**MAPPING OF TITAN: FIRST RESULTS FROM THE CASSINI RADAR.** E.R. Stofan[1], C. Elachi[2], R. Lopes[2], R. Lorenz[3], R.L. Kirk[4], F. Paganelli[2], C.A. Wood[5], S.D. Wall[2], J. Lunine[3], L.A. Soderblom[4], and the RADAR Science Team, [1]Proxemy Research, PO Box 338 Rectortown VA 20140 ellen@proxemy.com, [2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA 91109; [3]Lunar and Planetary Lab, University of Arizona, Tucson, AZ 85721-0092; [4]US Geological Survey, Flagstaff, AZ 86001; [5]Planetary Science Institute, Managua, Nicaragua Branch.

**Introduction:** Like Venus, the surface of Titan is hidden from view, with little known about its geology prior to Cassini [1]. The first Synthetic Aperture Radar (SAR) swath across the surface of Titan has revealed a surprisingly complex surface, with few features that can be reliably identified as impact craters [2-5]. More detailed reports on the results of the first radar encounter with Titan can be found in this volume [3, 5-9].

**Background:** The Cassini Radar imaged about 1% of the surface of Titan during its first encounter (Ta) in October of 2004, with a second swath to be obtained in February 2005 (T3) (Fig. 1). The Ta encounter was the first of 23 close flybys of Titan on which SAR data of Titan will be obtained. The Ta SAR swath extends from 32°N, 133°W to 29°N, 12°W, covering 9.4 x $10^5$ $km^2$ [2]. The planned T3 swath will lie to the south of the Ta swath and, unlike Ta, will overlap remote sensing data obtained by other Cassini instruments.

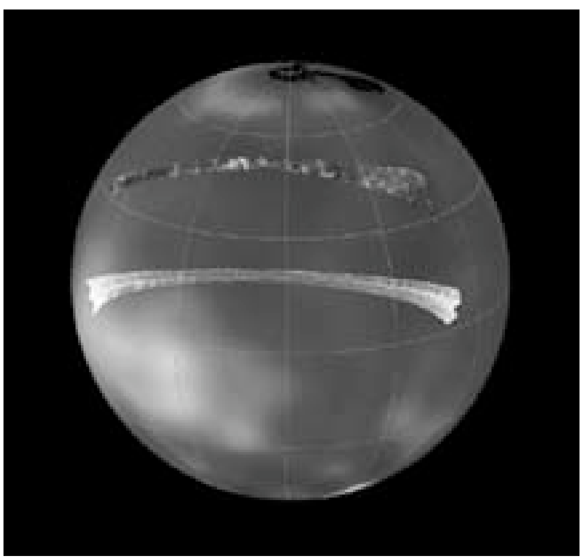

Fig 1. The Ta swath is seen superposed on a globe of Titan overlain with HST data. The southern swath shows the location of the T3 radar swath.

The Cassini radar is a multimode Ku-band (13.78 GHz, $\lambda$=2.17 cm) instrument with four operating modes (scatterometry, radiometry, imaging and altimetry) [2-4]. The SAR mode is used at altitudes below 4000 km, with spatial resolution from about 400 m to 1 km. A swath 120-450 km wide is created from 5 antenna beams. SAR coverage at Titan is dependent on spacecraft range and orbital geometry.

Radar backscatter variations in SAR images can generally be interpreted in terms of variations in surface slope and surface roughness. The dielectric properties of the surface also affect the returned radar signal. On Titan, the likely surface materials (ice, ammonia-water ice mixtures, hydrocarbons, tholins) are very different from those of bodies previously imaged with planetary radars, and volume scattering may be significant [1-4].

**Ta SAR Data:** The Ta SAR swath reveals a geologically complex surface, with a number of distinct units and features. We have mapped five basic surface units, based on brightness variations, general planform shape and texture [2]. These units are not yet classified as rock (ice) stratigraphic units, as we do not fully understand the causes of the variations in radar brightness (i.e., composition, volume scattering effects, roughness).

*SAR Units*. The two dominant units in the SAR swath are a homogeneous unit and a mottled unit. The homogeneous unit has relatively low backscatter and is not completely featureless (Fig. 2). Within the homogeneous unit, there are scattered bright spots and patches of variable backscatter with indistinct boundaries. The mottled unit has moderate to bright backscatter and gradational boundaries. The mottled unit occurs in patches ranging from 10s to 100s of km across. Both of these units may be fractured ice or ice with bubbles or lenses [2].

One of the most intriguing units is the bright lobate unit, which occurs in several locations in the Ta swath (see Fig. 2, Lopes et al., this volume). Both sheet-like and digitate examples of the unit have been mapped, each with boundaries varying from distinct to gradational. The unit also tends to have variable brightness. We have mapped two occurrences of the unit in close association with circular features. We interpret this unit to represent cryovolcanic flows [2, 7].

The bright lineated unit has parallel, bright lineations spaced 1-2 km apart (Fig. 2). The unit has relatively distinct boundaries, and is found as a relatively small (<150 km across) unit in two locations. This unit may be fractured ice, possibly similar to grooved terrain seen on other icy satellites [2].

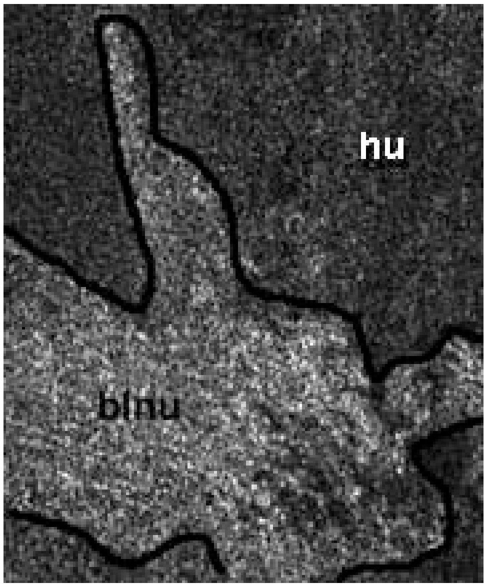


Fig. 2. Bright lineated unit (blnu) surrounded by homogeneous unit. (hu)

A dark mottled unit is the fifth unit we have mapped (Fig. 3). This unit forms patches 10's-100's km across. The dark patches are most commonly irregular in shape, though in several places they form crescent or oxbow shapes (see Fig 1, Lorenz et al., this volume). The dark patches within this unit may be ponds or smooth deposits of hydrocarbons [2, 9].

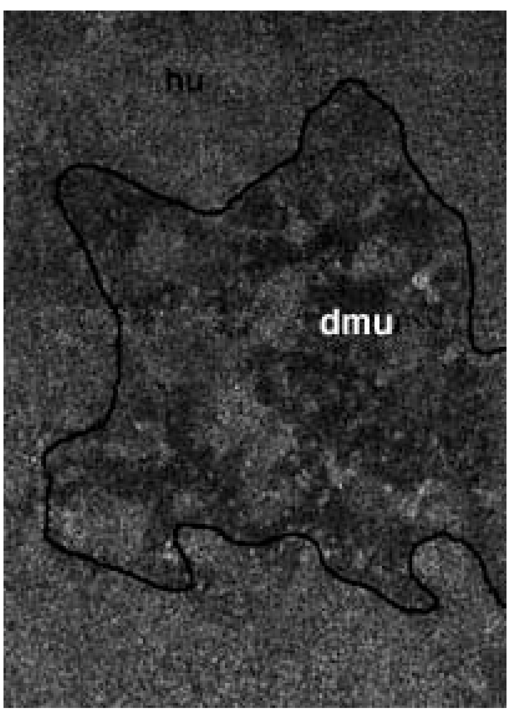


Fig. 3. Dark mottled unit (dmu) with the homogeneous unit (hu).

*Features*. In addition to the units described above, a number of distinct features can be seen in the SAR swath. Circular features of possible impact or cryovolcanic origin are described in this volume by Wood et al. [5] and Lopes et al. [7]. At this time, a cryovolcanic origin is favored for most of the circular features in the Ta swath.

Sinuous lineaments can be mapped at several locations within the Ta radar swath, some associated with fan-shaped deposits (see Fig. 4, Paganelli et al., this volume) [8]. Many of the sinuous features occur in pairs, suggesting they are channels. The origin of the channel-like features and fan-shaped deposits is likely related to the transport and deposition of material; possible transport mechanisms include slope-related processes, cryovolcanism, or hydrocarbon fluid flow.

**Implications:** While we have mapped only about 1% of the surface of Titan with the Cassini radar, we have been surprised at the paucity of impact craters, the lack of large bodies of liquid, and the variability of the surface. While much of the first radar swath is composed of mottled to homogeneous units probably representing some form of ice, regions of high complexity with channels, apparent flows and fan-shaped deposits can be mapped. All of this suggests that Titan has been recently geologically active. The most likely resurfacing process based on our initial view of Titan is cryovolcanism, but burial by stratospheric photochemical materials or aeolian deposits are also possible.

**References:** [1] Lorenz R (2002) Lifting Titan's Veil, Cambridge Univ. Press, 260 p. [2] Elachi C. et al. (2005) *Science* (submitted). [3] Elachi C. et al., this volume. [4] Lorenz R. et al. (2004) *Trans. AGU*. [5] Wood C.A. et al. (2005), *LPSC XXXVI*, this volume. [6] Kirk R. et al. (2005), *LPSC XXXVI*, this volume. [7] Lopes R. et al. (2005) *LPSC XXXVI*, this volume. [8] Paganelli, F. et al. (2005) *LPSC XXXVI*, this volume. [9] Lorenz R et al. (2005) *LPSC XXXVI*, this volume.