GEOLOGICAL MAPPING OF THE NORTH POLAR REGION OF VENUS (V-1 SNEGUROCHKA PLANITIA): SIGNIFICANT PROBLEMS AND COMPARISONS TO THE EARTH'S ARCHEAN. J. W. Head[1], D. M. Hurwitz[1], M. A. Ivanov[1,2], A. T. Basilevsky[1,2], and P. Senthil Kumar[1,3], [1]Dept. of Geological Sciences, Brown University, Providence, RI 02912 (james_head@brown.edu), [2]Vernadsky Institute of Geochemistry and Analytical Chemistry, RAS, Moscow, Russia, [3]National Geophysical Research Institute, Hyderabad 500007, India (senthilngri@yahoo.com).

Introduction: The geological features, structures, thermal conditions, interpreted processes, and outstanding questions related to both the Earth's Archean and Venus share many similarities [1-3] and we are using a problem-oriented approach to Venus mapping, guided by perspectives from the Archean record of the Earth, to gain new insight into both. The Earth's preserved and well-documented Archean record [4] provides important insight into high heat-flux tectonic and magmatic environments and structures [5] and Venus reveals the current configuration and recent geological record of analogous high-temperature environments unmodified by subsequent several billion years of segmentation and overprinting, as on Earth. We have problems on which progress might be made through comparison [6]. Here we present the major goals of the geological mapping of the V-1 Snegurochka Planitia Quadrangle, and themes that could provide important insights into both planets:

Goals in the Geological Mapping of the Snegurochka Planitia Quadrangle (V-1): V-1 (Fig. 1-2) is centered on the N. Pole and contains two major plains areas, Snegurochka and Louhi Planitiae, forming a broad circular to angular depression about 2500 km across (Fig. 3). This depression is surrounded to the south (Fig. 1-2) by Ishtar Terra, a complex tessera/coronae region (Tethus Regio), a circular lowland (Atalanta Planitia), a fan-shaped zone of deformation belts (Lukelong to Okipeta Dorsa) converging into Dennitsa Dorsa toward the pole, and a region of multiple coronae and volcanoes (Metis Regio) adjoining the western edge of Ishtar Terra.

Contained within central V-1 are abundant *volcanic plains* (Fig. 4-5) deformed by wrinkle ridges, similar to those widely distributed on Venus [7-10] and containing extensive sinuous rilles, suggestive of high effusion rates and high-temperature lavas [11]. Key questions are: What is the evidence for their mode of emplacement in this area? How are they related in time, space, and mode of origin to the lobate plains seen at the margins of the tessera (Fig. 5-6)?

Deforming the central part of the plains, and converging toward the pole, is a series of belts representing both extensional and contractional deformation. Belts of extensional origin emerge from Metis Regio to the south, intersect with Anahit and Pomona Coronae, and then turn north at the edge of Ishtar Terra, toward the pole (Fig. 2). A series of belts of contractional origin (Dennitsa Dorsa) enter the quadrangle from the fan-shaped belt opening to the south and contain a distinctive corona-like structure (Fig. 2, 4); this belt merges with a low-elevation tessera region near the pole and then extends south in the form of Sel-Anya Dorsa into Tethus Regio, merging with Semuni Dorsa (Fig. 5), marking the margin of Fortuna Tessera. Thus, a critical goal is to establish relationships between: 1) deformation belts and the regional plains, 2) deformation belts and wrinkle ridges that deform the plains, and 3) two different types of deformation belts themselves. For example, do the geological relationships support a pre-plains, syn-plains, or post-plains age for the deformation belts? Did the two types of deformation belts form at different times, perhaps representing sequential styles of tectonism, or did they form simultaneously as part of a regional stress field?

Three major *corona* structures occur within the quadrangle and represent an opportunity to assess their comparative structure, as well as their age and geological relationships to more regional units and structures. Anahit and Pomona Coronae (Fig. 2) lie at the edge of Metis Regio and contain the classic highly deformed annulus surrounding an area of central domal uplift. Each shows evidence for a late stage volcanic center that might represent post-diapiric-rise intrusion and associated magmatism and volcanism. Some classification schemes suggest that *volcanic edifices* might represent initial or late stage phases of corona formation, or proto-coronae that did not form annuli due to contrasting thermal structure [12]. The presence of an adjacent classic *shield volcano*, Renpet Mons (Fig. 2), offers the opportunity to assess these relationships and address these questions. A third corona, Maslenitsa, lies along the southern part of Dennitsa Dorsa (Fig. 2), and shows very close and distinctive relationships with this deformation belt (Fig. 4). Do coronae represent buoyant diapiric upwelling processes and how are such processes related to regional tectonic trends and sense of deformation [13-14]?

Tessera terrain occurs in two settings (Fig. 2). A patch of low-standing tessera lies near the N. pole with several converging deformation belts; this offers the opportunity to assess the relationships of deformation belts and tessera formation. For example, tessera is defined in part as superposition of two generally orthogonal tectonic deformation patterns; we are assessing whether this tessera region results from the contemporaneous confluence of two different types of deformation belts, or are there clear superposition relationships that would help to assess the regional ages of the different deformation belts. The most significant development of tessera lies along the S. margin of V-1 in the form of the northern margin of Ishtar Terra (Itzpapalotl and Fortuna Tesserae; Fig. 5-6); these are part of one of the most distinctive and contiguous tessera terrains on Venus, second only to Aphrodite Terra. Our mapping in V-7 to the south of Itzpapalotl [15] provides an excellent setting in which to examine this important area. Furthermore, the mapping of V-2 [16] is providing an important framework for the interpretation of the northern margin of Fortuna Tessera in the Semuni Dorsa region (Fig. 5). These two occurrences permit us to assess important questions about the nature of crustal thickening processes. Itzpapalotl Tessera lies at the N. edge of a crustal plateau containing folded mountain belts (Freyja Montes) lying ~7 km above Snegurochka Planitia (Fig. 3, 6); the edge of the plateau drops 3-4 km to a distinctive lobate lava-flow-containing moat and adjacent outboard rise (Fig. 6) that bears very strong similarity to a flexural margin [17]. The deformation within Itzpapalotl shows signs of intense shortening, folding and shear [18-19]. What is the detailed relationship between the range of structures observed and topography? What are the detailed relationships between Itzpapalotl and the adjacent less-deformed volcanic plains? What deformational processes are responsible for the extreme crustal thickening implied by the topography (Fig. 3) in the absence of current plate tectonics? Additional clues to these questions can be obtained from the assessment of the Semuni Dorsa deformation

belt lying along the northern margin of Fortuna Tessera. Here the topographic rise is much less extreme (Fig. 5) and the deformation leading from the plains to the tessera is more transitional than at Itzpapalotl. Thus, these provide two examples of crustal thickening processes that are actually contiguous; initially, the differences are being documented at these two sites and the intervening margin is being traced out (Fig. 1) to complete a full comparison of this important transition.

Summary: Geological mapping and process studies in V-1 provide key features and relationships that permit us to address many important Venus-Archean thematic questions [6] including: 1) crustal thickening environments and processes, 2) the nature of diapirism, 3) the nature and origin of deformation belts, and 4) the origin and context of regional plains-forming volcanism.

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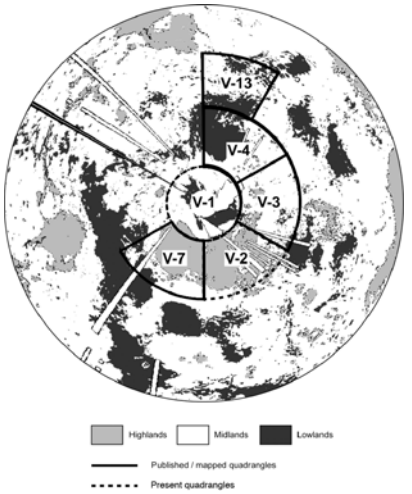

Fig. 1. Northern hemisphere of Venus. Solid lines indicate maps completed (V-4, V-13 published, V-3 in proof, V-7 in review).

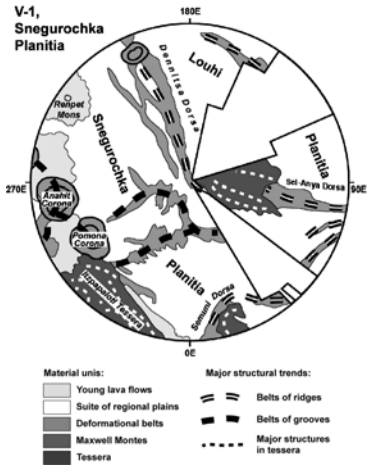

Fig. 2. Geologic sketch map of Snegurochka Planitia (V-1) quad.

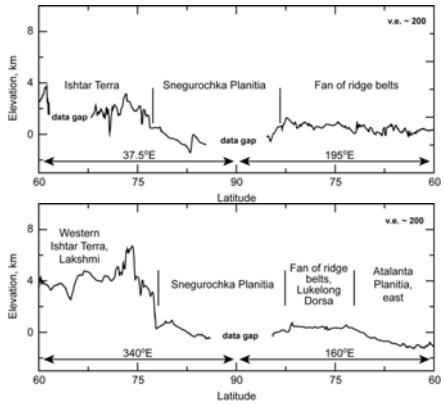

Fig. 3. Topographic profiles across V-1. (Top) Left (37.5°E; 60°N to pole); right (195°E; pole to 60°N. (Bottom) Western Ishtar Terra (Lakshmi Planum) across entire polar region along 340-160°E.

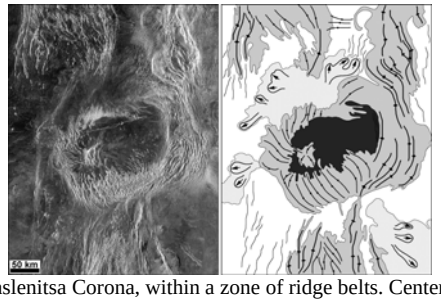

Fig. 4. Maslenitsa Corona, within a zone of ridge belts. Center ~76.5°N, 208°E. Key: black, intracorona plains; dark gray, tessera; medium gray, deformation belts; light gray, lobate plains (arrows show lobes); white, regional plains; lines, diamonds-ridges, circles-troughs, sinuous light-wrinkle ridges, dashed-tessera structural trends.

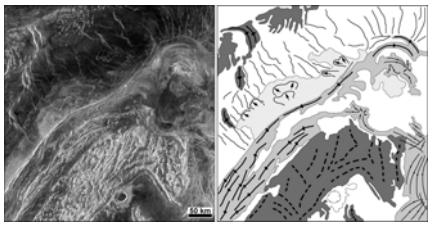

Fig. 5. NW Fortuna Tessera (V-1). Tessera (bottom) is outlined by a broad belt of ridges (Semuni Dorsa), in contact with Snegurochka Planitia regional plains. Plains surface near contact forms an elongated depression, partly filled by young flows. Center ~77°N, 12.5°E.

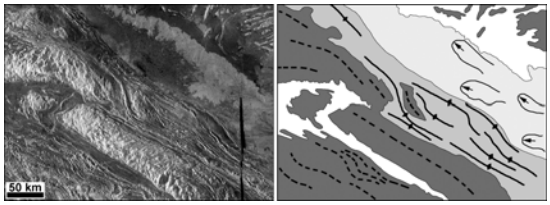

Fig. 6. A portion of Itzpapalotl Tessera, between Freyja Montes (lower left) and Snegurochka Planitia (upper right), separated by a belt of ridges; some ridges have an S shape. Elongated depression at scarp base partly filled by young flows. Center ~75.5°N, 345°E.