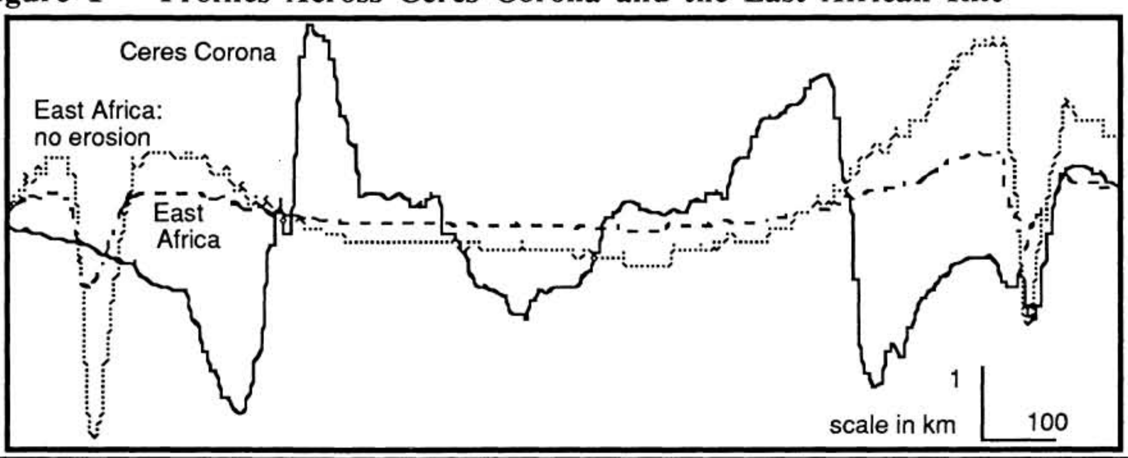
THE EVOLUTION OF LARGE CORONAE; R. C. Ghail, Environmental Science Division, Lancaster University, Lancaster, LA1 4YQ, United Kingdom.

A puzzling feature of Dali Vinculum is that its coronae are younger and larger than almost all other coronae on Venus. Parga Vinculum, on the other hand, has the single largest concentration of coronae on Venus, yet they are all old and small, between a tenth and a fifth of the size of the coronae of Dali Vinculum. For the most part, this problem has not been recognised or addressed in the literature. The coronae of Dali Vinculum and those of Parga Vinculum are fundamentally different structures and the generic nature of the term corona is therefore misleading. If one examines the regional setting of the coronae along a central section of Parga Vinculum, it is apparent that they form one arc of a large oval feature that I have called Nekhebet Corona. I suggest that this oval feature is the relaxed remains of a corona that was originally similar to Ceres Corona in appearance. The smaller coronae located around the rim of the oval feature may have developed towards the end of active rifting in the manner suggested by [1, 2], perhaps in association with rift related batholith and dyke intrusions. However, I propose that active simple shear rifting organised around triple junctions is required to explain the presence of large coronae such as Ceres and the putative Nekhebet.

The dimensions and structures of Ceres Corona are comparable to those of the eastern and western rifts around Lake Victoria in the East African Rift system (Fig 1). Although similar in form, the topography of Ceres (solid line in Fig 1) is, however, much more extreme than the present profile across the Lake Victoria region (dashed line in Fig 1). This is a consequence of the difference in erosion rates between Venus and Earth. The high temperature and high density of the venusian atmosphere, coupled with the lack of water or other solute, results in a remarkably low rate of erosion on Venus, from 3 to 230 nm a^{-1} [3]. The Miocene pre-erosional topography across the Kenya Dome has been determined by McKenzie[4] to be about three times more extreme than the present topography. Exaggerating the topography by a factor of 3 across the whole Lake Victoria region results in the dotted line in Fig 1. The similarity of that profile to the profile across Ceres Corona is apparent.

Figure 1 Profiles Across Ceres Corona and the East African Rift



The profiles across the chasmata that define Ceres Corona are asymmetric; they are bounded on their interior margins by scarp slopes, up to 5 km high, from which their exterior margins gently recover through a series of normal block faults. Interior to the scarp slopes are broad updomed rises that gently slope down to the level of the interior plain. This asymmetry is similar to that predicted by the simple shear model of rift development proposed by Wernicke [5]. The crustal stretch exceeds the mantle shear towards the interior of the corona, such that the shear zone is oriented away from the axis of the corona.

In the case of Ceres Corona, I suggest that the southern section of the annulus formed before the northern part. It is both more extensive and topographically better defined than the northern, suggesting that it has reached maturity and that thermal relaxation is deepening the trough.

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Diana Chasma extends southwest of Ceres Corona to form the southern margin of a feature that may be an example of this dichotomy caught in the act. As yet there is no northern counterpart to Diana Chasma in this region. The northern boundary chasma of Ceres Corona terminates in the complex terrain northwest of Ceres Corona but there is evidence that it is propagating southwestward towards the northern margin of the feature bounded by Diana Chasma. Fluctus deposition is indicative of the earliest stages of rift propagation and a number of fluctus deposits are present in this region. A topographic low extends into this area and is associated with a number of gräben and shear structures all of which indicate extension in this area. It is likely therefore that a northern annulus will develop over perhaps the next 10 to 20 Ma, forming a new corona similar in size and appearance to the present Ceres Corona.

Why do venusian rifts form in this way, becoming the annuli of elliptical structures? This is not a common occurrence with terrestrial rifts; East Africa may be the only example. I think the answer lies in understanding why the elliptical nature of the eastern and western flanks arose in the East African Rift and not elsewhere.

The key difference between the East African rift and almost all other terrestrial rifts lies in the nature of the African plate. It is almost completely surrounded by spreading ridges and is devoid of a subduction zone. Subduction zones provide the major driving force in plate tectonics, applying a tension across the whole plate to which they are attached. Consequently, almost all terrestrial plates are in a state of tension and are easily broken apart by rifting. The African plate is therefore unusual in that it is not under tension and may even be under slight compression. This is one reason for Africa being the highest standing continent. It is also unusual in that it is rifted despite this lack of overall tension.

A triple junction of three rifts is orientated such that the three rifts propagate from a point in three directions at 120° to one another. The effect of tension is to alter the state of principal stress, and consequently the position of the rift axes. The conditions of a stable triple junction are no longer met by triaxial rifting, with two possible consequences. One rift axis may transform into a shear zone, such as at rift-transform-rift stable triple junctions, or rifting may revert to the uniaxial case, avoiding the triple junction problem altogether. Thus the case of a stable triaxial rift triple junction is unusual on Earth and those that do occur are related to the African Plate in some way. The classic triaxial rift junction is the Afar Triangle, at the northern edge of the East African Rift, but I suggest that the elliptical Lake Victoria region is bounded by two triaxial rift junctions: one at the southern end of the East African Rift, where the western and eastern rifts of the Lake Victoria region converge with the Nyasa Rift in Tanzania; and the other at the northern end, where the eastern and western rifts converge with the Ethiopia Rift extending from the Afar Triangle. The elliptical nature of the Lake Victoria region can now be understood in terms of the interaction of two of the three rifts from each of the triple junctions.

Rift gräben are rarely uniform or linear. Often, they are listric in both plan and section. This is not surprising given the locally rapid changes in structure, composition and state of stress of the crust and mantle along a rift zone. The simple shear model [5] is itself a simplification of nature but attempts to give a more reliable prediction of rift behaviour than the first order pure shear model [6]. The simple shear model predicts asymmetric faulting, with concomitant asymmetric topography. In a normal corona, two rifts are oriented in opposite directions, such that the raised topographic margins of the rift are oriented towards the interior of the corona, with the rift troughs located on the exterior.

References: [1] Strom, R.G. *et al.* (1994) *J. Geophys. Res.* 99, 10899. [2] Baker and Wohlenberg (1971) *Nature* 229, 538. [3] Wernicke (1985) *Can. J. Earth Sci.* 22, 108. [4] McKenzie, D. (1978) *Earth Plan. Sci. Lett.* 40, 25. [5] Janes, D.M., & Squyres, S.W. (1995) *Proc. 26th Lun. Plan. Sci. Conf.* 673. [6] Janes, D.M. *et al.* (1992) *J. Geophys. Res.* 97, 16055.