Geomorphological analysis and Digital Elevation Model of Monad Regio, Triton

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Abstract

Introduction The complex geomorphology of Triton reflects its geological history [1]. The morphological heterogeneity on small scale has led to discerning three main complexes: cantaloupe terrains, equatorial plains, and south polar cap terrains. We analyse an area located in the east equatorial zone of Triton called Monad Regio (centred at 37°N, 2°E), characterized by the presence of walled plains. We produced a new geological map and a DEM (Digital Elevation Model) to recognize the main terrains and features in the study area. We used Voyager 2 imagery named c1139533 (600 m/px) [2], properly calibrated, filtered, and georeferenced using the Integrated Software for Imagers and Spectrometers (ISIS4) [3]. Results and conclusions We mapped the different geological units and main features according to differences in surface morphology (Fig.1). Terraced terrain covers most of the studied area. It shows a chaotic pattern characterized by several terraces, some of which lay in a parallel arrangement around some of the large depressions. These basins have areas ranging from 1300 to 2050 km2, and their degree of alteration is variable, with the features inferred to be more recent showing an inner minor basin within the main one. The most altered basins appear smoother, featureless, and shallower. Sizes and excavation depths estimated using DEM data of the observed basin features appear to be relatively homogeneous, which leads us to exclude an impact related origin. We argue that the origin of these depressions is linked to processes analogue to those described in the formation of terrestrial maar craters and possible explosion craters discussed on Titan [4]. Alternatively, diapirism may also explain the origin of such features. Further analysis could help to understand the nature and related processes that originated these basins. Acknowledgements G.M., C.C. and D.S. acknowledge support from the Italian Space Agency (2020-13-HH.0). References [1] Basilevsky A.T. et al.,1992. Adv. Space Res.,12(11), 123-132. [2] Smith, B. A., et al. (1989), Science, 246 (4936), 1422-1449. [3] Houck J.C. and DeNicola L.A. (2000) Astronomical Data Analysis Software and Systems IX, ASP Conference Series,216. [4] Mitri G., et al. (2019), Nature Geoscience, 12, 791,796.

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Introduction

The complex geomorphology of Triton reflects its geological history. Our knowledge of this moon comes from the Voyager 2 mission, which obtained several images, covering about 40% of Triton's surface. The most fascinating observation concerning this moon regards its ongoing geological activity, with plumes and geysers whose origin is still controversial. Triton's crust is composed predominantly by solid nitrogen (N_2) but several other ices have been detected. Crater counting has revealed that the surface is very young and likely it went through a resurfacing process in the past. In fact, a very small number of craters has been detected, and these usually exhibit a typical bowl-like shape. Geological features on Triton include regions, called terrains, such as cantaloupe terrains or plains, which show different textures. Plains are usually distinguished between smooth, walled and terraced plains.

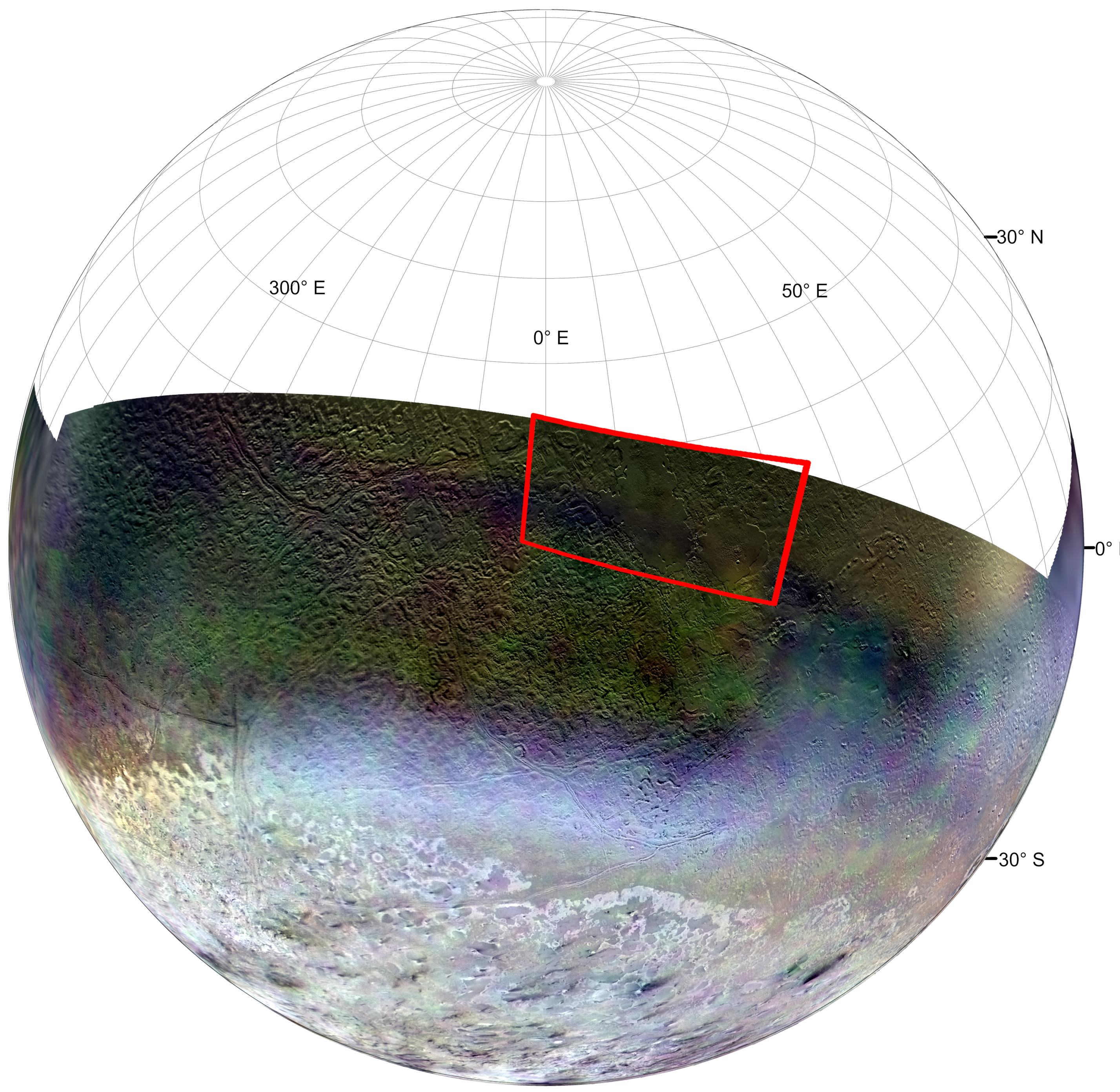

Fig. 1
Triton Voyager 2 Global Color Mosaic 600m v1 (courtesy by the Lunar and Planetary Institute).
The red polygon outlines the study area.

Methods and results

We analysed an area located in the eastern equatorial zone of Triton called Monad Regio (centred at 37°N, 2°E), characterized by the presence of walled plains. We produced a new geological map and a DEM (Digital Elevation Model) to recognize the main terrains and features in the study area. We used Voyager 2 imagery named c1139533 (600 m/px), properly calibrated, filtered, and georeferenced using the Integrated Software for Imagers and Spectrometers (ISIS4). The DEM of the study area has been produced by using the open-source suite of tools NASA Ames Stereo Pipeline (ASP). We applied the photoclinometry-based "shape-from-shading" (SfS) tool to produce the Digital Elevation Model. Since SfS needs an input DEM generated preferably with stereo images, and we do not have such data for this area, we applied the methodology proposed by Lesage et al. 2021. We mapped the different geological units and main features according to differences in surface morphology observed both in the Voyager imagery and in the Digital Elevation Model.

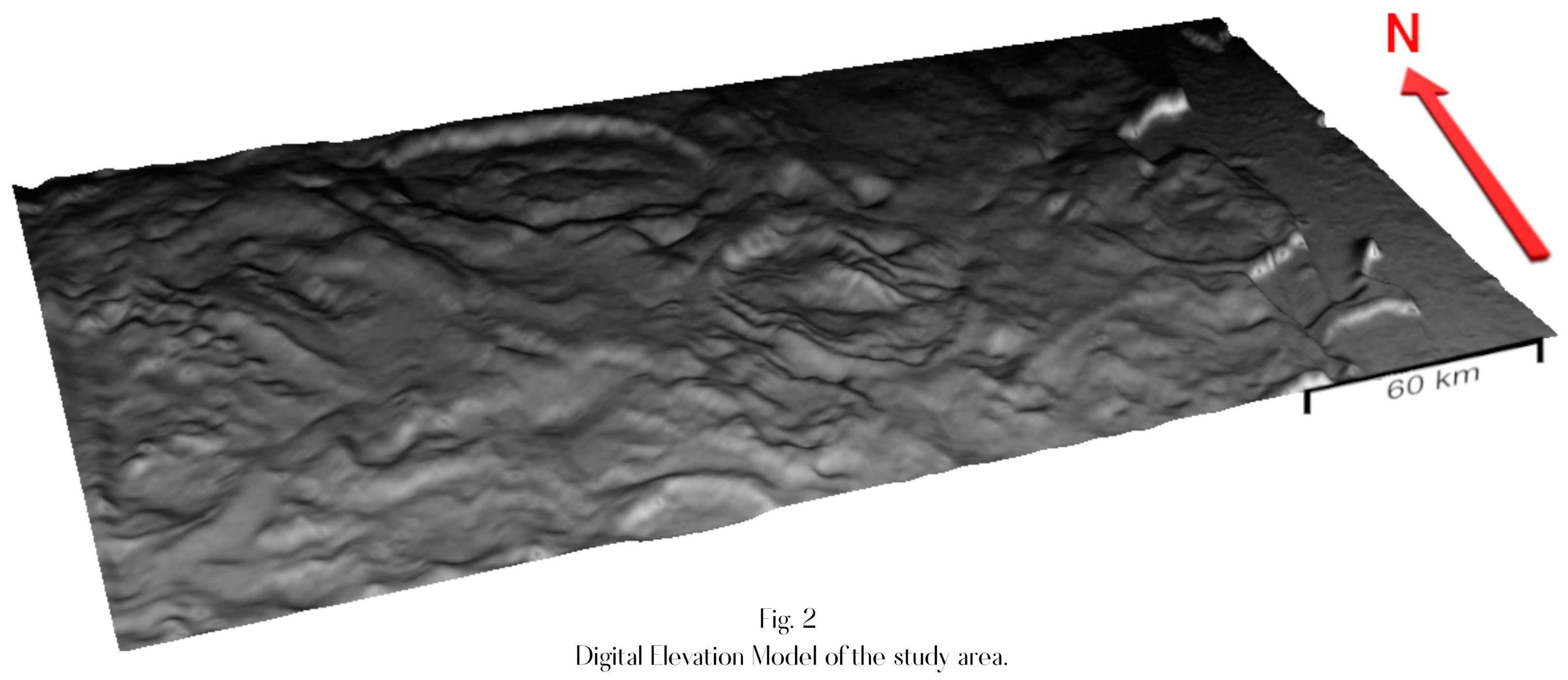

Fig. 2
Digital Elevation Model of the study area.

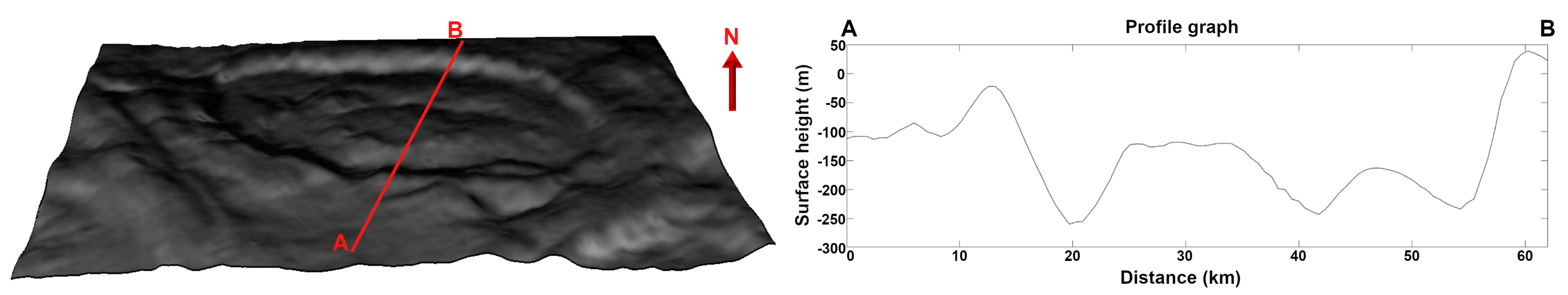

Fig. 3
Digital Elevation Model of Kulilu Cavus (A–A') and relative cross section.

Discussion

We mapped the different geological units and main features according to differences in surface morphology (Fig. 4). Terraced terrain covers most of the studied area. It shows a chaotic pattern characterized by several terraces, some of which lay in a parallel arrangement around some of the large depressions. These basins have areas ranging from 1300 to 2050 km^2, and their degree of alteration is variable, with the features inferred to be more recent showing an inner minor basin within the main one. The most altered basins appear smoother, featureless, and shallower. Sizes and excavation depths (estimated using DEM data) of the observed basin features appear to be relatively homogeneous, which leads us to exclude an impact-related origin. We argue that the origin of these depressions is linked to processes analogue to those described in the formation of terrestrial maar craters and possible explosion craters discussed on Titan. Alternatively, diapirism may also explain the origin of such features. Further analysis could help to understand the nature and related processes that originated these basins.

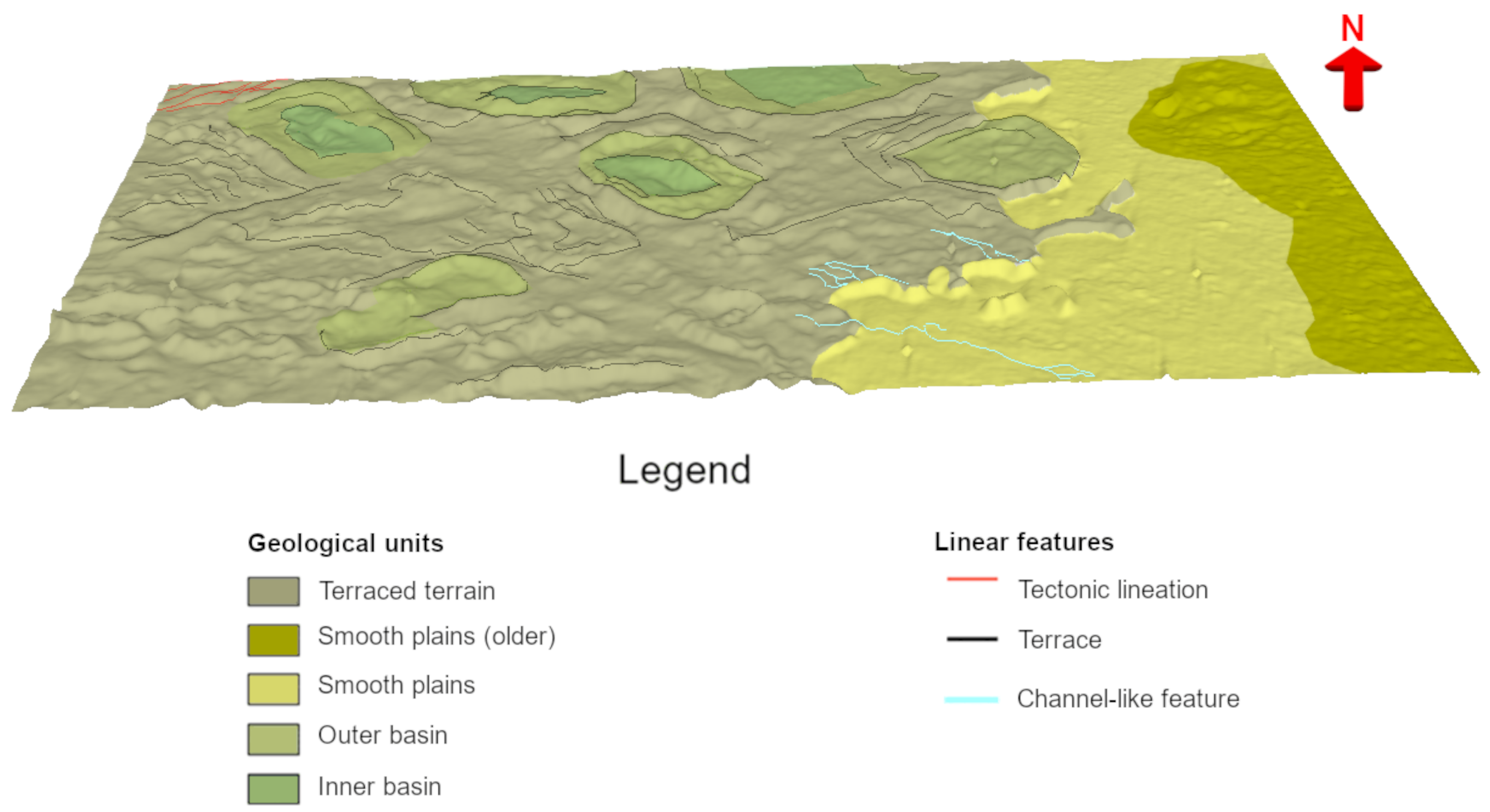

Fig. 4 Geological map of the study area overlaid on the Digital Elevation Model.

Acknowledgements and References

G.M., C.C. and D.S. acknowledge support from the Italian Space Agency (2020-13-HH.0).

[1] Basilevsky A.T. et al.,1992. Adv. Space Res.,12(11), 123-132.
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