EPSC Abstracts
Vol. 8, EPSC2013-941, 2013
European Planetary Science Congress 2013


# Rampart Collapse of DLE craters on Mars and Implications for Deposition Chronology.

**G. Wulf** (1) and T. Kenkmann (1)

(1) Institute of Earth and Environmental Sciences - Geology, Albert-Ludwigs-University Freiburg, Germany, (gerwin.wulf@geologie.uni-freiburg.de).

## Abstract

Preliminary results of the contact zone between the inner and outer ejecta layer of DLE craters are presented. They indicate a successive deposition chronology in such a way that the inner ejecta layer overlays the outer layer followed by a partial collapse of the distal part of the inner layer.

## 1. Introduction

Most Martian impact craters display layered and fluidized ejecta blankets [1, 2]. Three different types of fluidized ejecta impact craters are generally proposed: single-layered ejecta (SLE) craters that possess a single continuous ejecta layer surrounding the primary crater, double-layer ejecta (DLE) craters including two ejecta layers and multiple-layered ejecta (MLE) craters with more than two ejecta layers surrounding the crater. DLE craters are located in both hemispheres of Mars, though they are concentrated at mid-latitudes, preferentially in the northern lowlands [3-7]. They can be found at a variety of terrain types, elevation levels and surface ages and coexist with SLE and MLE craters of the same size and age (erosion state) on apparently identical geologic units. The deposition chronology of the two layers is still controversial. Some authors have supposed that the inner layer overlays the outer layer which indicates a successive deposition [8, 9, 10], whereas other authors have assumed that the inner layer was deposited first, followed by the outer layer after a hiatus, e.g. involving a high-velocity outflow of materials from tornadic winds and the change from a supersonic to a subsonic flow generated by the advancing ejecta curtain or a base surge [3, 7]. New results of the Bunte Breccia ejecta morphology of the Ries impact crater show striking morphological similarities to double-layer ejecta craters [11] and demonstrate the importance of understanding the ejecta emplacement processes of DLE craters also for terrestrial issues.

Here we show preliminary results of the contact zone between the inner and outer ejecta layer of a DLE crater on Mars that confirm a successive deposition chronology meaning that the inner ejecta layer overlays the outer layer followed by a partial collapse of the distal part of the inner layer.

## 2. Methods

The Steinheim crater on Mars (190.65°E 54.57°N) is a relatively pristine 11.2 km diameter DLE crater in Arcadia Planitia. The excellent coverage of high-resolution image data, especially HRSC, CTX and HiRISE, allows the detailed mapping [11] and analysis of surface structures of the crater and ejecta blanket. The data were processed by using ISIS (The Integrated System for Imagers and Spectrometers) to get the base data for further mapping in ArcGIS. The contact zone between the inner and outer ejecta layer was analyzed with emphasis on indicative features of the deposition chronology. The results were compared with other DLE craters.

## 3. Results and Discussion

The rampart of the inner ejecta layer of Steinheim crater and other DLE craters display characteristic morphologies: The inner slope shows radially grooved and ridged smooth surfaces that ascend to the crest line of the rampart. In contrast, the outward facing slopes beyond the crest line devoid of radial striations but form irregular, bulky, sometimes crenulated convex slopes that overlay the outer layer of the craters (Fig. 1, 3). The transition between the smooth and striated inner part and the bulky outer slope at the top of the rampart is often abrupt along steep linear to arcuate escarpments (Fig. 3). They are interpreted as the headscarps of normal faults and extensional graben and indicate the gravitational collapse of the underlying bulky material that ooze out onto the outer ejecta layer and thereby forming convex slope morphologies. The outer layer has small-scaled, approximately radially oriented, sublinear ridges and furrows that are interrupted abruptly at the contact with the inner ejecta layer (Fig. 2).

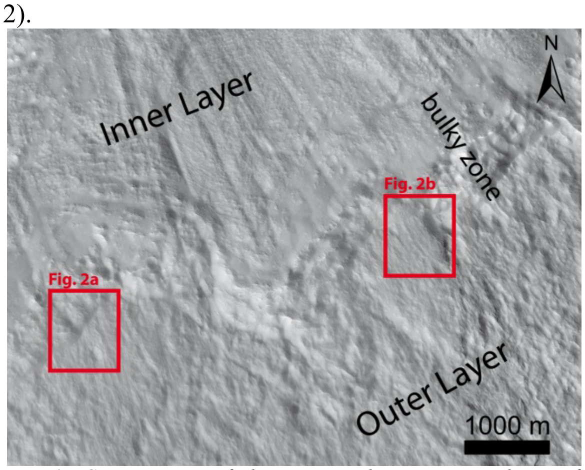


*Fig. 1: Contact zone of the inner and outer ejecta layer of Steinheim crater, a bulky zone (partially with smooth surfaces) indicates a collapse region (HiRISE images PSP_007736_2345 and PSP_007235_2350).*

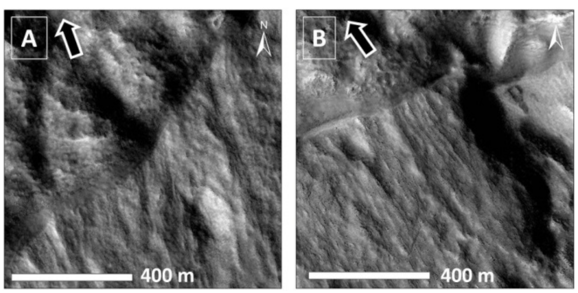


*Fig. 2: Lithological contact of the inner and outer ejecta layer of Steinheim crater, HiRISE image sections showing furrows and ridges that are interrupted abruptly at the contact with the inner ejecta layer (black arrows show the orientation of the crater centre; A part of HiRISE image PSP_007736_2345 (0.31m/px); B part of HiRISE image PSP_007235_2350 (0.31m/px).*

The analyzed features suggest that the inner ejecta layer in fact overlays the outer layer. But the presence of a bulky zone indicates that the distal part of the inner layer partially became instable after deposition showing features of slumping and sliding. Originally, the striations of the inner layer almost extend to the contact of the inner and outer layer and thus are direct depositional features. In some areas, the outer part of the rampart starts to collapse along escarpments whereby the surface of some the slumped blocks still shows the typical radial features of the inner ejecta layer indicating a rigid surface unit on top of a ductile subsurface.

The mapping areas and analyzed structures will be extended in future works to other DLE craters to better understand the underlying processes and conditions. Furthermore, the results will be used to verify existing ejecta emplacement models.

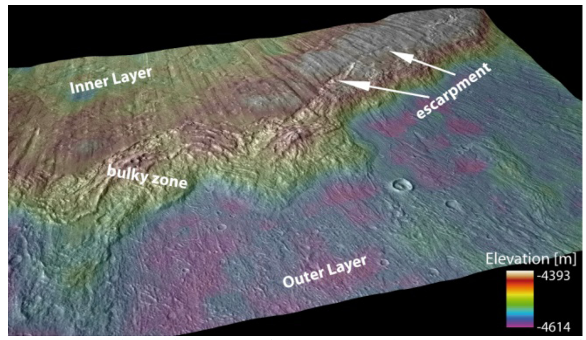


*Fig. 3: Lithological contact of the inner and outer ejecta layer of Bacolor crater, a bulky zone (with varying degrees of slumping) indicates a collapse (vertical exaggeration is 5x, superposed HRSC DTM over CTX mosaic,image area is 24x15 km²).*

# Acknowledgements

The project was financed by the German Research Foundation DFG, grant KE 732/19-1.

# References

[1] Barlow, N. G. et al. (2000): J. Geophys. Res., vol. 105, p. 26.733-26.738.
[2] Barlow, N. G. (2005a): In Large Meteorite Impacts III, Kenkmann T., Hörz F., Deutsch A., GSA SP 384, p. 433–442.
[3] Boyce, J. M. and Mouginis-Mark, P. J. (2006): J. Geophys. Res., vol. 111, E10005.
[4] Barlow, N. G. and Bradley, T. L. (1990): Icarus, vol. 87, p. 156-179.
[5] Barlow, N. G. and Perez, C. B. (2003): J. Geophys. Res., vol. 108, p. 5085.
[6] Barlow, N. G. (2005b): LPSC XXXVI, Abstract #1415.
[7] Mouginis-Mark, P. J. (1981): Icarus, vol. 45, p. 60-76.
[8] Carr, M. H. et al. (1977): J. Geophys. Res., vol. 82, p. 4055-4065.
[9] Osinski, G. R. (2006): Meteoritics & Planet. Sci., vol. 41, p. 1571-1586.
[10] Wulf, G. et al. (2012) LPS XLIII, Abstract #1744.
[11] Sturm, S. et al (2013): Geology 41 (5), 531-534.