GEOLOGIC MAP OF THE SNEGUROCHKA PLANITIA QUADRANGLE (V1): IMPLICATIONS FOR TECTONIC AND VOLCANIC HISTORY OF THE NORTH POLAR REGION OF VENUS.

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Introduction: Geologic mapping of Snegurochka Planitia (V1) 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 to produce a detailed map in ArcGIS and a stratigraphic column and correlation chart (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 (*ps*), smooth radar dark plains material (*pds*), smooth radar bright plains material (*pbs*), belts of fractured material (*fb*), lobate plains material surrounding large edifices >50 km in diameter (*lp*), small edifice features (*ed*, ~20-50 km in diameter), and craters material (*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. In contrast, *pld* material, while is also generally characterized by high elevation and a rough surface texture, has a single primary orientation of fractures. If these *pld* plains have been compressed into 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, *ps* plains are embayed by the *pdd* 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} 235E) and near the Itzpapalotl Tessera-Snegurochka Planitia boundary (+76^{o} 10E), 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 early in its history. This early period of deformation was followed by an initial phase of regional plains emplacement (*pbd*, *pdd*) that was also subjected to tectonic deformation, though this deformation was less intense than earlier activity. At this time, volcanism was focused in clusters that formed plains of overlapping flows that originated from local small shield volcanoes (*ps*). This distribution implies the presence of multiple conduits connecting widespread shallow subsurface magma source regions 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*) that were apparently emplaced in a relatively short period of time. 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 the large shield volcanoes (*lp*, *ed*) observed. These eruptions fed surface flows that in most cases cover the plains units described above, suggesting that this volcanism occurred very recently in Venus's geologic history. Also during this time, fracture belts (*fb*) may have developed as magma rose from the subsurface and caused localized extension. This is evident in the vicinity of Laka Mons (+80^{o}, 260E), where lava flows over a belt 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 Snegurochka Planitia. 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.

Once mapping is completed and the regional distribution of *rb* and *fb* is identified, a more comprehensive picture of the mantle evolution in this region can be interpreted. This evolution will have implications for our understanding of bot the formation of the neighboring Ishtar Terra highlands [7] as well as the emplacement of the identified volcanic features.

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 & J.Head *Plan. Space Sci.*, 43(12), 1523-1553, 1995 [7] Ivanov and Head, *Plan. Space Sci*., *56*, 1949-1966, *2008*.

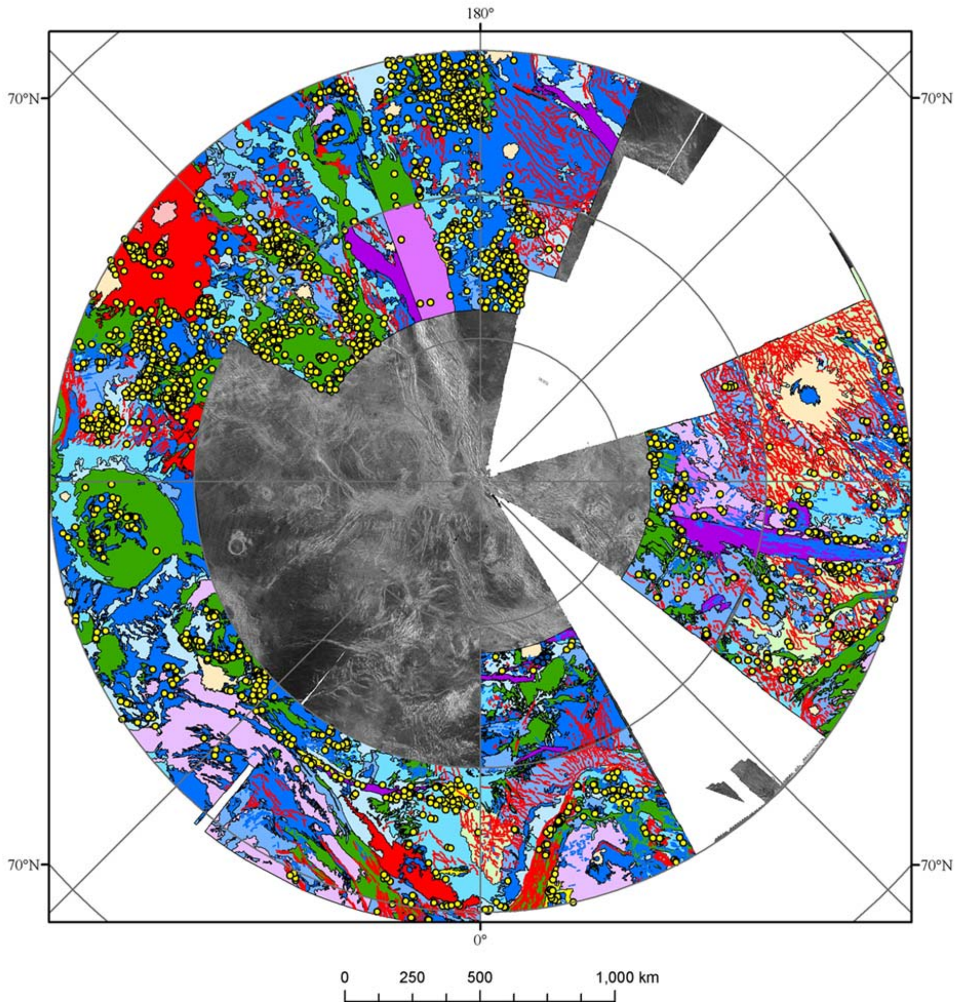

Figure 1: Geologic map of the V-1 Snegurochka Planitia quadrangle. Status as of January 1, 2009.

Figure 2: Units identified in V-1 Snegurochka Planitia.

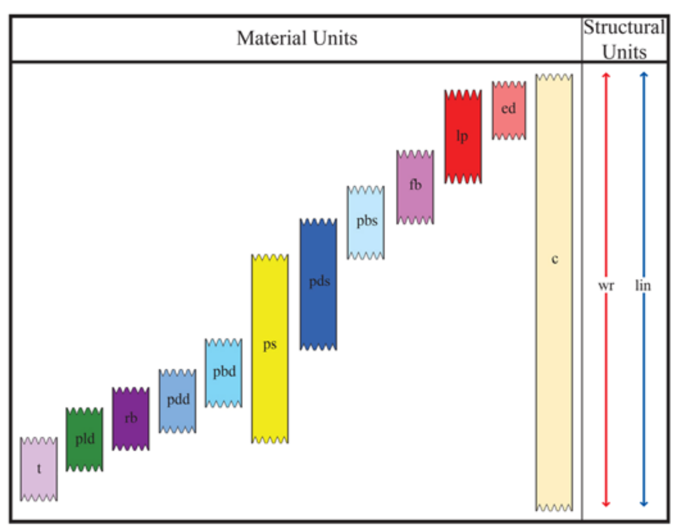

Figure 3: Stratigraphic column for V-1 Snegurochka Planitia.