TESSERA TERRAIN IN OVDA REGIO, VENUS: PRELIMINARY RESULTS OF A GEOLoGIC MAPPING TRAVERSE; M.A. Ivanov¹, J.W. Head² 1- Vernadsky Inst. 117795, Moscow, Russia, 2- Brown Univ., Providence, RI 02912 USA

INTRODUCTION. Tessera terrain covers about 35x10⁶ km² (~ 8%) of the surface of Venus [1]; everywhere it has been examined it appears to represent the oldest stratigraphic unit [1-3]. There have been only a few attempts to decipher the details of tessera internal structure [4-7]. We have completed a geologic traverse across a large tessera occurrence in the central portion of Ovda Regio (at about 82°E) in an attempt to understand 1) the units making up the surface of tessera and the nature of the tessera precursor terrain, 2) the sequence of events in Ovda tessera evolution, and 3) the timing of this process. We analyzed the morphology of the tessera structural facies to assess the nature of the tessera precursor terrain and the sequence of events leading to tessera formation and we used intratessera plains as a stratigraphic marker in defining stages in the formation and evolution of Ovda Regio.

GENERAL TOPOGRAPHY & UNITS WITHIN THE TRAVERSE AREA. Ovda Regio is a plateau-shaped highland with dimensions of ~5600 x 2000 km, and is 1660 km wide in the traverse area. The main topographic features in the southern and central portions of the highland are broad ridges several tens of km wide oriented generally E-W. The northern portion of Ovda is more complex due to the presence of broad deep curvilinear troughs which comprise a ridge and trough zone. Two morphologically distinct members make up the surface of Ovda highland: Heavily deformed tessera and smooth intratessera plains. To a first order, tessera is older while the plains are younger.

TESSERA FACIES. Tessera terrain within the traverse area consists of two facies: Blocky and lineated tessera. Zones of lineated tessera are oriented preferentially in an E-W direction. They separate and frame fragments of blocky tessera and thus appear to be older. Blocky tessera consists of elongated fragments several tens of km wide and up to a hundred km long. The fragments have a gently wavy surface heavily disrupted by numerous low scarps. Sometimes narrow and shallow graben also complicate the surface. Sets of scarps and graben are mostly oriented chaotically but occasionally one can see two sets of features crossing each other at high angles. There is no clear sequence of tectonic structures; rather they appear to be overlapping in time. In between the tectonic features remnants of the pre-tessera terrain are sometimes visible and those demonstrate morphologic similarity to typical lava plains. In addition, in rare cases there are deformed shield-like domes (sometimes with central pits) on the surface of flat blocks. The domes appear similar to small shield volcanoes typical of some kinds of regional plains on Venus [2,3]. The plains-like morphology of less deformed blocks and the presence of the domes suggests that the initial surface of the blocky tessera was made up of pre-tessera lava plains. Typical features of the lineated tessera are narrow (usually less than 1 km wide), parallel, and curvilinear lineaments which often are resolved as fine-scale ridges. The large number of such ridges soften the relief of the lineated tessera in contrast to the sharp morphology of the blocky tessera. The fine ridges run along the axis of the larger subparallel 10-15 km wide ridges which dominate the topography of the lineated tessera and are thought to be a result of compressional tectonics. The fine ridges obscure relicts of previous terrain within lineated tessera. However, because the lineated tessera appears to be younger unit it is very likely that some portion of the blocky tessera had been involved in formation of the lineated tessera. Both, blocky and lineated tessera, are cut by a set of subparallel long narrow graben which are the youngest tessera tectonic features and are typical of all large tessera regions and mountain ranges as well [1,8].

INTRATESSERA PLAINS. There are three types of intratessera plains within the traverse area. The stratigraphically oldest plains occur as angular fragments a few km across and have been emplaced before formation of the long narrow graben because the graben cut the plains. In stereo images one can see that small fragments of the old intratessera plains are not horizontal and hence have been tilted after their emplacement. Fragments of these old plains are separated by series of low scarps and these also distort the surface inside of the plains occurrences. Some fragments of the plains form elongate saucer-shaped depressions which are oriented conforming to general strike of larger and finer ridges in lineated tessera. Intratessera ridged plains usually cover the floors of the large troughs in the ridge and trough zone in the northern portion of Ovda and depressions at the southern edge of the highland. A characteristic feature of the plains is that their smooth surface is deformed by wrinkle ridges, and where relationships can be determined, they overlie the previously described plains and underlie the smooth plains. The wrinkle ridges have a morphology similar to the ridges typical of regional plains on Venus [2,3]. Material of the ridged plains embay the long narrow graben. Stereo images and topo profiles across occurrences of the intratessera ridged plains show that in the south the surface of the plains is almost horizontal while in the ridge and trough zone the ridged plains are tilted conforming to the general slopes of the trough walls. The smooth plains within the traverse area have no visible tectonic features on their surface and are stratigraphically youngest. The plains fill local depressions in southern, central, and northern Ovda. Occurrences of the plains vary in dimensions from a few km to hundreds of km across. Stereo images and topo profiles demonstrate that in the southern and central portions of the highland the surfaces of the smooth plains are almost perfectly horizontal while northern occurrences in the ridge and trough zone are slightly tilted.
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INTERPRETATION & CONCLUSIONS. The high elevation and broad ridges dominating the general topography of Ovda Regio strongly favor an interpretation that the highland has been produced by compressional tectonics (defined as Phase I, a progressive stage). Tessera terrain is the oldest defined morphologic terrain unit of Ovda Regio. Orientation of structures in both tessera facies coincides with the orientation of the main topographic features of Ovda. This, in combination with the stratigraphic position of tessera suggest that tessera terrain formed during initial stages of Ovda Regio formation. The detection of plains with shields in the earliest tessera stratigraphy is evidence for a plains-like nature of the precursor of blocky tessera. The contrast in morphology between two structural tessera facies is may be due to different properties of material forming the facies. For instance, material densely fractured before highland formation, could, under compression, imbricate and produce fine-scale parallel ridges and the softened relief characteristic of the lineated tessera. Initially undeformed plains material could be more rigid and under the same circumstances be deformed by numerous chaotically or more organized sets of scarps and graben typical of the blocky tessera.

The initial progressive stage of highland and tessera formation changed to Phase II, a regressive stage of extension during which the long narrow graben were formed, probably due to gravitational relaxation. In the waning part of the first stage an episode of volcanism occurred producing the saucer-shaped intratessera plains. Conformity between the strike of the tilted fragments of these plains and the orientation of larger and finer ridges in lineated tessera could be interpreted as evidence that the plains underwent displacement oriented in the same manner as the tessera facies. The plains, although warped, tilted and slightly deformed, still keep their initial morphology. This means that the tilting and deformation of the plains could mark the end of progressive tessera-forming tectonics, which was then followed by a regressive episode of gravitational relaxation and formation of long narrow graben. The stratigraphic position of the warped and tilted plains does not mean, however, that there was a significant gap in time between the progressive and regressive stages. Indeed, the two stages probably overlapped in time and the first tectonic phase could be characterized by sporadic volcanism. Products of volcanic activity could be involved in tessera formation and only the last deposits of volcanism survived when the Phase I tectonics faded out.

Ridged intratessera plains embay the long narrow graben, a relationship strongly indicating that the plains formed after cessation of the Phase II tectonics. Long narrow tessera graben are also embayed by regional plains south and north of Ovda. Since both regional and ridged intratessera plains embay the graben they are the upper stratigraphic limit of tessera tectonic deformation in Ovda Regio. Surfaces of the plains both inside and outside Ovda are deformed by wrinkle ridges. If we assume that the ridges indicate a global tectonic phase, which is suggested by impact crater morphology [9] and by results of regional mapping in many areas on Venus [2,3], then formation of the in-tessera and off-tessera ridged plains appears to be close in time. Since regional ridged plains cover the majority of the surface of Venus [1,2,10] the density of impact craters on them must be close to the global average and their crater retention age should be close to the estimated age for the whole planet, 300-500 Ma [9,11,12]. This age thus is probably an upper time limit of tessera tectonic deformation in Ovda Regio. Tilting of the ridged intratessera plains in the ridge and trough zone in northern Ovda suggest that this portion of the highland was less stable and experienced some amount of movement which did not lead, however, to tesseraization of the ridged plains. Smooth intratessera plains were emplaced on the already-formed highland (except maybe for its northern edge) and this episode of volcanism in Ovda is separated from the previous one by phase of wrinkle ridge formation. The broad tilting of Ovda margins (Phase III), probably indicating long-term isostatic adjustments [13], continued beyond the period of visible tectonic deformation (Phases I and II).

The above analysis of tectonic and material units within the geologic traverse across tessera in Ovda Regio shows that two contrasting morphological members, tessera terrain and intratessera plains, can be used to decipher the evolution of the highland. Tessera terrain in Ovda Regio marks a phase of intense and probably rapid growth of the highland (Phase I) while the graben and later intratessera plains mark a phase of highland stabilization and its relaxation and associated tectonic deformation (Phase II) which was largely completed by 300-500 Ma ago. Subsequently, Ovda Regio underwent broad-scale topographic evolution related to further isostatic adjustments (Phase III deformation [13]) which did not result in the production of significant major tessera tectonic fabric. Tessera precursor terrain appears to have been volcanic plains and volcanism occurred throughout tessera emplacement, culminating in the smooth intratessera plains.