TESSERA TERRAIN FORMATION AND EVOLUTION ON VENUS: EVIDENCE FOR PHASE III EPEIROGENIC UPLIFT IN OVDA REGIO; J. W. Head[1] and M. A. Ivanov[2], 1- Brown Univ., Providence, RI 02912 USA, 2- Vernadsky Inst. 117795, Moscow, Russia.

ABSTRACT. Using Magellan altimetry and image data, we define a Phase III of tessera terrain evolution in which a considerable portion of the present elevation of tessera in Central Ovda Regio is obtained, but during which there is little obvious evidence for formation of distributed tectonic deformation features typical of the tessera fabric. We interpret a major part of the Phase III topographic contribution of tessera to be due to post-tessera formation epeirogenic uplift related to isostatic readjustment associated with crustal thickening accompanying tessera formation. Stratigraphic arguments suggest that considerable amounts of uplift followed the emplacement of the regional wrinkle-ridged plains (with a crater retention age of ~300 Ma) but that much of the uplift had occurred by the time that the smooth and lobate plains were emplaced (perhaps 100-200 Ma ago). The major fracture belt localized along the southern margin of Ovda Regio appears to be a direct manifestation of this uplift. The broad topographic uplift of Phase III tessera evolution contrasts to the distinctive distributed tectonic structures of Phase I/II.

INTRODUCTION. In previous studies the global distribution of tessera has been defined and the broad phases and sequence of deformation outlined [1,2]. Large areas of tessera terrain are characterized by an initial Phase I of shortening and compressional deformation (broad arches and folds) followed by a partly overlapping Phase II of extensional deformation (narrow and wide graben) commonly attributed to gravitational relaxation. Tessera is stratigraphically older [3] than the regional plains but is not statistically significantly older on the basis of crater size-frequency data [4]. No craters are known to be deformed by Phase I deformation and the small number that have been modified by Phase II deformation suggest that the termination of I and the duration of II was geologically short (<40Ma) [5]. In this analysis we examine a geotraverse across Ovda Regio [6] (Fig. 1a) and focus on the relationship of topography to internal morphology of tessera tectonic units, to external stratigraphic units and regional structure (Fig. 1b), and to Phase I and II deformation.

INTRATESSERA GEOLOGIC UNITS & TOPOGRAPHY. Units within this portion of Ovda tessera can be divided into ridge and valley structures [7] (I, IV), and disrupted facies (II, III). The valley and ridge units are 150-350 km in width and appear to be symmetrically distributed on both the northern and southern margins of the plateau. The northern disrupted facies is about 400 km wide and the southern disrupted facies is up to 500 km in width. Topographic profiles show that there is a gradual increase in average elevation from the north to the south within the tessera, and that the cross-sectional topography of each tessera unit differs. We are analyzing the topography and morphology of these units and assessing the strain history of tessera formation. Here we concentrate on the general characteristics of the topography. For the three profiles, the peak elevations of tessera above MPR are ~3.7, ~4.0, and ~4.2 km. The external plains units that embay the tessera fabric are situated on broad slopes extending away from the tessera edge and descending at least 1.7 km to as much as 3.0 km into the surrounding lowlands (Fig. 1b). Maximum elevations from the lowest elevation of the outer margin of the tessera (the boundary with surrounding embaying regional volcanic plains) and the highest tessera elevations are ~1.7, 2.2, and 2.0 km, a factor of ~2 less than the elevation of the outer margins of the tessera above MPR. On the basis of the observations that the volcanic plains embay the tessera and that tessera deformation of Phase I and II appears to be completed by the earliest stages of plains emplacement [1,3-5], we interpret these relationships to indicate that the initial topography on the tessera in this area was of the order of about 2 km. Because of the extensive additional slopes characterizing the present configuration of the plains embaying the tessera, we infer that major tilting of the plains occurred subsequent to their emplacement. We now investigate the nature of the embayed plains and associated structure in more detail.

RELATIONSHIP OF TOPOGRAPHY TO EXTERNAL STRATIGRAPHIC UNITS & REGIONAL STRUCTURE. The configuration of external units (Fig. 1c) shows that volcanic plains units embay the tessera at the margins. Unit Pwr (volcanic plains with wrinkle ridges) is the most extensive unit in the mapped area and is relatively early in the plains stratigraphic sequence. We find no positive evidence for these plains having been produced on extensive slopes; numerous small shield volcanoes in Pwr and Psh and their deposits are circular and show no evidence for downslope preferential emplacement. Unit Pl (lobate plains) however, is composed of long flows streaming down the regional slopes and thus shows evidence of having been emplaced on slopes extending away from the tessera. In addition, a major fracture belt, Ix Chel Chasma, is superposed on the southern margin of the tessera [8,9], also cutting the early Pwr plains units; at least some of the lobate flows appear to emanate from fractures in this belt. We interpret these observations to mean that significant topographic changes occurred following the formation of the Phase I and II tessera deformation and at least partly following the emplacement of Pwr, but before the final emplacement of Pl.

DISCUSSION & INTERPRETATION. Sources of topographic changes might be positive or negative elevation of either the tessera or the surrounding plains or a combination of both. Emplacement of plains increases topography but their subsidence due to loading could decrease topography; thermal subsidence of the plains

lithosphere, and post-crustal thinning isostatic adjustments in these areas could also lead to lowering of plains topography relative to tessera [10]. Regional geologic mapping [11] and global observations [3] indeed suggest that such plains subsidence occurred during and following the emplacement of Pwr. Sources of topographic change in the tessera could include decreases in topography due to gravitational relaxation, a process thought to be related to Phase II deformation [1], and increases due to continued underthrusting and crustal thickening, but apparently not manifested in Phase I and II type tectonic deformation. An additional possible source of increased tessera topography is broad uplift related to isostatic adjustments following tessera formation by crustal thickening processes. In terrestrial geological terms, Phases I and II would correspond to an orogeny, and this type of uplift to an epeirogeny (e.g., "movements of uplift and subsidence that have produced...broader features...in contrast to orogeny, which has produced mountain chains. Movements in epeirogeny are dominantly vertical." [12]). Although plains subsidence is clearly occurring, we tentatively interpret the data from this geotraverse to indicate that a significant component of the tilting is related to the post-formational broad uplift of the tessera massif due to isostatic adjustments linked to crustal thickening. Evidence for this interpretation includes the distinctive fracture belt located along the southern margin, the relatively symmetrical and broad plateau-like evenness of the topography, and the fact that post-shortening and post-crustal thickening isostatic adjustments are a natural consequence of the formation of tessera [1,13], particularly if it formed relatively catastrophically [e.g., 14]. We refer to this as Phase III (largely epeirogenic) tessera deformation and contrast this with the orogenic activity that characterized Phases I and II.

On the basis of these observations we infer the following series of geologic events: Earliest are tessera formation through shortening, compression, underthrusting, and thickening of pre-tessera volcanic plains crust; termination of Phase I shortening was followed immediately by gravitational relaxation and graben formation (Phase II) and these early phases produced thickened crust and primary topography of the order of ~2 km. Emplacement of inter- and intra-tessera volcanic plains immediately followed with embayment of deformed tessera; little evidence of extensive tilting of tessera margins exists throughout the emplacement of Pwr. Along the S margin of Ovda, these early plains are cut by the faults of Ix Chel Chasma, and later Pl flows are clearly controlled by steep slopes, indicating that much of the tilting along this margin occurred after the emplacement of Pwr but before the formation of Pl. This suggests that epeirogenic uplift was either delayed, or that the Pwr and related plains were emplaced relatively rapidly geologically. We are presently analyzing the stratigraphic sequence of plains emplacement in more detail, and comparing the evidence for Phase III epeirogenic uplift with marginal topography elsewhere along Ovda and in other tessera terrain.

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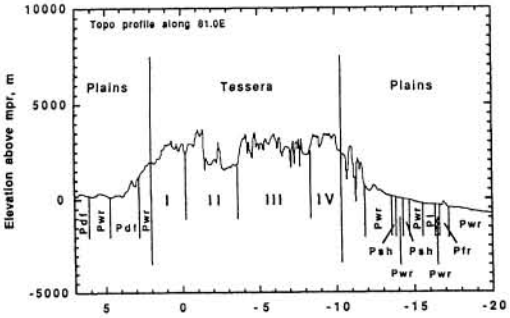

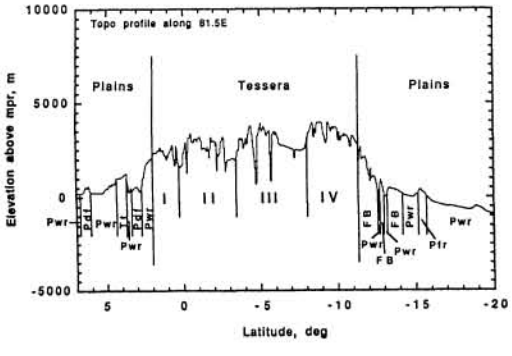

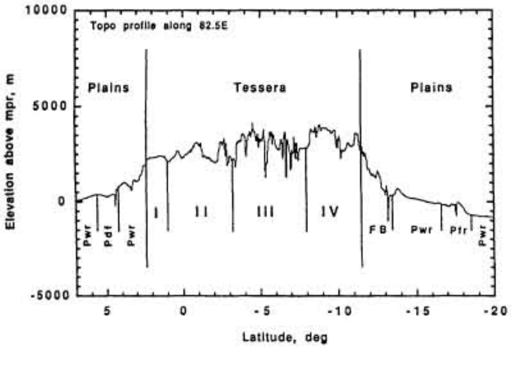

Fig.1. Topographic profiles. Units are, in stratigraphic order, Pdf (densely fractured plains), Pfr (fractured and ridged plains), Psh (shield plains), Pwr (wrinkle-ridged plains), and Pl (plains with lobate flows) [3]