STRUCTURE OF LAIMA TESSERA: COMPARISON WITH EARTH'S OCEANIC CRUST; A.V. deCharon and J.W. Head, Dept. of Geological Sciences, Brown University, Providence, RI 02912

Introduction: The morphological, morphometric, and structural similarity between the trough-and-ridge tessera subtype and fracture zones/abyssal hills of the Earth's seafloor [1] is further investigated in an analysis of Laima Tessera, Venus (30°-60°E / 45°-54°N). In a comparison of major troughs within Laima Tessera and oceanic fracture zones [2] it has been shown that the troughs fall within the range of characteristics of fracture zones in terms of length, overall bend (curvature), and regional convergence (variation in separation distance between adjacent FZ's or troughs). In this study, we continue the comparative analysis by focusing on the topographic characteristics of domains (regions between troughs/fracture zones) and assessing elevation differences between domains, and within domains both along and across their strike. Depth-to-basement contour data from the terrestrial 5700 km long Kane Fracture Zone (KFZ)/Mid-Atlantic Ridge area [3] has been reprocessed at a resolution similar to Venera doppler-sharpened altimetry data, allowing a detailed comparison between a seafloor spreading system and Laima Tessera.

Subdivision into Domains: Laima Tessera is subdivided into eight east-west trending domains on the basis of their location on major bounding troughs and/or regional textural changes such as orientation of ridges and smaller troughs (numbered I to VIII from N to S). The widths of individual domains range from about 100 km to 250 km; the longest domain approaches 1400 km in length.

Variation in altitude between adjacent domains: Terrestrial fracture zones are commonly the location of topographic step-downs between two domains caused by the juxtaposition of crust of different ages linked to the offset of the rise crest between transforms. For the Laima domains, twelve Venera 15/16 doppler-sharpened altimetry profiles which cut across the strike of the domains are used to delineate average altitude within individual domains. Preliminary analyses of the eight domains indicate that the mean altitude of adjacent domain segments with equivalent variances are everywhere consistently statistically different. Altitude values from adjacent domains that passed the variance (F) test with high levels of confidence, also passed the t-test, and thus have significant differences in the values of their means; differences in these means vary from 160 to 680 meters. Two types of relationships between domains are observed: 1) consistent step-down across a trough into an adjacent domain throughout the whole domain (between Domains I and II; Domains V and VI); 2) variable step-down; relative topographic offsets between other domains are more variable particularly near the eastern and southern edges of tessera, and include both step-downs and step-ups. Some terrestrial FZ's are characterized by consistent step-down relationships (e.g. Mendocino FZ) while the KFZ shows a variable step-down [3].

Along-strike trends of average altitude within domains: Average altitudes within individual domains are plotted versus distance along the direction approximately parallel to the major bounding troughs. Three types of trends are seen (Fig. 1 a-c): 1) linear (Domains V and VIII); 2) irregular (Domains IV and VII); 3) exponential (Domains I, II, III and VI). In general, the profiles show altitudes decreasing from west to east. All three of these types of trends are also observed along the KFZ (Fig. 1 d-f); linear (horizontal) between 1000-2000 km east of the rise in a region of thermal equilibrium; an irregular topographic trend 1500-2500 km west of the MAR interpreted to be due to crustal thickness variations associated with enhanced magmatism or compression within the Kane transform valley at the time of crustal creation [3]; and exponential, at the rise crest, reflecting the evolving thermal boundary layer.

Across-strike topographic variations within domains: Topographic variations across the strike of the domains are observed in Laima and are typically in the amplitude range of 200-500 meters, giving the profile a corrugated appearance (Fig. 2a). Actual amplitude variations may be greater because the radar footprint averages over a broad area and thus underestimates narrow peaks and troughs. Comparison to fifty N-S oriented profiles across the KFZ (Fig. 2b) shows a similar frequency of topographic variation but the amplitude of the variations is greater on the terrestrial profiles (200-1500 m). Topographic variation in the KFZ is directly attributable to smaller hills and valleys that parallel the major fracture zone. These ancillary troughs are the result of complex processes at the ridge-transform boundary that occur commonly at terrestrial spreading systems [4,5].

Nature of the troughs: The overall appearance of the profiles across Laima Tessera troughs and the KFZ are similar although the terrestrial troughs are, in general, narrower and deeper (KFZ trough 10-40 km wide, 500-2000 m deep; Laima troughs 20-60 km wide, 200-1000 m deep).

Assessment of domains showing exponential variations in topography: The trend of altitude data from Domains I, II, III and VI compare favorably to the predicted thermal boundary layer profile from a slow-spreading (about 3 cm/yr) ridge under Venus conditions (Fig. 1c) [6]. If these trends represent active thermal boundary layer topography, then there are two possibilities: these trends could be from the direction of a spreading axis and the approximate distance. At northern Laima Tessera (i.e., Domains I through III), each of the domains is within 1000 km to the east of a theoretical spreading axis. Therefore, these domains may be in close proximity to or perhaps include the central axis of a spreading system. The fit of the data from each of the domains relative to another indicates that the proposed spreading system should be left-lateral. If so, this would predict curving or hooked abyssal hill promontories at the edge of the domain that curve toward the direction of transform offset [3,7]. This predicted sense of spreading center offset is consistent with the sense of curvature observed in many of the abyssal-hill-like ridges within northern Laima Tessera.

Conclusions: This analysis shows that the Laima Tessera troughs and their associated domains are similar to terrestrial fracture zones and domains (as exemplified by the KFZ) in terms of variation in altitude between adjacent
domains (style and consistency), trends in altitude within domains (style and magnitude), and cross-strike topographic variations within domains (frequency). Differences are observed in amplitude of cross-strike variations within domains (KfZs are greater) and trough/fracture zone widths and depths (Laima troughs are generally wider and shallower). One type of along-strike variability (exponential) may represent thermal boundary layer topography, and the configuration of several examples suggests the presence of a spreading center with right-lateral steps in NW Laima Tessera. We conclude that these many similarities provide additional support for the hypothesis that trough and ridge tessera in Laima Tessera formed from crustal spreading-type processes [8,9]. As a further test, we are presently modelling the nature of magmatic processes in rise crest regions in the Venus environment [10] in order to predict the general configuration of associated structures and we are assessing other hypotheses for the origin of Laima (e.g., gravitational relaxation and gravity sliding).


Fig. 1. Along-strike trends of average altitude (std. deviation shown) for Laima Tessera domains (a,b,c) and Kane Fracture Zone / Mid-Atlantic Ridge (MAR) area (d,e,f). Range of KfZ/MAR data points is 0.25 km. a) Linear trend in altitude of Domain VIII; b) Irregular trend in altitude of Domain IV; c) Values of average altitude of Domain II shown plotted against predicted thermal boundary profile [6]; d) Linear topographic trend between 1000-2000 km east of MAR axis; e) Irregular topographic trend 1500-2500 km west of MAR axis; f) Average height of crust 1000 km east of MAR axis plotted against theoretical thermal boundary profile.

Fig. 2. Topographic variations across the strike of Laima Tessera domains and the Kane Fracture Zone. Major trough locations are designated by arrows. a) One of the twelve Venere doppler-sharpened altimetry profiles used in this study. Individual domains (I through VI) are labelled; b) A north-south trending profile from the Kane Fracture Zone reprocessed data set located approximately 100 km west of the Mid-Atlantic Ridge axis.