

SAND DISTRIBUTION AND POSSIBLE SURFACE ALBEDO INFLUENCES IN THE SHANGRI-LA SAND SEA OF TITAN. B. D. Lake¹, J. Radebaugh¹, E. H. Christiansen¹, D. Rose¹, J. W. Barnes², E. P. Turtle³,

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Introduction: Equatorial regions of Titan are dominated by linear dune fields made of complex organic particles [1]. These dunes have many similarities to terrestrial dunes, such as those found in the Namib Sand Sea [1, 2]. A sand sea of particular interest on Titan is Shangri-La, centered on 15° E, 5° S. Shangri-La has an abrupt boundary along its southeastern margin where it meets the lowland region Xanadu (Figs. 1-3). The unusual geomorphology of this boundary has warranted closer analysis, as terrestrial dune fields are typically obstructed by highland topography [3]. Previous studies of Shangri-La have mapped sand sea margins [4, 5, 6], but have not focused on mapping sand abundances. Mapping sand distributions and abundances would reveal patterns in sediment transport and accumulation and could show regions affected by obstruction of sand movement. It may also provide additional insights into understanding the history and current forces at work in the region. Using Cassini data, we made correlations across different imaging datasets in order to map interpreted sand abundances in Titan's Shangri-La sand sea and identify regions influenced by obstruction.

Methods: The locations of the thickest sand deposits were inferred by first mapping the darkest regions visible in Imaging Science Subsystem (ISS) near-infrared imagery. This interpretation is reasonable because at a wavelength of 938 nm, ISS imagery generally images the surface and near surface. These regions also correlate with patches especially dark in higher resolution Synthetic Aperture RADAR (SAR) imagery. The locations of moderate sand thicknesses were determined by the presence of any other dunes in SAR outside of the regions that contain the sandiest portions outlined above. Because of limited high resolution SAR imagery, extrapolations were carefully made by using lower resolution ISS imagery for regions not covered by the SAR mosaic, after the methods of [6]. Outside of the regions with highest and moderate sand thicknesses exist regions with sand deposits thin enough to only be visible in Visual and Infrared Mapping Spectrometer (VIMS) (N-IR) imagery, similar to [4]. These were inferred to be thin, or discontinuous sand deposits. This is a logical assumption as VIMS covers the top millimeter of the surface at low resolution, so there is interpolation across large regions.

Results: The relative coverage of high vs. moderate vs. low thickness of sand in Shangri-La are 17%,

70%, and 13% respectively. The interpreted extent of relative sand abundance suggests the thickest deposits are in the S-SE region of the Shangri-La sand sea (Fig. 1). Some of these thick sand deposits extend across the center of a narrow southwestern area of eastern Shangri-La. Sand deposits become gradually thinner with distance across NE Shangri-La. Many of the thinnest sand regions correlate with the downwind sides of topographic obstacles (Fig. 1).

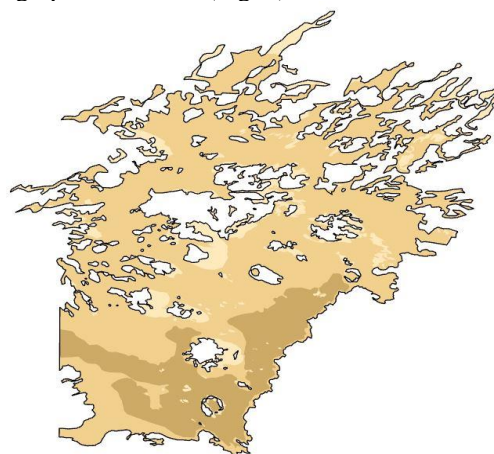


Figure 1. Outlines and inferred thicknesses of sand in eastern Shangri-La. Dark tan values represent thickest sand deposits, lightest tan represent thinnest deposits.

Discussion: The narrow area covered by thick sand deposits across the southwestern region of eastern Shangri-La could be a result of accumulation along the pathway of sediment transport along the dominant wind direction [5] and in a region of low elevation (Fig. 2). In northern and southern Shangri-La are highlands (Fig. 2). The thickest sand deposits in eastern Shangri-La are along the SE boundary of the sand sea (Fig. 1), suggesting particularly strong obstructive influences here. The region is adjacent to the SAR-bright Xanadu terrain, which with the exception of a northern E-W trending ridge, is dominantly low in elevation (Fig. 2). Because sand is typically obstructed by topographic highs, Shangri-La must be bounded on its eastern margin by some obstruction other than topography.

It has been suggested that a river of methane could cause the abrupt SE boundary of Shangri-La in a manner similar to the northern boundary of the Namib Sand Sea [7]. However, the orientations of drainages

visible in SAR imagery and topography suggest that such a channel would have an orientation perpendicular to the regional slope for hundreds of kilometers. Such a channel would need to be deeply entrenched in order to prevent avulsion, or a re-routing of the channel down the regional slope. Furthermore, VIMS imagery shows no evidence of water ice typical of other river channels on Titan, but rather indicate that organic deposits are uniformly thick and uneroded along the NW boundary of Xanadu. SAR imagery (albeit at 170 m resolution) also does not reveal such a channel. Additionally, if a methane river was flowing along the downwind margin of Shangri-La, sand would likely be blown into and transported by the river to a distal alluvial fan [7]. VIMS imagery does not show evidence of deposits of organic sediment similar to that of the dunes anywhere near the proposed terminus of such a drainage, but again the limited image resolution may preclude detection of such materials.

Another barrier to sand movement may exist in wind transport mechanisms. Visible to N-IR reflective surfaces, such as Xanadu, may create anomalously cold bodies of air that spread outward similar to air currents above terrestrial glaciers [8]. Xanadu is bright to ISS and VIMS, and RADAR brightness temperatures across much of central Xanadu are 20° C colder than SE Shangri-La at a wavelength of 2.2 cm [9](Fig. 3). Such a gradient may generate katabatic, or cold density-driven, winds across Xanadu that would flow for a distance up the gradual slope to the SE boundary of Shangri-La [10], where they would collide with westerly sand-bearing winds. This collision of wind currents would account for the obstruction of the migration of the dunes. Additionally, opposing winds would promote accumulation of thick sand deposits near the SE boundary of Shangri-La because of the reduction in velocity of the sand-bearing current.

Conclusions: Regions of most abundant sand in eastern Shangri-La are generally along the SE margin of the sand sea. There are sand dunes found extensively across Shangri-La, which we have defined as indicating moderate sand abundances. We argue that colliding air currents above the southeastern margin of Shangri-La could account for the geomorphology of the sand dune field, its interpreted sand depths, and the relative topography of the region compared to Xanadu.

Future Work: This concept will be further tested by evaluating other regions to determine if high albedo elsewhere on the surface of Titan also affects sand collection and dune morphologies independent from topography. We will carefully examine all possibilities affecting sand distribution.

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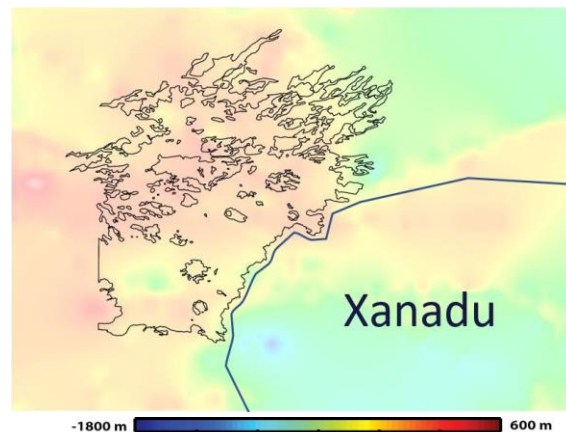


Figure 2. Topographic map of Titan. Eastern Shangri-La outlined [10]. Xanadu is to the E/SE.

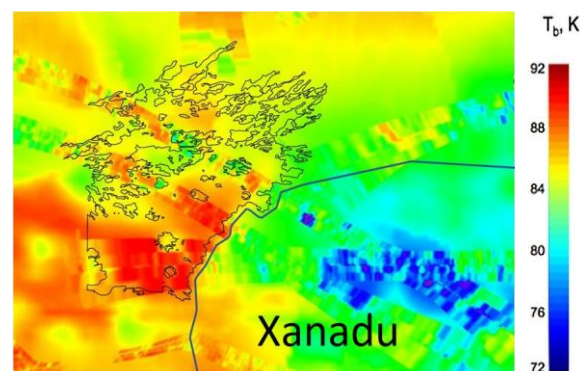


Figure 3. RADAR brightness temperature map of Titan. Eastern Shangri-La outlined [9]. Xanadu is cold.