IDENTIFYING LANDSLIDES IN ATLA REGIO ON VENUS. E. Jesina¹, L. Carter¹, and I. Ganesh², ¹The University of Arizona, Lunar and Planetary Laboratory, Tucson, AZ, USA. ²The University of Alaska Fairbanks, Fairbanks, AK.

Introduction: Atla Regio, located in eastern Aphrodite Terra, is a volcanically active region [1] that contains six previously confirmed landslides [2]. This region also contains three volcanoes: Maat, Ozza, and Sapos Mons, with Maat Mons being the tallest volcano on the planet and showing recent signs of volcanic activity [1]. There are also three chasmata in the region: Ganis, Parga, and Dali Chasma, which contain the six previously found landslides in the region. We carry out a detailed mapping of landslides in Atla Regio to study their spatial distribution, morphology, initiation, and transport mechanisms. After a review of the Magellan data, 29 additional landslides have been found in Atla Regio with characteristics similar to landslides on Earth and Mars.

Methods: Previous examinations of the Venusian surface yielded few results for landslides, with only 19 across the entire surface. Of these results published by [2], six of them were located in Atla Regio. These landslides had been categorized with characteristics similar to landslides found on Earth and Mars, and this inspired our search for more in the same region. To find these landslides, we primarily used Magellan Cycle 1 left-look synthetic aperture radar (SAR) data resampled to a resolution of 75 m/pix. Cycle 1 was almost exclusively used due to the higher surface coverage than the other cycles. Where it was possible, the right-look data was compared to confirm that a landslide was detected. Our study area extends from 16° S to 21° N and 147° W to 179° W (Fig 1).

Landslide determination was done by comparing the radar backscatter images to characteristics for landslides previously observed on Venus, Mars, and Earth [2,3,4]. These characteristics included, but were not necessarily limited to, the size, runout distance, and texture of the deposits of potential landslides. The characteristics were used to make four categories, and one sub-category, of landslides on Venus, using the categories in [2]. These four categories are rock slumps, debris avalanches, debris flows, and rock/block slide avalanches, with the sub-category being small rock/block slides.

A majority of distinction and characterization of landslide type was done visually. Landslides were classified into one of the four categories based on the following characteristics. Rock slumps’ material is relatively contained within the scarp it came from, resulting in a smaller area. Debris flows are relatively smooth and radar-dark with flow features within their relatively long deposits. Debris avalanches are similar to debris flows, though they are slightly more radar-bright and rockier, though not as rocky and radar-bright as rock/block slide avalanches, which were also very large in area. The sub-category, small rock/block slides, has the same characteristics as rock/block slide avalanches, though on a much smaller scale with areas not exceeding 50 square kilometers. Measuring the runout distance and deposit area was done with the “Measure” feature of ArcMap. No landslides were found at this point in our research that did not fit into any of these categories.

Results & Discussion: There were 29 total landslides found on the surface (Fig 1). This includes 8 rock/block slide avalanches (see Fig 2), which were the most common alongside the 8 debris avalanches found, 6 small rock/block slides, 3 debris flows, and 4 rock slumps. The smallest landslide had an area of 2.3 square kilometers, which was a debris avalanche. The largest landslide was 373.88 square kilometers, a rock/block slide avalanche. Most landslide areas are less than 75 square kilometers. The shortest runout distance was 1.2 kilometers, a debris avalanche. This is likely the shortest runout distance we can measure due to the low resolution available. The longest runout distance was 19.5 kilometers, a debris flow.

Debris flows, and occasionally debris avalanches, tend to exhibit flow features. This process is believed to be possible due to atmospheric entrainment, a process initially suggested by [2], where the gases in the atmosphere mix with the loose soil on the surface as a landslide occurs. This is the prevailing theory due to the small size of the particles on the surface [5] as well as the amount of gas in Venus’ atmosphere. Landslides in this region may have had several causes. These include volcanotectonic activity (venusquakes), impacts, or slope failure due to rock or slope properties. Volcanotectonic may be a dominant cause due to landslides’ proximity to the large volcanoes of Maat and Ozza Mons, which both are greater than 100 kilometers in diameter. Most landslides were found in rift zones, which are the main geological features formed from the flows of these volcanoes [6]. One landslide was found in the collapsed dome of Sapos Mons.

Future Work: Moving forward in this research, we plan to continue to look at landslides across the entire surface of Venus. We can compare the quantity of landslides found in other regions to determine any correlations and to confirm the conclusions drawn thus far. Furthermore, with future missions’ higher resolution
data, this region could be re-analyzed to confirm the landslides found, better measure their properties for characterizing possible formation mechanisms, or potentially see how they have changed over time. We can also use the data to find more landslides, as over 100 potential landslides were found for this region. Many were not able to be confirmed as landslides at this time due to the low-resolution data available.

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Figure 1. A map of the Atla Regio region with the different landslide types marked against the surface backscatter. The landslide types marked on a paper by [2] were not differentiated on this map. The two noticeably dark, elliptically shaped features towards the center of the image are the vents of the volcanoes Maat and Ozza Mons, with Maat Mons being the southernmost vent. This image extends from approximately 179°W and 16°S to 147°W and 21°N.

Figure 2. Examples of rock/block slide avalanches. The red arrows point to the extent of the deposits. (A) Deposit #18, centered at (8.5°N, 171.7°W). This landslide is located approximately 40 kilometers from the vent of Sapas Mons. (B) Deposit # 20, centered at (13.7°S, 175°W), is a combination of four separate landslides grouped into one since they occurred so close together.