VENUS: EVOLUTION OF CENTRAL EISTLA REGIO. G. E. McGill, Department of Geosciences, University of Massachusetts, Amherst MA 01003.

Among the many puzzling tectonic/volcanic features on Venus are the large topographic rises. These pose fundamental questions concerning the processes responsible for them. Are they predominantly of constructional origin, or are they predominantly due to internally driven uplift? Is the current relief supported isostatically by thickened crust, elastically by a strong lithosphere, or dynamically by mantle flow? When did rises form relative to the origin of other major venusian stratigraphic and tectonic elements, such as tessera terrain, regional plains, coronae, and large central volcanoes? Are anomalous features with characteristics transitional between coronae and shield volcanoes uplifted coronae or corona-like late-stage structures superposed on shield volcanoes? Answers to these questions will provide important constraints on the dynamic models developed to explain the origin of rises. Partial answers derive from detailed mapping and tectonic analysis, and some relevant results of mapping and analysis [1,2] within the Sappho Patera quadrangle are presented here. The Sappho Patera quadrangle includes all of central Eistla Regio as well as the "saddles" separating central Eistla from western and eastern Eistla.

Eistla Regio is a moderately elevated rise extending northwestward from the western end of Aphrodite Terra to about 30^{o}N, 340^{o}E, a total length of about 7500 km. The typical relief of the rise above the surrounding plains is about 1 km, but where younger, presumably volcanic edifices occur, the relief is greater. Eistla Regio has been interpreted as a broad rise overlying one or more large mantle upwellings [3,4,5,6,7,8]. In addition, several large central volcanic sources occur along the rise, including Sif, Gula, Irnini, Anala, and Kali Montes. It is not clear if these volcanic centers represent major constructional additions to rise relief or if they, too, owe some or most of their relief to uplift.

Central Eistla Regio is dominated by an elevated region that includes the corona Sunrta and two shield-shaped edifices, Irnini and Anala Montes, with corona-like features on their summits. The feature at the top of Irnini Mons is a 225 km diameter rimmed depression, Sappho Patera, that is classified as a concentric corona [9]. Anala is classified as a volcanic corona on the same list.

Evidence from central Eistla Regio is relevant to two aspects of rise evolution: 1) when, relative to other materials and structures, did the rise form; and 2) how much of the relief appears due to uplift and how much to volcanic construction?

1. Relative age of the Eistla rise: There is clear stratigraphic evidence that the Eistla rise began to form prior to the emplacement of the globally extensive regional plains, that most of the uplift occurred after emplacement of these plains but before the construction of the large, relatively young volcanic centers, and that limited uplift continued after late volcanism. Evidence for this progressive development includes local pinching out of plains materials against older materials along the rise axis, exposure of a patch of pre-regional plains material on the flank of a volcanic construct, continuous exposure of regional plains units across the rise axis, and control of lava flows from the young volcanic centers by older ridges and valleys.

2. Cause of relief: In order to assess the relative contributions of volcanic construction and uplift it is necessary to address, at least in a preliminary way, whether Irnini Mons/Sappho Patera and Anala Mons are more akin to shield volcanoes or to coronae. The excellent preservation of the corona-like structures at the summits of Irnini and Anala Montes provides an important constraint on the evolution of these edifices. It is difficult to see how they could have started as coronae and then evolved into shield volcanoes; Anala is 2.25 and Irnini 1.75 km high; if any significant fraction of this relief is due to

volcanic construction all evidence of a precursor corona would be buried.

Thus, we seem to be left with one of two explanations: 1) both Anala and Irnini are shield volcanoes that evolved into coronae with time, or 2) both are basically coronae that have been uplifted to their present elevations. The local geology favors the first alternative; the edifices have typical shield profiles and flank slopes, and all of the deposits and structures related to the corona-like summit features are younger than the youngest lava flows on the flanks of the edifices [2]. The second alternative requires that corona formation be accompanied or followed by uplift to form edifices indistinguishable from shield volcanoes, and also requires that all flank flows pre-date the development of the characteristic concentric and radial structures of the summit coronae. Although this is not impossible, it seems less likely than the first model.

The consequences for the origin of topography along Eistla Regio are great. If Irnini and Anala Montes are shield volcanoes that evolved into coronae, then it is possible that a large fraction of the rise topography is constructional. The evidence for rise topography that is older than the large volcanic centers indicates that all of this topography cannot be due to volcanic construction, but the relative proportions cannot be determined at present. On the other hand, if Irnini and Anala Montes are coronae, then virtually all of the rise topography must be due to uplift.

Most published models for corona and shield formation suggest that it is not likely for a shield volcano to evolve into a corona [8,10], although this is not a consensus opinion [11]. However, Irnini and Anala Montes are not like most other coronae or most other shield volcanoes. Based on model studies, it has been suggested [12] that these are transitional features.

The following hypothesis is here proposed: Irnini and Anala Montes formed as shield volcanoes on an elastic lithosphere that was only slightly thicker than the transitional thickness between lithosphere favoring corona development [11,13] and lithosphere favoring shield volcano development. The local heating due to the underlying mantle plume eventually thinned the elastic lithosphere under the central parts of the volcanic constructs sufficiently to favor the formation of coronae. A late collapse phase of corona evolution could yield complex topography or a simple rimmed depression, as elsewhere on Venus, but this corona topography would be restricted to the summit regions of the older shields. Sappho Patera, a simple rimmed depression, would fall into the concentric class of coronae [9]. The summit area of Anala Mons is more complex, but it also includes a small, irregular depression.

The most likely model for central Eistla Regio involves temporal evolution from thin to thick lithosphere concommitant with global cooling following the major resurfacing event several hundred million years ago. At a smaller scale, local plume heating caused temporal lithospheric thinning. Thus even though central Eistla as a whole evolved from corona dominated to shield dominated, some individual features evolved in reverse -- from shields to coronae.

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