

## STRATIGRAPHY AND STRESS HISTORY RECORDED BY A COMPLEX VOLCANO-TECTONIC FEATURE IN THE NEMESIS TESSERA QUADRANGLE, VENUS. T.C. Doggett<sup>1</sup> and E.B. Grosfils<sup>2</sup>.

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**Introduction:** Magellan radar imagery of Venus shows a complex volcano-tectonic feature at 45°N, 191°E in the Nemesis Tessera quadrangle. This quadrangle is intermediate between compressive N-S tectonic ridges in Vinmara Planitia [1] to the north, mantle upwelling in Atla Regio [2] to the south and mantle convection in Atalanta Planitia and the Beta-Atla Themis volcanic zone [2,3] to the northwest and southeast respectively. In this study, we explore the stratigraphic relationships of the structural units in the region of the volcano-tectonic feature in order to understand the local stress history.

The volcano-tectonic feature lies at the juncture of the western edge of an E-W ridge belt (Akewa Dorsa) and the northern end of one arm of a Y-shaped ridge belt cut by a dike swarm [4] in Ganiki Planitia. A segment of Nemesis Tessera is located to the east of the feature, which is centered on the western flank of the topographic rise associated with the tessera. The structural fabric within the tessera records a pre-plains stress history that is not evaluated as part of this study. All of these elements are located within the 1520 km wide radar-dark deposit associated with the Yarbolina impact crater at 48°N, 195°E [5].

**Methods:** Using Magellan FMAP data (75 m/pixel) and synthetic stereo data from the USGS, material units were mapped on the basis of variations in texture and radar brightness, a process complicated by the pervasiveness of the dark surficial deposit from Yarbolina. Lineations were mapped on the basis of orientation, length and morphology, with five distinct sets identified. Stratigraphy was evaluated using crosscutting and superposition relationships.

**Results:** The oldest lineations are a regionally pervasive set of sinuous, radar-bright ridges trending E-W. These are mainly concentrated in Akewa Dorsa. A small, slightly NW-SE trending set of ridges concentrated to the northwest of the feature is superimposed upon the wrinkle ridges. Nijole Mons, a large shield volcano at 45°N, 185°E [6] in the middle of Akewa Dorsa, appears to predate the ridges since associated lava flows extend in a symmetric pattern that ignores the topography of the ridges.

Several NE-SW trending sets of trenches exist: one north of the feature, another to the south, a small one in between the feature and the segment of Nemesis Tessera to the east, and a densely packed set on the northern end of the northwestern arm of a Y-shaped ridge system in Ganiki Planitia. These NE-SW sets crosscut the E-W and NW-SE trending sets of ridges,

and are crosscut in turn by the N-S trending ridges of the Y-shaped Ganiki Planitia ridge belt.

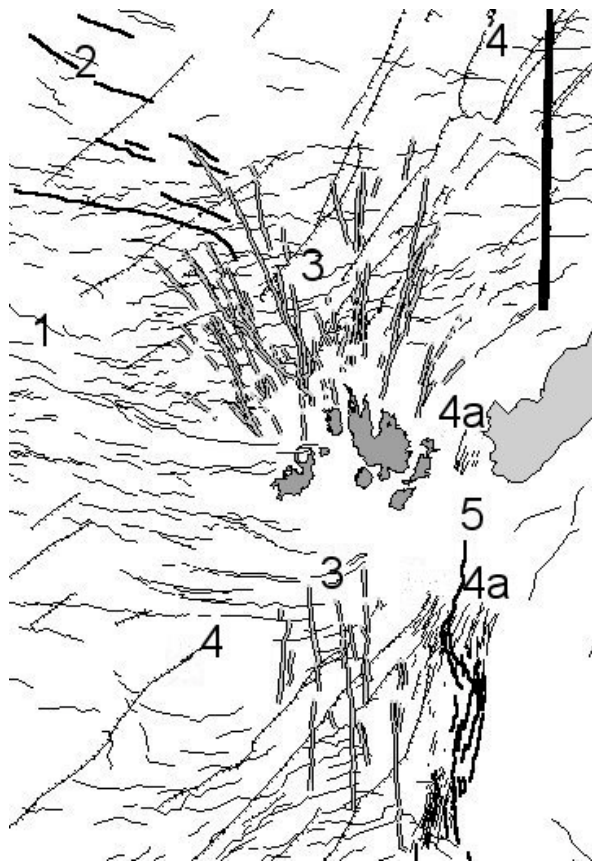
Although a few E-W trending trenches exist at the center of the feature, for the most part the lineaments directly associated with the feature are all trenches oriented in a N-S direction. The northern part of the feature is dominated by linear trenches as long as 170 km which fan out over roughly 90° of arc. In the southern part, a N-S trend exists without any fanning. In several cases close to the center of the feature, the lineaments take the form of chains of pits, a morphology which is most likely indicative of a magmatic origin [7]. The N-S trenches are crosscut by the NE-SW trending set to the south, but to the north the NE-SW trenches both crosscut and are crosscut by the N-S fanning trenches, implying contemporaneous formation.

**Discussion:** Mapping of the feature (Figure 1) and its vicinity shows the following stratigraphic sequence from oldest to youngest: tessera, plains, Nijole Mons, E-W wrinkle ridges/Akewa Dorsa, NW-SE ridges, the N-S fanning trenches and pit chains associated with the feature, NE-SW trenches, and finally the N-S arm of the Y-shaped ridge belt.

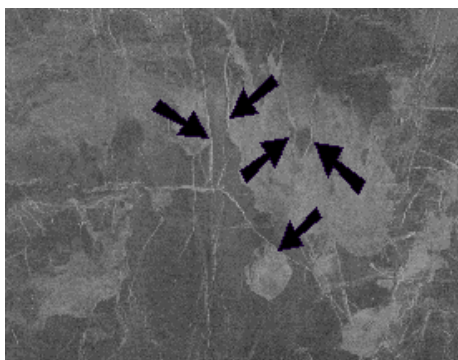
The radar bright flows at the center of the feature are younger than the N-S trenches and the Y-shaped ridge belt in Ganiki Planitia is younger than the NW-SE trenches, but the relative ages of the radar bright flows and the Y-shaped ridge belt remain unclear. In many cases, however, the flow direction appears to be controlled by pre-existing N-S structural lineaments (Figure 2), suggesting that the flows are the younger feature. This occurs even though the topography of each lineament is in bulk negative (i.e., trenches), which implies an elevated rim along the edges of these structures and that the flow thicknesses are less than this rim height. The Yarbolina impact is probably the most recent major geological event, as indicated by the existence of the large radar dark deposit, which is considered an ephemeral phenomenon [5].

The direction of maximum horizontal compression indicated by some of the units rotates from N-S with the wrinkle ridges [8], through slightly NW-SE with the next oldest ridge set, to NW-SE with the NE-SW trench sets and then E-W with the youngest Y-shaped ridge belt. The only interruption of a clear clockwise rotation of maximum horizontal compressive stress from N-S to E-W is the radial stress inferred from the structural lineaments which define the feature (Figure 3).

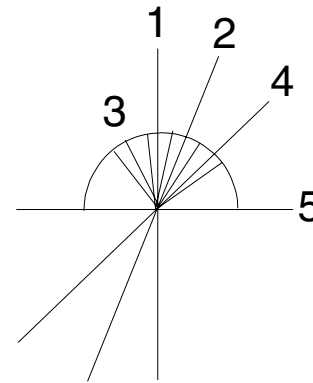
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**Figure 1:** Material units and lineament map of the feature. North is up, image is 380 km wide. Plains are white, Nemesis Tessera is light gray and radar bright flows are dark gray. Solid black bar is a radar data gap. Lineament sets are numbered in stratigraphic order from oldest to youngest: 1) E-W wrinkle ridges, 2) NW-SE ridges, 3) N-S trenches, 4) NE-SW trenches, 4a) dense sets of NE-SW lineaments, 5) N-S ridges.



**Figure 2:** Magellan image of the radar bright flows at the center of the volcano-tectonic feature. North is up, image is 120 km wide. Examples of flow-controlling lineaments are marked by arrows.



**Figure 3:** Schematic of the stress history in the vicinity of the feature, showing the inferred direction of maximum horizontal compressional stress over time. The numbering is the same as in Figure 1.

**Conclusion:** The simplest identification of the feature would be as a giant radiating dike swarm, albeit a relatively small one and one which was not identified in [4]. The linear trenches and pit chains are consistent with this interpretation, as is the magmatic activity in the center indicated by the radar bright flows. The temporal spacing between this feature and Nijole Mons indicates that reservoir-derived volcanism has persisted within the study area throughout the time interval recorded by the stratigraphy.

The local stress history is essentially the gradual clockwise rotation of maximum horizontal compressive stress from N-S to E-W. It is tempting to associate the E-W compressional stress at the final stage of this stress history with that of the compressional ridges to the north in Vinmara Planitia, but further detailed mapping of the Nemesis Tessera quadrangle is required to provide a better understanding of the broader stress history of the quadrangle and its interaction with the Vinmara Planitia ridge belts and the mantle dynamics in Atla Regio, Atalanta Planitia and the Beta-Atla Themis volcanic zone.

**References:** [1] Zuber, M.T. (1987) *JGR*, 92, E541-E551. [2] Bindschadler, D.L. et al. (1992) *JGR*, 97, 13495-13532. [3] Phillips, R.J. and V.L. Hansen (1998), *Science*, 279, 1492-1497. [4] Grosfils, E.B. and J.W. Head (1994) *GRL*, 21, 701-704. [5] Campbell, B.A. et al. (1992) *JGR*, 97, 16249-16277. [6] Crumpler, L.S. and J.C. Aubele (2000) in *Encyclopedia of Volcanoes*, 727-769. [7] Mege, D. and P. Masson (1996), *LPSC*, #1226. [8] McGill, G.E. (1993) *GRL*, 21, 2407-2410.

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