CONSTRAINTS ON THE VOLCANIC EVOLUTION OF THREE VENUSIAN CORONAE. N.P. Lang[1], I. Lopez[2], [1]Department of Geology, Mercyhurst College, Erie, PA 16546, nlang@mercyhurst.edu; [2]Departamento de Biología y Geología, Universidad Rey Juan Carlos.

Introduction: Volcanism at Venusian coronae manifests itself in a variety of ways including large-scale flows [1], clusters of small volcanic constructs or shields [2], and localized intermediate-size volcanic edifices including steep-sided domes or tholi [3]. This diversity of volcanic products is captivating because it is not clear as to why such a range of volcanic styles should occur nor is the role they play in coronae evolution.

With the goal of better constraining the timing and styles of volcanism at Venusian coronae, we have geologically mapped three geographically separate coronae (Fig. 1). Specifically, using Magellan synthetic aperture radar (SAR) imagery (~75 m/pixel), we have mapped the extent and distribution of volcanic products at Aramaiti, Bhumidevi, and Zemire coronae. Our results: 1) indicate that the volcanic and structural evolution of these coronae are potentially interrelated and 2) have implications for the petrology of corona-related volcanic products.

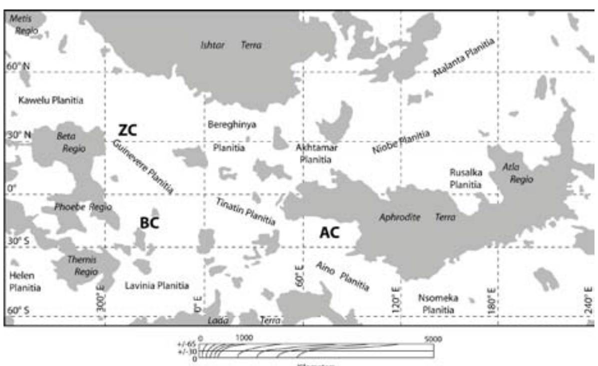

Figure 1: Sketch map of Venus in Mercator Projection showing the locations of the three coronae presented here: (1) Aramaiti Corona (AC:), (2) Bhumidevi Corona (BC:), and (3) Zemire Corona (ZC:). Gray regions represent highlands. After [4].

Study Areas: In selecting our study areas to address questions of coronae-related volcanism, we selected coronae that appear to have undergone all of the steps of corona evoulution as outlined by [5].

Aramaiti Corona: Aramaiti is an ~300 km diameter corona centered near 26S, 82E. Located in Tahmina Planitia, Aramaiti is associated with two other coronae situated north-northwest of Kunapipi Mons. Local basement materials (i.e., tessera) form northwest-tredning outcrops around Aramaiti; plains materials around Aramaiti are deformed by both northwest-trending wrinkle ridges and northeast-trending fractures. Aramaiti is characterized by an annulus of concentric fractures that surround an interior topographic depression or moat; a large topographic dome rises ~700 m from the middle of the depression. Narina Tholi is situated on the fracture annulus and is superimposed on a lava flow that has travelled ~600 km north; the flow appears to have originated from the fracture annulus at the same spot Narina Tholi is situated. The interior depression appears to be partially filled by flow materials; the source of these materials is unclear, but may have also originated from the annulus fractures. Shields occur across the map area, but are concentrated on the northeast-trending fractures and interior topogrpaphic dome. Cross-cutting and superposition relations indicate that the north-trending lava flow (and consequently Narina Tholi) postdate annulus formation as did volcanism in the interior depression. Timing of shield formation is more ambiguous, but may have occurred throughout Aramaiti's evolution.

Bhumidevi Corona: Bhumidevi is an ~300 km corona centered near 17S, 344S. It is located in Kanykey Planitia in between Vasilisa and Alpha regios. Bhumidevi occurs in a cluster of other coronae. Local basement materials outcrop in the vicinity of all the coronae here. Bhumidevi is characterized by an annulus of concentric fractures that have been locally covered by extensive flow materials that appear to have erupted from within the annulus. Fractures radiate in all directions of the corona where they cut and are covered by the extensive flow material. No tholi are observed at Bhumidevi, but numerous shield volcanoes occur and are predominantly assocated with the radial fractures. Topographically, Bhumidevi is distinguished by a 1 km tall topographic rim that surrounds an interior depression. Similar to Aramaiti, the extensive lava flows at Bhumidevi postdate formation of the annulus; the timing of shields is, again, ambiguous.

Zemire Corona: Zemire Corona is an ~250 km diameter corona located near 31N, 314E. It is located in Guinevere Planitia at the southeastern end of Breksta Linea; Pasu-Ava Corona occurs immediately southeast of Zemire. Local basement materials also outcrop in the vicinity of Zemire. Topographically, Zemire is similar to Bhumidevi where it is distinguished by a topographic rim that surrounds and interior depression. Similar to the other two coronae, Zemire is characterized by an annulus of concentric fractures that have been locally overprinted by extensive lava flows that have travelled in all directions from the corona. Two tholi occur on the northern part of the annulus and are superimposed on the extensive lava flows. Shields are not as abundant at Zemire as they are at the other two coronae, but those that do occur are spatially associated with radial fractures and the corona interior.

Volcanic Evolution: The results of our mapping show a similar volcanic history for each corona. Long lava flows appear to occur late in the structural evolution for each corona (i.e., during corona collapse and fracture annulus formation [e.g., 5]); flows originate from the concentric fractures and are superimposed by steep-sided domes at Aramait and Zemire. These relationships suggest that corona collapse may be the trigger for the eruption of the long lava flows and tholi.

Consequently, we propose the following model to describe the volcanic history (at least the late history) of Aramaiti, Bhumidevi, and Zemire coronae (Fig. 2): t1) The impingement of a plume or diapir on the base of the Venusian lithosphere induces bulging and the injection of dikes into the lithosphere associated with the formation of radial fractures [5]; some dikes reach the surface where shields form. t2) Some of the injected magma stalls and accumulates in the lithosphere to create a magma chamber that undergoes fractional crystallization where crystals may accumulate at the bottom of the magma chamber; volcanism continues during this time. t3) After the diapir cools and/or thermal support has diminished, the topographic bulge is unstable and collapses down into the lithosphere resulting in the formation of the concentric fractures. The collapse may reach into the magma chamber where the magma is squeezed up and out of the concentric fractures where it erupts as long lava flows; crystals at the bottom of the magma chamber may also be squeezed up and out where they erupt as a viscous crystal mush to create the tholi.

Our model is broadly similar to that of [6], who likened coronae to terrestrial calderas, but without the explosive eruptions. Our model also predicts that tholi may not reflect evolved magma (e.g., highly siliceous) as has been previously suggested [e.g., 7]. Instead, tholi at coronae may just represent mafic [e.g., 8] crystal mushes. Such a prediction is more in line with, both, most compositional measurements [9] and morphology of larger volcanic constructs on the Venusian surface [10]. However, this prediction could be tested by future surface landers on Venus.

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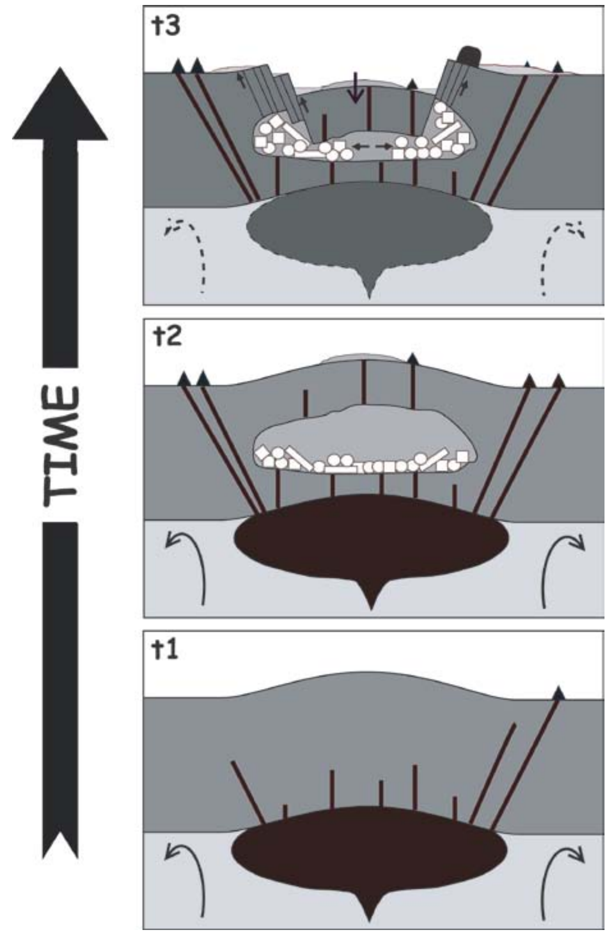

Figure 2: Cartoons outlining our hypothesis regarding the volcanic evolution of at least some Venusian coronae. Volcanism occurs at all three steps, but large-scale volcanism and tholi formation do not occur until structural collapse of the topographic dome; collapse of the dome (t3) forces magma in the chamber to erupt along fissures (i.e., the fracture annulus). This mgma will initially produce the long lava flows, but settling of the dome into the crystal mush at the bottom of the chamber induces tholi formation.