CORONAE AND CHASMATA MORPHOLOGY CONSISTENT WITH THE GENERATATION OF NEW VENUSIAN CRUST.

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Introduction: Despite similar physical and bulk chemical properties to Earth, Venus exhibits a distinct and enigmatic geodynamic style instead of plate tectonics [1]. Its resurfacing history and processes are key to characterizing Venus's geodynamic mode. The dominant resurfacing process within Earth's plate tectonic regime is seafloor spreading, where new basaltic crust is generated along a single, global, extensional tectonic environment, the Mid-Ocean Ridge (MOR). While Venus also has a global extensional tectonic environment in the form of the Global Rift Network (GRN), it is morphologically different from the MOR. The GRN is distributed along sinuous and isolated *chasmata* that are sub-parallel to each other and appear to link major volcanic provinces and the southern margin of Aphrodite Terra. The *chasmata* that comprise the GRN are also associated with *coronae*, such as Taranga and Atahensik [2]. If the MOR and GRN are analogous, then the *chasmata* are regions in which new Venusian crust is generated. In that case, the morphology of Venus's *chasmata* and associated *coronae* will be consistent with numerical models of crustal generation under Venusian conditions.

Methods: By comparing the structure and topography of numerical models of crustal generation with the photogeology and topography derived from Magellan and other missions, it is possible to test whether or not the morphology of the GRN is consistent with crustal generation.

Model Set-Up. To simulate crustal generation processes, we use the 2D numerical modeling program GeoFLAC with some modifications [3]. Extension rates are varied between 1 cm/yr, 0.1 cm/yr, and 0.01 cm/yr by moving the left and right boundaries of the model. This range comes from estimates of Venus's strain rates based on crater deformation on the low end and Earth-like rates on the high end [4]. Surface heat flux is set to 50 mW/m2 and 80 mW/m2 based on estimates at Venus's *chasmata* from flexure and elastic thickness [5]. For this study, the rate of crustal generation at the rift axis is prescribed, which is for convenience and allows our models to be agnostic to melt processes. New basaltic crust is generated as a column of elements at the center of the model domain over the same range of rates as extension rates.

Analysis. We can derive topography and gravity anomalies from the models for different regions of the explored parameter space. By comparing diagnostic features of the modeled topography (e.g., the height of rift flanks, presence or absence of an axial ridge, boundary troughs) with the actual topography of segments of the GRN, we can determine whether crustal generation is consistent with *chasmata* morphology [6]. While Venus's gravity anomaly data is too coarse for comparison, the model gravity anomalies can be used to make testable predictions for future missions.

Results: The eighteen models run can be grouped into three regimes based on the relative rates of extension and crustal generation. Where generation rates exceed extension rates, the addition of new crust cannot be spatially accommodated by rifting. In these "overthickening" cases, a central peak forms along the rift axis while a flexural trough forms to either side. As the new crust thickens, eclogite roots form and collapse into the mantle, causing a topographic inversion. The delamination of the crust maintains the boundary troughs but creates an elevated bowl shape in the interior. Figure 1 shows an example of this regime.

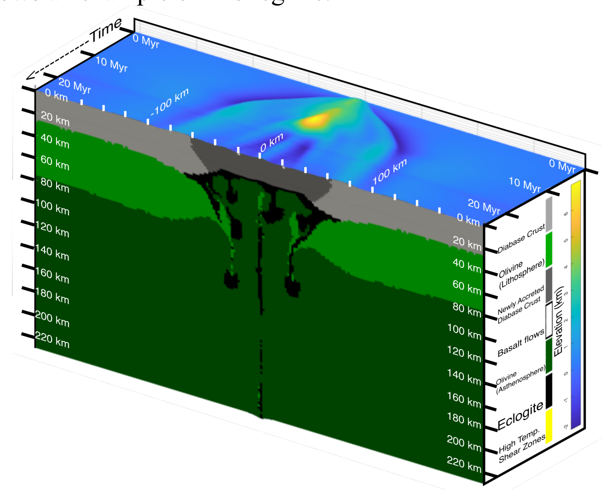

Figure 1: An example of the overthickening regime. In this model heat flow is set to 50 mW/m^2, extension is at 1 cm/yr, and crustal generation is set to 0.1 cm/yr. Colors on the face of the block diagram represent different lithologies, while the top surface shows the topography at different time slices over the 25 Myr runtime. Grey is diabase (basalt) crust, dark grey is the newly generated diabase crust, black is eclogite, and light and dark green are lithospheric and asthenospheric mantle, respectively.

In models where the generated crust can be accommodated by extension, a "steady-state" spreading regime occurs. Under these conditions, an axial valley or ridge forms at the center of a classical rift. Often, the rift is asymmetric (with thinner crust on one side) due to deformation localizing on one side or the other of the crustal generation axis. Where accommodation space is created faster than crust can be, a deep bowl-shaped rift is formed with an axial valley due to hyperextension. Because mantle material is exhumed to or near to the surface, the free-air anomaly takes on a diagnostic dome shape.

The overthickening cases share diagnostic features with *chasma*-associated *coronae* such as Taranga Corona (Figure 2 & Figure 3) or Atahensik Corona. The steady-state spreading cases are consistent with the morphology of major GRN segments such as Britomartis Chasma or Hecate Chasma. Still, they may also be interpreted as classical half-graben structures. The hyperextension cases aren't consistent with most *chasmata* morphologies.

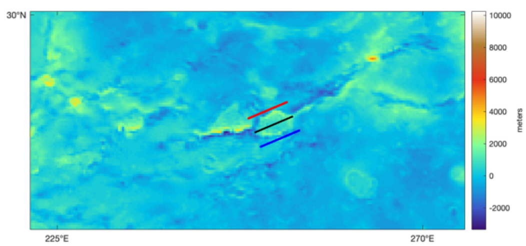

Figure 2: The location of Taranga Corona within Hecate Chasma as shown in colored topographic map view. The red, black, and blue lines represent the left boundary, center line, and right boundary of the topographic profiles shown in Figure 3.

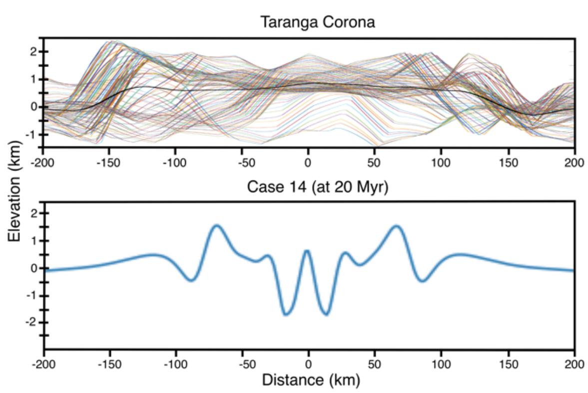

Figure 3: The cumulated topographic profiles of Taranga Corona (top panel, black line is the mean) compared to the topographic profile of the overthickening regime model in Figure 1 (bottom panel).

Conclusions: Because the *chasma*-associated *coronae* share diagnostic features with the overthickening regime in our numerical models, we conclude that similar processes (overthickening, crustal generation, eclogitization, delamination) are responsible for their formation. When their proximity to *chasmata* and the consistency of *chasmata* with the morphology of the steady-state spreading regime are taken into account, it is plausible that crustal generation is occurring along segments of the GRN. In places where excess crust is generated (possibly due to plumes or mantle heterogeneity), an eclogite root forms and then delaminates into the mantle to create *coronae*. These lithospheric drips do not form coherent slabs as in subduction but recycle the newly created crust. Unlike on Earth, where crust is generated and recycled at opposite ends of a plate, Venus's crust may be generated and recycled in the same tectonic setting. All of this suggests that the generation of Venusian crust is distributed along the discontinuous segments of the GRN and that the recycling of that crust may be co-located with its generation. This is consistent with plutonic-squishy lid models [1], delamination and localized subduction models of Artemis Corona [7], and pre-Magellan hypotheses of "distributed crustal spreading" [8].

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