CLASSIFICATION OF LABYRINTH TERRAINS ON TITAN. M.J. Malaska[1], R.M.C. Lopes[1], K.L. Mitchell[1], J. Radebaugh[2], T. Verlander[3], A. Schoenfeld[4]. [1]Jet Propulsion Laboratory / California Institute of Technology, Pasadena, CA. [2]Department of Geological Sciences, Brigham Young University, Provo, UT. [3]Northeastern State University, Broken Arrow, OK. [4]University of California, Los Angeles, CA. (Michael.J.Malaska@jpl.nasa.gov).

Introduction: The enigmatic labyrinthic terrains of Titan are defined as elevated highly-dissected plateaux with intersecting valleys or remnant ridges of low to medium backscatter[1,2] From radar emissivity, they appear to be large plateux composed of low-dielectric constant organic materials[2,3]. Sikun Labyrinthis (Fig. 1) located in the southern polar region of Titan is one example of a labyrinth terrain [1].

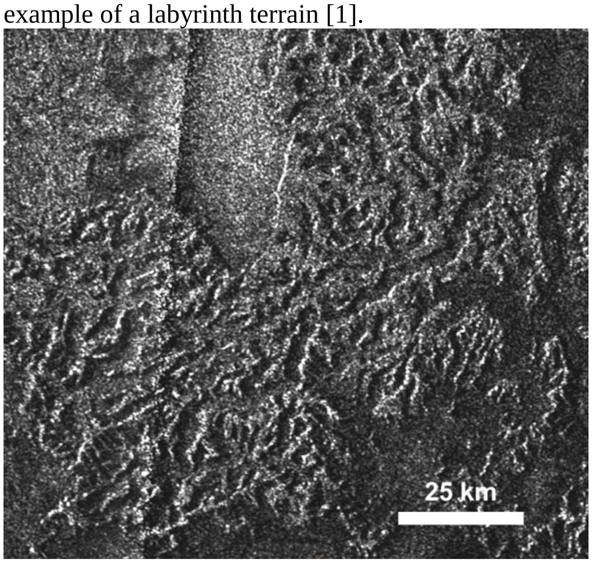

Fig. 1. SAR image of the southwest portion of Sikun Labyrinthus. Radar illumination is from the left, north is towards the top. Image is centered at (78°S, 32°W.)

As part of a global mapping effort of Titan's surface [4,5], as well as a desire to understand the formation and evolution of the labyrinth terrains, we determined a classification system for the observed labyrinths present on Titan's surface.

Methods: Using a set of Synthetic Aperture Radar (SAR) mosaics from the Cassini mission through the T120 radar pass, labyrinth terrains were identified, mapped, and characteristics recorded using ArcGIS functionalities. Valley slopes were identified by examining radar illumination geometries and noting bright-dark paring on sides of plateau or ridges. Slopes facing away from the direction of radar illumination exhibit downrange-darkening, while slopes facing towards the direction of radar illumination exhibited uprange brightening. The average spacing between valleys in a labyrinth terrain area was measured from the thalwegs of neighboring valleys. Mutiple measurement were made at diverse locations in the labyrinth terrain and the results averaged. The average amount of valley area was estimated across the labyrinth area and the value recorded. Many labyrinth terrains exhibit valleys and valley networks that are closed and internal to the labyrinth at the scale of Cassini SAR data (200 m per pixel). The areal percent closed valleys as a percentage of total area was recorded. A database of labyrinth terrain measurements was developed and the valley spacing (in km), valley areal percent (%), and areal percent closed valley (%) were used to characterize the labyrinth terrains.

Results: Over 187 labyrinths were identified, accounting for a little over 1% of the total surface area of Titan. A 3D plot of measured characteristics of all the Titan labyrinths is shown in Fig. 2.

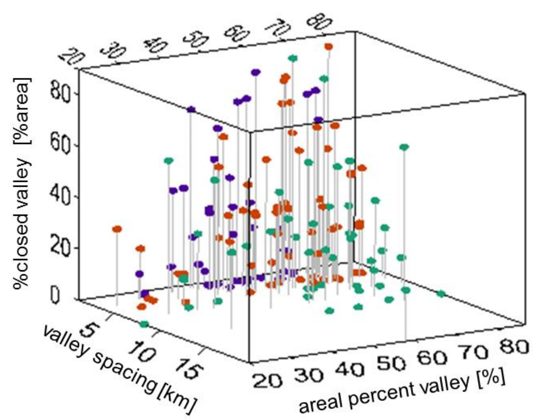

Fig. 2. 3D plot showing labyrinth characteristics for all identified labyrinths on Titan. Points are colored by valley spacing measurements purple = 1-3 km; orange = 3-5 km, green = >5 km. Lines from the points drop to the plane showing valley spacing and areal valley percent.

The areal percent of closed valleys versus areal percent of valley area for a subset of a labyrinth terrains with valley spacing from 4.2 – 5.2 km is plotted in Fig. 3. SAR images for representative labyrinths from several classes are shown. With a given valley spacing, as the valleys become wider, the valley areal% will increase and the labyrinth terrains will progress from incised plateau, to valleys and plateau, to remnant ridges. If the network is open, the plateau and ridges will have an open aspect such as those seen in the Sikun and T23 (informal name) Labyrinth. If the network is closed, the plateau and remnant ridges will resemble that of Ecaz Labyrinthus.

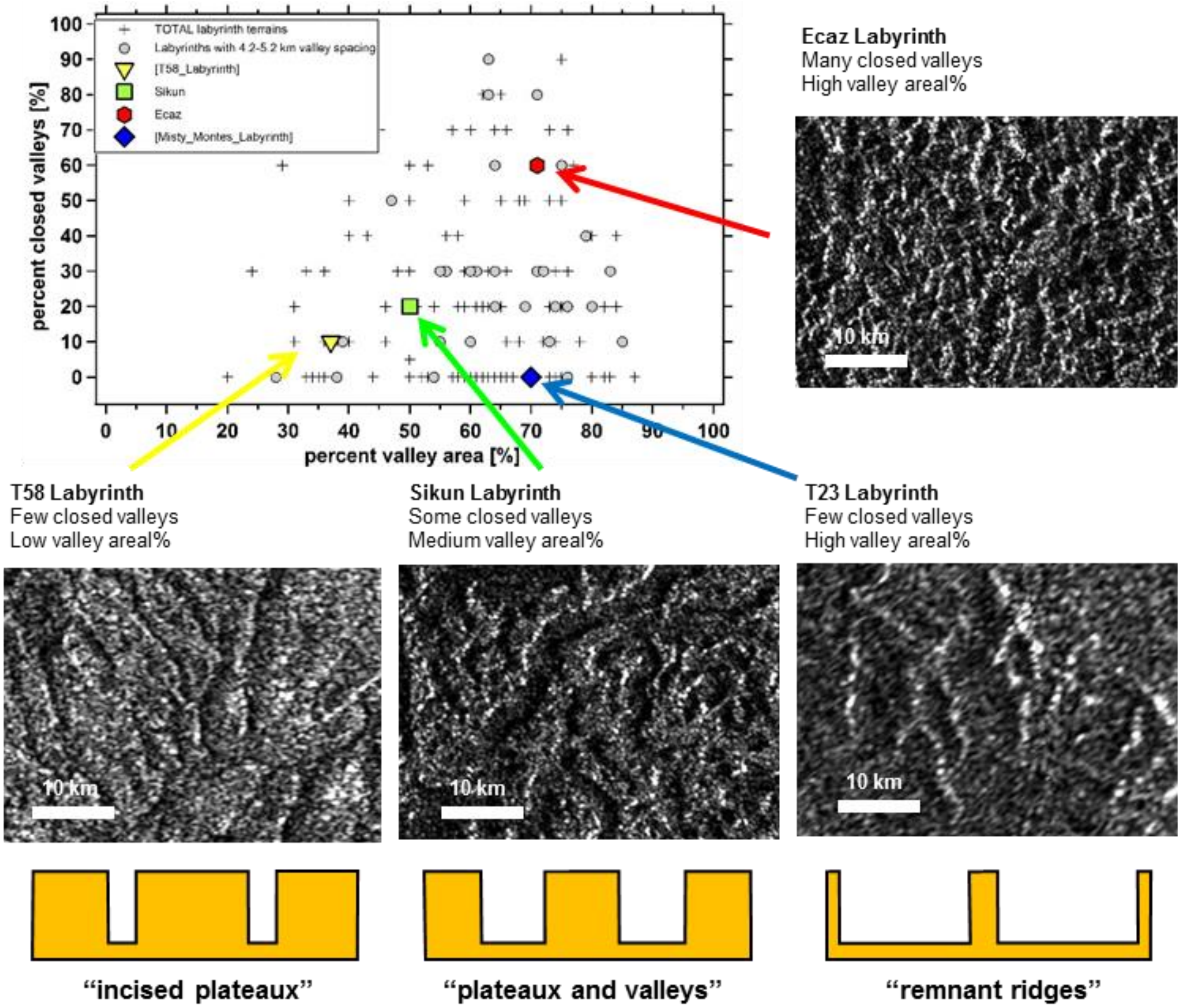

Fig. 3. Plot of closed valley areal% vs. total valley areal% for labyrinth terrains with valley spacing from 4.2 km to 5.2 km. SAR images of example labyrinths shown. Images are oriented so that radar illumination is from right, drainage roughly towards bottom. Graphic shows stylized valley profile for selected labyrinths.

Interpretation: The valley spacing is a characteristic of the terrain, likely the result of jointing and hydrologic parameters. The valley areal% is a reflection of the erosion state, with channels eroding into valleys which widen to give remnant ridges, which utlimately yields to plains as the ridges are eroded away [5,6]. The presence of closed valleys suggest removal by processes other than surface fluvial transport. On Earth, closed valleys are diagnostic for karstic dissolution processes [7]. Closed valleys on Titan suggest removal of material through either sublimation, dissolution, or subsurface flow [1,5,8,9]. Ecaz Labyrinthus and other labyrinths in that parameter space have a strong morphological resemblence to polygonal karst terrain on Earth [1,10]. Our inventory and classification system of labyrinth terrains will aid in the study and interpretation of the processes that created these features.

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