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A three-dimensional geological reconstruction of Noctis Labyrinthus slope tectonics from CaSSIS data

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Abstract

In November 2016 the CaSSIS (Colour and Stereo Surface Imaging System [1]) imaging system onboard the European Space Agency's ExoMars Trace Gas Orbiter (TGO) acquired 18 images (each composed by 30 framelets for each of the 4 colour channels) of the Martian surface. The first stereo-pairs were taken during the closest approach, at a distance of 520 km from the surface, over the Hebes Chasma and Noctis Labyrithus regions. In the latter case a DTM was prepared over a north facing slope bounding to the north a 2000 m deep depression and to the south a plateau complicated by extensional fault networks [2] (Fig. 1). Such slope is characterised by a downthrown block that can be interpreted as a Deep Seated Gravitational Slope Deformation (DSGSD) sensu [3,4]. In this work we will present a 3D geological reconstruction of the phenomenon that allowed us to constrain the possible main sliding surface, the volumes involved in the gravitational process and the kinematics of the mass movement.

1. 3D topographical and geological reconstructions

The DTM was realized by the pipeline developed by the team at the Astronomical Observatory of Padova (OAPD-INAF), the procedure includes the definition of tie-points by SURF operator [5], the production of a starting disparity map based on a fast NCC [6], and an iterative sub-pixel refinement with a least square matching algorithm [7]. The 3D geological reconstruction of the DSGSD was obtained using the 3DMove software, which enabled us to wrap the images onto the DTM and interpolate the mean stratification outcropping along the upper part of the displaced mass as well as the sliding plain at its base. 3DMove provided us the possibility to restore the geological section before the downward displacement and infer the kinematics of the mass movement.

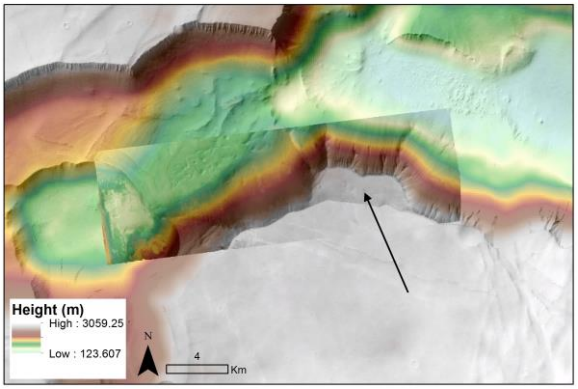

Figure 1 CaSSIS DTM in Noctis Labyrinthus over HRSC DTM. Note the downthrown block (black arrow) on the North eastern part of the CASSIS DTM .

2. Results

The CaSSIS images of the Noctis Labyrinthus acquired from the ExoMars Capture Orbit in November 2016 have revealed a DSGSD whose downward displacement exposed a 250m-high main scarp in the crown area. The displaced body does not show major internal deformations implying a still evolving en-mass sliding. The preserved stratification on the main downthrown block appear to be tilted suggesting a rotational sliding process with a gliding

surface defining a depth of the displaced mass of about 750 m (fig. 2). The upper part of the gliding surface has the same orientation of the main extensional faults transecting the plateau. This suggests a substantial structural control of the gravitational phenomena whose main gliding surface nucleated on inherited tectonic structures.

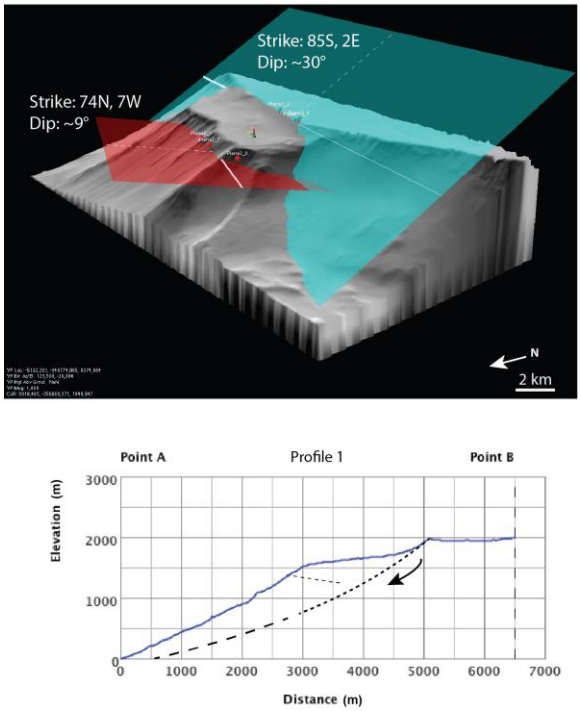

Figure 2. Top image: CASSIS DTM and interpolated planes of the stratification (red) and the upper part of the sliding surface (blue). Botton Image: geological section showing the tilted strata and the inferred gliding plain.

Acknowledgements

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