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Titan's Radial Labyrinths

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Abstract

We describe a subset of Titan labyrinth terrains as radial labyrinths. These are highly dissected plateaux characterized by a radial valley network system extending outwards from the center of the terrain. They are all found clustered in two mid-latitude locations: one in the northern hemisphere and another one in the southern hemisphere. Each cluster is associated with rare cross-cut hummocky terrains (formerly referred to as “Hot Cross Buns”), suggesting a relation between the two types of units.

1. Introduction

Titan is a complex world with a wide diversity of surface terrain classes, including mountains, plains, dunes, labyrinth terrains, hydrocarbon lakes, and rare craters [1]. The labyrinth terrains of Titan are defined as elevated, highly-dissected plateaux with intersecting valleys or remnant ridges of low to medium backscatter [2,3]. From radar emissivity, they appear to be large plateaux composed of low-dielectric organic materials [2,3].

As part of our global mapping of Titan, we classified several types of labyrinth terrains: valleyed labyrinths, polygonal labyrinth, finely dissected labyrinths, and an outlier labyrinth style in Xanadu – Kronin Labyrinthus. Each of these labyrinths had valley networks that display organized rectangular to dendritic drainage networks in the labyrinth area or in subsections of the labyrinth. During our mapping, we noted several labyrinths that had roughly circular plan form with clear radial valley networks. These we split out as a separate subgroup called radial labyrinths.

2. Radial labyrinths

The radial labyrinths are roughly circular to oval in planform, usually from 100-200 km across in the longest dimension. They are roughly dome shaped and elevated several hundred meters above the surrounding terrain. Anbus Labyrinthus [39.3°N, 215°W] is a type example shown in Figure 1.

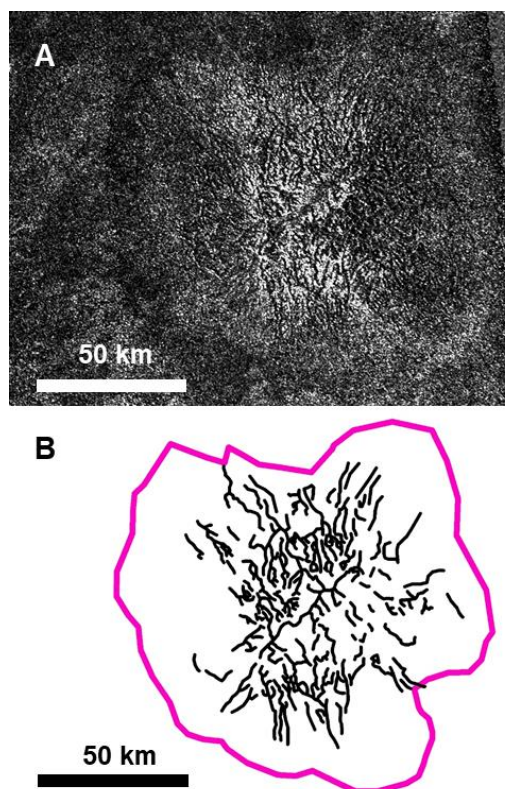


Figure 1: A) Cassini Synthetic Aperture Radar (SAR) image of type radial labyrinth Anbus Labyrinthus. B) Annotated valley trace (black lines) and outer contact with undifferentiated plains.

2.1 Localization

Radial labyrinths are found in the mid-latitudes, but not in the polar regions, unlike many of the other labyrinth terrain unit types. They are found in two clusters: one is located at [40°N, 205°W] in the Afekan region, and another one near [50°S, 20°W] in the Tseghi region.

2.3 Characteristics

Like the other labyrinth terrains, the radial labyrinths have high microwave emissivity, interpreted to be consistent with a composition of low-dielectric organic materials [4]. Spectral analysis using the Cassini Visual and Infrared Mapping Spectrometer (VIMS) suggests a thin coating of water ice materials similar to other labyrinth units and the undifferentiated plains [5].

2.3 Associations

Radial labyrinths are always found associated with undifferentiated plains. The plains units are found at the downstream termini of the valleys. Interestingly, the three cross-cut hummocky terrain units found on Titan are associated with the radial labyrinth terrain clusters. The cross-cut hummocky terrain units are both roughly the same size and planform of the radial labyrinths.

In one of the cross-cut hummocky units (Fig. 2), a small section of valley network consistent with a section of labyrinth terrain can be discerned. This observation is consistent with a causal relationship between the two units, with the cross-cut hummocky terrain being the end-stage that followed removal of the central section of labyrinth terrain after uplift as suggested by Schurmeier et al (2018) [6]. In this modified scenario, the cross-cut hummocky unit is revealed as a remnant following labyrinth unit uplift, erosion, and plateau removal.

3. Summary and Conclusions

We describe a subtype of Titan's labyrinth terrain. The terrain units may be part of an evolution sequence involving the cross-cut hummocky terrain in Titan's mid-latitude region.

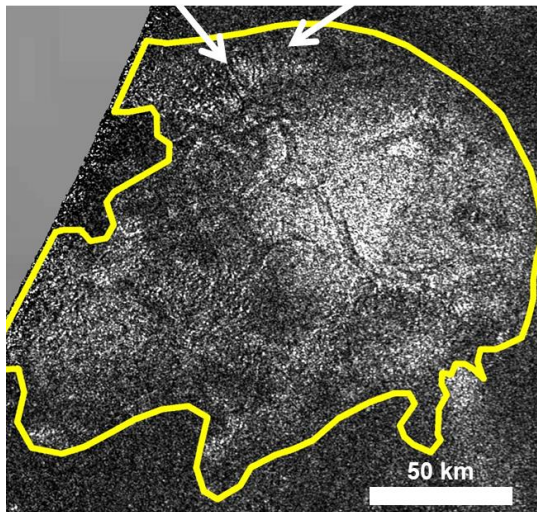


Figure 2: Cross cut hummocky terrain at (38°N, 203.6°W) near the Afekan radial labyrinth cluster. Yellow line shows outline, while white fiducial arrows show remnant patch of labyrinth terrain.

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