

# Faults mapping in Noctis Labyrinthus area



UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA

Mayssa El Yazidi <sup>2</sup>, Riccardo Pozzobon <sup>1,2</sup>, Stefano Debei <sup>2</sup>, Matteo Massironi <sup>1,2</sup>



<sup>1</sup>Dipartimento di Geoscienze, Università degli Studi di Padova, via Gradenigo 6, 35131 Padova, Italy. matteo.massironi@unipd.it, riccardo.pozzobon@unipd.it.

<sup>2</sup>Centro di Ateneo di Studi e Attività Spaziali "Giuseppe Colombo" - CISAS. Via Venezia 15, 35131 Padova, Italy. stefano.debei@unipd.it, mayssa.elyazidi@unipd.it.

## Overview

The Higher Resolution Stereo Camera (HRSC) of Mars Express is one of the successful scanning instruments to obtain near simultaneous images of specific areas. HRSC takes a colored image in 3D that contains a key information allowing the geologic context study. In addition, the CTX camera of the Mars reconnaissance Orbiter is also a powerful tool set to provide a large image spanning 30 Km of terrains, based on the data collected by HRSC. Therefore, this couple of instruments had obtained at least 119 images of the surface of Mars with higher resolution that contribute to the advancement of Knowledge of Mars' geology. In this frame, Noctis Labyrinthus is one of the region covered by this instruments. The data transferred by HRSC and CTX had indicated the complexity of the tectonics structures in this area that still until now, not well understood [4,5].

In this work, we will present the photogeological map for Noctis Labyrinthus area based in HRSC and CTX imaging data to understand how the originates and the evolution of the faults, grabens and pits echelon in this region.

## Noctis Labyrinthus

It is a region located in the western part of Valles Marineris, bordering Syria Planum to the north Noctis Fossae on NE, Syria Planum and Syria Colles on S-SE. It is classed like a part of Phoenicis Lacus quadrangle and defined at the surface of Mars by the coordinates "6.36°S, 258.81°E" [Fig.1].

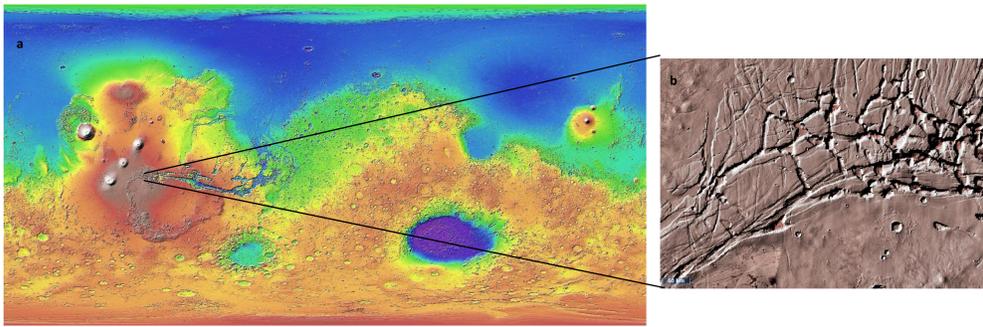


Fig.1: (a) Global map showing the location of Noctis Labyrinthus on the surface of Mars (Image from Mars Orbiter Laser Altimeter of Mars Global Surveyor spacecraft, with 463m/Pixel of spatial resolution). (b) Complex tectonic structures represented by branched networks of faults and extensional grabens (HRSC and CTX DTM images)

## Proposed Method: The Photogeological mapping to study the surface

The photogeological mapping it is a useful technique to map all the lineaments on a given portion of the Noctis Labyrinthus [1,9]. Taken the images H3210\_0000 and H3221\_0000 from HRSC Camera (12-13m/Pixel of spatial resolution, Mars Express) and a mosaic of images of CTX Camera (5.2m/Pixel of spatial resolution, Mars reconnaissance Orbiter) as a base map to delimit at different scale faults, scarps and grabens and then carried out a rose diagram that allow to investigate the orientation of this tectonics structure [Fig.2].

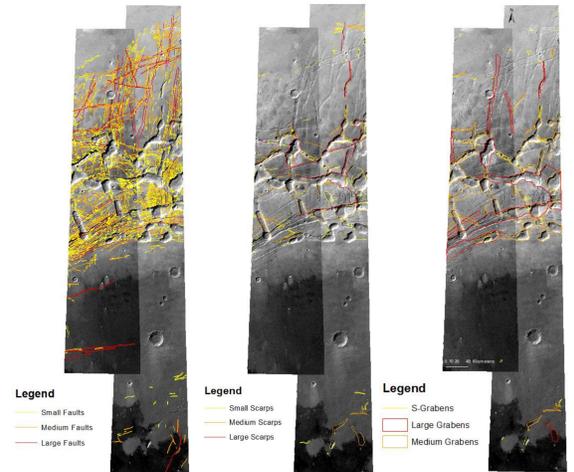


Fig.2: Faults (a), scarps (b) and grabens (c) mapping (H3210\_0000 and H3221\_0000 images from HRSC)

## Results

An intersecting canyons and complex branched networks of reverse and thrust faults and extensional grabens, have been found in Noctis Labyrinthus [2,6,7,8,9], the largest fault measured 209Km.

The Rose diagrams show all scales, two main trends of faults; ENE-WSW and N-S, that do not show preferential cross-cutting relationship of one direction over the other [Fig.3].

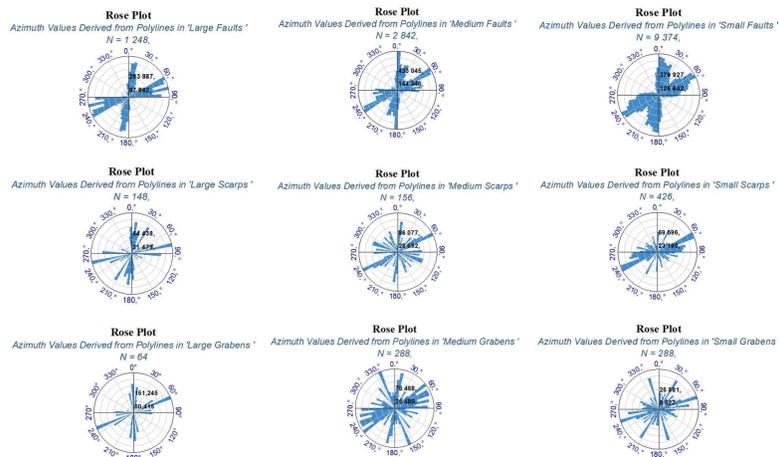


Fig.3: Rose diagrams of the faults, scarps and grabens relative to the tectonic context of the selected area (6.36°S, 258.81°E)

## Interpretation

The results carried out from Rose diagrams seems to support a coeval development of two systems potentially generated in response of the bidirectional or a radial extension [Fig.4], represented by a stress ellipsoid with the oblate Geometrie " Pure shear " according to Flinn diagram [Fig.5]. Particularly relevant are the pits which can be found within the tip and at the margin of the Noctis Labyrinthus grabens [3]. They seems due to the tectonic process of grabens propagation more than cratering phenomena and thus might give hints on the rheological subsurface layering which underwent the extensional deformation. Then, we propose that the oblate strain field drove an extensional tectonism responsible of the evolution of pits echelon and faults into grabens [Fig.6].

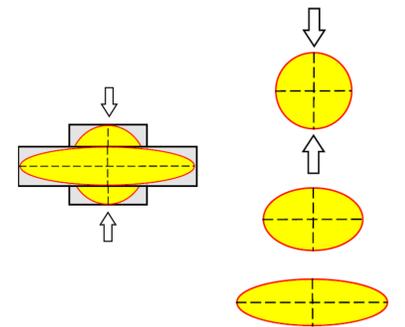


Fig.4: The Stress field in Noctis Labyrinthus that explained by the extension deformation, where the axes from their didn't move from their original positions (Images from School of Earth and Environment, University of Leeds)

Fig.5: Flinn diagram and possible strain ellipsoid. The Oblate strain of the Flattening, it is a round pancake-shaped ellipsoids, where  $X \geq Y \gg Z$  and the Prolate strain or the Constriction, it is a cigar-shaped ellipsoids where  $X \gg Y \geq Z$ .

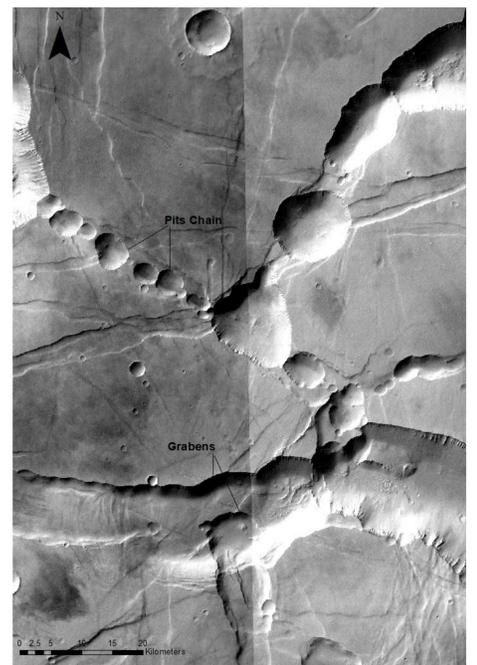
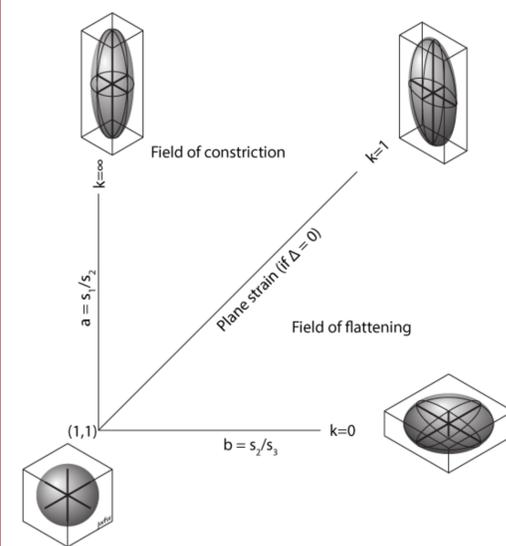


Fig.6: The complex features in Noctis Labyrinthus that represented by pits chain and interconnected grabens at different scales.

## Acknowledgements

The authors would like to thank CTX and HRSC experiments and instruments team of Mars Reconnaissance Orbiter and Mars Express for this successful space craft that make a major contribution to the study of the Martian surface and also to produce and make available their datasets. We also acknowledge CISAS for its support for this work.

## References

- [1] Rodriguez et al. (2015) Planetary and Spac.Sci, 124,1-14.
- [2] Spagnuolo et al. (2014) Earth Planet.Sci.Lett.,401, 83-94.
- [3] Bridges et al. (2009), Icarus, 205, 165-182.
- [4] Yin (2012), Geological Society of America, Vol.4, 286-330, doi: 10.1130/L192.0.
- [5] Montgomery et al. (2009), Geological Society of America Bulletin, 121, 117-133, doi: 10.1130/B26307.1.
- [6] Massironi et al. (2017), EPSC, Vol.11, 618-1.
- [7] Mudric et al. (2017), 48th LPSC Abstract, 1464.
- [8] Weitz et al. (2016), Annual Planetary Geologic Mappers Meeting, 7029.
- [9] Baioni et al. (2017), Acta Carsologica 2017, 46/1, 73-82.



UNIVERSITÀ  
DEGLI STUDI  
DI PADOVA

University of Padova  
<http://www.unipd.it>



G. COLOMBO

Center for Studies and Activities  
for Space "G.Colombo" - CISAS

<http://cisas.unipd.it/>