# Structural Analysis of grabens, Pit chains and rifting in Noctis Labyrinthus (Mars) based on Data derived from HRSC and MOLA


Mayssa El Yazidi (**1,3**), Riccardo Pozzobon (**2,3**), Luca Penasa (**2,3**),Stefano Debei (**1**) and Matteo Massironi (**1,2,3**)

(1) Centro di Ateneo di Studi e Attività Spaziali "Giuseppe Colombo"-CIAS, Via Venezia 15, 35131, Padova,
(2) Dipartimento di Geoscienz, Universita degli studi di Padova, Via Gradenigo 6, 35132, Padova,
(3) Instituo Nazionale di Astrofisica-INAF, Vicolo dell'Osservatorio 5, 35122, Padova.


## Research Aims

1. Study the tectonics features and the stress field in Noctis Labyrinthus.
2. Scrutinize the Pit Chains morohology and evolution.
3. Reveal the processes responsible for the complex ramify rift systems and troughs.

## Study Area

**Quadrangle:** Phoenicis Lacus (MC-17)

**Coordinates:**

-6°86N_ 6°54S
267°48E_101°12W

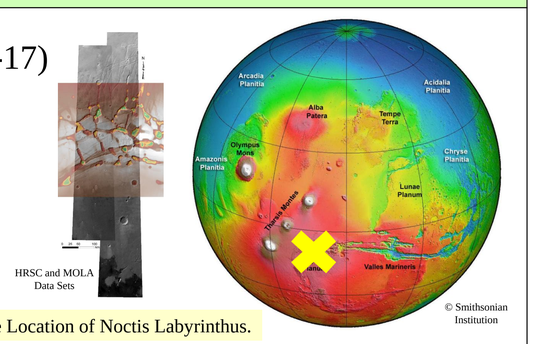


**Fig.1.** The Location of Noctis Labyrinthus.

## Early Extension and Magma Plumbing

To understand the origin of the rift systems and troughs in Noctis Labyrinthus, we mapped a large fraction of faults (N = 494) and checked their orientation (Fig.2), size and distribution (Fig.3). We also studied the relationship between the vertical offset and the length of fault systems through the equation $D_{Max} = \gamma L^n$ (Cowie , P.A & Sholz, C.H., 1992a,b., Clatk, R.M & Cox, S.J.D., 1996).

To determine the nature of the hosting rock, we plotted the fault length measurements on a cumulative frequency diagram (Fig.3) that shows a power law trend indicating a crust mechanically homogeneous up to the base of the interconnected fault systems . Moreover, the frequent interconnection between graben and pit chains calls for a possible common process responsible for their formation and evolution. In particular , Pit chains are bounded by two faults and connected to a swarm of small-sized cracks (Fig.4) and present a higher displacement compared to grabens.

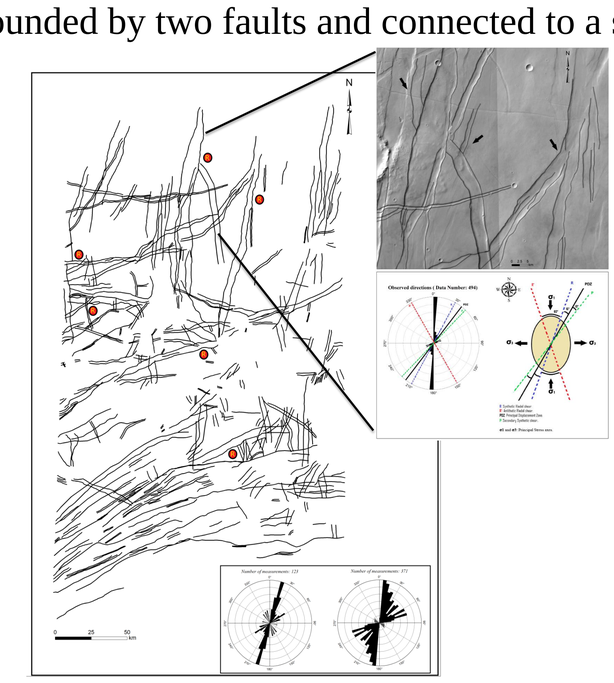


**Fig.2.** The direction attributes for all lineaments of the mapped faults. The red circles show zones of Riedel structures.

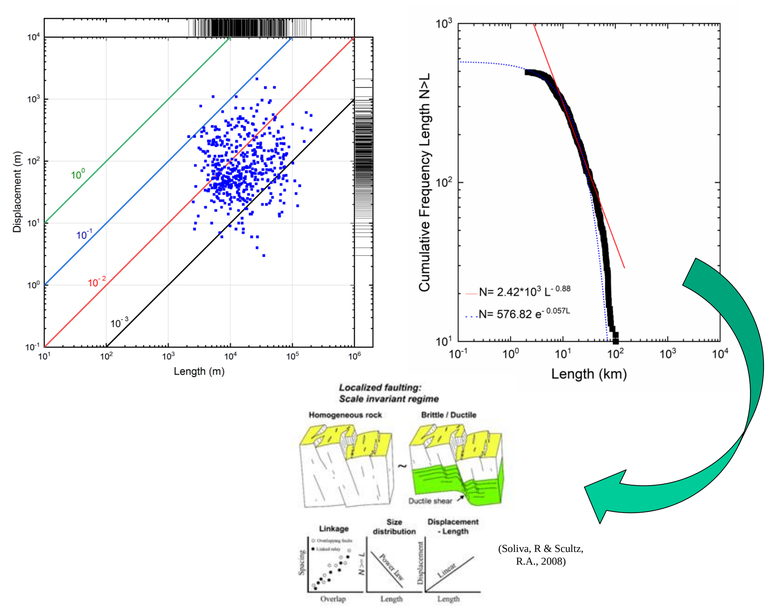


**Fig.3.** Displacement-Length diagram (Left) for the studied faults, shows a large scattering of values. Cumulative Frequency diagram (right) fits a negative power law trend, revealing the presence of a stratigraphic sequence of layered basalts.

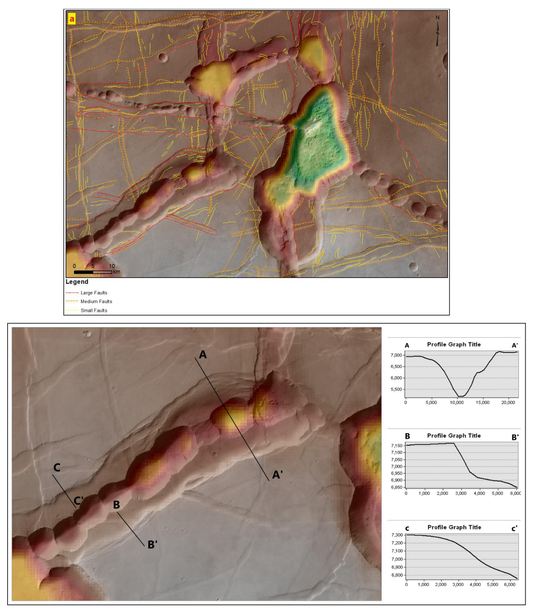


**Fig.4.**(a)Topographic view showing a series of linear trend of Pit chains, frequently bounded by a major grabens.(b) Compared sections between the maximum vertical offset generated by the grabens (B-B', C-C') and the throw generated by the Pit chains (A-A').

## Discussion and Conclusion

We assume that Noctis Labyrinthus is made up by an invariant oblate early stress field, responsible for the formation of the branched network of faults and grabens. Along these structures dikes could have been injected from deep magmatic sources and over their tips, deflating and collapsing processes might have happened at the surface on graben's floor. This would explain the lower displacement of faults bounding grabens compared to the pit chain related with grabens. Hence we tie together a Volcano-Tectonic activity behind the formation of the Noctis Labyrinthus rift systems.

## References


**[1]**Cowie.P.A & Scholz, C.H.,1992a.J.Geophys. Res.97.,11085-11095.**[2]**Cowie,P.A & Scholz,C.H., 1992b.J.Stru.Geo. 14, 1149-1156.**[3]**Clark, R.M & Cox,S.J.D., 1996.J.Stru.Geo. 18, 147-152.**[4]**Hauber, E et al.,2007. Lunar Planet.Sci.Conf.38, 1670.**[5]** Hauber, E et al., 2014. Lunar Planet.Sci.Conf.45, 1981.**[6]**Mège, D & Korme, T., 2004.J. Volca. Geo.Res. 132, 77-92. http://dx.doi.org/10.1016/S0377-0273(03)00317-2.**[7]**Maimon, O et al., 2012.Geophys.J.Int. 189, 956-966. http://dx.doi.org/10.1111/j.1365-246X.2012.05342.x.**[8]**Mège, D & Masson, P., 1996b. Planet.Space Sci.44,1499-1546.**[9]**Mège, D et al., 2003.J. Geophys. Res.108, E5, 5044. http://dx.doi.org/10.1029/2002JE001852.**[10]**Polit, A.T et al., 2009.J.Stru.Geo. 31., 662-673. http://dx.doi.org/10.1016/j.jsg.2009.03.016**[11]**Schultz, R.A et al., 2006.J.Stru.Geo. 28, 2182-2193. . http://dx.doi.org/10.1016/j.jsg.2006.03.034.**[12]**Schultz, R.A et al., 2008.J.Stru.Geo. 30., 1405-1411. http://dx.doi.org/10.1016/j.jsg.2008.08.001**[13]**Schultz, R.A et al., 2010.J.Stru.Geo.32, 855-875. http://dx.doi.org/10.1016/j.jsg.2009.09.005.**[14]**Watters,T.R., et al., 2000. J. Geophys. Lett. 27, 3659-3662, L011554.


## Acknowledgements


The authors would like to thank HRSC (Mars Express) and MOLA (Mars Global Surveyor) experiments and instruments team. This research has been supported by European Union's Horizon 2020 under grant agreement No 776276-PLANMAP.


twitter Instagram

*planmap.eu*

PLANMAP
Geologic Mapping of our Solar System