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Complex aqueous deposits in a small impact crater in Aeolis Planum, Mars

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Abstract

We have studied a collection of fan deposits in a 21 km diameter unnamed impact crater situated in Aeolis Planum that show a fascinating range of morphologies indicating a change in depositional regime during fan formation. Our study area is interesting in three aspects. (1) It shows a complex stratigraphy of morphologically very different fans. The large variety of fan shapes in such close proximity is very unusual. (2) Most fan structures are connected to exhumed sinuous ridges of equally diverse morphologies. These ridges appear to have served as feeder channels and pervade an area close to the western crater rim. They appear to originate from distinguishable source areas so complete fan systems are preserved. (3) Stratigraphic analyses indicate that the fan formation falls into the same time-frame as the flooding of Hesperian-aged HBu2-lavas and may be linked to the volcanic activity. As a consequence, this implies that the MFF is older than previously believed.

1. Introduction

The crater and the fans are embedded in and partly exhumed from material of the Medusae Fossae Formation (MFF) that comprises the Aeolis Planum plateau. The MFF is a fine-grained, friable, layered deposit of as yet unknown origin that ranges among the youngest (Late to Early Amazonian [see, e.g., [1], [2]) geologic features on Mars. The crater is approximately 25 km in diameter and 500 to 600 m deep. The depth of the crater floor correlates well with the height of the terrain surrounding Aeolis Planum wherefore the crater must have formed in an already existing plateau. However, part of the crater floor and the surrounding ejecta blankets are covered by a layer of MFF material indicating that the deposition of MFF material continued after crater formation. Prior to the fan formation and the deposition of the final layers of MFF material the crater had undergone extensive erosion.

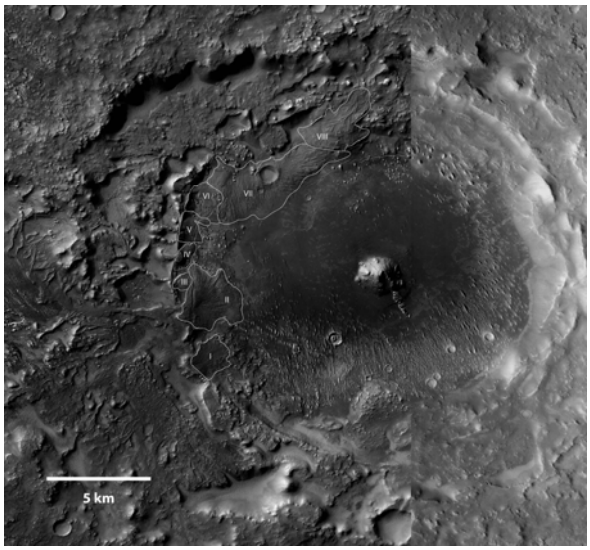

Figure 1: Study area; the crater is approximately 21 km in diameter and 500 to 600 m deep. Fans are found along the western and northern rim.

2. Fan deposits in the study area

We identified eight fan systems (fan-shaped deposit, associated feeder channel and source area) along the western and northern crater rim (Figure 1). Based on geomorphic shapes and size the deposits were classified into four different types:

Type 1 fan systems (fan systems III, IV, VI) have a small source region and short feeder channels. Feeder channels are narrow with no tributaries. The fans are characterized by short incised channels and a smooth surface morphology.

Type 2 fan systems (fan systems I, II, VII) have larger source areas and much longer flow paths. The Feeder channels exhibit several tributaries, are much broader than type 1 channels and show a complex channel history by superposition and cross-cutting of channels. Fan deposits are equally complex showing

numerous positive relief (exhumed) distributary channels.
The **Type 3** fan system (fan system IV) is characterised by a short and flat fan cut by a steep semicircular frontal scarp.
The **Type 4** (fan system VIII) fan system has two feeder channels and a complex fan showing a stair-stepped topography and numerous branched distributary channels. In clear contrast to the other fans the type 4 fan deposits are oriented more parallel to the crater rim.

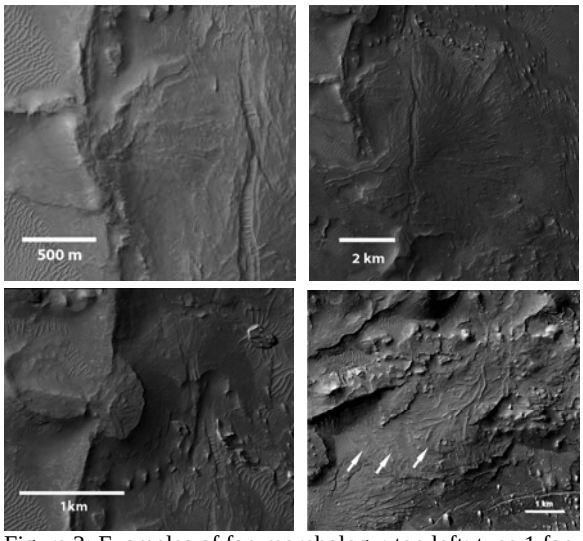

Figure 2: Examples of fan-morphology; top left: type 1 fan, note incised channel; top right: type 2 fan with complex morphology; bottom left: type 3 fan with steep frontal scarp; bottom right: type 4 fan with stair-stepped topography

3. Interpretation

The work presented here is still in progress and no final interpretations and conclusions have been drawn yet, particularly regarding the environmental conditions under which the fans formed. However, first results indicate a complex formation history. Based on cross-cutting relationships it appears that fan formation occurred in multiple (fluvial) phases. Type 1 fan systems formed first followed by the more complex and larger type 2 fans (phase 1). Both types are interpreted to be alluvial fans possibly formed by the runoff of precipitation. Incised channels cutting through the type 1 fan deposits indicate ongoing fluvial activity after fan deposition.
The deposits of type 3 and 4 fans superpose type 1 and 2 fans and are thus younger (phase 2). Their steep frontal scarps and stair-stepped topography might indicate that they formed as fan deltas in a standing body of water that formed as the results of the fluvial runoff during phase 1.

Stratigraphic analyses with the surrounding geologic units indicated an interesting correlation with the emplacement of Hesperian-aged lava flows directly north of Aeolis Planum (unit Hbu2 after [1], see also [3] and [4]). Volcanic activity in the nearby Elysium region could have been a trigger of fluvial activity in the study area.

4. Conclusion

The study area gives a new insight into the formation of crater fans and/or deltas on Mars and the climatic conditions under which they occur. Particularly the correlation with Hesparian volcanic activity will be investigated further and might shed new light onto the formation of paleoflow features in the Aeolis/Zephyria Plana region (see also [5]).

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