# TOPOGRAPHIC AND STRATIGRAPHIC CHARACTERISTICS OF RIDGE BELTS ASSOCIATED WITH TESSERA BOUNDARIES ON VENUS: EXAMPLES FROM NORTHERN OVDA REGIO MARGIN AND KUTUE TESSERA;

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Total of sixty-five ridge belts associated with boundaries of complex ridged terrain (CRT or tessera) areas were identified on Venus from the radar images acquired by the Magellan spacecraft [1,2,3]. Ridge belts were included to the survey based on their closeness and location relative to tessera margin and apparent influence of tessera terrain on the strike and location of the ridge belt. As a part of an ongoing study of these features I have undertaken a survey of topographic characteristics of the ridge belts. The first results of this study are presented in this paper. The case studies of the ridge belts adjacent to the northern margin of Ovda Regio and in the Kutue Tessera area reveal that the geologic history of these areas includes several episodes of ridge belt formation with interleaved plains emplacement and that there has been siginficant tectonic movements after the plains amplacement.

**Northern Ovda Regio boundary.** The CRT terrain at the boundary is characterized by boundary-parallel ridges and crosscutting finer-scale fractures and flat-floored valleys (interpreted to be graben). There are linear troughs with floors covered with plains material between the larger ridge-like structures of the tessera terrain. A few long, linear fractures crosscut these trough-like intratessera plains but usually the plains are unmodified. The CRT boundary is classified as subtype PF of the linear type (long ridges and troughs parallel to the tessera edge) of the tessera boundaries according to the classification of Ivanov and Head (1993) [4]. There are several ridge belts on the plain adjacent to the tessera margin. The belt at 3.5-6.5N, 84.5-89E is a type 1 ridge belt (directly in contact with the tessera [1,2]). The belt located to the NE of the previous belt is a type 2 belt (It is not in contact with the tessera margin but is located less than 100 km from a major tessera area and is clearly influenced by the presence of tessera terrain [1,2].). Both of these belts are embayed by dark and mottled plains that also embay the tessera. Some of the earlier plains surface, that the belts deform, is revealed at the belts and adjacent to it. Thus the belt formation has been an intermediate phase in the evolution of the terrain adjacent to the tessera in this area.

The topography of the area reveals that the belt at 3.5-6.5N, 84.5-89E is elevated over 1 km higher than the adjacent plains surface. Because the ridge belt and part of the tessera boundary are embayed by the same plains unit that covers the lower plains surface, the topography must be younger than the structures of the ridge belt or tessera and the embaying plains unit. This boundary area has thus been significantly uplifted after the embayment event.

The ridges of the belts are very similar to some smaller ridges within the tessera fabric and they also resemble long ridges that occur in the linear troughs between higher-standing large ridge-forms of the tessera terrain in this area. It is not clear if formation of the ridge belts and formation of these smaller tessera ridges are related but the similarities in their trend, size and morphology suggest that they may have originated in the same episode of compression and crustal shortening.

Further to the east along the northern Ovda Regio boundary, there several other ridge belts (e.g., at 6.3-6.9N, 98.5-96.6E) that are also mostly directly in contact with the tessera boundary and usually also embayed by later plains deposits. Topographically these belts are located on a shelf-like flanking plateau elevated ~1-1.3 km relative to the plains to the north but over 2 km lower than the adjacent high tessera. The scarp from the tessera plateau down to this shelf-like area is quite steep.

It is not so clear whether this area has also been uplifted sometime after the embayment of the ridge belts. There are also inliers of embayed tessera terrain on this shelf, which could suggest that the area is a subsided part of the tessera. The adjacent high tessera massif could have been uplifted relative to the shelf. The similar looking plains units on the shelf and on the lower plain suggest that the area may have been embayed and partly covered by similar deposits and after that partly uplifted. There is also a younger ridge belt that deforms these deposits and is located on the lower slopes of the shelf. Formation of this belt could have been associated with the uplift event. The issue is not resolved and more detailed mapping of the stratigraphy needs to be done.

**Kutue Tessera.** Kutue Tessera (at ~30N, 120E) is an elongated CRT area with a narrow neck-like central segment. The tessera terrain seems to have been subjected to rifting producing the observed elongated segments and troughs between the different parts. The trough floors have been subsequently covered with plains materials, apparently lava flows. There appears to have been two episodes of plains emplacement because there are patches of bright, textured plain visible occasionally along the margins of the CRT segments. This bright plains unit has been deformed by two ridge belts (at ~31.1N, 19.5-121E and 32N, 120-121.5). Subsequently this unit was embayed by later plains material that also partly embays the ridge belts. The ridges of the belts have similarities with the ridge-

**TOPOGRAPHY OF RIDGE BELTS**: Törmänen T.

like forms of the adjacent tessera but the ridge belt ridges lack the coarse fabric of superposed fractures and scarps of the CRT.

The topography of the Kutue Tessera area is dominated by a ridge-like high that corresponds with the elongated segment(s) of the tessera. The plains areas and the ridge belts between the ridge-like segments of the tessera terrain are topographically lower than the tessera terrain but still higher than the plains north and south of the tessera. In a few places (e.g., at 30N, 121.5E), the plain are is elevated almost as high as the adjacent tessera. This indicates that these plains areas are probably underlain by tessera terrain which has subsided and been covered by plains deposits. In a few places, the southern major ridge-like topographic high running in NW-SE direction between the larger tessera areas of Kutue Tessera is covered by a plains surface between discontinuous elongated segments of the tessera terrain. This would suggest that the topographic high was formed after the plains emplacement. Thus, also in this area, the vertical tectonic activity could have post-dated at least some of the geologic activity that produced the observed stratigraphic sequence of tessera, plains and ridge belt units.

**Discussion and conclusions.** The cases studied here indicate that when the ridge belts adjacent to tessera margins are embayed, the embayment and deformation relationships usually reveal the presence of an older plains unit deformed by the later ridge belts and that appears to have embayed also the tessera boundaries. These cases suggest, as does the analyses of other ridge belts, that in the areas where belts of several ages are located near tessera boundaries, usually only two episodes of ridge belt-forming compression can be identified. This suggests that either there has not been more compressional tectonic episodes or that traces of other older episodes, i.e. the earlier ridge belts, have been covered or destroyed, so that they can no longer be identified. At northern margin of Ovda Regio, the similarities between the ridge belt ridges and the ridges within the tessera fabric, in the troughs between tessera blocks, give hints of possible links in origin of the belts and the tessera fabric but the evidence is not conclusive.

The evidence of the uplift of the tessera margins with their adjoining ridge belts after the plains emplacement and ridge belt formation indicates that significant vertical tectonic movements have occurred after the large-scale modification and embayment of tessera boundaries, and that this activity may not have left distinct structural evidence. Therefore it is extremely important to always analyze topography together with the morphology and stratigraphy of the area. These observations show that the tessera boundary areas have had a very complex and varied deformational history.

If the tessera areas and most of adjoining structures were formed by large-scale tectonics and volcanism associated with a global resurfacing event about 300-500 million years ago [5,6], when this evidence of the post-plains emplacement uplift could indicate either the latest tectonic activity associated with the resurfacing event or some later modification of large-scale topographic features, such as tessera plateaus. The study of the tessera boundaries should help us to uncover the sequence of events during the later parts of the global resurfacing event and after it.

The ongoing work on the ridge belts associated with tessera margins includes more detailed mapping of ridge belts and their surroundings, comparative analyses of different regions and a survey of topographic characteristics of ridge belts and tessera boundaries. The goal of the study is to understand the deformational history of the tessera margins and how the tessera blocks and massifs have influenced the ridge belt formation and vice versa.

***References.*** [1] Törmänen T. (1993) *LPSC XXIV*, 673. [2] Törmänen T. (1993) *EOS*, *74*, 379. [3] Törmänen T. (1994) *Bull. Am. Astron. Soc.*, *26*, 1149. [4] Ivanov M.A. and Head J.W. (1993) *Vernadsky-Brown Microsymposium 18*, 23. [5] Schaber G.G. et al. (1992) *JGR*, *97*, 13257. [6] Strom, R.G. et al. (1994) *JGR*, *99*, 10899.