**MAPPING IN V-3 AND V-56 QUADRANGLES, VENUS: ASSESSMENT OF EVOLUTION OF THE TOPOGRAPHY OF THE MIDLANDS.** Mikhail A. Ivanov[1,2] and James W. Head, III[2]. [1]Vernadsky Institute, RAS, Moscow, Russia, mikhail_ivanov@brown.edu; [2]Dept. Geological Sci., Brown Univ., Providence, RI 02912 USA.

**Introduction:** The topographic province of midlands (0-2 km above MPR) recognized in the very beginning of the geological study of Venus [1,2] is the most widespread province, comprising about 80% of the surface and hosting the richest variety of terrain, units, and structures. Thus, the stratigraphic assessment of the timing of evolution of topography within this province plays an important role in the understanding of mantle dynamics during the observed portion of the geologic history of Venus. Here we report on the results of mapping accomplished within the V-3 and V-56 quadrangles. The majority of the area of both quadrangles is within the midlands.

**V-3 quadrangle: Regional topographic setting and stratigraphy:** The Meskhent Tessera (V-3) quadrangle (50-75°N, 60-120°E) is surrounded by large tesserae, Fortuna and Laima from the E, and Tellus from the S [3,4]. The large basin-like lowland of Atalanta Planitia is to the W of the quadrangle [5]. Topographically, the quadrangle is in a transition zone from uplands to lowlands. The gravity and topography of Atalanta Planitia have been cited as evidence for large-scale mantle downwelling [6-8] and the presence of large tesserae are consistent with extensive areas of thickened crust and tectonically stabilized lithosphere representing ancient and now extinct regimes of mantle convection [9,10]. Thus, the region of Meskhent Tessera quadrangle represents a good sample for the study of the formation and evolution of lowlands, midlands, and highlands, and possibly interaction between proposed downwelling and areas of thickened crust and lithosphere, the formation of associated tectonic features, and the emplacement of volcanic plains. Nine material and tectonic units make up the surface of the quadrangle and are arranged in the following stratigraphic order (from older to younger): Tessera material (t), Densely lineated plains material (pdl), Ridged plains material (pr), Groove belts (gb), Shield plains material (psh), Regional plains material (two units $rp_1$ and $rp_2$), Smooth plains material (ps), and Lobate plains material (pl).

**V-3 quadrangle: Topographic distribution of units:** Four major elevated regions separated by elongated lower-lying areas characterize the overall topography of the Meskhent quadrangle. The oldest unit in the map area, tessera, occupies three of them: Eastern Ishtar (Fortuna Tessera to the W), Tethus Regio (Meskhent Tessera to the NE), and an arc of Dekla Tesserae (to the S). The relatively old tectonized materials and deformational belts (pdl, pr, gb) are concentrated within the midlands on regional slopes predominantly near the major tessera-bearing highs.

Plains materials at middle stratigraphic levels, regional plains ($rp_1$) and shield plains, broadly embay the belts there. The most abundant unit in the quadrangle (shield plains) is preferentially concentrated on the broad slopes away from the major tessera regions where it embays the deformational belts and is embayed by regional plains. The fourth elevated region is in the central-eastern portion of the quadrangle and represents a large topographic ridge between Fakahotu Corona and Melia Mons. Groove belts characterize the core areas of Fakahotu Corona and the central portion of the ridge, the broad slopes of which are partly covered by the youngest and relatively non-abundant unit of lobate plains apparently sourced by Fakahotu Corona and Melia Mons. The major portion of the ridge slopes consists of shield plains. The lower unit of regional plains ($rp_1$) occurs throughout the map area (except for the major tesserae) but preferentially occupies the elongated lowlands where it embays all previous material and structural units. The upper unit of regional plains ($rp_2$) is related to a few distinct volcanic centers and local slopes away from the centers appear to govern the distribution of the unit. In places, the upper unit of regional plains occurs in the deepest areas of regional topography.

**V-56 quadrangle: Regional setting and stratigraphy:** The Lada Terra (V-56) quadrangle is almost antipodal to the V-3 quadrangle (50-75°S, 0-60°E) and covers the eastern regional slope of the upland of Lada Terra. Our mapping in this area reveals three groups of material and structural units that are defined by relationships of embayment and crosscutting: (1) the group of the oldest units, tesserae and ridge belts; (2) the group of units at the middle stratigraphic level (shield plains and regional plains); and (3) the group of youngest units (lobate plains and rift zones). The morphology and relative stratigraphic position of the units in the map area are broadly similar to those mapped in the V-3 quadrangle. Elongated occurrences of tesserae, ridge belts, and rift zones in the V-56 area form distinctive structural trends that correspond to specific regional-scale topographic features.

**V-56 quadrangle: Regional topography and topographic position of the units and structural zones:** The easternmost third of the V-56 quadrangle is within a gap of topographic data. The available data show that the map area extends from the highland of Lada Terra to the lowlands of Lavinia Planitia (to the NW) and Aino Planitia (to the N and NE). The central portion of Lada Terra represents a large dome-shaped topographic feature (a swell) thousands of km across and a few km high, which is topped by Quetzalpetlatl Corona. Two regional-scale topographic features (thousands of km long, hundreds of km wide, and several km in amplitude), an elongated depression, and a topographic ridge, concentrically outline the swell of

Lada from the E. The oldest units in the quadrangle (tessera and ridge belts) occur near the center of the swell and on its regional slopes, and correspond to local elevated areas that are broadly embayed by regional plains and younger plains units. The correspondence of tessera and ridge belts to the local highs is typical within the V-3 area and elsewhere on Venus as well [11-13]. Regional plains and shield plains are preferentially exposed within the elongated depression at the eastern edge of the Lada swell but these units are also seen in stratigraphic windows within the swell at relatively high elevation.

The most prominent structural zones within the V-56 quadrangle are very long swarms of broad graben (rift zones). There are two such zones in the map area. One of these corresponds to the large topographic ridge that is concentric to the swell of Lada Terra. This zone consists of a chain of coronae interconnected by graben and is split into three branches at about 65°S, 40°E. The most prominent, western, branch curves around the Lada swell and meets the second graben/corona zone in the NW corner of the quadrangle. The central branch apparently dies out at the northern edge of Lada Terra and the eastern branch extends into the eastern portion of it (out of the V-56 area). The second zone occurs in the NW corner of the area and is a continuation of the Kalaipahoa Linea that outlines the Lada swell from the N and separates it from the basin of Lavinia Planitia [14]. The coronae and some graben of the corona/graben chains are the sources of the youngest lava flows that flow down the actual topographic gradient (e.g. Mylitta Fluctus in the V-61 area [14]).

The highest area within V-56 quadrangle (center of Lada Terra) corresponds to the eastern portion of Quetzalpetlatl Corona (Boala Corona/Erzulie Mons), which is the source of large and voluminous young lava flows (lobate plains) that flow from this center down the regional slopes of the Lada Terra swell.

**Discussion and conclusions:** *V-3 quadrangle: Evolution of topography* The relative age relationships of the material and structural units within the V-3 quadrangle are consistent throughout the map area and establish a regional-scale stratigraphic column that is applicable to the entire map area and, perhaps, to the surrounding regions as well [13,5]. The stratigraphic position of the units and structures correlates well with topography on local and regional scales. The older units generally occupy the higher topographic levels, which is consistent with embayment by progressively younger units. This suggests two important characteristics of the regional-scale topography (at the scale of hundreds to thousands of km) within the quadrangle and, by implication, within the broader surroundings. First, the actual regional-scale topographic pattern apparently formed relatively early on in the time span from tessera to shield plains. In its areal distribution, the younger material of the lower unit of regional plains ($rp_1$) follows the regional topographic contours, is concentrated in regional lows, and is noticeably less abundant within the elevated areas. Second, this regional-scale topographic configuration appears to remain stable subsequent to the time it was established. The areal distribution of the youngest units (the upper unit of regional plains, $rp_2$, and lobate plains, pl) suggests, however, that the surface of the regional lows were warped and deformed after emplacement of vast regional plains to a relatively small extent (scale of tens to a few hundreds of km).

*V-56 quadrangle: Evolution of topography* The oldest units within the quadrangle (tessera and ridge belts) correspond to local elevated areas (up to a few hundred meters high) and, thus, appear to follow the general correlation with the topography established in the V-3 area. The correlation of the oldest units either with local or regional highs appears to be a typical feature of the surface of Venus [15,12]. Stratigraphically intermediate units (shield plains and regional plains) occur both in the regional lows (as in the V-3 quadrangle) and topographically high on slopes of the Lada swell and in the major topographic ridges that outline the swell. The topographic distribution of regional plains suggests that they were displaced due to development of the major topographic features of Lada Terra, the amplitude of which is up to a few kilometers.

There are several lines of evidence supporting the existence of relatively young upwelling under the central portion of Lada Terra. (1). Magellan gravity data [16,7] show that the eastern half of the quadrangle, which is dominated by the western portion of Lada Terra, is characterized by high values of both vertical gravity acceleration (up to 120 mGal) and height of geoid (up to 40 m). (2) The youngest deformational belts (corona/rift chains) concentrically outline the swell of Lada Terra. (3). The youngest lava flows and plains (lobate plains) are sourced at the central (highest) areas of the swell and flow down along the topographic slopes. This suggests that the most prominent topographic features in the V-56 quadrangle (the Lada swell outlined by the major depression and the ridge) began to form relatively late in the geologic history of the region, after emplacement of the background of regional plains.

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