VARIED GEOLOGIC TERRAINS AT TITAN'S SOUTH POLE: FIRST RESULTS FROM T39. E.R. Stofan[1], C. Elachi[2], J.I. Lunine[3] R.D. Lorenz[4], R.L. Kirk[5], R.M. Lopes[2], C.A. Wood[6], J. Radebaugh[7], S.D. Wall[2], K.L. Mitchell[2], L.A. Soderblom[5], P. Paillou[8], T. Farr[2] B. Stiles[2], P. Callahan[2], and the RADAR Science Team, [1]Proxemy Research, PO Box 338 Rectortown VA 20140 & Dept. of Earth Sciences, UCL London UK WC1E 6BT 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; [4]Space Dept., John Hopkins University Applied Physics Lab Laurel MD 20723; [5]US Geological Survey, Flagstaff, AZ 86001; [6]Planetary Science Institute, Tucson, AZ 85701 & Wheeling Jesuit University, Wheeling, WV 26003; [7]Dept. Geological Sciences, Brigham Young University, Provo UT 84602; [8]Observatoire Aquitain des Sciences de l'Univers UMR 5804 33270 Floriac France.

Introduction: The T39 pass by the Cassini spacecraft on December 20, 2007 allowed the first radar imaging (λ=2.17 cm) of the south pole of Titan. The returned data swath extends from about 30°S, 20°W to 27°S, 218°W, with an average swath width of 150-580 km. The total swath length is about 5600 km, with spatial resolution from about 400 m to 1 km. The region exhibits extremely varied and in some cases complex surface morphologies, indicating that a range of geologic processes have operated, and are operating, in the region.

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 (water ice, possibly with ammonia in places, dry ice, hydrocarbons, tholins) are very different from those of bodies previously imaged with planetary radars, and volume scattering is likely to be significant [1-4].

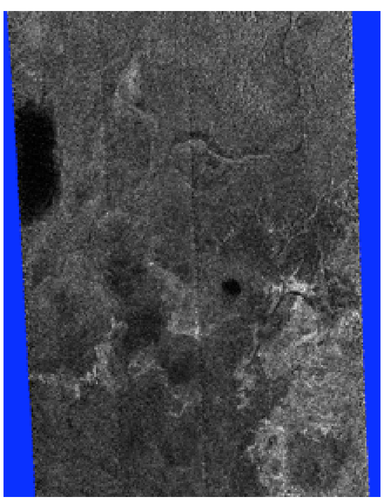

Fig. 1. Portion of T39 swath obtained by the Cassini spacecraft. This SAR image is centered near 86S, 201 W and covers an area of 220 by 170 km. The two very dark features are interpreted to be methane lakes.

Swath Overview: The T39 swath contains no features that can be unequivocally identified as impact craters, similar to much of the surface of Titan imaged by radar [2, 3, 5]. None of the area covered by the swath shows dunes; similar to the north polar regions where dunes are largely absent. It does contain two very dark features (Fig. 1) both of which are associated with channel-like features. The very low radar return indicates that the features are likely to be filled with liquid methane and/or ethane [6]. Unlike most lakes in the northern hemisphere, these lakes have relatively diffuse shorelines. While the T39 swath does have a few other features that can be interpreted as empty or drained lakes, the density of lake features is much lower than typically seen in the northern polar region. The steep-sided depressions common near the North Pole [6] and often containing lakes or dried lakes are largely absent here. However, portions of the dissected terrain described below are interrupted by broad, relatively sharp-edged, apparently flat-floored valleys filled with smooth material. Hypotheses for the formation of these broad valleys include extension, or erosion due to a flowing liquid or solid material [e.g., 7]. The smooth material within the depressions may be sediments deposited in standing bodies of liquid that have now drained/evaporated.

The T39 swath is dominated by dissected terrain, mountainous terrain, mottled plains and channels. The distribution and character of each of these are discussed briefly below.

Dissected terrain. The bottom half of Fig. 2 is characterized by a region of rugged, dissected terrain, located near the South Pole. Relatively short drainages, some with rounded heads, appear to have eroded apparently high standing terrain. Between many of the river valleys are flat-topped interfluves. The rounded heads of some of the valleys may indicate that sapping, along with rainfall, has contributed to the formation of the drainages. On a larger scale, the dissected terrain is cut by broad, flat-floored valleys described above. The dissected terrain differs from other rugged terrain mapped by radar on Titan, and here is concentrated near the pole in two separate areas.

Mountainous terrain. In the upper portion of Fig.2, mountainous terrain surrounds a low-lying, radar-dark area drained by channels. The dark area is above the noise floor, and is thus unlikely to be liquid-filled. The mountainous terrain has a crinkly texture in the radar data similar to mountainous terrain seen elsewhere on the planet, particularly in Xanadu and mountainous terrain near the North Pole [8, 9]. We interpret this terrain to be eroded mountains formed by some unknown tectonic process earlier in Titan's history, then eroded extensively, likely by methane rainfall. Fragments of this terrain can be identified throughout the T39 swath.

Fig. 2. Portion of T39 swath near Titan's South Pole. This SAR image is centered near 76.5S, 32.5 W and covers an area of 620 by 270 km.

Mottled plains. Much of the T39 swath is characterized by apparently flat-lying plains regions with a mottled texture in the SAR image. These are similar to mottled plains seen elsewhere by the Cassini Radar on the planet (e.g., 1-3). The mottled plains material embays the mountainous terrain, and in some cases, may be material shed from the mountains. In some places in the swath, the mottling becomes much more pronounced, similar to terrain in the central portion of the T7 swath and mottled terrain to the east of Ganesha Macula that was mapped in Ta. In T39, some of the radar-bright patches are associated with channels (as also seen in T3), indicating that some combination of erosion and deposition has roughened the surface.

Channels. Several types of channels can be identified in the T39 swath: long, broad sinuous channels, long, narrow sinuous channels, short, round-headed channels, and short, sinuous to straight channels. The long, sinuous channels are located in the mottled plains, and tend to be more meandering. Some of these channels are associated with filled or apparently empty lake basins. The shorter, more chaotic drainages are associated with the mountainous and dissected terrain. Some of the meandering channels have radar-bright edges, indicating that they are incised into, and thus able to erode, the underlying terrain. A number of channels converge on a broad circular bright area that seems to be a basin.

Conclusions: The south polar region of Titan contains a variety of distinctive geologic terrains, some of which have not been seen elsewhere on Titan. This swath across the region contains fewer lakes than in a typical swath across the north polar area, leading us to tentatively conclude that the southern polar region has fewer filled lakes, consistent with liquid methane seasonal variations [10]. The possible paucity of dried lakes compared to a similar swath in the northern hemisphere may imply that the presence or absence of lakes is not completely controlled by seasonal climate. Some of the river channels draining apparently empty lakes, such as near the top of Fig. 2, are broader and more meandering than channels seen elsewhere on Titan, and there are more channels in this region than at the North Pole, although channels in the north may be obscured by filled lakes. The dissected terrain is morphologically distinct from the mountainous terrain that is seen elsewhere on the planet. The flat-topped mesa-like features within it suggest erosion of relatively flat-lying layers. The broad valleys cutting this terrain are particularly intriguing, and we are currently considering a number of possible origins for them, including glacial-type flow of some sort of solid material (e.g., 7). We look forward to more coverage of the south polar region in Cassini's proposed extended mission, to allow a better understanding of the distribution and origin of these terrains.

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