EJECTA LAYER DEPOSITION CHRONOLOGY OF A DOUBLE-LAYER-EJECTA (DLE) CRATER ON MARS.
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Introduction: Most Martian impact craters display layered and fluidized ejecta blankets [1, 2]. Three types of fluidized ejecta impact craters are 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. They coexist with SLE and MLE craters of the same size and age (erosion state) on apparently identical geologic units. Some morphological characteristics distinguish them from other Martian craters: DLE craters possess two ejecta layers with radial texture composed of grooves and ridges that extend continuously from the crater rim to the outer edge of the continuous ejecta blankets [3]. The deposition chronology of the two layers is controversial. Some authors have supposed that the inner layer overlays the outer layer which indicates a successive deposition [8, 9], 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].

Here we present preliminary results of a detailed mapping of the contact zone between the inner and outer ejecta layer of a DLE crater on Mars. The results confirm a successive deposition chronology meaning that the inner ejecta layer overlays the outer layer.

Method: The Martian crater Steinheim (190.65°E 54.57°N) is a young 11 km diameter DLE crater in Arcadia Planitia (see figure 1) and has an excellent coverage of high-resolution image data. CTX and HiRISE 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. Particularly interesting areas were mapped with highest available resolution (HiRISE, 0.31-0.65 m/px).

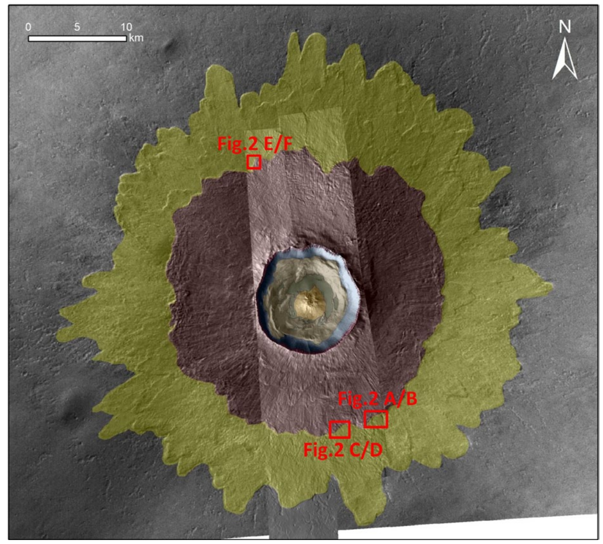

Fig.1: Structural map of Steinheim crater on Mars representing a double-layered ejecta crater (inner layer = red, outer layer = yellow, (part of HRSC strip 3650, HiRISE images PSP_007235_2350 and PSP_009160_2350)). Detailed mapping areas are marked by rectangles.

Results and Discussion: The outer ejecta layer shows surface structures with small-scaled, approximately radially oriented, sublinear ridges and furrows that are interrupted abruptly at the contact with the inner ejecta layer (see figure 2). These structures differ significantly in dimension and rectilinearity from the characteristic large-scaled and linear radial textures of the inner ejecta layer. The topographically higher inner layer appears to cover the outer layer, causing an overlayering of these surface features.

The contact zone does not show any kind of gradual transition. A partial superimposing of the inner layer by features of the outer layer that would be expected if the inner layer was deposited first and overprinted by the outer layer after a hiatus, could not be observed. Additionally, the inner layer forms a relatively steep slope with a sharp bend and contact to the outer layer, confirming the impression that the outer layer was deposited first and subsequently overprinted by the inner layer.

The analyzed features suggest that the inner ejecta layer in fact overlays the outer layer. Two scenarios may explain these observations: (i) The contact is a primary depositional one; the outer ejecta layer was

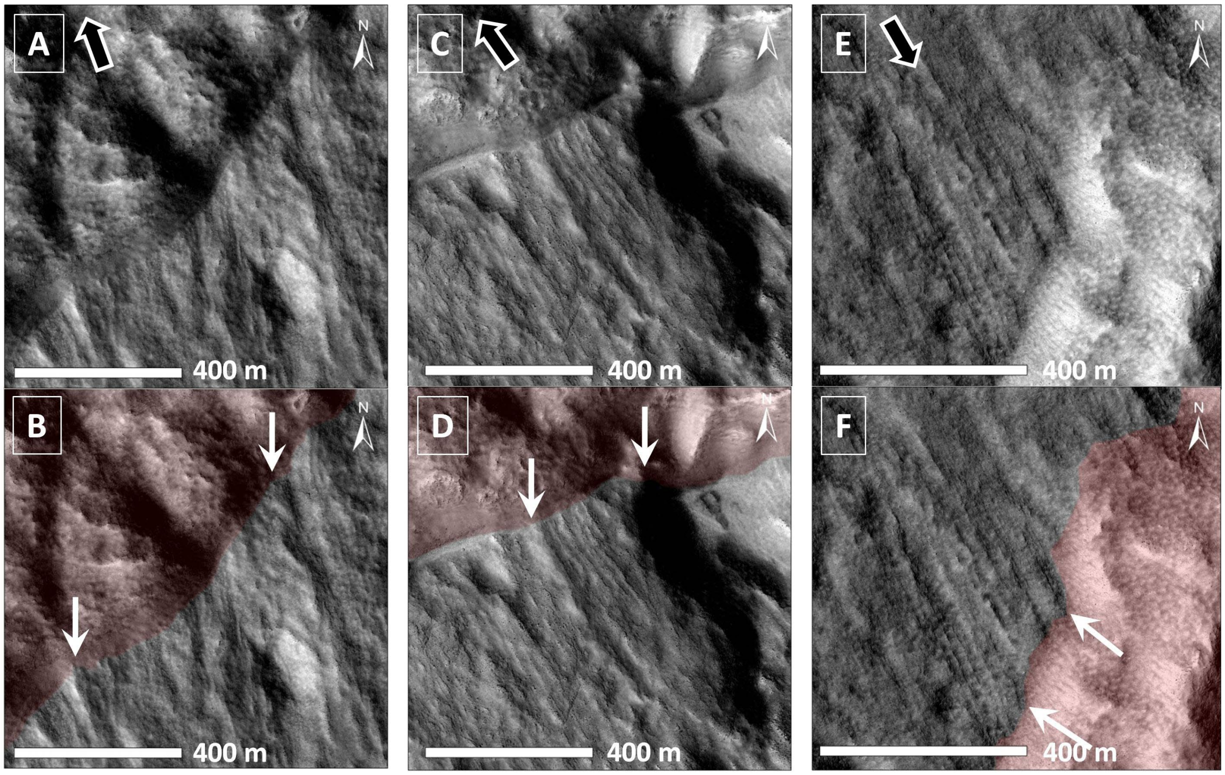

Fig. 2: Lithological contact of the inner and outer ejecta layer (white arrows), HiRISE image sections showing furrows and ridges that are interrupted abruptly at the contact with the inner ejecta layer (marked in red) (black arrows show the orientation of the crater centre; A/B part of HiRISE image PSP_007736_2345 (0.31m/px); C/D part of HiRISE image PSP_007235_2350 (0.31m/px); E/F part of HiRISE image PSP_009160_2350 (0.65m/px)).

emplaced first and was successively buried under the inner ejecta blanket that formed somewhat later. (ii) The inner and outer ejecta blankets were deposited more or less simultaneously. A remnant momentum of outward flow, probably caused by obliquely landing particles of the ejecta cone, is inherent particularly to the thick inner layer. This radial outward flow led to an overthrusting of the outer layer by the inner layer. The convex shaped rampart of the inner layer supports a lateral outward flow of the inner ejecta mass.

The mapping areas and analyzed structures will be extended in future works to other DLE craters and additionally, the influence of topographic features close to the contact zone will be considered. Furthermore, the results will be used to verify existing ejecta emplacement models.

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