EXPLORING METHODS TO RULE OUT SURFACE COMPOSITIONAL TYPES ON TITAN USING CASSINI VIMS T20 DATA. B. J. Buratti[1], K. M. Pitman[1], R. H. Brown[2], J. W. Barnes[2], K. Baines[1], R. Clark[3], R. Jaumann[4], P. Nicholson[5], and C. Sotin[6]. [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109 USA <corresponding author: Karly.M.Pitman@jpl.nasa.gov>, [2]Lunar and Planetary Lab, University of Arizona, 1629 E. University Blvd., Tucson, AZ USA, [3]U.S. Geological Survey, Denver, Denver Federal Center, Denver, CO USA, [4]DLR, Institute of Planetary Research, Rutherfordstrasse 2, D-12489 Berlin, Germany, [5]Cornell University, Astronomy Department, Ithaca, NY USA, [6]Laboratoire de Planétologie et Géodynamique, UMR CNRS 6112, Université de Nantes, 2 rue de la Houssiniere BP 92208, 44322 Nantes cedex 3, France

Introduction: On October 25, 2006, the Cassini-Huygens mission's visual and infrared mapping spectrometer (VIMS, [1]) conducted its T20 flyby of Saturn's largest moon Titan, yielding the highest resolution views to date of Titan's surface features (on the order of 400 meters or greater across) in the 0.35-5.2 micron wavelength range [2]. During the T20 flyby, VIMS observed a region of Titan known as Bohai Sinus ("Pacman Bay;" Fig. 1), a dune-free area that exhibits sharp polygonal boundaries and apparent color differences between bright and dark albedo material. Geomorphology of the region is similar to the Huygens landing site; north-south sinuous patterns (fluvial scour), evidence of features parallel to coastlines (sandbars), and patterns of faint sinuous and arcuate bright features in the dark plains are seen. In Bohai Sinus, there exists an area of bright material transitioning into "dark blue" material (cf. [3]), with an embayment of dark blue material. Some process appears to be responsible for converting the bright terrain in Bohai Sinus into the dark blue terrain type. Fluid flow may be responsible for the transition, with dark plains being interpreted as fluvial deposit and north-south grooving as erosional features. Stratigraphic relationships may be also possible; multiple episodes are suggested. Further understanding of the surface composition through spectral endmember analysis will aid in differentiating between the possibilities for Bohai Sinus' geology.

At this stage of analysis [2], the spectral differences in Bohai Sinus are seemingly related to differences in H_2O abundance. As determined from previous study of Titan Cassini VIMS flybys prior to T20, only a handful of options for spectral endmember composition in addition to H_2O need be considered [4]. The difficulty in making a conclusive spectral identification of surface terrain with VIMS data is that, in the absence of radiative transfer models to remove Titan's atmospheric spectral signature, VIMS sees a partial spectral signature from the surface; of the VIMS instrument's 352 spectral channels, surface I/F signal is only appreciably detected at a few near-infrared bands in the calibrated data due to the obscuring effects of atmospheric methane (CH_4). The goal of this work is to develop methods to recognize patterns in the partial spectral signature of and exclude options for the "missing mass" non-H_2O component for the Bohai Sinus T20 VIMS data.

Methodology: Figs. 1-4 illustrate a preliminary example of a method that may be employed when seeking to exclude spectral endmembers. For Bohai Sinus, we selected one of the high resolution T20 VIMS images (Fig. 1), noted where color differences occurred in the terrain, and extracted representative calibrated I/F spectra from those areas (Fig. 2). For Titan, maxima in the VIMS surface I/F spectra not corresponding to absorption by atmospheric CH_4 can be seen at 0.93, 1.08, 1.28, 1.59, 2.01-2.03 (doublet), 2.73-2.75 (doublet), and 5 microns ("windows"). Because diffraction by aerosols dominates at shorter wavelengths, the 2.73-2.75 microns doublet and 5 micron peak appear better for determining Titan's surface composition, but the full set of windows should be retained when normalizing the VIMS spectrum and isolating the peak bands (Fig. 3). Mixing the laboratory spectra of water ice and another putative Titan constituent, tholin, in a checkerboard model and isolating the same methane window bands, increasing the tholin content drives the modeled partial spectral signature farther away from the VIMS spectrum of the average terrain in Bohai Sinus (Fig. 4). Further analysis along these lines may yield new insights into understanding the composition of Titan's surface.

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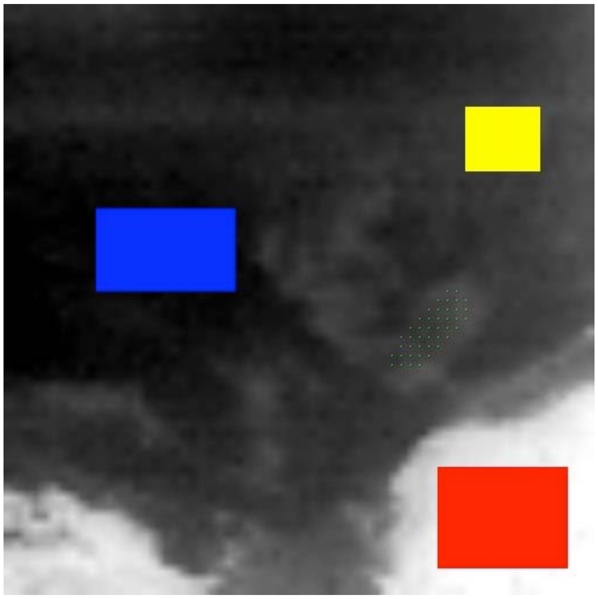

Fig. 1: A 64 x 64 pixel VIMS image of Bohai Sinus (“Pacman Bay”), acquired during Cassini’s T20 Titan flyby (sequence 031TI, observation COMPMAP101, VIMS prime, 80 ms integration time). The phase angle was 12 degrees; spacecraft range was 3886 km. Color differences are seen between bright and dark albedo terrains within Bohai Sinus; colored boxes indicate areas for which VIMS spectra were extracted for further analysis.

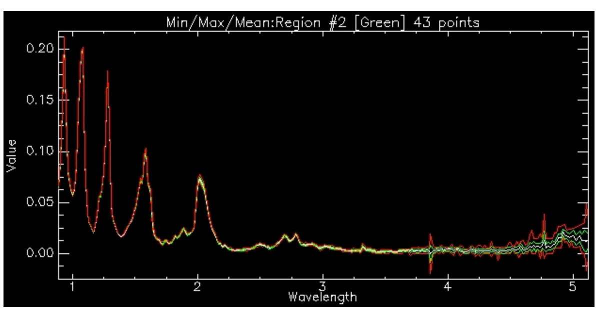

Fig. 2: Calibrated I/F as a function of wavelength for the average terrain in Fig. 1 (“ReefOutflowAvg” in Figs. 3, 4). The spectrum displays peaks not seen in other Titan surface spectra prior to T20.

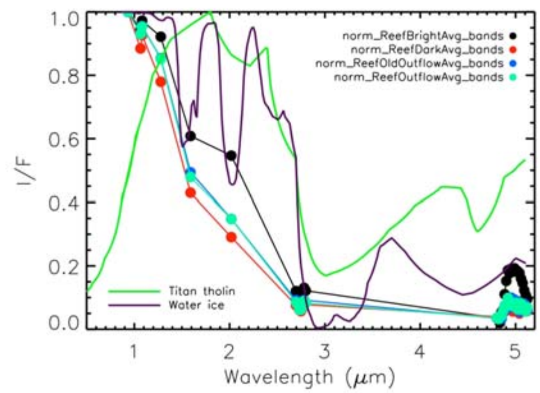

Fig. 3: For the T20 VIMS spectra, the mean I/F from terrain in each colored region of Fig. 1 was first normalized, then wavelength bands at the methane windows were isolated (colored dots) to characterize the gross spectral behavior of the terrains. Laboratory reflectance spectra of Titan tholin (green line) and water ice (purple line) were regridded to VIMS wavelength bins via cubic spline interpolation.

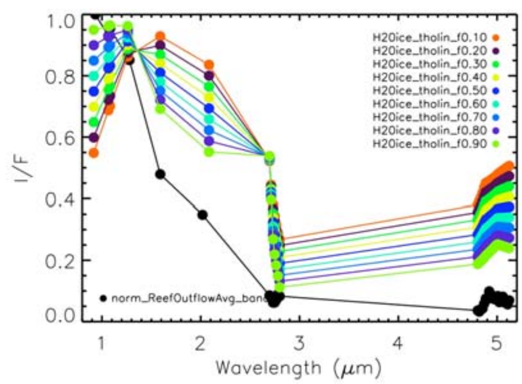

Fig. 4: Preliminary checkerboard model of two-component mixtures of Titan tholin and water ice, as compared to normalized VIMS surface signatures from T20. “fX.XX” indicates the percentage of water ice in each mixture (i.e., “f0.10” is 10% water ice, 90% tholin). Water ice is a better match than tholin to the gross behavior of the average terrain.

References: [1] Brown R. H. et al. (2004) *Space Sci. Rev.*, *115*, 111–168. [2] Brown R. et al. (2006) American Geophysical Union Fall Meeting 2006, Abstract # P11A-02. [3] Soderblom L. A. et al. (2006) American Astronomical Society, DPS meeting # 38, Abstract # 52.08. [4] McCord T. B. et al. (2006) American Astronomical Society, DPS meeting # 38, Abstract # 48.05.