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TESSERA TERRAIN ON VENUS: GLOBAL CHARACTERIZATION FROM MAGELLAN DATA;

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Introduction: Tessera terrain is characterized by relatively high elevations and complex tectonic patterns (1,2); analysis of Venera 15/16 data showed that large (up to thousands of km across) and small (up to hundreds of km across) occurrences of tesserae are widespread and non-randomly distributed and make up about 10-15% of the surface of Venus north of ~30°N (3). In a previous analysis (4), we used the Magellan Cycle 1 and 2 data to map the global distribution of tesserae on the basis of: 1) complex deformational patterns (two or more trends), 2) relatively high radar backscatter, and 3) relatively high elevation. Here we report on the quantitative aspects of tesserae areal, size, and shape distribution, and on the characterisitcs and distribution of tesserae boundaries. Experiments on volcanic flooding of tessera and implications for tessera presence beneath the plains (5) and analysis of the distribution of impact craters on tesserae and the plains (6) are reported elsewhere.

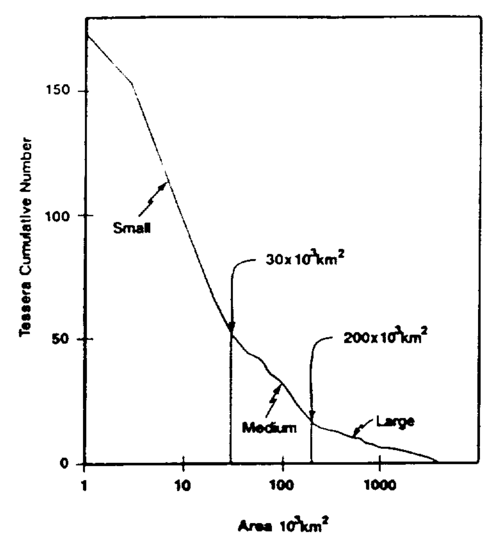
Tesserae Areal and Size Distribution: Using the global map of tessera terrain derived from Cycle 1 and 2 data (4), we have estimated the total area of all tesserae mapped to be about 10% of the total surface area of Venus. The size of individual tessera occurrences varies over a wide range from a few km to a few thousands of km. The largest tesserae have areas of about 3-4 x 10^6 km^2, each slightly less than 1% of the surface area of the planet. The cumulative distribution of tessera areas (Fig. 1) suggests three subdivisions separated by two breaks at about 30,000 km^2 and 200,000 km^2: Large Tesserae: (Fortuna, Ovda, Alpha, etc.) are regions of slightly elongated (aspect ratio of about 2:1) or equidimensional shape with a typical area about 1 - 2 x 10^6 km^2. Although only 9% of all tessera occurrences belong to this size class, their total area comprises about 82.5% of the tessera terrain on Venus. Medium-Sized Tesserae: (Shimti, Lachesis, etc.) are massifs with a typical area of about 100,000 km^2 and aspect ratios of about 3:1. Twenty-one percent of all tesserae belong to this size class and make up about 13.1% of the tessera terrain surface. Small Tesserae: (Nemesis, individual parts of Manzan-Gurme tesserae, etc.) are the most numerous and have typical areas of about 10,000 km^2 and aspect ratios of about 3:1. However, the total area of the small tesserae comprises only about 4.4% of the whole tessera population.

Three modes of occurrence are observed for tessera patches: 1) *arc-like* arrangements of equidimensional and elongated tessera patches. These arc-like bands may extend for thousands of km: examples are Kutue-Ananke tessera chain at the edge of Akkruva Colles Region; Dekla tessera; tesserae at the northern margin of Beta Regio and at Phoebe Regio. 2) *diffuse clusters* of tesserae. One large cluster begins at Atropos tessera and continues toward the southeast, including Fortuna, Laima, and Tellus tesserae to Thetis Regio. There the broad band of tesserae turns to the west and runs along Western Aphrodite extending to Alpha Regio where again the trend changes and continues to the southern margin of the mapped area. Another cluster of tesserae begins at Phoebe Regio and extends northward through Beta Regio to Virilis tesserae. Both these clusters contain all of the large and most of the medium-sized tesserae. Within the clusters, at their diffuse edges, and outside, there is a large number of individual small tessera patches and groups of them. 3) areas where tesserae are *rare or absent*; these regions occur in two contrasting environments: a) vast, low-lying plains like Guinevere, Sedna, Lavinia, Helen, Atalanta, and Navka Planitiae, and b) several of the broad volcanic rises (7) including Atla and Eistla Regiones where linear graben and volcanoes are the most important structures.

Tesserae Elevation Distribution: In terms of number of occurrences, tesserae do not display a strong correlation with elevation at the global scale. Although some large tessera massifs are at higher elevations (Fortuna, Ovda, Thetis) and dominate any terrain/altitude correlation, an abundance of small tessera patches commonly occupy low-lying regions. For example, small tesserae inside Atalanta and Lavinia planitiae are below the level of mean planetary radius. However, the greatest portion of tesserae of all size classes are concentrated at intermediate elevations.

Tesserae Boundaries: Tesserae are known to have two types of boundaries with surrounding plains (3,8). Type I boundaries have very sinuous outlines due to deep embayment of lava plains into tessera massifs. This type of boundary (sinuous/ embayment) is the most common; 73% of the total boundaries measured are of this type. The sinuosity of the shoreline and its similarity to the the lunar highlands-mare boundary suggest that Type I boundaries are also characterized by a shallow angle of dip under the plains. Small tessera patches and clusters of patches display sinuous boundaries almost everywhere on the Venus surface where they occur. This, in turn, suggests that in these areas, tessera material may underlie the lava plains between the tessera massifs. On the basis of these relationships, many of the clusters of small tesserae may represent outcrops of a single larger tessera massif almost completely flooded by lava plains (5). The predominance of Type I boundaries suggests that tesserae, taken as a type of terrain, are commonly the relatively older geological complexes on Venus, an observation supported by detailed crater counts (6). Type II boundaries are more linear at the tens to hundred kilometer scale but also often show plains embayment at the finer scale. This type of boundary (linear/tectonic) is less abundant and usually associated with large-scale tectonic features bounding tessera massifs; 27% of the total boundaries measured are of this type. For large tessera the linear boundary often coincides with the high elevated edges of the tessera. Ridges and troughs inside the tessera are in general oriented subparallel to this boundary. The linearity of Type II boundaries by themselves, the usual association of the boundaries with large scarps or tectonic features, and the sporadic occurrences of this boundary type, together suggest that Type II boundaries formed at tectonically active edges of tesserae.

Conclusions: Mapping of tessera terrain using Magellan global high-resolution data show that it: 1) comprises about 10% of the surface area of Venus, 2) is widespread but not randomly distributed, 3) is extremely highly deformed relative to intervening plains and is commonly characterized by initial compression followed by extensional deformation (2,3), 4) lies at a wide range of elevations, 5) largely predates adjacent volcanic plains which embay tessera for almost three-fourths of its boundaries, 6) may underlie a considerable percentage of the superposed volcanic plains, 7) has linear/tectonic margins for about 27% of its boundaries, and 8) is generally negatively correlated with broad lowlands and volcanic rises. Other studies show or suggest that: 1) there is a paucity of volcanism associated with the tessera (9), 2) there is a statistically significant greater number of large craters on the tesserae than the plains (6), 3) tesserae are associated with negative density anomalies in the lithosphere interpreted to be thickened crust (10), 4) tesserae show no distinctive relationship to recent mantle convection patterns (10, 11) and 5) tesserae may be the consequence of crustal thickening during mature stages of mantle downwelling following initial stages characterized by lowland formation (11). These characteristics tend to favor cold spot (11) over hot spot (12) models for the origin of tesserae, but these data, together with the potentially widespread distribution of tesserae below the volcanic substrate, also permit hypotheses favoring a global chemically evolved layer (13), or the catastrophic formation of a near-global highly deformed layer due, for example, to geologically recent instabilities in a depleted mantle layer (14) or lithosphere (15).



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