FLUVIAL VALLEYS ON TITAN – A GLOBAL PERSPECTIVE. M. Langhans[1], R. Jaumann[1,2], K. Stephan[1], R. H. Brown[3], B. J. Buratti[4], R. Clark[5], K. H. Baines[4], P. D. Nicholson[6] and R. D. Lorenz[7].
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Introduction: Fluvial valleys – often in form of networks – mark the surface of Titan. These valleys presumably developed as a result of precipitation of liquid hydrocarbons. To date a lot of studies focus on single channels or channel networks, e.g. [1,2,3]. This study is concerned with a global investigation of fluvial valleys. First of all the global arrangement of fluvial features in general is investigated. Secondly, the fluvial valleys were assigned to one of three different spectral units distinguishable through VIMS-data. Furthermore, according to the different channel morphologies found at Titan's surface, a classification of fluvial valleys was carried out to investigate the global distribution of the diverse channel types.

Database: An identification and classification of channels was based on Cassini RADAR-data captured between October 2004 and April 2007. VIMS-mosaics of the area between 30°S and 30°N were used to map the boundaries of the spectral units. VIMS-data were converted into false-color RGB-composits that display Titan's infrared reflectance in (rotioed) near-infrared atmospheric windows (R: 1.58µm/1.28µm, G: 2.0µm/1.28µm, B: 1.28µm/ 1.08µm). An assignment of the fluvial channels to the VIMS spectral units was based on a combined analyze of VIMS- and RADAR-data in a Geographic Information System (GIS).

Global View: Traces of fluvial erosion cover the entire surface of Titan (see Fig. 1). Fluvial valleys in form of meandering and/or branching single channels or networks of channels could be found at the equator [1], at midlatitudes [4] and at Titan's north pole [5]. Furthermore, there are also lots of regions, where channels are almost entirely missing, like the equatorial dune fields. Therefore the distribution of Titan's channels could tell us a lot about Titan's climate (presence or absence of precipitation) as well as its geology, e.g. the relative age of the morphological units.

Fluvial valleys and spectral units: In VIMS-ratio-composits three spectral units could be discerned: A bright unit that is supposed to be topographically high-standing terrain occurs in form of large "continents". This unit is disconnected through the brown surface unit that correlates well with Titan's dune fields. Finally a blue spectral unit could often be found at the eastern boundaries of the bright terrain [3,6]. As displayed in Fig. 1, fluvial valleys are mainly located on the bright spectral unit and just a few percent of them are exposed on the blue and brown surface unit.

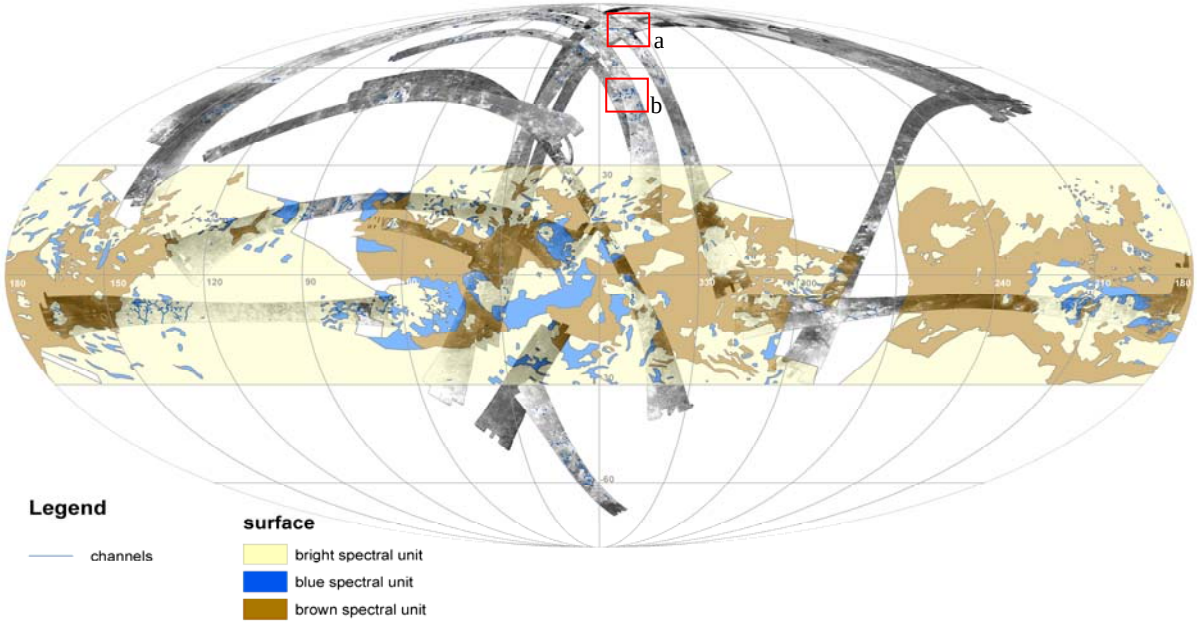

Figure 1: *Global map of Titan (Mollweide projection). VIMS-mapping of the spectral units overlaid on Radar swaths. Fluvial valleys are marked in blue.*

Interpretation. The brown dune unit has likely accumulated subsequent to the formation of fluvial channels since just a few channels could be found within that unit. Some channels found on the brown unit could also be a cause of a spatial mismatch between VIMS- and RADAR-data. The blue spectral unit – according to its often stated proximity to fluvial channels – is said to be associated with fluvial debris [2]. Just 3.5% of channels are located within the blue spectral unit. A calculation of the percentage of channels lying less than 100km away from the blue spectral unit resulted in about two thirds (~60%) of valleys between 30°S and 30°N that meet that condition. Although the assumption that the blue surface unit consists of fluvial deposits couldn't be proven so far, it is a further argument for this assumption.

Classification of channels: Titan's surface shows a great diversity of different channel morphologies: First of all dendritic channels dominate at Titan's north pole (see Fig. 2) as well as at the equator.

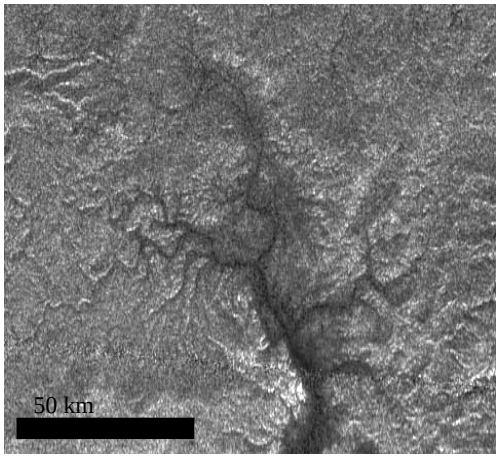

Figure 2*: Dendritic valley system near Titan's north pole. Close-up corresponding to rectangle a in Fig. 1 (Cassini RADAR, T28, 4/10/2007).*

This type is characterized by a meandering and/or branching morphology. Figure 2 highlights that through the geometry and arrangement of the several tributaries it is easy to derive appropriate flow directions and therefore to reveal local topographical conditions. Further on, the continuous and comprehensive structure of the network suggests a development through atmospheric precipitation. It remains unknown whether this took place in the past or if it is a still ongoing process. However, precipitation must have taken place at Titan's poles and equator at least in the past.

A second type of channels could be found at mid-latitudes. This type of valleys resembles deeply incised canyons on earth (see Fig. 3). The canyon-type of valleys could have developed or its development may have been supported by groundwater sapping. Furthermore, in the two examples displayed the structure and erodibility of the substrate seems not to be comparable. Without knowledge about the exact composition of the surfaces a visual interpretation of the shape and geometry of the two valley networks suggests that the substrate in Fig. 2 is less resistant than that in Fig. 3.

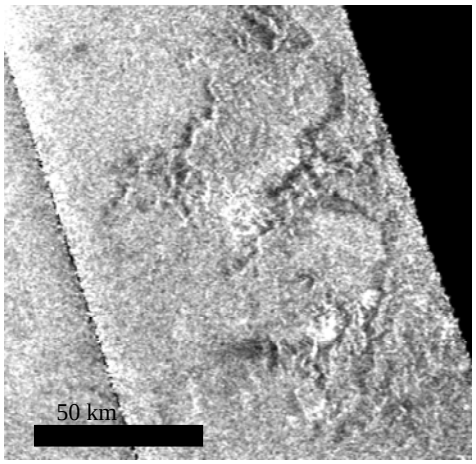

Figure 3*: Canyon-like valley system. Close-up corresponding to rectangle b in Fig. 1 (Cassini RADAR, T16, 22/07/2006).*

At the Huygens Landing Site another short and stubby type of channels is established, which is presumably caused by groundwater sapping [7]. Other channel types exist on Titan's surface, characterized by a more irregular arrangement.

Conclusions: Fluvial incision has shaped Titan's surface globally. Fluvial erosion appears to be attributed to the bright spectral unit while the bluish surface unit seems to be associated with fluvial deposition. Nevertheless, from a morphological standpoint fluvial shaping is not uniform. The morphological complexity points to a great diversity of processes forming Titan's surface as well as to a variety of bedrock types.

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References:

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