TITAN'S SURFACE AS REVEALED BY CASSINI'S IMAGING SCIENCE SUBSYSTEM. E. P. Turtle[1], J. Perry[2], A. S. McEwen[2], R. A. West[3], and S. Fussner[2], [1]Johns Hopkins Univ. Applied Physics Lab., 11100 Johns Hopkins Rd. Laurel MD 20723, Elizabeth.Turtle@jhuapl.edu; [2]Lunar and Planetary Lab., Univ. of Arizona, 1541 E. University Blvd., Tucson, AZ 85721; [3]Jet Propulsion Lab., 4800 Oak Grove Dr., Pasadena, CA 91109.

Introduction: Cassini's Imaging Science Subsystem (ISS) has been observing Titan for almost three years, beginning during final approach to the Saturnian system in Spring 2004 [1] and continuing through the 22 targeted Titan encounters that Cassini has performed through the end of 2006. Titan's atmosphere obscures its surface quite effectively at visible wavelengths, so the ISS narrow- and wide-angle cameras include a narrow bandpass filter at 938 nm and IR polarizer filters [2] to take advantage of a window in methane's absorption spectrum in the near-IR where the optical depth of Titan's complex organic atmospheric haze is lower and the fact that haze is highly polarized near phase angle 90º [3]. However, even with these filters, scattering by haze particles limits the best resolution that can be achieved to ~1 km [2]. Despite the challenges presented by Titan's atmosphere, to date Cassini has imaged almost all of Titan's illuminated surface at resolutions of tens of kilometers and a substantial fraction of the surface at significantly better resolution, down to the limit imposed by atmospheric scattering. These observations have been combined to produce an albedo map of the surface (Fig. 1).

Observations and Interpretations: The brightness variations revealed by ISS are due to the presence of surface materials with different albedos rather than topographic shading. Even high-phase-angle images are likely to reveal only albedo markings for two reasons: (1) an icy satellite of this size is expected to have relatively low topographic relief [4], certainly not high enough that shadows would be detectable at kilometer scales, and (2) the atmospheric scattering severely reduces the contrast between slope facets facing towards vs. away from the Sun. Furthermore, repeat observations with different illumination angles have not revealed changes consistent with topographic shading.

The compositions of the materials responsible for the albedo variations observed on Titan's surface are still not well understood; however, morphologic interpretations of ISS images as well as observations by Cassini's RADAR and Visual and Infrared Mapping Spectrometer (VIMS) and by Huygens' Descent Imaging Spectral Radiometer (DISR), appear to have confirmed hypotheses that darker regions are generally lower elevations where liquid and solid hydrocarbons, which are expected to have precipitated from the atmosphere in substantial amounts over Titan's history [e.g., 5] have accumulated, while brighter regions represent higher-standing exposures of less-contaminated water-ice or brighter organic material [e.g., 1, 6-10].

The morphologies of the albedo patterns observed on Titan's surface represent a wide variety of geological features (Figs. 1, 2; see also [11]): linear boundaries likely indicate faulting and tectonic control; bright, roughly east-west, streamlined shapes suggest aeolian processes, consistent with RADAR observations of expanses of dunes covering the dark equatorial regions [12]; narrow, curvilinear, dark lines that wind across the surface appear to be fluvial channels; Ontario Lacus, a dark feature near the South Pole that is a few hundred kilometers long with a very smooth margin is suggestive of a lake [13]; the rare circular structures may be impact craters; and other, more complex, patterns still defy easy interpretation. To date we have seen no evidence of changes in surface albedo patterns.

Although ISS has observed the specular point at numerous locations on Titan's surface, detailed analysis has detected no enhancement, indicating no substantial coverage of the surface by liquid in these areas. However, illumination geometry and scattering prevent useful observations of the specular point at high latitudes, where there is more compelling evidence for the presence of surface liquids. In addition to Ontario Lacus, ISS has observed numerous small, dark surface features around the South Pole where large convective cloud systems were commonly observed through 2004, evoking the interpretation of these features as lakes filled by recent methane rain [13]. Similarly, RADAR has detected lakes at high northern latitudes [14].

Upcoming observations: Cassini has only completed half of the Titan encounters planned during its nominal mission and much remains to be seen. Three more flybys are scheduled to occur within January and February 2007. The last of these three will provide ISS with an opportunity to observe a large expanse of territory north of Belet, Adiri, and Dilmun (north of 30° N, between 180° and 270° W) that has only been seen at very low resolution to date. Furthermore, high northern latitudes are beginning to emerge from darkness as Titan approaches equinox in August 2009.

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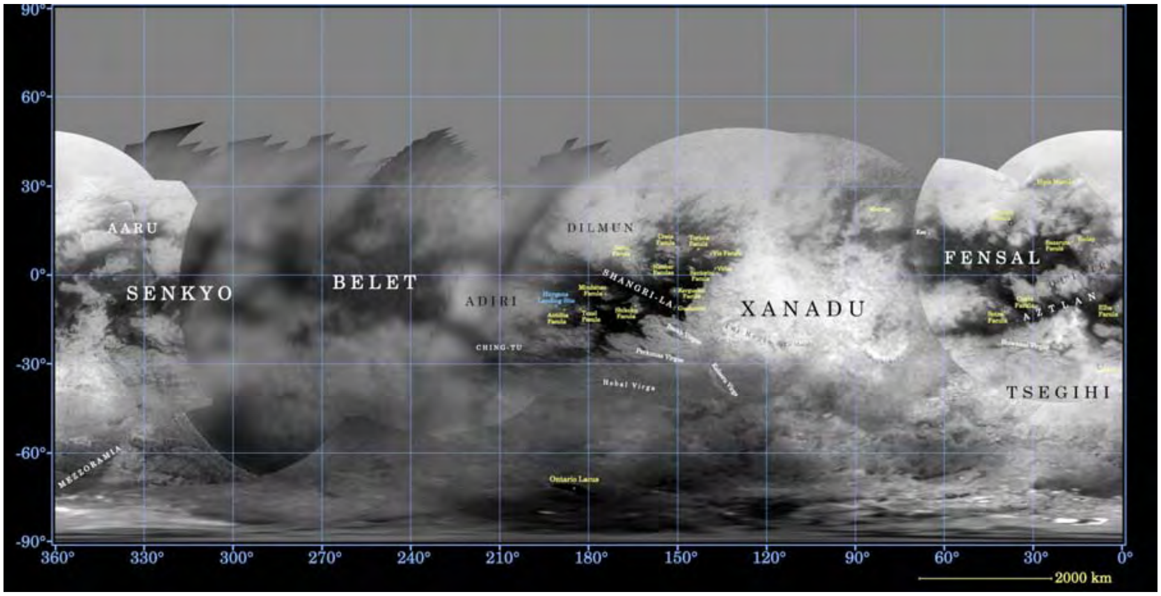

Figure 1: Albedo map of Titan compiled from ISS observations taken at a wavelength of 938 nm between April 2004 and October 2006. The map resolution varies across the surface, depending on Cassini's opportunities for viewing different parts of Titan. It is currently winter in Titan's northern hemisphere, so high northern latitudes are still unilluminated. Names that have been officially adopted by the International Astronomical Union are indicated.

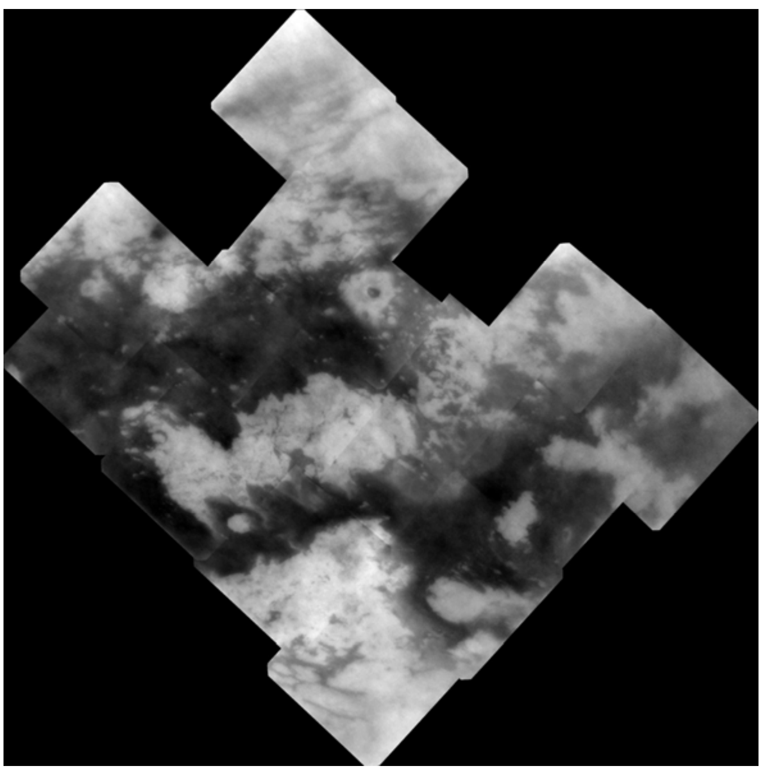

Figure 2: Mosaic of Titan's equatorial, anti-Saturnian hemisphere illustrating its complex albedo patterns. The smallest features that can be resolved are ~1-2 km across, e.g. the fine, dark lanes, possibly channels, within Quivira, the bright feature extending west from the center of the mosaic. Diffuse, bright margins that trend generally E-SE from bright regions like Quivira into the surrounding dark terrain suggest aeolian processes. The bright annular feature just above center, Bazaruto Facula, surrounds one of the few confirmed impact structures, the 80-km-diameter crater Sinlap. Dark lineaments near the bottom of the image, the eastern extent of Shiwanni Virgae, may be tectonic features that, like faults on Earth, have been modified by other processes, such as fluvial or aeolian infill, bestowing an albedo signature on the landforms.