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Abstract:

Cassini studies of the surface of Titan are beginning to reveal its nature. In addition to hills, channels, and cobbles seen by the *Huygens* probe [1], the Visual and Infrared Mapping Spectrometer (VIMS) and RADAR instruments on-board the orbiter have seen sand dunes [2, 3], channels [4, 3], mountains [5, 6], and cryovolcanic candidates [7, 8, 9]. Recently the RADAR team announced the discovery of possible lakes near Titan's north pole [10]. While this inventory of surface features and their morphologies is underway on Titan, the underlying geological and chemical processes that control those features remain poorly understood.

The combination of geomorphologic information from high-resolution RADAR coverage (∼ few hundred meters/pixel) with spectroscopic information from VIMS at more moderate resolution (∼ few km/pixel) can simultaneously address the geological and chemical processes of a given site on Titan's surface. We used VIMS data from *Cassini*'s T9 titan flyby on 2005 December 26 and RADAR SAR coverage from T13 on 2006 April 30; together these datasets allow evaluation of the composition of the same mountains and channels that were separately identified morphologically.

Figure 1 shows one of our study areas near the equator and east of Xanadu. Sinuous channels seen in the RADAR map correlate with dark blue subpixel linear markings seen by VIMS – both instruments see the same channels. These particular channels are rough as seen by RADAR, making them similar to those seen by *Huygens* but distinct from channels seen near the north polar lakes. The spectral signature of these particular channels matches that of the dark blue materials seen near the *Huygens* landing site [11] and elsewhere on Titan [3]. Assuming that each channel-containing pixel represents a mixture of dark blue and the surrounding equatorial bright terrain, we obtain fill fractions that we interpret as the spatial width of the channels (Figure 1d). The interpreted width of these particular channels is between 500 and 2000 meters, values consistent with those measured directly from higher resolution VIMS imaging in Bohai Sinus on T20 [12].

Regions containing mountain peaks and flanks in the radar view correlate with slightly bluer VIMS spectra (filled brown regions, Fig. 1d). These are seen as bright/dark banding and layover, indicators of steep flanks of summits, and as radar-bright aureoles, likely eroded materials surrounding the peaks. Other RADAR-rough regions that may also be mountains (but not ones high enough to display unambiguous evidence of such) also appear bluer than equatorial bright terrains. RADAR/VIMS overlap elsewhere does not always show the correlation. The spectral signature of the mountains is consistent with a slight enhancement in water-ice based on the increased absorption at 1.6, 2.0, and 5 microns relative to 1.3 microns.

Taken together, these observations allow us to propose a model for the processes affecting Titan's surface, at least in this area. (1) The chemical composition of Titan's crust in this area is predominantly water-ice. (2) Chemical weathering, haze deposition, or some other process coats the surface in the equatorial bright regions. Though the chemical nature of the coating mentioned in point (2) is not understood, it has been proposed to represent bright tholins [13]. (3) A higher rate of mechanical erosion in mountainous regions reveals a surface with a higher water-ice exposure percentage. (4) Highly mechanically altered weathering products, possibly cobble-sized water-ice rocks, are washed into and down channels. (5) The channels' output creates the dark blue spectral units present on the eastern side of bright regions near Titan's equator.

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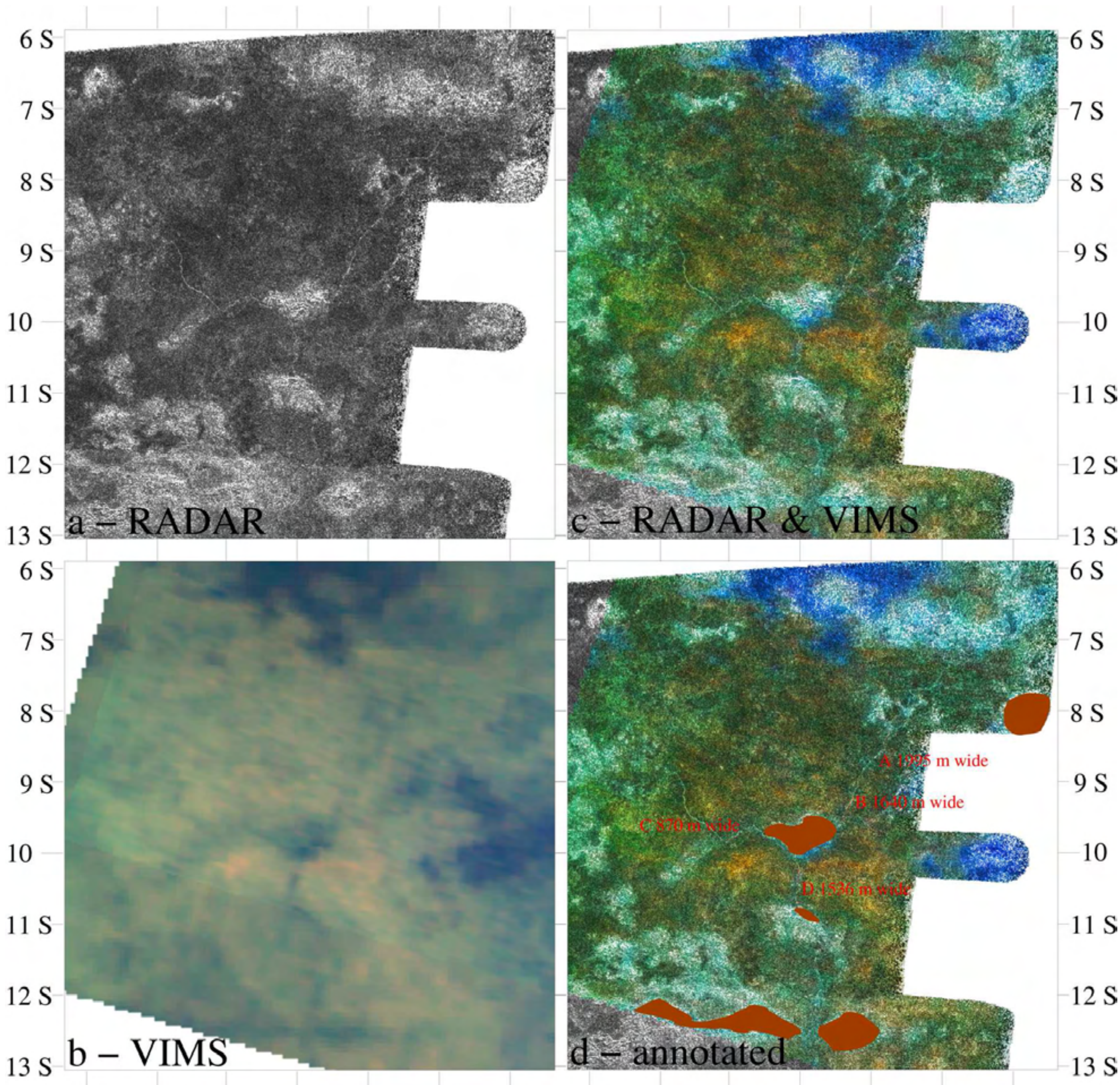

Figure 1: The *Cassini* RADAR SAR view east of Xanadu (a) from T13 is shown along with the view from the *Cassini* Visual and Infrared Mapping Spectrometer (b) of the same area obtained on T9 and shown with $5~\mu m$ as red, $2~\mu m$ as green, and $1.3~\mu m$ as blue. In (c) we show the combined view using RADAR for intensity and VIMS for coloration. The spectrally-derived spatial width of selected channels is shown in (d). Areas in brown (d) represent regions that display mountain-like aspects to RADAR and appear bluer than the surrounding equatorial bright terrain to VIMS.