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# Titan: Surface Compositional Units from the Cassini Visual and Infrared Mapping Spectrometer (VIMS)

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Titan's surface composition is difficult to study remotely due to its thick, absorbing, hazy atmosphere. Its general bulk composition is inferred to be mostly water and silicates, from the bulk density and theories about the materials available at formation. Thermal evolution models indicate that Titan is differentiated, which means that water should be concentrated nearer the surface and silicates nearer the center. Surface deposits of organic compounds have been suggested due to UV-induced photochemistry in the methane-rich atmosphere. The atmosphere is strongly scattering, especially toward shorter wavelengths, due to aerosols from the UV photolysis, and it also absorbs strongly, due to methane. Nevertheless, the surface can be observed, even in the visual part of the spectrum through the haze but only in narrow spectral regions between the methane absorptions. Observations have been made of the integral Titan disk using Earth-based telescopes and the surface reflectances derived were reported to be consistent with dirty water ice as a major constituent (1). Recent Cassini Mission Visual

and Infrared Mapping spectrometer (VIMS) observations resolved individual surface features and showed that there are spectral and therefore likely compositional units on the surface (2). By several methods, spectral albedo estimates within methane absorption windows between 0.75 and 5 $\mu$m were obtained for several different surface units. Of the spots studies, there appears to be two compositional classes present that are associated with the visually darker and the brighter materials, with more spectral variety among the brighter regions. One region is unusually bright at 2.8 and 5 $\mu$m. These Titan spectra were compared with laboratory and calculated spectra of several different candidate materials. Our results (2) suggest that water ice, perhaps contaminated with a darker material that is red in the visual range, matches the reflectance of the Titan regions that are visually darker. The brighter regions studied are not matched by water ice, pure or in mixtures that allow the water ice spectral features to be discerned or by pure or mixed unoxidized tholin or by the simple organic materials so far studied. In addition, we find, as do other investigators, that the 2.8-$\mu$m methane absorption window is complex and seems to consist of two weak windows at 2.7 and 2.8 $\mu$m (2, 3). Thus, the surface reflectances derived so far may be revised later as atmospheric scattering and absorption models improve.

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