

Thin/Thick Skin Deformation of the Tharsis Region of Mars; W. B. Banerdt (Jet Propulsion Laboratory, Pasadena, CA)

The Tharsis rise is a huge feature, over 1800 km across and rising up to 11 km above the datum. The size of its tectonic system, involving a full hemisphere of Mars, gives Tharsis a central role in the thermo-tectonic evolution of the planet. It is intensely fractured by long, narrow grabens that extend radially hundreds of kilometers beyond the rise and is ringed by mostly concentric wrinkle ridges that formed over 2,000 km from the center of the rise. There is a large excess of gravity relative to that which can be explained by simple compensation models, attesting to a huge load on the lithosphere.

The pattern of faulting represents a significant body of evidence regarding the structure of the lithosphere and the processes supporting Tharsis. From theoretical stress calculations of a roughly circular, long wavelength topographic high supported statically, it can be shown that distinct fault patterns are generated for flexural support, uplifted topography, and simple isostasy. Comparing calculated patterns to the observed faulting, we find that Tharsis tectonics can be quite well explained by a **superposition** of a simple isostatic stress state within the high topography and a flexural stress state in the outlying regions. However, relative age relationships among the structures indicate that they all formed nearly contemporaneously. This presents a problem because these situations are mutually exclusive, in that the isostatic case necessarily excludes any flexural stresses.

However the inner radial fault pattern may be a natural consequence of the thickened crust and higher heat flow resulting from the volcanic construction of the Tharsis rise. Far from Tharsis the mechanical lithosphere consists of both the crust and upper mantle. But within Tharsis itself the thickened crust and higher heat flow will act to decouple the upper crust from the strong upper mantle. In this situation the strong upper mantle, which constitutes most of the lithosphere in either case, will deform as part of the global shell, transferring flexural stresses and displacements to the rest of the shell. The relatively thin upper crustal layer will deform not as part of the greater shell, but rather as a spherical cap with a lubricated lower surface and a peripheral boundary which is fixed to the global shell. Thus it will respond primarily to isostatic spreading forces and increases in its radius of curvature. Both processes induce circumferential extension within the cap, leading to radial faulting within the highland area. Outside this region of decoupled crust, faulting will be due to flexural stresses in the underlying lithosphere. Radial compression will be concentrated near the boundary of the two regions.

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3. (a) w. Bruce Banerdt
M.S. 183-501
Jet Propulsion Laboratory
4800 oak Grove Drive
Pasadena, CA **91109**
(b) Tel: (818) 354-5413
(c) Fax: (818) 393-9226
(d) email: bruce.banerdt@jpl.nasa
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