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Venus Trough-and-Ridge Tessera: Analog to Earth Oceanic Crust Formed at Spreading Centers?

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One type of tessera terrain on Venus, the trough-and-ridge tessera, exhibits a distinctive morphology composed of throughgoing generally parallel linear valleys and shorter orthogonal valleys and ridges. The similarity of this pattern to oceanic crustal topography and morphology is examined. Oceanic crust on Earth is characterized by a distinctive orthogonal pattern, with transforms and fracture zones in one direction and linear abyssal hills developed parallel to the rise crest in the other. Similarities between the components of the tessera terrain and terrestrial seafloor fabric and structure are found in terms of linearity, parallelism, length, width, spacing, orthogonality, and general morphology. A difference is that trough and ridge tessera tend to occur as plateau-like regions at intermediate elevations (average ~2 km) above the surrounding plains, while terrestrial seafloor ranges in elevation from that observed at rise crests and oceanic plateaus such as Iceland, down to depths of several kilometers on the abyssal floors, where the orthogonal pattern is often masked by sedimentation. On the basis of the similarities it is proposed that trough-and-ridge tessera may have originated through processes analogous to those responsible for the ocean floor fabric on Earth, forming at a rise crest similar to divergent boundaries on the Earth's seafloor, and evolving to its present morphology and configuration through processes of crustal spreading. The plateau-like nature of the trough-and-ridge tessera distribution could be the result of localized crustal thickening in the spreading process, producing elevated Iceland-like plateaus whose texture is preserved from subsequent lowland volcanic flooding. Some regions of more complex tessera patterns may result from deformation of the basic trough-and-ridge pattern of tessera. This hypothesis can be tested with global high-resolution imaging and altimetry data and gravity data from the Magellan mission.

1. Introduction

Tessera ("tile" in Greek; also informally called "parquet") is an upland terrain type occurring in areas known to be distinctive on the basis of Pioneer Venus altimetry, roughness, and reflectivity data [*Head et al.*, 1985; *Bindschadler and Head*, 1989*a*,*b*]. This terrain was shown by Venera 15/16 radar images to have a distinctive morphology and texture dominated by closely spaced intersecting grooves and ridges that produce a variety of patterns (hence the term tessera) including orthogonal, diagonal, chevron, and chaotic [*Barsukov et al.*, 1986; *Basilevsky et al.*, 1986; *Sukhanov*, 1986; *Bindschadler and Head*, 1988*b*,*c*]. The spacing between ridges in tessera terrain varies but generally is in the range of 5-20 km. Ridge heights are generally not more than several hundred meters [*Basilevsky et al.*, 1986]. Tessera occur in both small isolated patches and in large regional configurations that comprise about 15% of the area north of 30°N. The morphology of tessera has been interpreted to be related to deformation which has acted with primarily horizontal components over broad areas (the areal deformation of *Basilevsky et al.* [1986], but the origin of the deformation is still controversial.

A range of models for tessera origin has been outlined and summarized by *Bindschadler and Head* [1988*c*] and includes (1 horizontal compression and crustal thickening due to asthenospheric currents [*Basilevsky*, 1986; *Pronin*, 1986]; (2 vertical uplift due to shallow mantle processes [*Phillips*, 1986; *Bindschadler and Parmentier*, 1987]; (3 gravity-driven deformation manifested as gravity sliding [*Sukhanov*, 1986; *Kozak and Schaber*, 1986; *Markov et al.*, 1989; *Smrekar and Phillips*, 1988] or gravitational relaxation [*Bindschadler and Parmentier*, 1987]; (4 seafloor spreading where structural patterns are related to rise-crest processes [*Bindschadler and Head*, 1988*c*]. Recent work by *Head and Crumpler* [1987] suggests that divergence and crustal spreading is occurring on Venus in Western Aphrodite Terra, to the south of the region covered by Venera 15/16 data, although the global extent and significance of this process is uncertain [*Kaula and Phillips*, 1981]. Analysis of terrestrial spreading centers extrapolated to Venus conditions [*Sotin et al.*, 1988; 1989*a*,*b*] shows that the gravity and topography data for western Aphrodite are consistent with a spreading hypothesis. There is also evidence that some of the equatorial regions thought to represent crustal spreading have the same radar characteristics as the tessera in the north [*Bindschadler and Head*, 1988a,*d*; *Senske and Head*, 1989]. The purpose of this paper is to investigate further the general similarity of morphology between the trough-and-ridge tessera and the fabric of the ocean floor and to investigate one of the hypotheses for tessera origin, that is, that the tessera texture might be related to a crustal fabric produced at spreading centers.

2. Characteristics of Tessera on Venus and the Trough-and Ridge Terrain in Laima Tessera

Pioneer Venus data show that tessera terrain lies at higher (generally 2 ±1 km) elevations than the surrounding plains and that it is characterized by relatively higher values of surface roughness at the centimeter-scale and the meter to decameter scale [*Head et al.*, 1985; *Bindschadler and Head*, 1989*b*] than most other surface units. Gravity data for one of the major regions of tessera (Tellus) led *Sjogren et al.* [1983] to suggest that Tellus is compensated at relatively shallow depths. The range of surface morphology observed in the tessera led

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