DISTRIBUTION OF VENUSIAN IMPACT CRATER EJECTA WITHIN TESSERA. J. L. Whitten[1] and B. A. Campbell[1], [1]Center for Earth and Planetary Studies, Smithsonian Institution, MRC 315, PO Box 37012, Washington DC 20013; (WhittenJ@si.edu).

Introduction: Tesserae are ancient, complexly deformed ridged upland terrains covering 7–8% of the surface of Venus [e.g., 1, 2]. Unlike the low-lying basaltic plains, the composition of the tesserae is not well constrained. Analysis of orbital datasets have provided evidence that supports a generally felsic composition for tessera [e.g., 3], but a more specific composition can only be defined by a landed mission. To determine the tesserae composition, a "pristine" landing site is required: an area that has not been contaminated by other geologic materials, particularly impact crater ejecta.

Approximately 60 impact craters on Venus are surrounded by a radar-dark "parabola" of material [4]. These parabolas are interpreted to be composed of fine-grained ejecta that were transported up to 2000 km to the west of the impact site [5]. The ability of the dense Venusian atmosphere to transport crater ejecta over long distances suggests that ancient tesserae could harbor relatively thick, accumulated deposits of fine-grained impact crater ejecta.

Radar datasets can be used to detect surface roughness variations at a variety of scales. Like-polarized linear (HH or VV, like Magellan) and opposite-sense circular (OC) signals are controlled by surface roughness variations on the order of tens to hundreds of meters in horizontal scale. On the other hand, cross-polarized linear (HV, VH) or same-sense circular (SC) signals are sensitive to smaller-scale surface roughness variations on the order of centimeters to decimeters. Deposits of fine-grained crater ejecta can mantle terrain and remove small-scale surface roughness variations, so HV, VH, or SC echoes are best suited to detect these deposits [6]. The limited spatial coverage of the Earth-based SC-polarization data, however, motivates development of methods that can be applied to the near-global coverage of Magellan SAR image data.

The goal of this study is to demonstrate the techniques needed to use Magellan SAR data to identify the presence of fine-grained crater ejecta within tesserae. Once the usefulness of Magellan SAR data is validated in regions of overlap with the Earth-based SC coverage [6], we search for concentrations of radar-dark (low backscatter) backslopes in Tellus Tessera to map possible spatial concentrations of fine-grained material.

Crater Ejecta Mantling on Tessera: There are only a few locations on Venus where fine-grained impact crater ejecta has been observed to overlay tesserae, including at Alpha Regio, Zirka Tessera, and Manzan-Gurme Tessera [4, 6, 7]. Eastern Alpha Regio has a lower radar echo compared with western Alpha, most easily observed in Earth-based SC data [6]. This radar-dark region was interpreted as a 4–7 cm minimum thickness deposit of distal ejecta from Stuart crater [6].

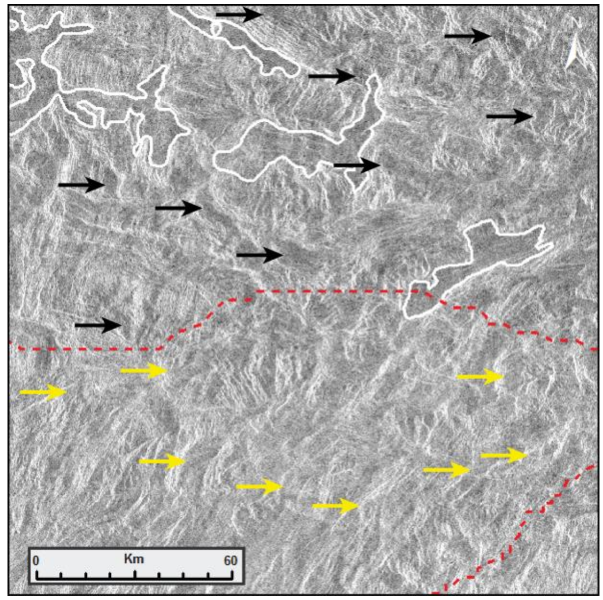

Figure 1. Close up view (25.2°S, 5°E) of ridge backslopes in Alpha Regio. The radar is looking from left to right. There is an obvious visual difference in the brightness of backslopes within Alpha Regio. Black arrows point to backslopes that are visually darker and yellow arrows point to brighter backslopes. The red dashed line defines the Earth-based radar-dark (low SC) region [6], where the top and bottom right region of the images are included in the low-SC region. Basemap is Magellan SAR data.

The technique proposed here examines Magellan HH-polarization echoes from the "back" slopes of tessera ridges because these areas provide the best viewing geometry to measure small roughness variations, rather than strong glints from the radar-facing "front" slopes (Fig. 1). By focusing on areas with high local incidence angles, we obtain a proxy for the small-scale roughness mapping of the Earth-based SC images.

A map of radar-dark backslopes within Alpha Regio is presented in Figure 2. The low backscatter values are not confined to the lowest elevations, but are present at all elevations within Alpha. The greatest spatial concentration of the low-return backslopes coincides broadly with the SC-polarization mapping of Stuart ejecta [6], suggesting that useful results may be obtained in regions outside the Earth-based coverage.

Investigating Tellus Tessera: Magellan SAR data reveal a high concentration of radar-dark backslopes in

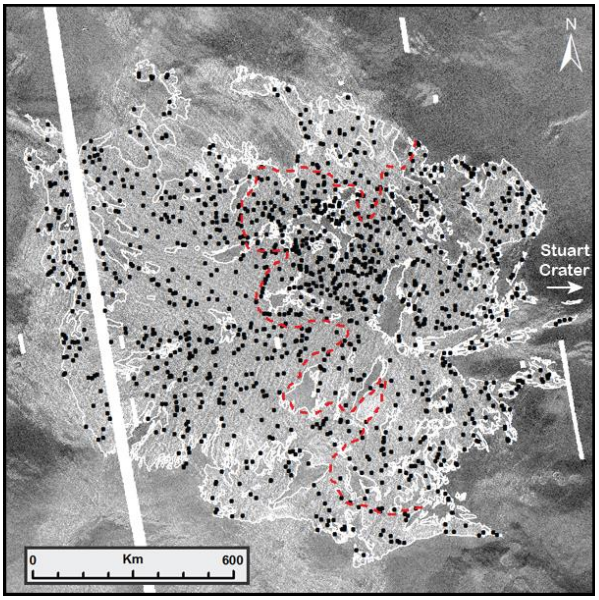

Figure 2. Alpha Regio (25.5°S, 0.3°E). Tessera terrain is outlined in white. Black dots represent radar-dark backslopes. Red dashed line defines the radar-dark region identified using Earth-based data [6] which is attributed to fine-grained impact crater ejecta. Note the high concentration of backslopes with low backscatter within this outline. Basemap is left-looking Magellan SAR data.

the central part of Tellus Tessera (Fig. 3). Unlike at Alpha Regio, there is not an impact crater in the surrounding plains with a distinct parabolic deposit. There are, however, several impact craters that occur on the border of Tellus or in the plains that could account for these low backscatter values, including Bernhardt and Mu Guiying. The predicted parabola dimensions for a crater the size of Bernhardt (25.3 km in diameter, dark-floored) (Fig. 3, red circle) can account for much of the concentration of low backscatter values in southeast Tellus, while Mu Guiying (32.3 km in diameter, bright-floored) (Fig. 3, yellow circle) may account for the low-backscatter slopes in the north central region of Tellus. The plains around Mu Guiying do not preserve evidence of a radar-dark parabolic deposit, but these plains do have lower backscatter values compared with adjacent plains. Another crater in northwestern Tellus (Khatun, 44.1 km in diameter, bright floored) (Fig. 3, blue circle) impacted directly into the tesserae terrain. There is little evidence of a radar-dark parabola around Khatun, but there are radar-dark backslopes that form a halo around the crater. As at Alpha Regio, the Tellus Tessera radar-dark backslopes are not confined to low-lying regions. This observation at both tessera locations suggests that fine-grained impact ejecta does not concentrate or get blown into topographic lows within the tesserae.

Discussion and Conclusions: In a novel method based on the characteristics of away-facing slopes, Magellan SAR data can be used to infer the presence of fine-grained impact crater ejecta in the tesserae. The entire extent of the fine-grained material within tesserae may not be mapped from Magellan or any radar-image data because of ejecta thickness variations; at least ~5 cm of debris is required to significantly reduce the 12.6-cm wavelength echoes.

The presence of radar-dark backslopes in north-central Tellus, but the absence of a dark parabola in the plains immediately adjacent to Mu Guiying crater, may indicate that tesserae are able to preserve or retain fine-grained crater ejecta for longer periods of time than the 35 ± 15 Ma [5] maximum estimated age for ejecta parabolas in the plains.

The observation that ~90% of the surface of Venus may have at some time been covered by impact crater ejecta [8], coupled with the possibility that tesserae preserve fine-grained debris for relatively longer periods of time, makes it essential to carry out the kind of radar-image studies described here for any candidate tessera landing sites.

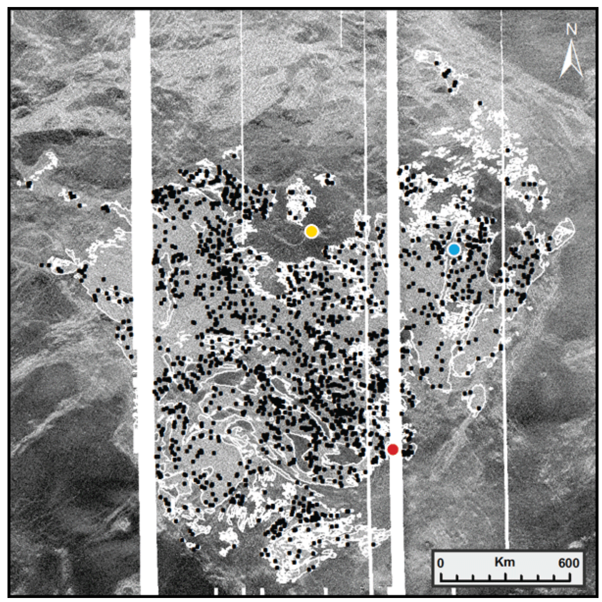

Figure 3. Tellus Tessera (42.6°N, 76.8°E), outlined in white. Black dots denote the location of radar-dark backslopes. Three impact craters are indicated by colored circles: Red- Bernhardt Crater, Yellow- Mu Guiying Crater, Blue- Khatun Crater. Note the high density of black dots in the center of Tellus, especially associated with Bernhardt and Mu Guiying craters. Basemap is left-looking Magellan SAR data.

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