EPSC Abstracts
Vol. 13, EPSC-DPS2019-577-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Fluvial network in southwestern Xanadu, Titan

Pietro Matteoni (1), Giuseppe Mitri (1), Valerio Poggiali (2), Marco Mastrogiuseppe (3), Gian Gabriele Ori (1)

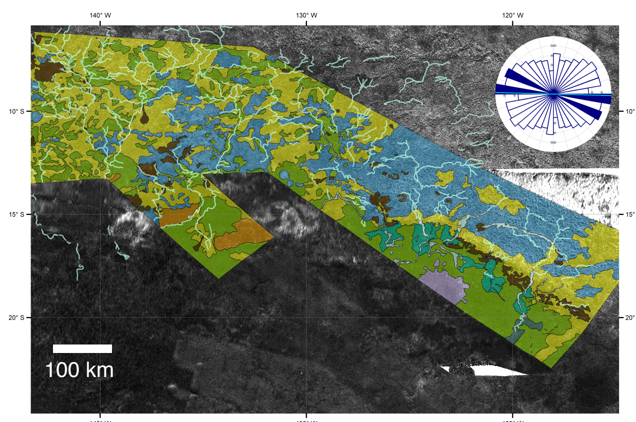
(1) International Research School of Planetary Sciences, Università d'Annunzio, Pescara, Italy (pietro.matteoni@unich.it); (2) Department of Astronomy, Cornell University, Ithaca, NY, USA; (3) Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA, USA

Abstract

Evidence for tectonic activity on Titan is exemplified by the presence of eroded mountain ranges [5,7], although it is unclear whether their origin is endogenic [6]. Xanadu is Titan's largest surface feature, possesses the highest albedo and has an average elevation ranging between -200 to 200 meters. It has been proposed that Xanadu has had a complex tectonic history involving both compressional and extensional events, resulting in a horst and graben structure [8]. Due to poor SAR resolution and paucity of low error range elevation data (i.e. Cassini RADAR's altimetry) tectonic indicators on Titan might be identified by indirect approaches such as analysis of drainage networks' azimuths [2,3] and planform geometries (e.g. width function, channel sinuosity) [1]. The wide distribution of fluvial features observed in western Xanadu makes it an ideal area for these types of analysis. Other approaches that involve measurements of topographic characteristics are possible but with careful consideration of the high error range of available data. Our aim is to investigate Xanadu's formation, through detailed geomorphological mapping and by applying Earth-based techniques of DTMs' analysis [9].

1. Methodology

Distinction among the different geomorphological units is based on Cassini's SAR backscatter characteristics, their relative contact relationships, texture and general appearance (Fig. 1). Fluvial networks' azimuths are investigated via rose diagrams. Three different elevation datasets are used to get topographic informations: RADAR's altimetry (error range: ± 30 m), SARTopo (± 150 m) and DTMs (± 100 m) processed through stereophotogrammetry. Thus, DTMs are available only in overlapping areas of different SAR swaths (Fig. 2). We are making use of TopoToolbox 2, a set of Matlab functions that support the analysis of relief and flow pathways in DTMs [9]. The extrapolated stream network is compared to the mapped fluvial valleys to subsequently carry out analysis of stream profile and flow directions.



Symbol used	Unit	Symbol used	Unit
	Rough Highlands Unit (RHU)		Dark Mottled Unit (DMU)
	Dissected Highlands Unit (DHU)		Wide Fluvial Valleys Unit (WFVU)
	Smooth Plains Unit (SPU)		Meander belt Subunit
	Labyrinth Unit (LU)		Deltaic Subunit
	Impact Crater Unit (ICU)		Narrow Fluvial Valleys Unit (NFVU)

Figure 1. (Top) Geomorphological map of Xanadu's southwestern margin; inset shows a rose diagram of the fluvial network's azimuths.
(Bottom) Units legend.

2. Results and discussion

We show how the surface of SW Xanadu is rugged (on both SAR images and DTMs) and intensely reworked by the activity of erosive agents (Figs. 1-2). The last process that dominated the region is most probably fluvial. The high SAR backscatter (σ^0) of the river valleys is considered to be due to an elevated density of icy pebbles, which could imply that the valleys are no longer liquid-filled [4]. The reworking action of such rivers masked the surface's appearance; together with poor SAR resolution (~350 m/pixel), this effect makes it difficult to clearly identify potential tectonic features by mere observation. Analysis of the whole fluvial network's azimuths (Fig. 1, rose diagram) shows a mean value along an E-W trend, in agreement with the interpretation of a rectangular drainage pattern developed under the influence of tectonic control [3]. By deriving the stream network from one DTM's topographic gradient and comparing it with the overlapping part of the SAR-mapped fluvial network, we find a generally good correlation among the two sets. This analysis brings further evidence for the fluvial network's existence and is the first not based on SAR images interpretation only.

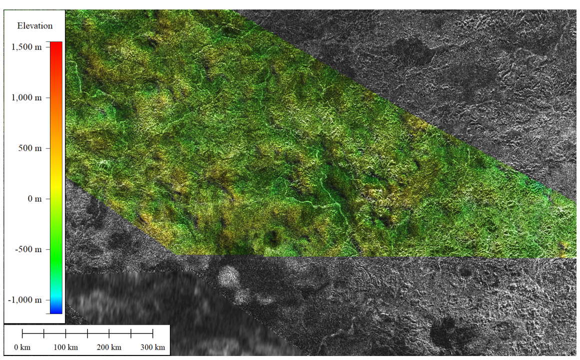


Figure 2. DTM overlain on SAR mosaic

Acknowledgements

PM is supported by Latium Region's Study and Knowledge Promotion (DiSCo) Programme 2018-19, European Social Fund 2014-20.

References

[1] Black, B.A., Perron, J.T., Burr, D.M., Drummond, S.A.: Estimating erosional exhumation on Titan from drainage network morphology, J. Geophys. Res., 117, E08006, 2012.

[2] Burr, D.M., Jacobsen, R.E., Roth, D.L., Phillips, C.B., Mitchell, K.L., Viola, D.: Fluvial network analysis on Titan: Evidence for subsurface structures and west-to-east wind flow, southwestern Xanadu. Geophys. Res. Lett., 36, 1–5, 2009.

[3] Burr, D.M., Drummond, S.A., Cartwright, R., Black, B.A., Perron, J.T.: Morphology of fluvial networks on Titan: Evidence for structural control. Icarus 226, 742–759, 2013.

[4] Le Gall, A., Janssen, M.A., Paillou, P., Lorenz, R.D., Wall, S.D.: Radar-bright channels on Titan. Icarus 207, 948–958, 2010.

[5] Mitri, G., Bland, M.T., Showman, A.P., Radebaugh, J., Stiles, B., Lopes, R.M.C., Lunine, J.I., Pappalardo, R.T.: Mountains on Titan: Modeling and observations. J. Geophys. Res. E Planets 115, 1–15, 2010.

[6] Moore, J.M., Pappalardo, R.T.: Titan: An exogenic world? Icarus 212, 790–806, 2011.

[7] Radebaugh, J., Lopes, R.M.C., Lunine, J.I., Kirk, R.L., Wall, S.D., Radebaugh, J., Stofan, E.R., Lorenz, R.D.: Mountains on Titan observed by Cassini Radar. Icarus 192, 77–91, 2007.

[8] Radebaugh, J., et al.: Regional geomorphology and history of Titan's Xanadu province. Icarus 211, 672-685, 2011.

[9] Schwanghart, W., Scherler, D.: TopoToolbox 2 – MATLAB-based software for topographic analysis and modeling in Earth surface sciences. Earth Surf. Dyn. 2, 1-7, 2014.