

VENUS GEOLOGIC MAPPING: INSIGHTS INTO CRUSTAL EVOLUTION ON LOCAL, REGIONAL, AND GLOBAL SCALES. S. M. McColley and J. W. Head, III, Dept of Geological Sciences, Brown University, Providence, RI 02912. Shawn_McColley@brown.edu

Introduction and Background: Over the last several years, two views have emerged regarding the large scale evolution of the crust of Venus. A global stratigraphic model is supported by [1] and [2]. This model, defined as directional by [3], finds evidence for the time-dependent evolution of surface feature formation, as well as a traceable progression in the type and style of volcanism that has occurred over the visible geologic past of Venus [1, 2]. Adopting these principles provides the means of cataloging and organizing geologic units into epochs of Venusian history. In response to the global stratigraphic model proposed by [1] and [2], [3] suggested that coronae, rifts, wrinkle ridges, small and large edifices, and large flow fields have formed throughout the geologic history that is recorded on the surface of Venus. They further assert that both tectonic and volcanic features show evidence for protracted histories and possibly reactivation following periods of dormancy, implying a nondirectional evolution for the observable history of Venus.

The surface of Venus is geologically young with a crater retention age of 300-500 Ma [4, 5, 6]. A broad range of geodynamic models have been proposed to explain the apparent youth of the surface. Models include: heat pipe mechanisms [7], hot/cold spot tectonics [8], stagnant lid convection [9], mantle overturn [10], a thin-to-thick lid transition [11], shift from plate tectonics to a one-plate planet [12], and several other derivations. Geodynamic models carry implications for the way in which a body will evolve both from an internal and a surface point of view. These implications are governed by assumptions regarding heat loss. Heat loss predominantly dictates the type of features (tectonic, volcanic, etc.) that are observed on the surface. Thus, in terms of the global stratigraphic model (directional) and the nondirectional model for the observable history of Venus, what type of features might we observe if Venus has lost heat monotonically, or in contrast, in a more step-like fashion?

Methods: In an attempt to constrain better the evolution (at a variety of scales) of Venus, we have undertaken several mapping projects ranging from the regional-scale (the Lada Terra (V-56) quadrangle) down to the detailed mapping of individual volcanic deposits (festoons). Lada Terra quadrangle (Figure 1a) lies between 50-75°S and 0-60°E. The quadrangle contains a sufficient representation of currently identified Venusian geologic units, such that we feel it and surrounding quadrangles may hold significant clues to the overall evolution of Venus. We are utilizing all available Magellan data (C1MIDR, C2MIDR, FMIDR, GXDR, and gravity) to identify local and regional variations in geology and structure, as well as styles of volcanism.

Figure 1b is an example of high resolution (FMAP scale) mapping from within the quadrangle. The eastern third of Eithionha Corona is shown as well as the Chang Xi Chasmata. Lobate flows (sourced from rift-related fractures) are seen superposed on the annulus of Eithionha Corona and on the radar-dark plains with superposed wrinkle ridges. These same lobate flows are observed embaying shield fields (not shown on Figure 1b) which superpose the tessera near Chang Xi Chasmata. These relationships suggest (at a local scale) superposition relationships in addition to a change in the style of volcanism (small edifice to rift related) that has occurred in this area. Thus, relevant geodynamic models for this region, need to include: 1) early shield plains formation, 2) regional plains emplacement, 3) regional wrinkle ridge formation, 4) rift formation, and 5) rift related volcanism forming lobate flows.

The volcanic festoon deposits on Venus appear to represent a distinctly different type of lava relative to the predominantly basaltic nature of the surface (e.g. the lobate flows discussed above). Flows on Venus that are interpreted to be basaltic tend to be long with sinuous margins that can not be detected in the Magellan GTDR, implying flow thicknesses less than the ~50 m vertical resolution of this data set [13]. The festoon flows lie in stark contrast to the regional plains flows. The festoon located within Ovda Regio at 6.5°S, 95.5°E (Figure 2a) lies in some of the highest standing tessera on Venus. The flow interior is intermediate in radar backscatter, while the margins are characterized by high backscatter. The flow margins are visible in the GTDR indicating thicknesses of 100-200 m. The flow is composed of at least (at FMAP resolution) 7 subunits (Figure 2b) and shows pervasive compressional ridges (Figure 2c) that formed due to the disruption of the overlying cooling thermal boundary layer during emplacement. A large portion of the flow lies in a depression that is manifested by a set of deep troughs that are oriented NE-SW. The origin of the underlying tessera (mantle downwelling followed by contraction and crustal thickening or hot-spot upwelling producing extension followed by collapse) is one of the key issues in Venus geodynamics. Is this flow evidence of melting of thickened crustal roots possibly producing a more evolved composition, and if so which geodynamic model(s) or combination of models predicts evolved lava on Venus? We are currently assessing the sequence in Ovda tessera to distinguish between these models.

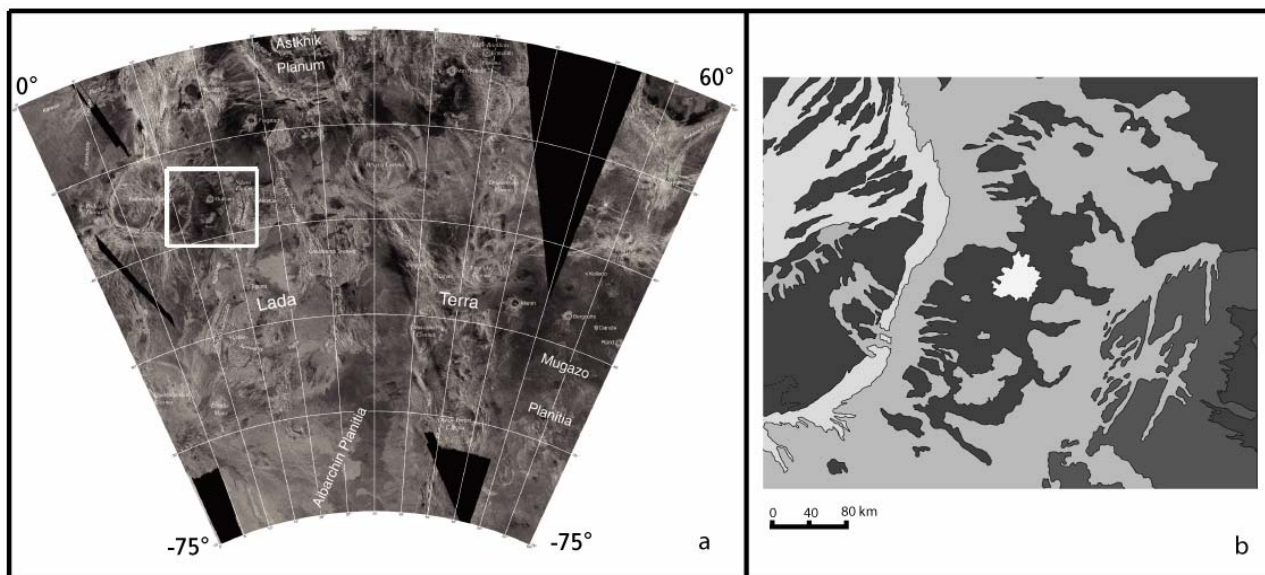


Figure 1. a) The Lada Terra (V-56) quadrangle (50-75°S, 0-60°E). The white box indicates the location of the sketch map shown at the right. b) Sketch map showing inferred cross-cutting and embayment relationships (white = crater material, intermediate grey = lobate plains, light grey = densely fractured plains, black = plains with wrinkle ridges, dark grey = tessera, shield fields lie just to the south of the sketch map).

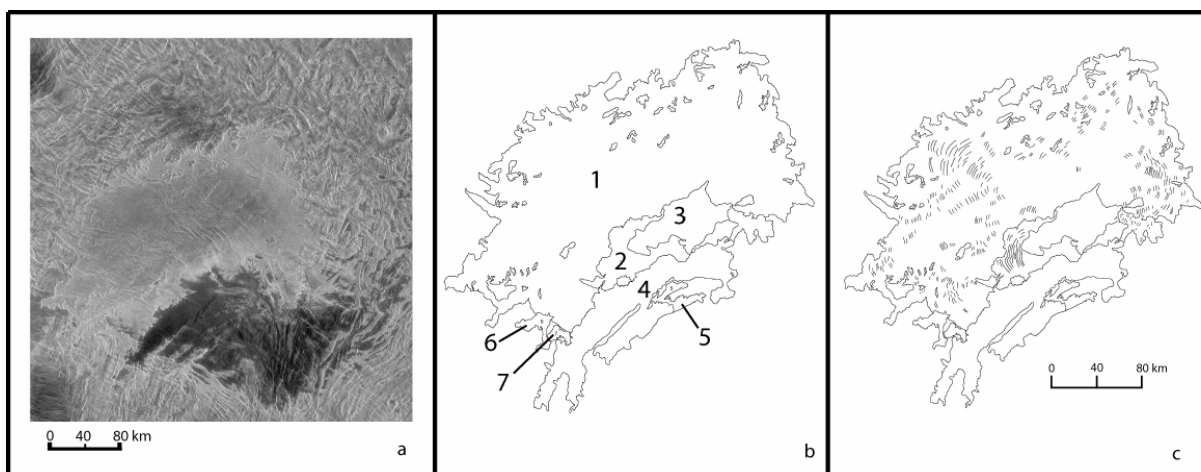


Figure 2. a) Festoon deposit superposed on the tessera of Ovda Regio (6.5°S, 95.5°E). b) Sketch-map showing the seven subunits that comprise the festoon (map scale is equal to that of c). c) Sketchmap showing a distribution (about every fifth ridge) of compressional ridges used to infer flow direction and possible source areas.

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