WHICH TESSERAE ARE THE BEST TESSERAE TO MEASURE TESSERA COMPOSITION? M. S. Gilmore, Dept. of Earth and Environmental Sciences, Wesleyan University, Middletown CT, mgilmore@wesleyan.edu

Science Goal(s): The goal of this study is to measure tessera composition. The measurement of tessera composition addresses VEXAG goals: II.B.1, II.B.2, II.A.1, II.B.5, II.A.2, III.A.3, III.B.2.

Target: The least modified, most primitive tessera surfaces. These include: W-Central Alpha, E or W Tellus, central W. Ovda, and Fortuna tesserae.

Session/Instrumentation: Observations from Orbit. Landing site selection.

The identification of primitive tessera targets will enhance geochemical and mineralogical measurements of tessera composition from surface landers. This knowledge is also key to the interpretation of 1 micron emissivity data collected from orbit or from within the atmosphere as well as for the interpretation of optical imagery collected from probes or balloons.

Discussion: Venus tessera terrain is defined as having two or more sets of intersecting ridges and/or grooves that contribute to high radar backscatter [1]. Tessera terrain consistently appears locally and perhaps even globally [2] as the stratigraphically oldest material on a planet with an average surface crater age of ~300 [3] to ~800 Ma [4]. Thus the tesserae provide the best chance to access rocks that are derived from the first 80% of the history of the planet, an era for which we have currently have no information.

The composition of tessera terrain is currently unknown, but will provide critical constraints on Venus geochemistry, geodynamics and the history of water on the planet. If the tesserae are basaltic, we may consider that they formed via mantle melts that were deformed during an extinct and higher strain era prior to plains emplacement [5]. A confirmed basaltic composition can be used to limit the input for mechanical models of lithospheric parameters derived from structural wavelengths [e.g., 5]. Measurement of the weathering products of tessera basalts combined with measurement of lower atmospheric chemistry can help constrain surface –atmosphere chemical cycling [e.g., 6]. These minerals may tell us something about past climates if found to be in disequilibrium with present day lower atmospheric chemistry.

If the tesserae are felsic, there are several possible consequences. Granitic magmas require both abundant water and a mature plate recycling mechanism for their formation [e.g., 7]. Such conditions are likely limited to the lifetime of abundant water on Venus, which is also likely to be confined to Venus early history [8]. As such, granitic rocks on Venus would not only record a very different climatic and tectonic regime, but may require that, despite a young crater age, those rocks be very old and thus a vital target for surface study and sample return. Anorthositic magmas can be formed by copious degrees of partial melting and differentiation of mantle melts, similar to the Proterozoic massif anorthosites on Earth. Lunar-like plagioclase flotation on a magma ocean is not predicted for Venus [9].

Which rocks should we target to measure tessera composition? Because of our ignorance, the Venus community tends to talk about the 35 million km^2 [2] of tessera terrain as if it is all the same material and have the same age. But there are several processes that should be considered in target selection.

High Reflectivity Mountaintops. Materials at elevations >~6054 km have high radar reflectivity values, interpreted to result from an increase in the dielectric constant of the rocks [e.g., 10]. Several candidate high dielectric minerals have been advanced to explain this phenomenon, but most models agree that the materials are formed via a surface-atmosphere chemical reaction at the lower temperatures at these elevations [e.g., 11, 12]. The chemistry and extent of these reactions are poorly constrained. I would argue that these materials should be avoided if we want to measure primary tessera compositions. High reflectivity surfaces are characteristic of much of E. Ovda, Thetis, and w. Fortuna tessera.

Crater Parabolas. Campbell et al. [13] recognized parabolic deposits associated with some craters and interpreted to be crater ejecta entrained and redeposited westward by the upper level winds. For plains craters this ejecta is nominally basaltic and may distribute cm thick deposits of materials 100s - 1000 km away from the crater [13]. These materials possibly obscure tessera rocks and fill hollows. There are ~60 craters with parabolas recognized in the SAR and emissivity datasets [13, 14]. The following parabolas (sizes as mapped by 13] intersect major tessera regions: crater Stuart at E. Alpha, Adivar at NW Ovda, and Bassi at SW Ovda.

Observations of multiple parabola degradation states and the youthful appearance of parabola craters support the idea that the parabolas are young and ephemeral features, meaning that all craters above a certain diameter likely generated parabola deposits [e.g., 13, 15]. Certainly tesserae have received such aeolian deposits over the course of their lifetime.

However, it is not clear that these deposits prohibit access to tessera rocks. Radar reflectivity data of tessera terrain is similar to that from terrains on Earth with roughness at the 10s cm scale [16, 15], perhaps similar to the Venera 9 landing site [17, 18]. Deposits of the crater Stuart are not obvious in Alpha Regio in the Magellan single polarized data, suggesting they are on the order of cms in thickness [15].

Large (~10 km scale) mass movements are observed to occur on steep slopes along Venus chasmata [19] and we would expect the mass movements occur on steep slopes within tessera as well. As on Earth, fresh extensional fault scarps are predicted to lie at 60-70° slopes, however, processes of mechanical weathering will serve to reduce these slopes to the angle of repose (~35°) on both planets. Measurements of 170 faults across Venus using radargrammetry yield an average slope of 36±2° [20] consistent with mass wasting along these faults. As weathering on Venus is largely limited to mass wasting, tessera surfaces similar to scree slopes in arid regions on Earth are expected, where submeter scale rocks form talus deposits of tessera rocks at the angle of repose. If the talus formation rate > the aeolian deposition rate, tessera rocks should be readily available and widely distributed at the surface below these faults. In this case, one might target tessera regions with pervasive fractures and graben (e.g., Fortuna tessera) – a typical region in central Ovda Regio shows graben slopes comprise only 1% of the area. SAR radargrammetry data (~2 km spatial resolution) [21], show average kilometer scale slopes in a typical region in central Ovda Regio tessera terrain are ~5-10° and areas with slopes >10° are limited (0-5% of the region).

Tessera Craters. Gilmore et al. [22] conservatively recognized 80 craters on tessera terrain. Tessera craters of course will excavate and redistribute tessera materials over large regions and this may be an attractive feature of a landing site. We may identify the freshest of these craters via bright floors and preserved impact melt. Such candidates include crater Khatun in E. Tellus.

Obducted and assembled materials. There are several examples of tessera boundaries where there is clear evidence that plains materials are being deformed, uplifted and incorporated onto older regions of tesserae. Prominent examples are W. Alpha Regio [23], SW Tellus Regio, and N. Ovda Regio [24]. Tellus and Ovda Regio also show evidence of assembly of regions of tessera with distinct structural fabrics [25]. These pieces can be placed in stratigraphic context, for example central Tellus Regio is deformed by and thus predates SW Tellus. E. Tellus and E. Ovda comprise ridge belts that lie adjacent to less deformed tessera fabrics. Such regions may allow analysis of contacts between different terrain (and perhaps material) types.

Plains materials and flooding. North-central Tellus lies at very low elevations and is thoroughly flooded by plains. Several coronae intersect Ovda Regio. These areas should be avoided.

Phoebe. The structural fabric of Phoebe tessera is unlike all other major tessera occurrences in that is dominated by extensional structures [2] and may not be representative of the general characteristics of the terrain.

Conclusion- where should we go? The qualitative analysis presented here suggests that the most unadulterated tessera surfaces can be found in W-Central Alpha, E or W Tellus, central W. Ovda, Fortuna. I will confirm this with a quantitative analysis for the meeting that will also consider smaller regions of tessera.

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