Continental-Like Tectonics Revealed by the Structural History of Thetis Regio, Venus.

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Background: Thetis Regio (Fig 1) is a crustal plateau approximately the size of western Europe (2500 x 1500 km), located in the equatorial region of Venus (10°S, 130°E). It is characterised by high topography (>4 km), tesserae (stratigraphically the oldest terrain-type on Venus), and intratesserae basins. It is postulated to result from either downwelling [1] or upwelling [2] mantle and subsequent relaxation structures. To test these models, the large-scale tectonic structures within Thetis Regio were mapped and the kinematic history of the plateau unravelled.

Kinematic History: In contrast to the predictions of either [1] or [2], the kinematic history is neither uniform nor monontonic. Several distinct terrain units (named after local craters) can be identified (Fig 2), each representing an episode of tectonism, some of which may have occurred concurrently. The oldest unit, Whiting, forms the core of Thetis, and is structurally the most complex terrain. Identified structural trends parallel the Gilmore and Bonin terrains, from which it is separated by deep narrow NE-SW oriented troughs. Overprinting these are several sets of very long (~1000 km) linear narrow parallel graben, some of these are assoicated with neighbouring coronae (*e.g.*, Rosmerta) and with 'islands' within the rift to the SE of Gilmore. These graben are interpreted as the surface expression of dyke swarms. The SW portion of Whiting, referred to as Winnemucca, is lower than the rest, lying below the 'frost-line' and thus appearing darker. It may represent subsidence associated with rifting to the south, but is structurally contiguous with the rest of Whiting.

Bonin and Gilmore both appear to be modifications of Whiting terrain. Bonin is strongly deformed by shearing along its NW margin and extension to the south. These boundaries are marked by a major strike-slip system to the NW [3, 4] and rifting to the south, but Bonin is also undergoing considerable internal deformation, overprinting the Whiting structures with NNE oriented strike-slip faults.

Gilmore is simpler, consisting of NE-SW oriented folds or thrusts, overprinted by the same graben swarms as Whiting. It is the highest terrain in Thetis Regio. Fragments of Gilmore occur in the NE and in the SE, adjacent to Jumaisat terrain, isolated from the main part of Gilmore by the rift system Vir-Ava Chasma that connects through to Innari Corona, and other E-W oriented rifts south of Thetis.

The northern margin of Whiting is bordered by Khelifa terrain, a fold/thrust system oriented WNW-ESE. This system is bordered to its north by a low-lying corona/rift system, and builds up the topography to the level of the plateau over a distance of a few hundred km. It is similar to Jumaisat, apparently the youngest terrain, another thrust/fold system, described by [5].

Tectonic Interpretation: It is extremely difficult to connect structures and cross-cutting relationships across the whole of Thetis Regio. However, the kinematic relationships imply a general rotational movement of the whole of Thetis in a clockwise direction. The major linear basins dividing Whiting from Bonin and Gilmore might reasonably be interpreted as strike-slip faults, allowing shear deformation of the whole of Thetis, but most prominantly in Bonin, which is undergoing NE directed shear transport. Either driving this NW movement, or resulting from it, are the extensional structures to the SW and the compression at Khelifa in the NE. The history of the SE quadrant of Thetis is more complex. Gilmore apparently derives from an early NW directed compression, that was later cut by rifting in Vir-Ava, and lastly by further NW directed compression in Jumaisat.

Speculation: The tectonic history is much more heterogenious than is predicted by either [1] or [2]. Thetis Regio records a long history of tectonic activity involving tens to hundreds of km of horizontal movement in discrete episodes, forming a number of distinct terrains. Unlike terrestrial tectonics, these movements do not arise from oceanic-type plate tectonics (subduction/spreading), but are probably driven by convection in the Venus mantle. It is believed that Venus is in a state of stagnant-lid convection, similar to Mars, but it is possible that it is in a 'half-way house' between stagnant lid and plate tectonic convection, *i.e.*, that although plate tectonics proper does not occur on Venus (with the possible caveat of episodic events), the lithosphere is sufficiently thin and rigid to be broken into small plates [6] that are mobilised by the viscous drag of its local convection cell, forming rift zones and mountain belts. These movements are uniquely recorded in the structural geology of Thetis Regio and probably other plateaux.

References: [1] Philips, R.J., & Hansen, V.L., 1998, *Science 279*, 1492-1497. [2] Bindschadler *et al.*, 1992, *JGR 97*, 13495-13532. [3] Davis, A.M., & Ghail, R.C.,1999, *LPSC XXX, 1330*. [4] Tuckwell, G.W., & Ghail, R.C., 2001, *LPSC XXXII*, this issue. [5] Ghail, R.C., & Egan, S.S., 2000, *EOS 81*, F770. [6] Ghail, R.C., 1996, *LPSC XXVII*, 403-404.

THE STRUCTURAL HISTORY OF THETIS REGIO. R. C. Ghail

Figure 1. Magellan SAR and colour-coded emissivity image of Thetis Regio, equatorial Venus.

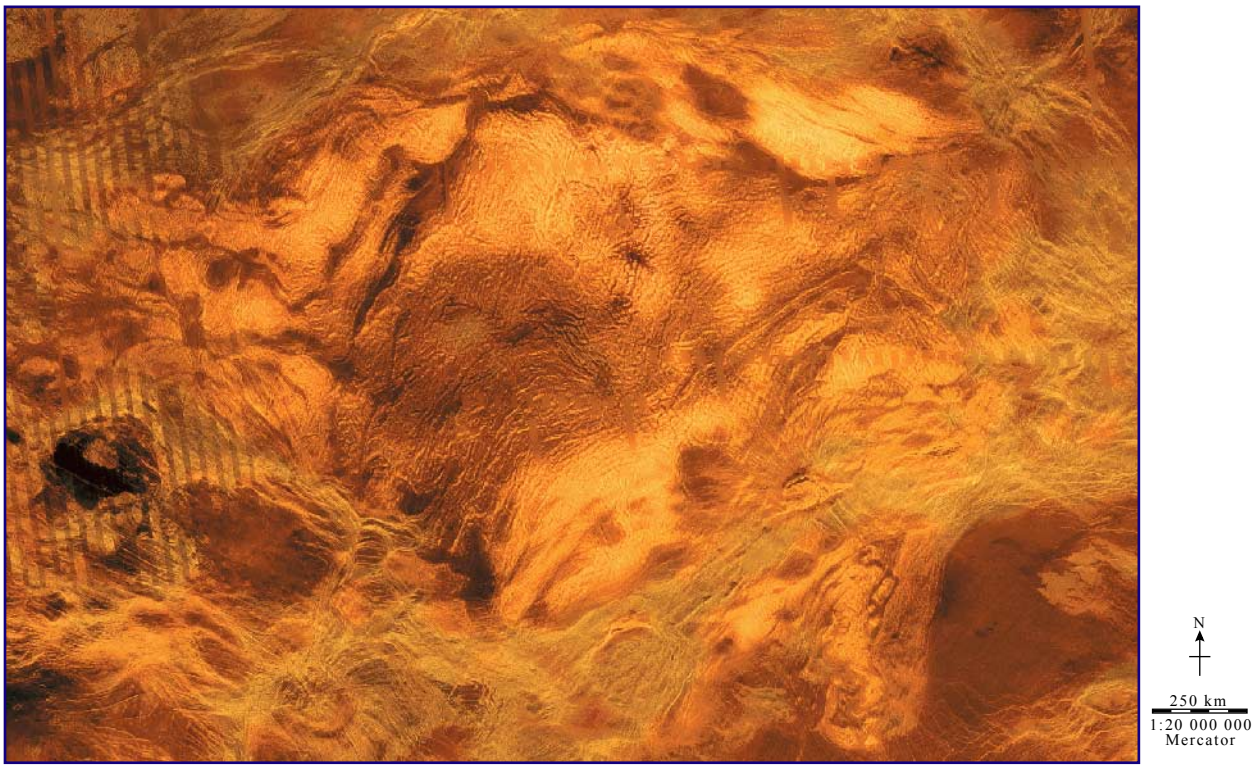

Figure 2. Terrain units and structures within Thetis Regio.