the series could provide us with an insight to build a relative timeline of events in the region.

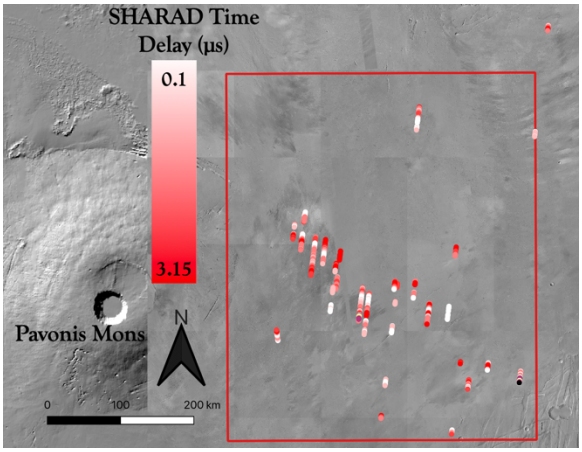

Figure 4: Map of high-confidence tracks, MOLA Hillshade Map, CTX Overlay, Murray Lab, 2018

The work described in this abstract is preliminary work to a larger project attempting to uncover a relative timeline of events in the Tharsis region. In the future, the radargrams in the other areas of interest can be analyzed, and other tools such as Marsis and HiRise can be used to help achieve this goal. Lastly, other areas of interest could be selected and analyzed, and the results from each area of interest could be compared for potential insight on stratigraphic history.