GEOLOGIC MAP OF THE SNEGUROCHKA PLANITIA QUADRANGLE (V-1): IMPLICATIONS FOR TECTONIC AND 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 progress in mapping the spatial and stratigraphic relationships of material units and our initial interpretations of the tectonic and volcanic history of the region surrounding the north pole of Venus.

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]. On the basis of initial regional reconnaissance geological mapping, twelve material units and two structural units have been identified and mapped in detail 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.

Material and Structural 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. Similarly, *rb* material has parallel lineations that have been confined to unique belts of material that often have distinctive topographic profiles with both positive and negative elevations observed. 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 and in some cases volcanism (e.g., 80°N, 260°E, 84°N, 95°E), indicating episodes of localized uplift possibly related to initial stages of volcanism. Deposits of *lp* material, mostly surrounding Renpet Mons (76°N, 235°E) and near the Itzpapalotl Tessera-Snegurochka Planitia boundary (76°N, 10°E), are characterized by lobate-tipped flows surrounding smaller edifice structures. Gash-like fractures (*lin*) and jagged wrinkle ridges (*wr*) are mapped as separate lines and are superposed on material units.

Geologic History: The most tectonically deformed material (*t*, *pld*, and *rb*) formed earliest in the observed history of Venus, suggesting that Venus was more tectonically active in the earlier phases of its recorded geologic history. This early period of deformation was followed by an initial phase of regional plains emplacement (*pbd*, *pdd*) that was subjected to subsequent tectonic deformation, though this deformation was less intense. This period of regional volcanism was followed by a period of more localized volcanism with overlapping flows that originated from clusters of small shield volcanoes (*psh*). This clustered distribution implies the presence of multiple conduits connecting a widespread shallow subsurface magma source to the surface.

After these smaller clusters of volcanoes formed, a massive resurfacing of Venus is thought to have occurred between 500 Ma and 1 Ga [2, 6] due to the widespread distribution of smooth plains material (*pds*, *pbs*). As the interior of Venus continued to cool over time, melting transitioned from facilitating distributed flood-basalt style volcanism to more localized magma upwellings that led to the formation of large shield volcanoes (*lp*, *ed*). These eruptions fed surface flows that in most cases cover the plains units described above, suggesting that this volcanism occurred more recently in Venus's geologic history. Also during this time, fracture belts (*fb*) developed as magma rose from the subsurface and caused localized extension. This is evident in the vicinity of Laka Mons (80°N, 260°E) and Szél-anya Dorsa (84°N, 95°E), where lava flows over belts of fractured material.

Key Results: The mapping presented here has led to key observations that provide insight into the tectonic and volcanic history of this region of Venus. Ridge belt material (*rb*) formed relatively early in the region's history, indicating that compression resulting from possible mantle downwelling pre-dated the vast regional volcanism that characterizes a period of extension within Snegurochka Planitia (V-1). In contrast, fracture belt material (*fb*) has been interpreted to be young and related to mantle upwelling and young edifice-forming volcanism. 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. This evolution has implications for our understanding of both the formation of the neighboring Ishtar Terra highlands [7] as well as the emplacement of the identified volcanic features.

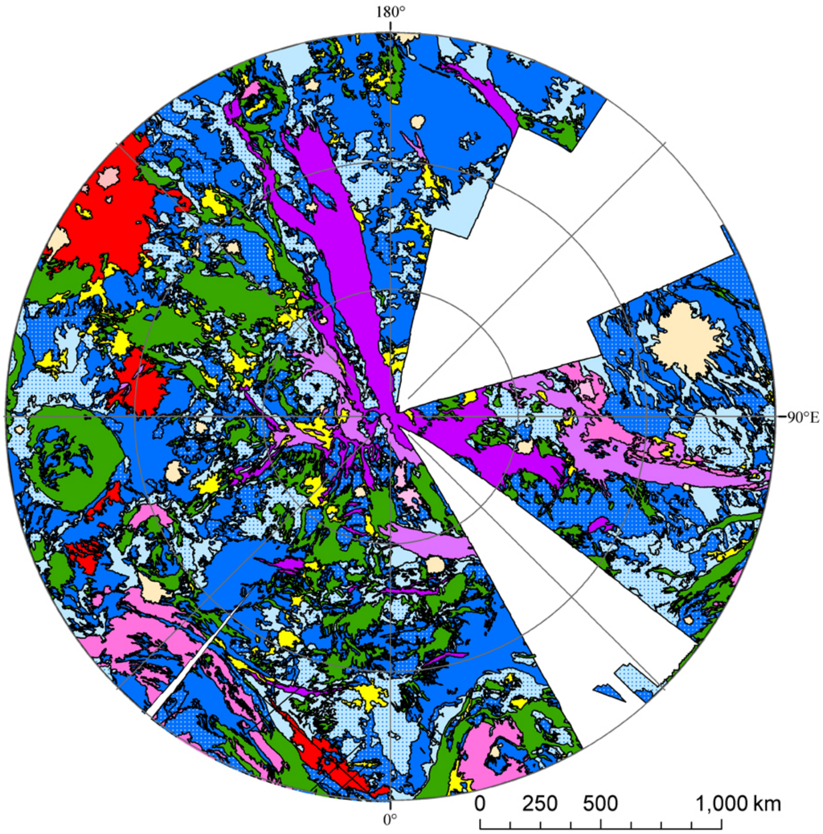

Figure 1: Geologic map of the V-1 Snegurochka Planitia quadrangle.

Figure 2: Units identified in V-1 Snegurochka Planitia

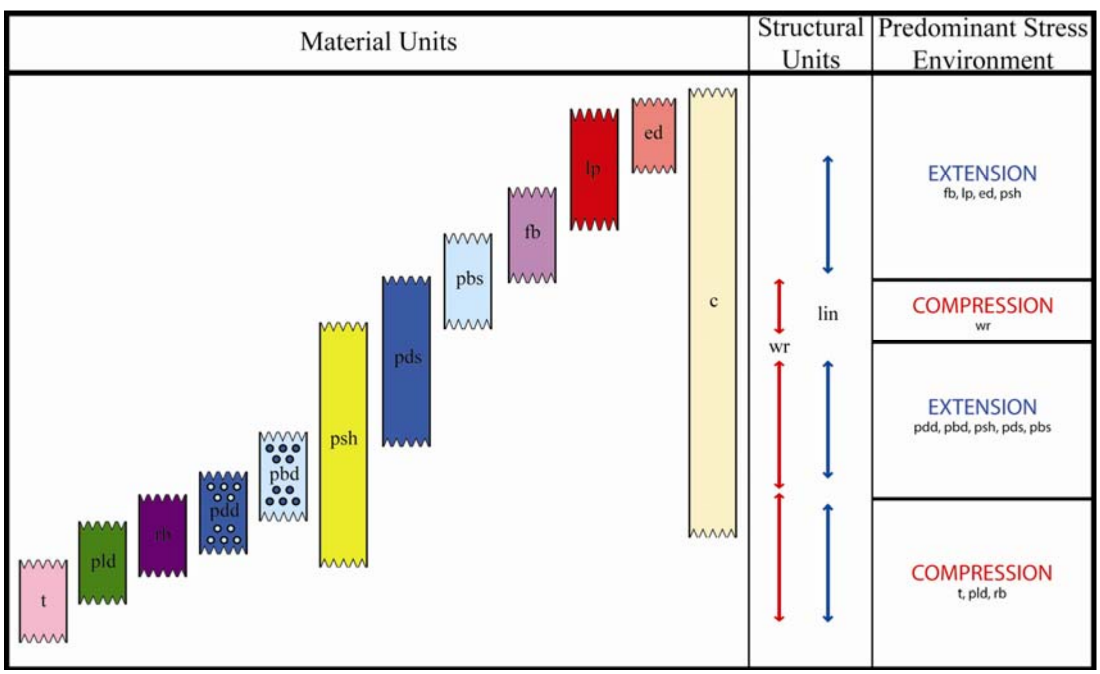

Figure 3: Correlation of mapped units for V-1 Snegurochka Planitia.

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] M. Ivanov and J. Head, *Plan. Space Sci.*, *56*, 1949-1966, *200*8.