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Comparison of Venusian Coronae with Giant Circumferential Dyke Swarms on Earth

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The surface of Venus features a large number (>500) of quasi-circular tectono-magmatic features known as coronae. Coronae are characterized in part by their topographic characteristics, which can be diverse and complex. However, most morphologies involve a topographic rim that may or may not circumscribe an interior depression. Coronae have an average diameter of approximately 200-300 km, but diameters up to 2600 km have been observed. Many are also characterized by the presence of a circumferential graben-fissure system (which forms the annulus of extensional lineaments that is often correlated with the topographic rim) and/or the presence of a radiating graben-fissure system. Coronae are strongly associated with volcanism and other magmatic features, and are thought to be related to mantle plume processes (Stofan et al., 1992; Stofan et al., 2001). Corona formation models that involve diapiric uplift suggest that radiating graben-fissure systems should be generated during the initial uplift and construction phase, and circumferential graben-fissure systems should form subsequently, during gravitational relaxation of the diapir, or deflation of an underlying deep crustal magma chamber (as presented herein) (Stofan et al., 1991).

Modelling and multiple lines of evidence have led to the suggestion that radiating graben-fissure systems associated with coronae and volcanic centers on Venus can be underlain by laterally propagating, radiating dyke swarms (Parfitt and Head, 1993; Grosfils and Head, 1994). Observational evidence for radiating dyke swarms includes linear chains of volcanoes and pit craters that follow graben, as well as volcanic flows that emanate directly from radiating graben. Circumferential graben-fissure systems are also associated with the aforementioned features. We propose that circumferential graben-fissure systems associated with coronae may also be underlain by dykes. The presence of circumferential dyke swarms underlying Venusian coronae would have significant implications on corona formation processes; especially the underlying magmatic system (Bethell et al., 2016).

On Earth, a new type of dyke swarms, 'giant circumferential dyke swarms', is being recognized in association with large igneous provinces. Diameters are typically hundreds of kilometers, but may extend up to nearly 2000 km. Giant circumferential dyke swarms are interpreted to circumscribe mantle plume centers at the time of formation and are sometimes associated with giant radiating dyke swarms of similar age (Buchan and Ernst, 2016). One of the most notable examples includes the 1385 Ma Lake Victoria dyke swarm, which has an approximately 180° arc and is associated with the Kunene-Kibaran large igneous province. Models infer the majority of the Lake Victoria giant circumferential dyke swarm to possess an inward-dipping cone sheet morphology (Mäkitie et al., 2014).

One of the best preserved circumferential graben-fissure systems on Venus occurs at the annulus of Fatua corona (17.7° E, 16.3° S). Fatua corona has a catalogued diameter of approximately 400 km, however our detailed mapping has revealed that the annulus, which has a 360° arc, extends to a much greater diameter of approximately 895 km. The circumferential graben-fissure system associated with Fatua corona, which has a maximum width of approximately 390 km, therefore extends significantly (up to 300 km) beyond the topographic rim. This suggests that the processes that generate corona topography do not entirely control the formation of the annulus. Fatua corona is also associated with a radiating graben-fissure system that extends approximately 1500 km southward into Brynhild fossae. Interestingly, cross-cutting relationships demonstrate the radiating graben-fissure system to be younger than the circumferential graben-fissure

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system in some areas. This would suggest coronae can experience multiple episodes of uplift.

Other coronae, such as Cybele (20.7° E, 7.5° S), appear to possess multiple annuli of different diameters around a single magmatic center. Cybele corona has a maximum annulus diameter of approximately 670 km. The annulus exhibits three cross-cutting circumferential graben-fissure systems. Multiple circumferential graben-fissure systems in the annulus may represent multiple pulses of deflation (following inflation) of an underlying deep crustal magma chamber.

Various features support the interpretation that circumferential graben-fissure systems in the annulus of coronae can be underlain by dykes. Cybele corona is also associated with magmatic features, such as canali and volcanic flows, which have been observed to emanate from circumferential graben. Also, corona annuli are commonly associated with clusters of volcanoes and steep-sided domes. Some examples, such as Fotla corona (163.5° E, 58.5° S), have multiple steep-sided domes and chains of volcanoes within its annulus. These volcanic features along the annulus of Fotla corona appear to be younger, or of similar age to the circumferential graben-fissure system.

The similar scale and morphology of Venusian coronae and giant circumferential dyke swarms on Earth suggests an analogy can be made. The distribution of dykes as revealed by the graben-fissure extensional lineaments at the surface, may provide insight on the depth and size of the underlying magma chamber.

References

Bethell E, Ernst RE, Samson C, and Buchan KL, 2016. *Circumferential graben-fissure systems of Venusian coronae as possible analogues of giant circumferential dyke swarms on Earth*. LPSC XLVII, Abstract #1471.

Buchan KL, and Ernst RE, 2016. *Giant circumferential dyke swarms on Earth as possible analogues of coronae on Venus*. LPSC XLVII, Abstract #1183.

Grosfils EB, and Head JW, 1994. Emplacement of a radiating dike swarm in western Vinmara Planitia, Venus: interpretation of the regional stress field orientation and subsurface magmatic configuration. *Earth, Moon, and Planets,* 66: 153-171.

Mäkitie H, Data G, Isabirye E, et al., 2014. Petrology, geochronology and emplacement model of the giant 1.37 Ga arcuate Lake Victoria Dyke Swarm on the margin of a large igneous province in eastern Africa. *Journal of African Earth Sciences,* 97: 273-296.

Parfitt EA, and Head JW, 1993. Buffered and unbuffered dike emplacement on Earth and Venus: implications for magma reservoir size, depth, and rate of magma replenishment. *Earth, Moon, and Planets,* 61: 249-281.

Stofan ER, Bindschadler DL, Head JW, andParmentier EM, 1991. Corona structures on Venus: models of origin. *Journal of Geophysical Research: Planets,* 96: 20933-20946.

Stofan ER, Sharpton VL, Schubert G, Baer G, Bindschadler DL, Janes DM, andSquyres SW, 1992. Global distribution and characteristics of coronae and related features on Venus: implications for origin and relation to mantle processes. *Journal of Geophysical Research,* 97: 13347-13378.

Stofan ER, Smrekar SE, Tapper SW, Guest JE, andGrindrod PM, 2001. Preliminary analysis of an expanded corona database for Venus. *Geophysical Research Letters* ,28: 4267-4270.