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].

Arandas crater

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

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 dating 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 Si-IIl units.

Units description (Fig.2)

- Hummocky ejecta unit (He) : smooth materials with hummocky material.
- Inner layer unit (Il) : presence of radial ridges and a terminal peak.
- Striated inner layer unit (SII) : radial ridges with concentric crest on an irregular surface (fig.3.a).
- Concentric inner layer unit (CII) : gradual disappearance of radial ridges and increase of concentric crest (fig.3.b).
- Outer layer (OII) : lobate morphology.
- Distal lobe unit (Di) : thick terminal 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-II, SII-II, OII-Dl).

Fig.1 Location of Arandas crater

Fig.2 Geological map of Arandas crater

Fig.3 : Radial ridges on the CII Unit, b : Concentric crest on the SI unit, c : Distal lobes defining the edge of the Di unit.

Fig.3.a Fig.3.b Fig.3.c

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 radial grooves (Fig.3.a) formed at the moment of the impact [9].

Conclusion

- According to the relatively homogeneous crater population of Di-CII 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 basis 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.

References


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