ASSESSING THE NATURE OF TESSERA FROM ALTITUDE. D. C. Nunes, Jet Propulsion Laboratory, California Institute of Technology, Mail-Stop 264-535, Pasadena CA 91109 (Daniel.Nunes@jpl.nasa.gov)

The mode of formation of tessera remains as one of the unanswered first-order questions following Magellan. Most of tessera is contained in the domains of plateau highlands, which are one of the principal physiographic types of provinces on Venus. The so-called "downwelling vs. upwelling" debate focused on rheological arguments and on the mapping of the distinct features in the tectonic fabric of tessera. The nature and relative timing between some of the small-scale features is difficult to entertain with the limited resolution of SAR imaging and, especially, altimetry data from Magellan. Given that in the great majority of cases tessera is embayed by volcanic plains, the question of whether tessera is mostly localized to plateaus or if it is a much more expansive morphological unit still remains open. Finally, tessera are at least as old and the plains and possibly older, and the geologic history is has recorded may reflect environmental conditions different from those extant. These few questions and points, alone, quickly show that we lack basic understanding of how Venus, a body of similar basic properties as Earth, functions as a terrestrial planet.

Here is a summary of basic science goals studying for tessera, a list of a few suggested targets, and some of the techniques/platforms that may be able to provide us with the data needed.

Session: The science goals described here, which address the nature of tessera, can be accomplished either from orbit or atmospheric sondes. As such, this abstract can fit in either the "From the Atmosphere" or "From Orbit" break out sessions.

Target: Instead of a single location, the proposed measurements can be accomplished at many tessera locations tesserae found throughout Venus. Here are listed a couple of examples to help focus on specific science goals1

Table 1 – Description of Science Goals for tessera science from the following platforms: O=orbital, A= atmospheric.

Test Target	Type	Lat Range		Lon Range	
Alpha Regio	tessera plateau	35°S	14°S	355°E	13°E
Fortuna	tessera plateau	51°S	80°S	6°E	92°E
Xi Wang-mu	tessera inlier	37°S	23°S	55°E	67°E

Science Goal(s): The science goals are summarized according to VEXAG Investigations and types of remote sensing data. There is no reason why one of the platforms cannot have other instrumentation to address other investigations, but the focus here is on the nature of tessera.

Table 2 – Description of Science Goals for tessera science from the following platforms: O=orbital, A= atmospheric.

VEXAG Goal	II				III	
Obj./Investigation	**A.1**	**A.3**	**B.2**	**B.3**	**A.2**	**A.3**
Possible Data Types						
Optical Imaging	A	A		A	A	
Radar Imaging	O/A	O/A		O/A	O/A	O/A
Spectral Imaging	O/A	O/A	O/A	O/A	O/A	O/A
Gravity	O/A	O/A	O/A	O/A	O/A	
Altimetry	O/A	O/A	O/A	O/A	O/A	

Discussion: The crustal composition, the mode of formation and evolutionary sequence of tessera is not known. Areally, most of tessera occurs in elevated plateaus [1] for which gravity analyses point towards isostatic support of the topography [e.g. 2]. In terms of number of occurrences, most of tessera occurs as small patches that are often organized as arcuate inliers [1]. Given that the tessera morphology at the inliers is similar to the morphology of tessera at crustal plateaus [3], it is possible the inliers represent the end of an evolutionary track, where high-standing plateau has lost some of their topographic support and amplitude, and have been successively embayed by plains volcanism. Another possibility is that tessera extends much more globally beneath the plains and represents a time-specific unit [e.g. 1].

All of these issues are coupled together. The mode of formation has implications for the crustal composition and stress and thermal states, which in turn drive control the surface deformation and the evolutionary track. The embayment relationship between tessera and plains may also be subtle, if gentle slopes are involved, and may be not clearly captured by Magellan SAR data due to resolution limitations and the vicissitudes of accounting effects such as surface composition, roughness, and volumetric heterogeneities [e.g.,4]. Also, the Magellan altimetry data suffers from relatively large uncertainties (10's to 100's of meters) due distortions of the surface echo due to roughness [5,6].

High-resolution imaging by orbital radar or atmospheric radar or optical (visible) platforms should elucidate the nature of the small-scale (~ m-scale) features in the tectonic fabric of tessera, their dimensions and relationship to the rest of the fabric. The advantage of an optical platform is that we do not have regional optical coverage of the surface, and the interpretation of deformational features is more readily accessible in optical data (no geometric, dielectric effects). When combined with high-resolution altimetry, the ability to map morphologic units will be fully realized.

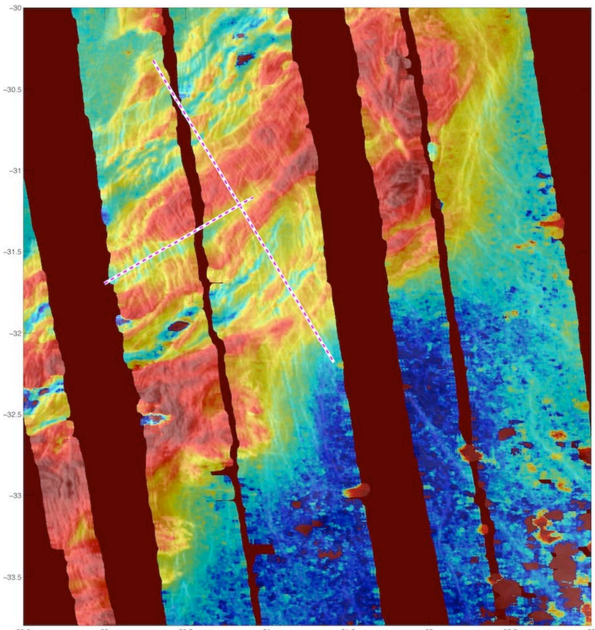

Fig 1 - Section of the DTM of [8], underlain by the mosaicked F-FBIR's, showing a segment of the Xi Wang-Mu Tessera in great detail. Folds run SW-NE, while small ribbon grabens run SE-NW. Color represents elevation from -500 m (blue) to 1500 m (dark red). The two dashed lines mark profiles in Fig. 2.

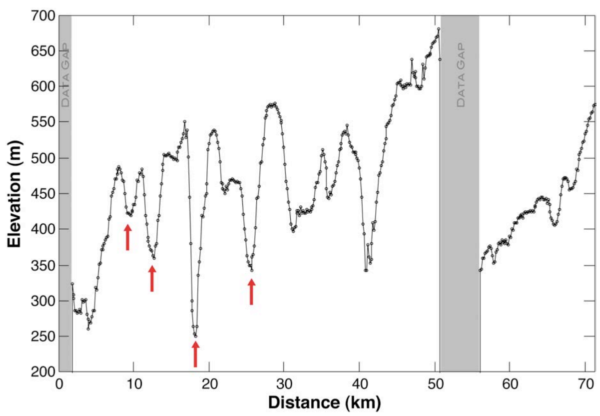

Fig 2 - Stereo-derived elevation and vertical errors for the SW-NE profile in Fig. 2 that cuts across ribbon grabens. Ribbons (red arrows) are ~2 km wide and range between 75 and 300 m in depth.

For example, [7] created from Magellan stereo SAR a ~30°×10° high-resolution mosaic of the Xi Wang-mu tessera inlier, south of Aphrodite Terra. The fabric of tessera in this inlier contains both folds and small-scale grabens dubbed "ribbons", the latter hypothesized to represent extensional brittle failure down to a uniform brittle-ductile transition (BDT) [8]. Profiles across the DTM show that the ribbon grabens have widths similar to those measured from SAR imagery along, but their individual depths from 50 to 300 m. As such, the model for brittle extension over a shallow and uniform BDT is negated. This finding, of course, casts a possible shadow in some models of plateau formation that stipulate ribbons as the earliest recorded deformation.

The Magellan gravity dataset suffers from large variations in quality across Venus, with the maximum degree strength varying from 70 to 110 harmonic degrees. Such a resolution (629 km to 344 km, respectively) is essentially at the limit for resolving intra-plateau structure. [9] showed that at Ovda Regio, location where the quality of gravity data is best, variation in crustal properties exist between the periphery of the plateau and the center of its domain. Understanding if and how such variations exist across tessera plateaus is the simplest way to access the deep crustal structure (in the absence of seismometers on the surface at all of the plateaus), and it would provide tangible tests to the diverse formation models so far proposed or lead to a new view of Venus evolution.

Magellan introduced Venus to us in a global scale, and showed how little we understand terrestrial planets. It is past the time to address such a vital gap in our knowledge.

References: [1] Ivanov M. A. and Head J. W. (1996), *JGR*, *101*, 14861-14908. **[2]** Grimm, R. E. and Hess P. C. (1997), in *Venus II*, 1205-1244. **[3]** Phillips R. J. and Hansen V. L. (1994), *Ann Rev Earth and Planet Sci*, *22*, 597-654. **[4]** Ulaby F. T. et al. (1986), *Microwave Remote Sensing: Active and Passive*. **[5]** Plaut, J. J. (1993), *Ch. 03* in *Guide to Magellan Image Interpretation*. **[6]** Rappaport N. J.et al. (1999), *Icarus*, *139*, 19-31. **[7]** Nunes D et al. (2013) P41D-196, Fall AGU Meeting Dec 2013. **[8]** Hansen V. L. and Willis J. J. (1996), *Icarus*, *123*(296-312). **[9]** Anderson F. S. and Smrekar S. E. (2006), *JGR*, *111*, E08006.

This research was carried out at the California Institute of Technology Jet Propulsion Laboratory under a contract from NASA.