DATATION OF A DOUBLE-LAYER EJECTA CRATER ON MARS

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Introduction

The martian surface presents thousands of lobate ejecta craters. Their formation is in part due to the presence of volatiles in the subsurface [1,2]. From balistical analysis, each ejecta layer are formed at the same time [2].

Ejecta lobate crater have a sufficient surface to date their formation by counting craters present on their blankets. Knowledge of the formation age of this type of craters is therefore essential for informations on the subsurface in one place and at one time and to better constrain climatic variations on Mars.

Methodology

In order to better constrain the dynamic and evolution of layered ejecta craters, we did :

- a detailed geological map of a double-layer rampart crater (Fig.1).
- registration of all craters with diameters larger than 100 m [3,4,5].
- exclusion of secondary craters population by identifying limited overcraterisation density areas.
- an estimation of the formation age of the different morphological units.
- check the validity of the ages we got by an analysis of the crater size distribution with a randomness analysis [6].

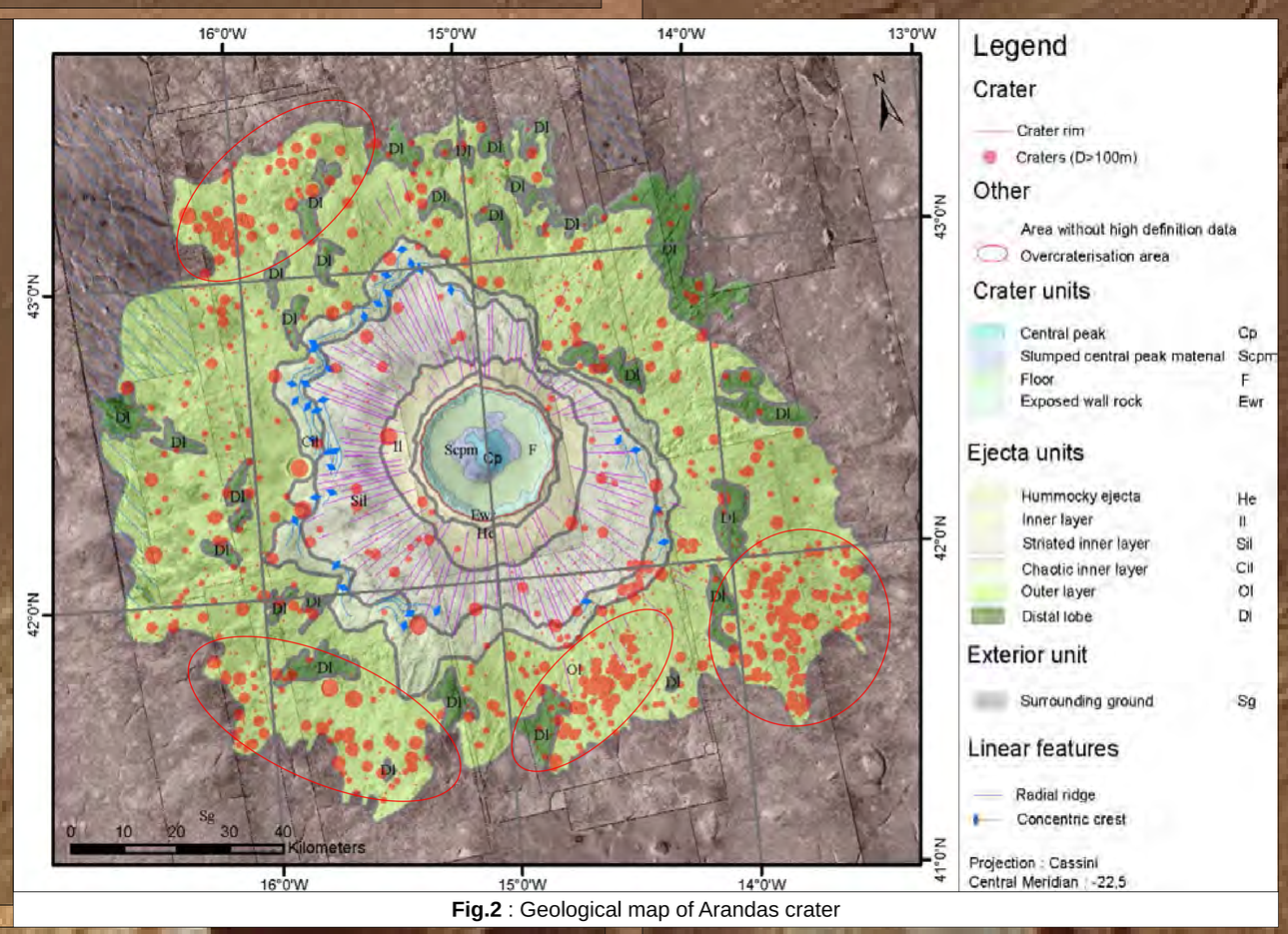

Fig.2 : Geological map of Arandas crater

Variability of measured ages

- The crater age is necessarily more recent than the age of the Sg surrounding unit : 2,3±0,2 Gyrs (white curve in Fig.4).
- Our geomorphological and datation study indicate that the age of each unit increase with the distance to the crater rim.
- The crater age formation vary from 93±20 Myrs (He and Il units) to 410±60 Myrs (Dl and Ol units).

- Other similar studies on few DLERS in Acidalia Planitia shows the same trend.
- Craters population reach a random distribution from 250 m of diameter.
- Crater number deficit smaller than 200m on Sil-Cil units.

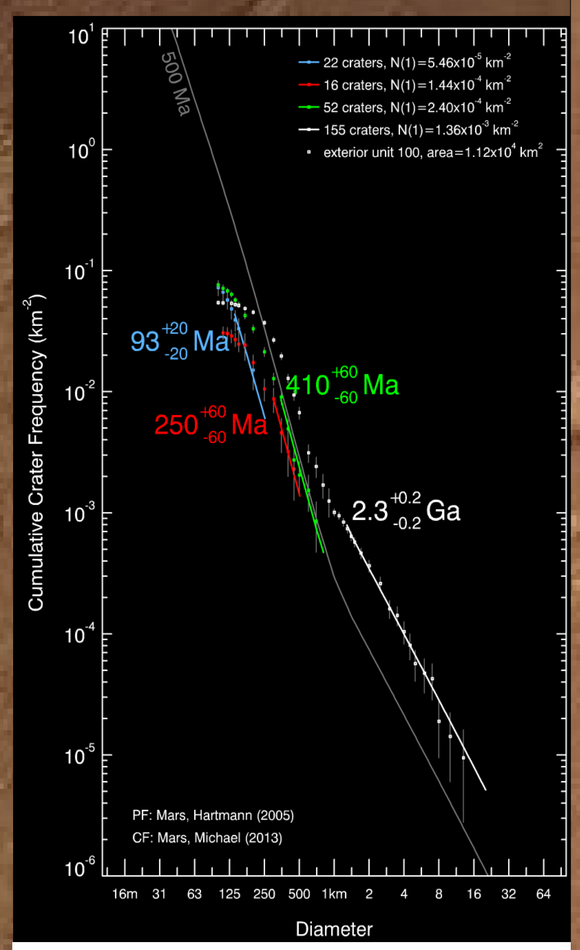

Fig.4 : Units age measurements. *White :* Sg unit craterisation curve (C.R.), *Green :* Dl and Ol units C.R., *Red :* Sil and Cil units C.R., *Blue :* Il and He units C.R.

Arandas crater

Arandas crater on Mars is located in Acidalia Planitia, is a well pre-served 25.1km double-layer ejecta rampart crater (DLER) [7] (Fig.1) and provides an excellent opportunity to study potentials relations between craterisation density and ejecta morphology.

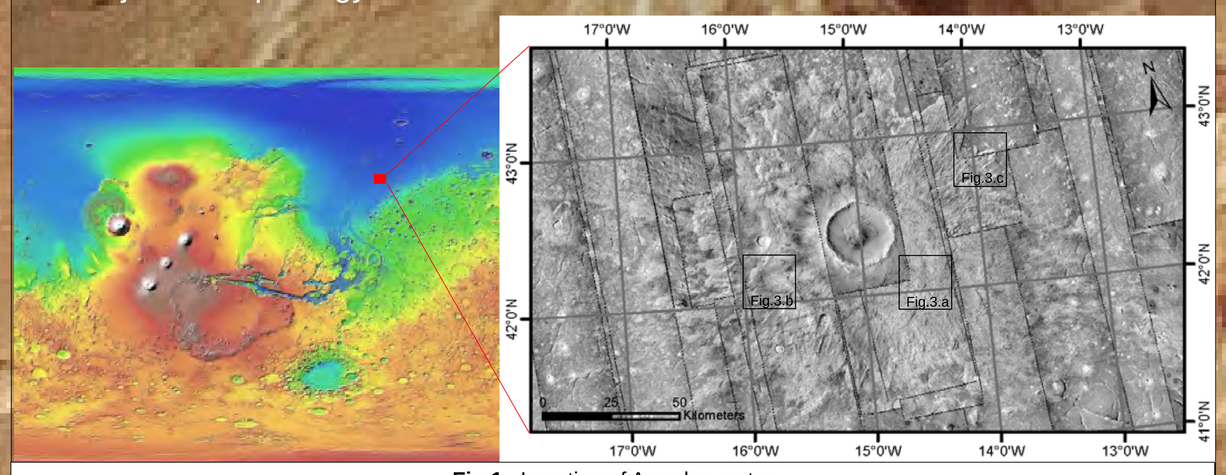

Fig.1 : Location of Arandas crater

→ Resurfacing processes are more active on the inner layer because the slope is higher than at distal units.

→ The inner ejecta layer slides off uplifted rim, assisted by basal snow and ice layer [8].

→ But if this resurfacing process obliterate craters on the inner layer, it doesn't explain the presence of radially grooves (Fig.3.a) formed at the moment of the impact [9].

Units description (Fig.2)

- Hummocky ejecta unit (He) : smooth materials with hummocky material.
- Inner layer unit (Il) : presence of radial ridges and a terminal bead.
- Striated inner layer unit (Sil) : radial ridges with concentric crest on irregularly surface (fig.3.a).
- Concentric inner layer unit (Cil) : gradual disappearance of radial ridges and increase of concentric crest (fig.3.b).
- Outer layer (Ol) : lobate morphology.
- Distal lobe unit (Dl) : thick terminale lobes (fig.3.c).

In order to have a satisfying statistical sample of craters for units dating, we grouped in pairs the units with similar geomorphological characteristics (He-Il, Sil-Cil, Ol-Dl).

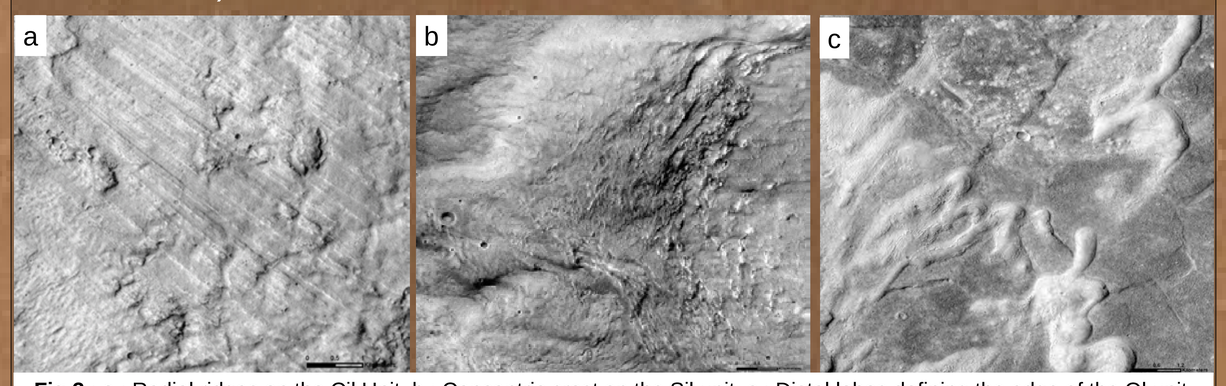

Fig.3 : a : Radial ridges on the Cil Unit, b : Concentric crest on the Sil unit, c : Distal lobes defining the edge of the Ol unit.

Conclusion

- According to the relatively homogeneous crater population of Dl-Ol units (fig.5), Arandas crater was formed 410±60 Myrs ago.
- Age of each unit increase with the distance to the crater rim.
- The methodology used to obtain this formation age provide a solid base to date the emplacement of this type of crater.
- Extended to a larger scale, this study will help to better constrain the spatial and temporal evolution of the martian permafrost and will clarify the ejecta lobate crater emplacement.

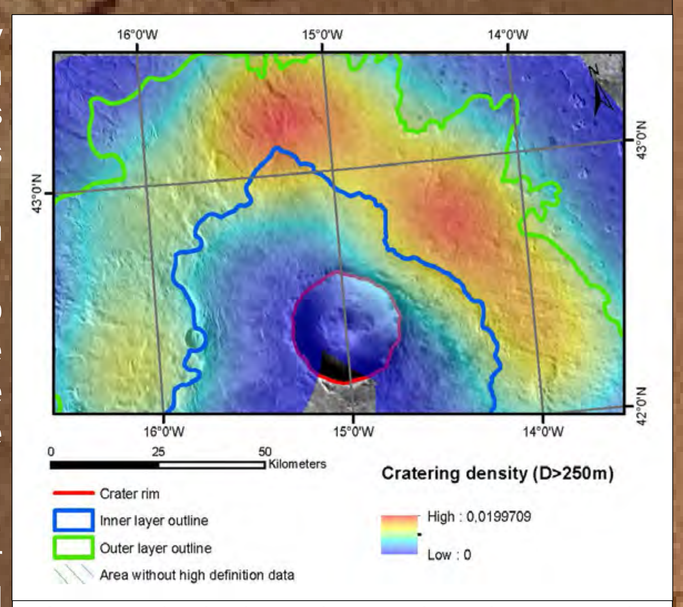

Fig.5 : Cratering density map for craters larger than 250m on the outer ejecta layer

References

[1] Wohletz, K. H. and Sheridan, M. F. (1983) *Icarus*, 56, 15-37. [2] Melosh, H.J. (1989) *Oxford University Press*. [3] Kneissl, T. et al. (2011) Pl. and Space Sci., 59, 1243-1254. [4] Michael, G. G., and Neukum, G., (2010) Earth an Pl. Sci. Letters, 294, 223-229. [5] Hartmann, W. K. (2005) Icarus, 174, 294-320. [6] Michael, G. G., et al. (2012) Icarus, 218, 169-177. [7] Barlow, N. et al. (2000) JGR, 105, 26733-26738. [8] Weiss, D.K. and Head, J.W. (2013) GRL, 40, 3819-3824. [9] Boyce, J. M. and Mouginis-Mark, P. J. (2006) JGR, 111, E10005.

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