Global Patterns of Tectonism on Titan From Mountain Chains and Virgae

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This research is based on the exploration of tectonic patterns on Titan from a global perspective. Several moons in the outer solar system display patterns of surface tectonic features that imply global stress fields driven or modified by global forces. Patterns such as these are seen in Europa's tidally induced fracture patterns, Enceladus's tiger stripes, and Ganymede's global expansion induced normal fault bands. Given its proximity to Saturn, as well as its eccentric orbit, tectonic features and global stresses may be present on Titan as well. Titan displays possible tectonic structures, such as mountain chains along its equator (Radebaugh et al. 2007), as well as the unexplored dark linear streaks termed virgae by the IAU.

Imaged by Cassini with the RADAR instrument, mountain chains near the equator are observed with a predominante east-west orientation (Liu et al. 2012, Mitri et al. 2010). Orientations such as these can be explained by modifications in the global tidal stress field induced by global contraction followed by rotational spin-up. Also, due to Titan's eccentric orbit, its current rotation rate may be in an equilibrium between tidal spin-up near periapsis and spin-down near apoapsis (Barnes and Fortney 2003). Additional stress from rotational spin-up provides an asymmetry to the stress field. This, combined with an isotropic stress from radial contraction, favors the formation of equatorial mountain chains in an east-west direction.

The virgae, which have been imaged by Cassini with both the Visual and Infrared Mapping Spectrometer (VIMS) and Imaging Science Subsystem (ISS) instruments, are located predominately near 30 degrees latitude in either hemisphere. Oriented with a pronounced elongation in the east-west direction, all observed virgae display similar characteristics: similar relative albedos as the surrounding terrain however darkened with an apparent neutral absorber, broken-linear or rounded sharp edges, and connected, angular elements with distinct, linear edges. Virgae imaged during northern latitude passes are oriented with their long dimensions toward Titan's anti-Saturn point.

If the virgae are of tectonic origin, for instance if the turn out to be i.e. grabens, they could serve as markers to Titan's global stress field. Using them in this way allows for a mapping of global tectonic patterns. These patterns will be tested for consistency against the various sources of global stress and orientations of mountain chains. By determining what drives Titan's tectonics globally, we will be able to place Titan within the context of the other outer planet icy satellites.

References:

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