GEOLOGIC MAP OF THE SNEGUROCHKA PLANITIA QUADRANGLE (V-1): IMPLICATIONS FOR THE VOLCANIC HISTORY OF THE NORTH POLAR REGION OF VENUS.

D. M. Hurwitz and J. W. Head, Department of Geological Sciences, Brown University, Providence RI 02912, debra_hurwitz@brown.edu.

Introduction: Geologic mapping of Snegurochka Planitia (V-1) reveals a complex stratigraphy of tectonic and volcanic features that can provide insight into the geologic history of Venus and Archean Earth [1,2], including 1) episodes of both localized crustal uplift and mantle downwelling, 2) shifts from local to regional volcanic activity, and 3) a shift back to local volcanic activity. We present our interpretations of the volcanic history of the region surrounding the north pole of Venus and explore how analysis of new data support our interpretations.

Mapping Methods: We have used full-resolution (75 m/pixel) images where available to produce a detailed map in ArcGIS and a correlation chart of mapped units (Figures 1-3) in conjunction with the USGS planetary mapping effort [3]. Twelve material units and two structural units have been identified and mapped and are found to be similar to those identified in previous studies [e.g., 4,5]. The material units include (from older to younger) tessera material (*t*), densely lineated plains material (*pld*), belts of ridged material (*rb*), deformed and ridged plains material, both radar dark and radar bright (*pdd*, *pbd*), shield plains material (*psh*), smooth radar dark plains material (*pds*), smooth radar bright plains material (*pbs*), belts of fractured material (*fb*), lobate plains material surrounding large edifices >100 km in diameter (*lp*), small edifice features (*ed*, ~20-100 km in diameter), and crater materials (*c*). Structural units identified are wrinkle ridges (*wr*) and lineaments (*lin*) that deform the material units.

Mapped Units: The tessera terrain is consistently the oldest material in the region and is characterized by high elevation, extensively deformed radar bright material that is embayed by younger plains units. The fractures that define this unit are generally characterized by at least two intersecting orientations of deformation (subunit *t1*), though localized exceptions to this trend have the radar bright, deformed morphology but lack the clear intersecting deformation patterns (subunit *t2*). In contrast, *pld* material, while also generally characterized by a rough surface texture, has a single primary orientation of fractures. If these *pld* plains are observed to be confined to a single belt of material, they have been identified as *rb*. These three types of deformed plains are all typically embayed by surrounding plains units.

The next suite of material units identified includes the regional plains material units. The oldest plains units include *pdd* and *pbd*, material that is characterized by dense, small scale fractures and ridges. These units are commonly embayed by *ps*, material with a high concentration of small volcanic shields that range in size from 1-20 km in diameter. In turn, *psh* plains are embayed by the *pbs* and *pds* units, deposits that have generally not been heavily deformed by tectonic processes. Smooth *pbs* plains are commonly spatially related to small shield clusters, though there are examples of *pbs* that lack evidence of nearby shield volcanism.

The youngest material units in Snegurochka Planitia are *fb*, *lp*, and *ed*. Units of *fb* are characterized by local belts of fractured material, indicating episodes of localized uplift possibly related to initial stages of volcanism. Deposits of *lp* material, mostly surrounding Renpet Mons (+76^o 235^{o}E) and Sarasvati Mons (+76^o 354^{o}E), are characterized by lobate-tipped flows surrounding smaller edifice structures. Gash-like fractures (*lin*) and jagged wrinkle ridges (*wr*) are mapped as individual structures and are superposed on material units.

New Insights: Analysis of mapped features have indicated that the V-1 region experienced significant tectonic uplift in the formation of tessera units such as Itzpapalotl Tessera as well as early episodes of mantle downwelling in the formation of ridge belt material (*rb*). These older tectonic features were subsequently modified by a series of volcanic events. The first variety of volcanic activity involved small-scale, local volcanic eruptions that resulted in the formation of small shield volcanoes (*psh*), the second variety involved a regional expression of the proposed planet-wide resurfacing event that resulted in the formation of the plains (*pds*, *pbs*, [2,6-9]), and the third variety involved a transition back to more localized volcanic activity that resulted in the formation of large shield volcanoes (*lp*, *ed*) and fracture belts (*fb*).

These observations suggest that localized regions of extensional deformation of the surface may be induced by mantle upwelling and may indicate the locations of stalled or actively ascending volcanic plumes. Recent work using ESA Venus Express VIRTIS emissivity data targeted Idunn Mons, Hathor and Innini Montes, and Mielikki Mons, three of nine identified 'hot spot' volcanoes on the surface of Venus. The elevated emissivity signatures found in association with the stratigraphically youngest portions of these volcanoes have been proposed to indicate that volcanism in some locations of Venus may have occurred as recently as within the past 250,000 – 2.5 million years [10]. In addition, analyses of gravity and topography anomalies on Venus indicate local density anomalies beneath Idunn, Hathor, and Innini Montes [11]. While similar analyses have not yet been completed for the north polar region of Venus, these observations support our interpretation that the youngest volcanism on the surface of Venus is concentrated in large shield volcanoes.

Many questions still remain as to how volcanism shifted from localized, small shield forming activity to broad, plains forming activity and back to localized, large shield and fracture belt forming activity. For example, did plate tectonics once exist on Venus, and did the termination of this process lead to a catastrophic resurfacing event? Further analysis of mapped stratigraphic relationships in conjunction with Venus Express data can enhance our understanding of these processes. Understanding the mechanics behind the evolution of volcanism on Venus is vital for understanding the geologic history of Venus and for identifying possible analogs behind the volcanic history of Venus to apply to our understanding of the volcanic history and/or future of Earth.

References: [1] J. Head et al., *EPSC* (abs.) 2008 [2] M. Ivanov et al., *LPSC* abs. #1391, 2008 [3] K. Tanaka, *USGS Open File Report 94-438*, 1994 [4] A. Basilevsky & J. Head *Plan. Space Sci.*, *48*, 75, 2000 [5] M. Ivanov & Head J. W. *JGR*, 106, 17,515, 2001 [6] A. Basilevsky and J.Head *Plan. Space Sci.*, 43(12), 1523-1553, 1995 [7] R. J. Phillips et al., *JGR*, *97*, 1992 [8] N. Namiki and S. Solomon, *Science*, *265*, 929-933, 1994 [9] I. Romeo and D. L. Turcotte, *Icarus*, *203*(1), 13-19, 2009 [10] S. E. Smrekar et al., *Science*, *328*(5978), 605-608, 2010 [11] B. Steinberger et al., *Icarus*, *207*(2), 564-577, 2010.

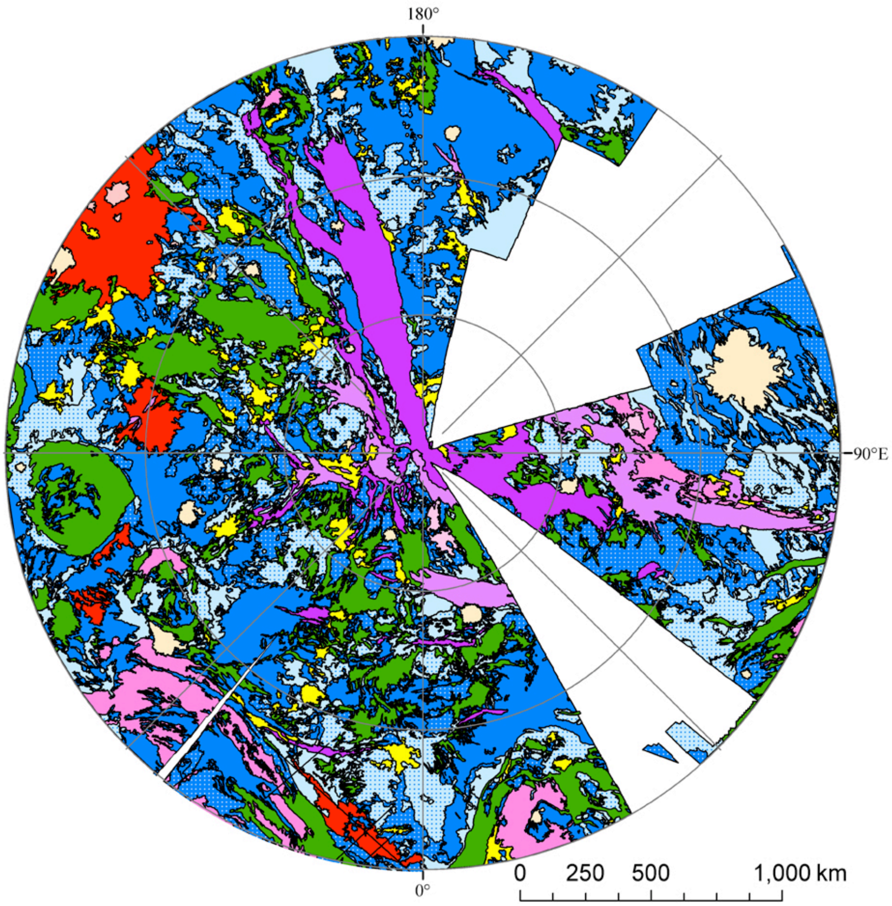

Figure 1: Geologic map of the V-1 Snegurochka Planitia quadrangle.
Map status: Submitted, revisions in progress

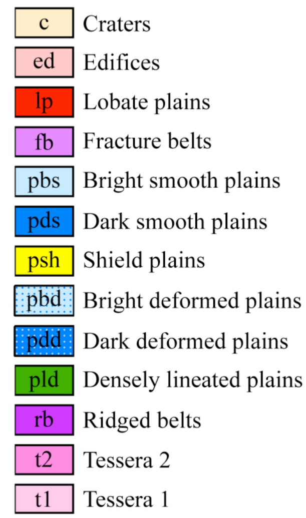

Figure 2: Units identified in V-1 Snegurochka Planitia

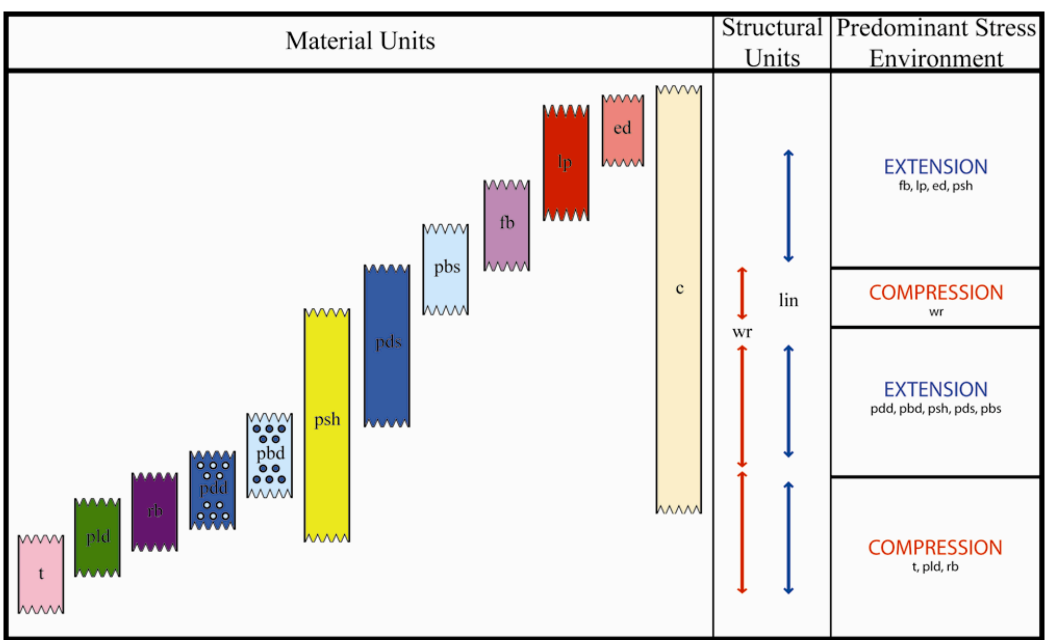

Figure 3: Correlation of mapped units for V-1 Snegurochka Planitia.