VIMS OBSERVATIONS OF TITAN DURING THE FIRST TWO CLOSE FLYBYS BY THE CASSINI-HUYGENS MISSION.

S. Rodriguez[1], S. Le Mouëlic[1], C. Sotin[1], B.J. Buratti[2], R.H. Brown[3] and the VIMS Science Team. [1] Laboratoire de Planétologie et de Géodynamique de Nantes, Sciences et Techniques, 2 rue de la Houssinière, B.P. 92205, 44322 Nantes, France, (email: sebastien.rodriguez@chimie.univ-nantes.fr), [2]Jet Propulsion Laboratory, Pasadena, CA, [3] University of Arizona, Tucson, Arizona.

Introduction: The joint NASA-ESA-ASI Cassini-Huygens mission reached the saturnian system on July 1st 2004. It started the observations of Saturn's environment including its atmosphere, rings, and satellites (Phoebe, Iapetus and Titan). Titan, one of the primary scientific interests of the mission, is veiled by an ubiquitous thick haze **[1]**. Its surface cannot be seen in the visible but as the haze effects decrease with increasing wavelength, there is signal in the infrared atmospheric windows if no clouds are present **[2]**. Onboard the Cassini spacecraft, the VIMS instrument (Visual and Infrared Mapping Spectrometer) is expected to pierce the veil of the hazy moon and successfully image its surface in the infrared wavelengths, taking hyperspectral images in the range 0.4 to 5.2 µm **[3]**.

On 26 October (TA) and 13 December 2004 (TB), the Cassini-Huygens mission flew over Titan at an altitude lower than 1200 km at closest approach. VIMS acquired several tens of image cubes with spatial resolution ranging from a few tens of kilometers down to 1.5 kilometer per pixel, demonstrating its capability for studying Titan's geology.

Global coverage of Titan surface at TA and TB: The two flybys have similar trajectory and imaged the same areas between -70°W to 130°W in longitudes and from 50°N to south pole in latitudes (*Figure 1*). However the high-resolution images were taken at different places. TA global coverage map of the VIMS instrument (*Figure 1* – top) was realized with a mosaic of six cubes with a mean spatial resolution of 30 km/pixel and TB global coverage map (*Figure 1* – bottom) with a mosaic of 15 cubes with a spatial resolution ranging from 60 to 45 km/pixel. For these maps, the 2.03 µm image is selected because it offers the greatest signal-to-noise ratio while minimizing the scattering due to atmospheric haze. Bright pixels on the edge of each reprojected mosaic are artifacts due to reprojection effects and photometric corrections.

Each map shows same highly contrasted patterns with a dark and bright dichotomy at very large scale. This dichotomy has already been observed at low resolution by ground-based telescopes **[4]**. No significant changes at these resolutions can be seen between the two flybys. Examples of sharp edges between dark and bright terrains ehave been found on different planets : they can correspond to differences in surface composition or surface morphology including topography variations. In Titan's case, it is tempting to interpret such a feature as a shoreline between bright continents and liquid methane. But the analysis of TA high-resolution images do not favor this hyposthesis as described below.

High-resolution VIMS observations:

TA. The VIMS high-resolution observations during TA were made during a 25-minute period that ended just before closest approach. Two images were acquired over the same area at 20 minutes interval. The second image shown in *Figure 1- inset b* was taken with a 80-ms integration time with a resolution varying from 2.6 km/pixel to 1.8 km/pixel. This image is about 150 km x 150 km, located slightly north of the equator at the eastern edge of the large dark material patch.

At the center of the image is a bright feature about 30 km in diameter with two elongated wings extending westwards. This peculiar structure does not resemble any other feature seen so far on the largest icy satellites. Several hypotheses are explored including that the feature is atmospheric, fluid-driven, a depression, or a topographic dome. At 2.03 µm, the bright regions are about twice as bright as the dark regions with I/F ratios equal to 0.090 and 0.055, respectively. The spectra look very similar to first order, indicating that the materials are similar in composition. Our preferred interpretation is that the structure is a dome that could be a cryo-volcano where methane, destabilized in the subsurface, would be released in Titan's atmosphere. Besides, the E-W linear features could be interpreted as tectonic features or flow lines if a liquid is present around the central feature. These spectral observations also suggest that H_2O is not dominantly exposed on the surface of the circular feature **[5]**.

TB. Two high spatial resolution cubes were acquired during TB flyby sequence by the VIMS instrument a few minutes before closest approach. They were taken over the same aera, only 5 minutes apart. *Figure 1- inset c* presents one of these two images at 2.03 µm. This image covers a region slightly larger (170 x 170 km) than the highest resolution image taken at TA flyby and is located same longitude but 20° norther. The spatial resolution varies from 2.8 km/pixel to 2.4 km/pixel.

As on TA high-resolution image, this image presents patches of high contrasted dark and bright materials (with 30% of I/F ratio variations between dark and bright terrains at 2.03 µm). However, it shows radically different features, probably due to its higher latitude. Located outside the large dark terrain, it witnesses a region likely to be different in composition and morphology. Separately, dark and bright regions are homogeneous without any significant sub-structure at this spatial resolution. Dark material forms parallel 10 to 15 km wide lineaments with a large darker patch at the S-W corner of the image. Detailed analysis is underway for interpretating this image including tests to check wether the dark terrains are not depressions filled with fluids.

Conclusions: These images of Titan show that VIMS is an excellent optical instrument for studying the geology of Titan. Complementary SAR data over the same area will be acquired later this year and will be very important to test the first interpretations based on VIMS oservations. Also, the data that will be collected by the Huygens probe will provide ground truth that will help understand Titan's young and complex geology.

References: **[1]** Lorenz R. D. and Mitton J. (2002) *Lifting Titan's veil: Exploring the giant moon of Saturn*, Cambridge University Press. **[2]** Smith P. H. et al. (1996) *Icarus, 119, 336.* **[3]** Brown R. H. et al (2003), *Icarus, 164, 461*. **[4]** Gibbard, S.G. et al, *Icarus,139, 189*. **[5]** Sotin C. et al (2005), *submitted*.

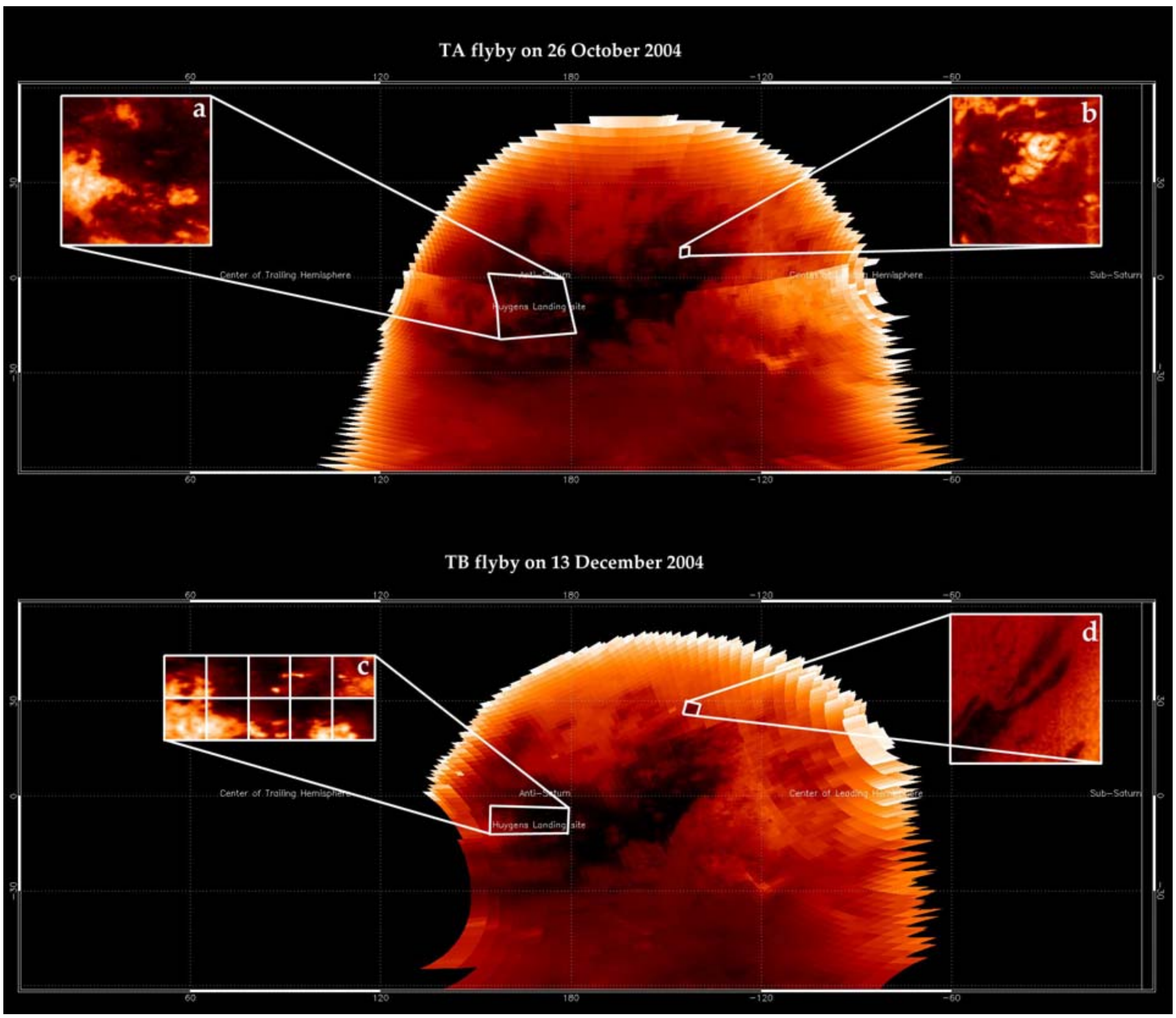

Figure 1. Titan seen by VIMS at 2.03 µm (one of the 7 infrared spectral windows) during the two first flybys by the Cassini mission. Different sets of images with increasing spatial resolution have been used to realize these maps. Insets **a**,**b**,**c** and **d** are highest resolution raw images available from each flyby. In particular, VIMS has mapped the future Huygens landing site at high spatial resolution (insets **b** and **d**).