INITIAL INTERPRETATIONS OF TITAN'S GEOLOGY FROM *CASSINI'S* IMAGING SCIENCE SUBSYSTEM.

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Observations of Titan's surface by *Cassini's* Imaging Science Subsystem (ISS) have revealed complex albedo patterns indicative of modification by diverse processes, *e.g.* aeolian, tectonic and fluvial. Only a few candidate impact structures have been seen. The observations [1] imply that substantial modification has occurred over Titan's history.

Brightness variations detected on Titan's surface by the ISS are most likely due purely to variations in albedo, with no contribution from topographic shading [1,2]. The causes of the albedo differences are still not certain. However, darker regions are thought to indicate lower elevations where hydrocarbons (liquid or solid, precipitated from the atmosphere) have accumulated, with brighter regions representing higher-standing, less-contaminated water-ice [3,4]. This hypothesis is consistent with observations by the Huygens Probe's Descent Imaging Spectral Radiometer (DISR) [5] and with morphologic interpretations of the ISS images. Although Earth-based radar measurements have been attributed specifically to the presence of liquid hydrocarbons [6], there is no correlation between their locations and surface albedos observed by the ISS. Furthermore, neither Earth-based observers nor *Cassini* has found evidence at IR wavelengths of specular reflections, which are expected to be detectable if bodies of liquid are present on Titan's surface.

To date, Cassini has imaged almost all of Titan's surface that is illuminated during southern-hemisphere summer, at pixel scales of 10s of km and ~40% of the surface at substantially better pixel scales: 2 km to a few hundred meters. Intricate albedo patterns have been revealed, including diffuse bright streaks, narrow dark lineaments (straight and curved), and bright and dark patches at a variety of scales with curved and angular boundaries. Processes likely to be responsible for these patterns include aeolian and fluvial activity, perhaps sapping, tectonics, and cratering. As on Earth, in many cases a combination of processes is probably responsible for the observed features.

At the global scale, significant albedo contrast is seen near the equator and around the South Pole, whereas the middle latitudes appear more uniformly bright. Xanadu Regio (a large bright region centered at ~10°S, ~100°W) is flanked by ~100-km-scale dark features, some with strikingly angular boundaries, suggesting tectonic influences. In addition, several narrow (~10–20 km wide), dark features can be seen to extend up to ~1500 km across the surface. Some of these features are straight, whereas others, particularly near the South Pole, appear to wind across the surface as would liquid-carved channels (analogous to those observed by DISR [5] but at much larger scales). Variations in surface patterns at different latitudes may reflect the cumulative effects of seasonal meteorological variations, *e.g.* high-latitude channels could be more extensive due to greater precipitation in polar regions (where clouds have been most abundant recently).

Straight and angular boundaries and lineaments suggest tectonic processes have played roles in shaping Titan's surface. Western Xanadu exhibits prominent lineaments with strikes of ~N50°W and ~N80°E, like conjugate faults. One interpretation of these features is large-scale tectonic modification of bright material, with accumulations of darker material in low-lying areas enhancing the morphologic patterns. Transport of liquids within the ice bedrock could result in sapping, enlarging and darkening tectonic zones of weakness.

Diffuse, ~E-W-trending, bright streaks are common in the dark, equatorial regions flanking Xanadu; many bright patches within this region have distinct western margins and diffuse eastern margins, consistent with aeolian origins due to eastward flow. The preferred orientations suggest that these features are related to tropospheric super-rotation rather than tidal winds [2].

Few circular features suggestive of impact structures have been identified to date: 6 with $D > 20$ km, the largest being a ~300-km-diameter dark annulus at ~20°N, ~85°W. Based on the expected cratering rate [7] (and assuming impact structures can be recognized on the basis of albedo alone), rates of surface modification within the dark, anti-saturnian, equatorial region must have been sufficient to eliminate km-scale relief over timescales of ~100s of Myr. One explanation for a relatively young surface would be the presence of NH_3, which lowers the melting point of water-ice and makes the resulting liquid neutrally buoyant [8], facilitating endogenic resurfacing despite relatively low heat flow.

Cassini's early imaging observations of Titan are revealing a complex world, which appears to be influenced by tectonic, fluvial and atmospheric processes, in many ways similar to Earth, although the rates of such activity may be much slower on Titan.

[1] McEwen *et al.*, Titan after the Huygens and First Cassini Encounters Conf., 2005. [2] Porco et al., *Nature* **434**, 2005. [3] Lorenz & Lunine *PSS* **53**, 2005. [4] Griffith *et al. Science* **300**, 2003. [5] Tomasko M., personal communication. [6] Campbell et al., *Science* **302**, 2003. [7] Korycansky & Zahnle, *PSS* **53**, 2005. [8] Croft *et al.*, *Icarus* **73**, 1988.