IMPLICATIONS OF VENUS EVOLUTION BASED ON RIBBON TESSERA TERRAIN RELATIONS WITHIN FIVE LARGE REGIONAL AREAS. V.L. Hansen[1] and I. López[2], [1]Department of Geological Sciences, University of Minnesota Duluth, Duluth, MN 55812 (vhansen@d.umn.edu); [2]Área de Geología, Escuela Superior de Ciencias Experimentales y Tecnología. Universidad Rey Juan Carlos, 28933. Móstoles, Madrid, Spain (ivan.lopez@urjc.es).

Introduction. Venus' ribbon tessera terrain [1,2] (rtt) records ancient environmental conditions significantly different than contemporary Venus [3,4], and geologic relations are consistent with rtt representing the oldest locally exposed unit across Venus [5], although individual tracts of rrt may have formed at differnet times [6]. We have constructed a global geologic map of rtt exposures and structural fabric. In this contribution we examine global rtt outcrop and structural patterns, and rtt outcrop and structural relations within five large regional areas: (A) lowland environment, (B) lowland-volcanic rise transition, (C) volcanic rise environment, (D) mesoland environment, and (E) a single planitia basin. These areas individually and collectively provide a diverse record of long histories and evolutionary processes preserved on Venus' surface.

Ribbon tessera terrain. Ribbon tessera terrain (rtt), characterized by generally orthogonal ribbons and folds [1-2] constitutes Venus' locally oldest surface unit [3], although diverse tesserae could have different ages [2,6]. Long to short-wavelength folds record layer shortening; ribbons and graben record layer extension [1-3,6-7]. Locally, volcanic deposits flood structural lows within tessera fabric. Although debate exists as to whether folds dominantly pre- or post-date ribbons, most workers agree that: a) fold and ribbon formation broadly overlapped in time, b) graben formed late, and c) volcanic activity accompanied tessera fabric formation [2-3,6-10]. Ribbons represent brittle extensional structures in which spacing reflects the depth to a brittle-ductile transition [1-2]. Thermal modeling indicates that ribbon fabric formation requires an extremely high thermal gradient [2-3]. The regular spacing of ribbons across millions of km^2 [11-12] implies a thermal control for the base of the upper strong layer corresponding to a regional brittle–ductile transition depth [2,4,13]. Calculated heat flow values for ribbon formation requires values similar to terrestrial mid-ocean ridges; additionally, the estimated depth to the crustal solidus requires either extremely thin crust, or a crustal magma reservoir across the area of ribbon tessera terrain formation [4]. Thus, ribbon tessera terrain record regional environmental conditions quite different from that of contemporary Venus.

Global map of ribbon tessera. We constructed a global geologic map of rtt delineating unit exposures and structural trends of ribbon and fold fabrics, of individual georeferenced USGS VMap quadrangles (VMaps 1-61; V-62 is currently unavailable), using both SAR and synthetic stereo images (created using macros by D.A. Young), each view in both normal and inverted modes. Data are manipulated and projected using ArcGIS[tm] and ArcGlobe[tm] which allow us to quatify areas of rtt exposureshallowly buried rtt (<0.75 km depth), and regions of Venus that lie beneath >1km cover. ArcGlobe project allows us to resolve cartographic issues that greatly hamper spatial analysis of globally extensive units and tectonic patterns. This contribution focuses attention on five regional areas, each of which record different clues of rtt formation, evolution of the Venusian surface, and constrints for the operative processes that lead to the preserved geologic record. (For information regard the global distribution of rtt please see the contribution by the same authors in the same volume [2064.pdf]).

Breifly, rtt is exposed across ~54 million km^2, or about 12% of the surface, with unequal distribution. Continuity of structural trends between adjacent rtt inliers is consistent with the interpretation that ribbon tessera lies buried between adjacent inliers [8,15]; ~30% of Venus has rtt exposed at the surface or shallowly buried (>0.75 km). Only 53% of the surface could lie buried deeper than 1-km. The spatial distribution of burial is also unevenly distributed by hemisphere. Large areas ($\geq 7 \times 10^6$ km^2) lacking rtt exposures are rare, and occur dominantly in the southern hemisphere from ~90-240E. Exposures of rtt and shallowly buried rtt show no coherent pattern with respect to global average model surface (AMSA) provinces defined by impact crater morphology and crater density [16,17], nor do they show strong spatial correlation with topography.

Regional areas. Geologic relations preserved at within five separate regions, each representing a different tectonic environment provide evidence for the richness of the geologic history preserve on Venus and which can be gleaned from careful analyis of Magellan data. Region A, a lowland region (centered at ~37N/125E) that includes portions of Lowana, Niobe, Vellamo, and Llorona Planitiae, lies almost completely within the old AMSA province, and preserves a rich geologic history, including cross-cutting relations between two suites of rtt. An older suite defined a circulr structure originally 1500-2000 km diameter, which is overprinted by suite of rtt that trends NE across its northern margin, and extends for thousands of kilometers. The circular structure includes interior inliers providing strong evidence that rtt underlies the complete circular region. The incredible continuity in structural fabrics and colleration iwht topography elements indicate that rtt did not form within a single global event, and also provide strong evidence that this large portion of the lowland could not have experienced either: 1) near global volcanic flooding/burial [19-22]; or 2) near global subduction, which would have result in completely recycling of the surface rtt to the mantle [23-25].

Region B (centered at ~37/285E) straddles a lowland-highland transition along the northern edge of Beta Regio. Early-formed rtt is locally disrupted by N-trending fracture zones and flows of Beta Regio, and preserved in Guinevere Planitia. Differnces in regionall structural trends within Beta and the planitia could record two rtt ‘events’, or could result represent tectonic complexity within a regional rtt formation event. Clearly the formation of Beta result in relatively static up-lift of rtt, which represents a sort of ‘basement’ terrain, not unlike distinctive Archean terrain preserved within younger terrestrial terrains.

Region C comprises portions of Bell and eastern Eistla Regiones (centered at ~15N/45E). In this case numerous narrow but elongate exposures of rtt (100’s of km long) collective extend several thousand kilometers parallel to the NE-trending fabricspreserved within each exposure. Individual exposures are separated by several houndreds of kilometers, yet structural fabrics within each outcrop preserve a coherent pattern. The rtt fabrics clearly formed prior to emplacement of the mons and coronae of Bell and eastern Eistla Regiones, respectively, and the mons and coroane area almost certainly the mechanism by whcihlocal resurfacing occur within this region, as cleary indicated by cross-cutting relations preserved within the local topography. The rtt exposures form a part of a much larger belts that extends both north and south of this specific map area.

(D) This region (centered at 25S/30E), east of Alpha Regio and lying mostly in a lowland to mesoland environment, preserves a wealth of small or medium-sized exposures of rtt. Several structural patterns are preserved across the area; locally cross cutting relations within larger tracts of rtt indicate different events during the evolution of rtt; elsewhere the rtt are small, and will require more detailed study in order to establish the relative history recorded therein. It is notable that although inidivdual rtt exposure might be separated by several hundreds of kilometers, and although rtt exposures make up no more than 10% of the surface area in this region, rtt structural fabrics describe coherent trends across much of the region. These relationships are diffcult to reconcile with either deep and extensive burial/flooding, or with large scale regional subduction and catastrophic resurfacing.

Region E (centered at ~47S/350E) includes Lavinia Planitia, and is located almost completely within the young AMSA province; yet the area preserves numerous exposures of rtt, both within the deformation belts and ‘plains’ of the long-wavelength Lavinia Planitia basin. Topographic highs of coronae disrupt large arcuate tracts of rtt (Tyche and Lhamo Tessera) that lie within elevated Astkhik Planum to the east. Clealry the mecahism that served to disrupt rtt within Lavinia Planitia differ from the diruption and local resurfacing caused by coronae within adjacent Astkhik Planum.

References: [1] VL Hansen, JJ Willis, 1996, Icarus 123, 296-312; [2] VL Hansen, JJ Willis, 1998, Icarus 132, 321–343; [3] M Gilmore et al., 1998, JGR 103, 16,813–16,840; [4] J Ruiz, 2007, Planet Space Sci. 55, 2063-2070; [5] AT Basilevsky, JW Head, 1995, Planetary Space Science 43, 1523-1553; [6] VL Hansen et al., 2000. JGR 105, 4135–4152; [7] DL Bindschadler et al., 1992, JGR 97, 13,495–13,532; [8] MA Ivanov, JW Head, 1996, JGR 101, 14861-14908; [9] VL Hansen, 2006, JGR 111, E11010; [10] I Romeo, R Capote, F Anguita, 2005, Icarus 175, 320–334; [11] Pritchard et al., 1997, GRL 24, 2339-2342; [12] RR Ghent, VL Hansen, 1999, Icarus 139, 116–136; [13] [14] VL Hansen, 2006, JGR 111, E11010; [15] VL Hansen, 2005 GSAB117, 808-822; [16] RJ Phillips, NR Izenberg, 1995, GRL 22, 1517–1520; [17] VL Hansen, DA Young, 2007, GSA Special Paper 419, 255–273; [18] GG Schaber et al. 1992, JGR 97, 13257-13302; [19] RG Strom et al., 1994, JGR 99, 10899- 10926; [20] RR Herrick, 1994, Geology 22, 703-706; [21] AT Basilevsky, JW Head, 1996, GRL 23, 1497-1500; [22] AT Basilevsky, JW Head, 1998, JGR 103, 8531- 8544); [23] DL Turcotte, 1993, JGR 98, 17061-17068; [24] DL Turcotte et al., 1999, Icarus 139, 49-53; [25] I Romeo, DL Turcotte, 2008, EPSL 276, 85–97.