POSSIBLE DETECTION OF LOCAL ENRICHMENT IN WATER ICE IN THE VIMS OBERVATIONS OF THE HUYGENS LANDING SITE. S. Rodriguez[1], S. Le Mouélic[1], C. Sotin[1], H. Clénet[1], R.N. Clark[2], B. Buratti[3], R.H. Brown[4], T.B. McCord[5], and the VIMS 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@univ-nantes.fr), [2] USGS, Denver Federal Center, Denver, [3] JPL, Pasadena, [4] Lunar and Planetary Lab and Stewart Observatory, University of Arizona, Tucson, [5] HIGP/SOEST, University of Hawaii.

Introduction: The joint NASA-ESA-ASI Cassini-Huygens mission reached the Saturnian's system on July 1st 2004. With 44 planned flybys over the four years of the nominal mission, Titan is a primary target of the Cassini orbiter. Onboard the Cassini spacecraft, the VIMS instrument (for Visual and Infrared Mapping Spectrometer) has proved to be able to successfully pierce the veil of the hazy moon and image its surface in the infrared wavelengths, taking hyperspectral images in the range 0.4 to 5.2 µm **[1]**.

Entirely dedicated to the study of Titan, the european Huygens probe was successfully parachuted on Titan's surface on 14th January 2005. The DISR instrument (for Descent Imager/Spectral Radiometer) onboard Huygens took series of spectra and images of the ever-approaching surface, as it dropped through Titan's atmosphere **[2]**. The high resolution images acquired before the landing provide an inestimable ground truth and will greatly help us to constrain observations from orbit.

With the help of Huygens high resolution views, we discuss the first images of the Huygens landing site acquired by VIMS during the first flyby of Titan. We present preliminary morphological and spectral implications on possible nature of Titan's surface around the Huygens landing site area.

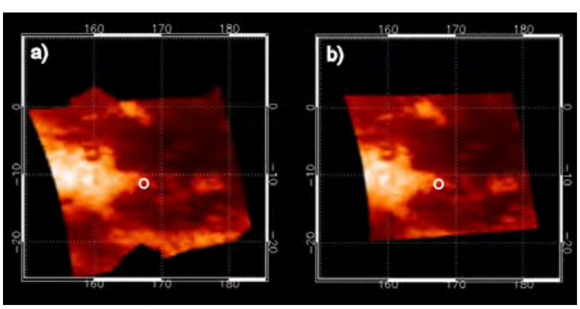

Figure 1. Huygens landing site on Titan seen by VIMS at 2.03 µm (one of the 7 infrared spectral windows) during the the first flyby by the Cassini mission. **a:** Long time exposure image. **b:** Short time exposure image, taking 15 minutes after **a**. The average spatial resolution ranges from 16.2 km to 14.4 km per pixel. The white circle on each image indicates the estimated Huygens landing site (Latitude: -10,3°, Longitude: 167,6°E – **[2]**).

VIMS TA images of the Huygens landing site: The first close flyby of Titan by the Cassini spacecraft (tagged TA) occurred the 26th October 2004. During this flyby, two 64x64 pixels images of the Huygens entry site have been acquired by VIMS with time exposures of respectively 200 and 40 ms. No significant changes are observed between the long and short time exposure acquisitions, which were made 15 minutes apart, suggesting that all features seen on the images belong to the surface. Figure 1 shows the cylindrical reprojection of the 2.03 µm band of the long and short time exposure observations. These cubes were acquired when Cassini was respectively 35000 and 28000 km over Titan's surface, a few hours before TA closest approach, providing a mean spatial resolution around 15 km per pixel.

First order removal of backscattering by aerosols: We propose an empirical approach to remove the fraction of photons reflected by Titan's atmosphere without any interaction with the surface **[3]**. This method relies on three assumptions: first, the scattering haze has a uniform (additive) reflective contribution over the scene at each wavelength; second, the photometric function is approximately independent of wavelength; and third (most important), the atmospheric scattering at 5 µm is negligible. This approach is similar to the one which was used by **[4]** to derive the global offset of Clementine infrared images of the Moon and was already successfully tested on VIMS high resolution cubes **[5]**. Compared with a single scattering model (**[6]** and **[7]**) tested on a realistic Titan's haze, the empirical method gives as well satisfaying results for the TA observations of the Huygens site **[3]**.

Morphological analysis and first implications for surface composition using band ratios: Band ratios, corrected from atmospheric contributions, are particularly useful to cancel out the effects of albedo and illuminating conditions and emphasize subtle spectral variations of Titan's surface. Band ratios corrected from additive haze scattering are shown in Figure 2.

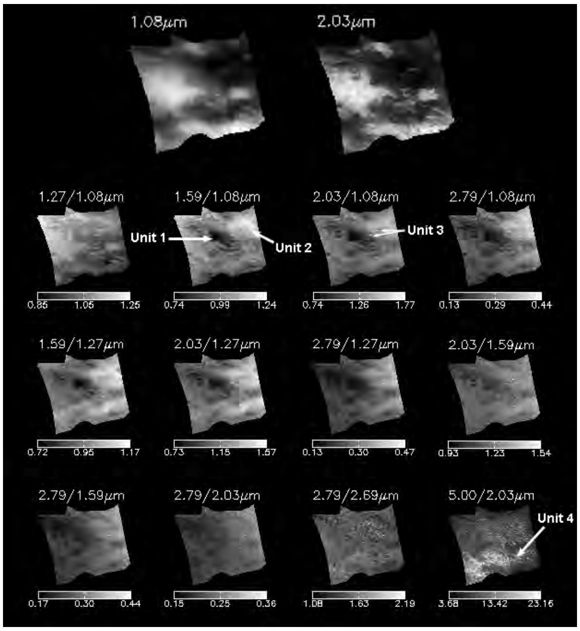

Figure 2. Ratio images empirically corrected from atmospheric haze scattering. As expected, the correlation with albedo has also disappeared. Local heterogeneities disconnected from albedo variations appear in the ratio images. The four main units which appear are displayed on the relevant ratio images.

One of the most striking features is the well spatially delimited dark area (**unit 1** in Figure 2) which appears in the 1.59/1.27 µm image at the center just north east of the large bright structure. This anomalous dark area, disconnected from I/F units observed in single band images, also shows up with the same spatial extension in all corrected ratios involving the 1.59 and 2.03 µm bands. It may indicate a spatially delimited presence of a constituent that absorbs at 1.59 µm and 2.03 µm, and much less at 1.08 and 1.27 µm. In this region, the DISR/Huygens spectral measurements show evidence for reddening **[2]**, similar to what we observe here in the VIMS ratio images.

Enrichment in H_2O ice, upon hydrate state or mixed with a material that globally darkens its spectrum (as tholins) is a good candidate to explain the spectral behaviour of the dark unit 1. This molecule has absorption bands at 1.6 and 2 µm, which are particularly strong and broad in the case of the H_2O ice with large grains sizes, and comparatively higher reflectance in the spectral region between 1 and 1.3 µm. This unit extends to the lower plains where small round pebbles, mainly composed with water ice, were imaged by the Huygens probe **[2]**. This areal enrichment in water ice may be related to what can be detected in the VIMS ratio images of Figure 2.

Apart from unit 1, three other patterns with peculiar spectral behaviours show up in the corrected ratio images:

- A relative bright feature (**unit 2** in Figure 2) appears in the 1.59/1.08, 1.59/1.27, 2.03/1.27 and 2.79/1.08 µm ratio images. It is related to the darkest region we can find in the single band images. That suggests a local exposure of a material more reflective at 1.59 and 2.03 µm than at 1.27 µm. It may be associated with a local depletion in H_2O ice or a coating by a component that globally raises the spectral reflectance at 1.59 and 2.03 µm with respect to the one at 1.27 µm.

- Two strikes, elongated westward, can also be seen in the 2.03 µm image at the centre of the north-east dark unit. These structures are distinguishable in all the ratio images (**unit 3** in Figure 2), except those involving wavelengths where the flux is very low (2.79 and 5 µm in the last row of the Figure 2). They appear bright at all wavelengths. It may be compatible with local CH_4 ice deposits.

- The 5/2.79 µm ratio presents an area 1.5 to 2 times brighter than the surrounding terrains, south of the large western bright structure (**unit 4** in Figure **2**). This area does not appear distinctively on other ratio images and may indicate the presence of materials in a different physical state only distinguishable at longer wavelengths (warmer than the surroundings or composed of thinner grain size ices, witnessing older terrains).

Figure 3 summarizes our first interpretations for the "spectro-"morphological properties we proposed for the Huygens landing area.

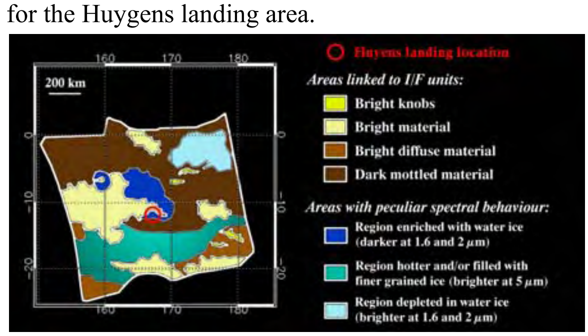

Figure 3. *Geological sketch of the Huygens landing site proposed o**n the basis of albedo and spectral variations in ratio images.***

References: **[1]** Brown R.H. et al (2003), *Icarus, 164, 461*. **[2]** Tomasko M.G. et al (2005), *Nature, 438, Issue 7069, 765*. **[3]** Rodriguez S. et al., *P&SS, accepted*. **[4]** Le Mouélic S. et al. (1999), *J. Geophys. Res., 104, 3833*. **[5]** Sotin C. et al. (2005), *Nature, 435, Issue 7043, 786*. **[6]** Sobolev (1975). Light scattering in planetary atmospheres. *Pergamon Press, Oxford*. **[7]** Combes et al. (1991), *P&SS, **39**, 189*.