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MORPHOLOGY AND EVOLUTION OF CORONAE AND OVOIDS ON VENUS. Steven W. Squyres, Cornell University, Duane L. Bindschadler, UCLA, Daniel M. Janes, Cornell University, Gerald Schubert, UCLA, Virgil L. Sharpton, Lunar and Planetary Institute, Ellen R. Stofan, Jet Propulsion Laboratory

Coronae and ovoids on Venus were first identified in Venera 15/16 data [1]. They are distinctive and apparently unique to the planet, and may be important indicators of processes operating in the venusian mantle. Magellan images have provided the first high-resolution views of corona and ovoid morphology. In this abstract, we describe the general geologic character of coronae and ovoids, and draw some inferences about their geologic evolution. In two related abstracts in this volume we discuss models of corona and ovoid formation [2], and attempt to relate the characteristics of the features to mantle processes [3].

For consistency with previous work, the following working definitions are adopted here for coronae and ovoids. Coronae are circular to elongate features surrounded by an annulus of deformational features, with a relatively raised or indistinct topographic signature and, commonly, a peripheral trough or "moat". Ovoids are circular to elongate features other than coronae with either positive or negative topographic signatures, associated with tectonic deformation and volcanism. Coronae are thus rather specifically-defined features, whereas ovoids encompass a wider range of morphology. Typical diameters of both classes of features are a few hundred km.

Magellan altimetry data have provided considerable new information on the gross topographic character of coronae. (The reader should be warned that our sample of these features to date is both geographically incomplete and biased toward features with clear topographic signatures.) The outermost topographic feature of many coronae is the moat: a broad trough that partially or completely encircles the corona. Typical moat widths are 50-100 km, and typical depths are a few hundred m. Incomplete, discontinuous moats are more common than complete ones in the coronae observed to date. Interior to the moat is an annular ridge, again typically 50-100 km wide, but generally with greater relief than is shown by the moat. Discontinuous annuli are also observed, but they are less common than discontinuous moats in our sample. There is wide variability in the elevation of corona interiors. Some rise a kilometer or more above the level of the surrounding plains, while others actually lie a few hundred meters lower than the plains. Most coronae are quasi-circular, but a few have been found that are markedly elongate or irregular in shape. A few instances of overlapping coronae have also been observed.

Corona moats are usually sites of deposition of young lavas. Where the source of these lavas can be identified, it is commonly not in the moat itself, but in the corona interior. Many corona interiors are sites of substantial extrusion of very fluid lavas, and in some cases these lavas spill over the annulus or through gaps in it, and pool in the low-lying moats. In the few instances where moats do not appear to be flooded, they still are generally characterized by less intense faulting and fracturing than much of the rest of the corona, particularly the annulus.

Corona annuli are sites of intense tectonic deformation. The most common manifestations of this deformation are radar-bright fractures and grooves. Most of the grooves are very narrow, and appear to be graben. The overall appearance is one of extensional failure of a thin brittle surface layer that has been stretched across a topographic rise. Most corona annuli display a set of concentric fractures, concentrated on the crest and/or flanks of the annular ridge. Some also display a second set of fractures that is related to a regional tectonic framework that appears to be independent of the corona itself. Some regions of Venus exhibit such a framework, with a clear preferred orientation for extensional fracturing that is consistent over large areas [4,5]. In such regions, corona annuli can exhibit fracturing that is aligned with this regional trend, independent of the local orientation of the trend with respect to the annulus.

Corona interiors commonly are sites of substantial volcanic activity [6]. Evidence for this activity takes a variety of forms, including small calderas and other collapse features, lava channels, and small volcanic cones and domes. Most significant, however, is voluminous flooding of the corona interior by low-viscosity lavas. In many coronae this flooding has obscured any evidence of former tectonic features that might have been present. In a few instances, however, remnants of older materials still protrude through the central lavas; some of these surfaces still display older tectonic features. In most such instances, the older fracturing is radial. Fracturing subsequent to flooding is also observed, and commonly aligns with a regional tectonic framework if one is present.

A variety of other circular volcanotectonic features is observed on Venus. We refer to these collectively as ovoids, although their histories and even origins may not all be similar. Of the ovoids observed by Magellan to date, there are two primary topographic types. One is a simple dome. Several of these have been found, with heights above the surrounding plains that can exceed 1 km. The domes are broad and gently sloping, with no annular ridge and at most a very subdued partial moat. Examples include Pandora* (42.5° S lat, 6° E lon) and Baltis* (9° N lat, 348.5° E lon). The other type is a simple, nearly circular topographic depression, with no discernable bounding ridge. Examples include Damkina* (7° S lat, 13° E lon) and Amaterasu* (8.5° N lat, 12° E lon). Typical depths of these are 500 m, with relatively steep walls and flat floors.

The tectonic features associated with these two types of ovoids are as different as is their topopgraphy. The domical ovoids are characterized in most cases by a well-developed radial fracture pattern. Again, this fracturing is clearly extensional, with well-developed grabens commonly visible. Some concentric fracturing may also be observed, though it is generally less well-developed than is the radial fracturing. The ovoids that are depressions, on the other hand, are characterized primarily by concentric extensional fractures. These fractures are found both on the lip and the wall of the depression, but are less common on the floor. As is the case for coronae, fracturing of all sorts in ovoids can be enhanced where it is aligned with a preferred direction for extensional failure in the surrounding terrain.

Based on the coronae and ovoids that have been observed so far, it is possible to draw some inferences about the sequence of events involved in their formation. In the broad sense, this sequence is similar to that inferred from pre-Magellan data [7,8]. We believe that it is an important observation that dome-shaped ovoids have pronounced radial fracturing, and that some coronae also show evidence for intense radial fracturing in their interiors, now largely buried under younger lavas. In addition, coronae and domical ovoids have similar shapes, similar sizes, and commonly occur in close geographic association [2]. These observations lead us to infer a genetic relationship between the two; we believe a domical ovoid to be the first stage in formation of a corona. During this stage, the lithosphere is uplifted and intensively fractured in a dominantly radial pattern. We believe that the domical ovoids we observe are coronae either actively in the process of forming or whose formation was somehow arrested in this early stage.

Several events follow the initial central uplift phase as a corona continues its development. One clearly is volcanism. Looking at the coronae observed to date as an ensemble, there does not seem to be distinct epoch of volcanism during development of most coronae. Instead, volcanism seems to occur intermittently, and in some cases voluminously, throughout much of a corona's history. At one extreme, some domical ovoids are already partially buried by volcanics originating within the dome. At the other, many coronae that have completely lost their central uplift have young, unfractured lavas ponded in their lowest-lying areas.

Following the initial uplift and occurring concurrently with the volcanism, the topographic history of a corona seems to be characterized by subsidence of the central dome, uplift of the annulus, and subsidence of the moat. As these motions take place the lithosphere undergoes flexure and failure, sometimes influenced both by the flexure itself and by an independent regional structural framework. Through careful study of crosscutting relationships, it may be possible for us to discern a relative timing of these uplift and subsidence events, but initial examination indicates that determining the sequence, if there indeed is one, will not be straightforward.

We are uncertain of the relationship of the ovoids that are pure depressions to coronae. It may be that they are another possible endpoint of corona evolution, but we cannot exclude the possibility that they are a different genetic class of features entirely, more akin to calderas.

Coronae and ovoids are known to be present over much of the rest of Venus, and we anticipate finding many more of them as the Magellan mapping mission continues. With the complete diversity of corona and ovoid forms determined, we hope to understand more fully the genetic sequence of these features, and to relate this sequence to processes operating in the venusian interior.

References

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*All names for features used in this abstract are provisional, and have not yet been approved by the IAU.