Models for the Origin of Tessera Terrain on Venus. D.L. Bindschadler and J.W. Head, Brown University Dept of Geological Sciences, Providence, RI, 02912

The tesserae (or parquet terrain) of Venus are important to understanding the tectonics of Venus [1,2,3] given their unusual morphology, areal abundance, and location [3]. Different morphologic subtypes of tessera have been recognized and a classification has been proposed [3]. Here we list a number of possible modes of origin for the tessera in order to begin to understand the implications of this complex terrain for the tectonics of Venus. In doing so we examine potential morphologic analogs as well as analytical models while still attempting to formulate testable models for the formation of the tessera.

Observations gathered from Pioneer Venus and Venera data [3] suggest key characteristics that any successful model of tessera formation must be able to reproduce. These include gross (100 km scale) topography, PV radar properties, LOS gravity data, and morphologic and morphometric properties from Venera data. We suggest four general types of formational models to be tested to determine which provide(s) the best explanation for the observed characteristics of the tesserae.

Model I: Analogy to terrestrial seafloor. Portions of the seafloor are characterized by roughly orthogonal patterns of ridges and troughs (Fig. 1), created during migration of crust off of spreading centers and associated transform fault activity. Similar structural patterns are observed in the trough and ridge terrain (Ttr), one proposed subdivision of the tessera [3]. In this model, the tessera would represent regions of thickened crust that may have undergone some deformation but still retain the basic structural fabric due to their origin. Examination of Pioneer Venus data for Aphrodite Terra has led Head and Crumpler [4] to propose that crustal divergence is occurring there. Thus, we note with interest that a predicted planet-wide distribution of tessera based on PV reflectivity and rms slope data predicts a concentration of tessera within Aphrodite Terra [5,6].

Model II: Horizontal compression. In this model, horizontal motion of crustal material leads to folding, thrusting, and subsequent thickening of the crust. Such a model relies partly upon analogies with terrestrial orogenic belts such as the Andes or the Tibetan plateau. The more complex aspects of the structure of tesserae might be explained as superposition of folds due to a change in the principal direction of compression or differences associated with the low erosion rates characteristic of the surface of Venus[7].

Model III: Vertical uplift due to shallow mantle processes. LOS gravity data suggest relatively shallow depths of compensation beneath the tesserae [8,3]. This does not completely rule out mantle processes; a relatively shallow thermal anomaly beneath the crust can produce high topography and extension by thermal and dynamic uplift (perhaps similar to that observed in the Basin and Range). An additional or alternate contribution to uplift can be caused by emplacement of differentiated (i.e. ~crustal composition) magma bodies within and at the base of the crust. Each of these mechanisms has consequences for deformation at the surface [9,10].

Gravity-driven deformation. The gravitational potential of the typically upland tessera provides a mechanism for their deformation. This deformation may occur in a brittle fracture mode by gravity sliding [2,11] or in a viscous flow mode by gravitational relaxation [10]. Gravity sliding has been proposed to explain the Olympus Mons aureole deposits on Mars [e.g. 12] (Fig. 3). Such a model explains the presence within the deposit of ridges which parallel topography and graben that strike perpendicularly, as well as the huge scarp around Olympus Mons (thought to represent a detachment fault). While there is evidence that structures in the tessera often follows topography, there is a lack of perpendicular extensional features or detachment faults. Models of gravitational relaxation [10] have shown that significant deformation of the surface can occur subsequent to creation of topography. In particular, for compensated topography, the relaxation process will cause extension within the interior of a high region and concurrent compression around the periphery of the region, subject to regional stress fields. If high topography is undercompensated, a relatively short lived episode of compression will occur within the high region and along its periphery, lasting until compensation is achieved. Thus if gravitational relaxation has occurred in the tessera, compressional features due to either horizontal compression or to undercompensated loading of the surface must predate extensional features. Detailed examination of the sequence of events within individual regions of tessera will help to assess the importance of gravitational relaxation for the origin of tesserae.

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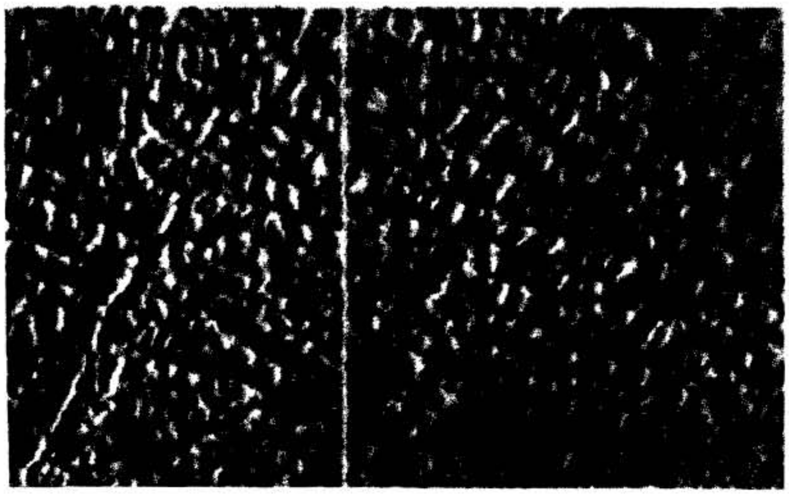

Figure 1. Shaded relief of topography near the Mid-Atlantic Ridge. Scale is approx. 1:20,000,000.

Figure 2. Shaded relief of topography within the Basin and Range Province. Scale is approx 1:15,000,000.

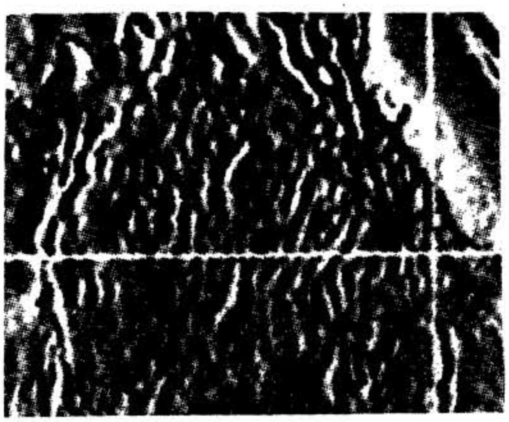

Figure 3. Viking Orbiter photo of the Olympus Mons aureole. Subparallell ridges are spaced approx. 5 to 10 km apart.