OBSERVATION AND INTERPRETATION OF AN INVERTED CHANNEL FEATURE IN THE MIDDLE MEMBER OF THE MEDUSAE FOSSAE FORMATION, EQUATORIAL MARS

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Introduction: We present new mapping and analysis of an unusual set of inverted channel features located on the central lobe of the Medusae Fossae Formation, centered at roughly 5°S, 179°E.

These features include an apparently dendritic inverted channel system located within a scallop-edged depression that intersects with a large crater (~ 20 km diameter). In particular it is the inverted channel which is of principal interest, as equivalent examples have yet to be mapped this far eastward in the Medusa Fossae formation [1,2].

There is good imaging coverage of these features from the High Resolution Imaging Science Experiment (HiRISE; NASA/JPL/University of Arizona) at ~ 30 cm/pixel resolution and the Context Imager (CTX; NASA/JPL/MSSS) at ~ 6 m/pixel, and it is these two datasets that form the basis of our study.

Background: Positive relief channels are a well studied phenomenon on Earth and can form when a fluvial channel becomes more resistant to erosion than the terrain around it and is then left high-standing as erosion occurs. Processes that lead to such topographic inversion include cementation or armouring of the channel floor, infilling of the channel and even capping by lava flows that have followed the channel path [3].

Over 200 positive relief sinuous ridges (SRs) have been identified at the 1-10 m scale, over areas of ~10 to 100 km^2 [4] across Mars. Although commonly interpreted as inverted channel forms, SRs differ in spatial distribution and geologic setting from typical valley networks on Mars [5]; the former being observed over a variety of terrains but the latter occurring primarily on the highlands.

Burr and colleagues [6, 7] have conducted surveys documenting the occurrence and morphologies of sinuous ridges across the western portions of the Medusae Fossae Formation and the surrounding areas, a study which Zimbelman and Griffin [2] further expanded. Such ridges were observed at multiple and distinct stratigraphic horizons and it is estimated that over 80% of SRs are interpretable as some aspect of fluvial channel flow.

Approach: We used CTX image P16_007394_1748_XN_05S180W and HiRISE images PSP_007394_1750 and PSP_008185_1750 (Fig. 1) to create a geomorphological map of the study area (Fig. 2). We then used our observations to infer possible origins for the inverted channel feature and the implications of such for the composition of the Medusae Fossae Formation materials.

Key observations: The positive relief channel system described here is over 14 long and over 11 km wide. It lies within a scalloped edged depression of ~ 16 km diameter, which itself intersects with a 20 km diameter impact crater to the north. In planform, the channel system appears dendritic with channel order up to 4 and has uneven edges and large (often near right-angled) junction angles between the branches.

Figs. 1&2 shows the main surface geomorphological features observed across both the inverted channel and the floor of the large crater. These include:

- Surface cracking on the upper surface of the inveted channel that is parallel to the inferred flow direction and follows sinuosity
- Braiding present within the proximal debris cone at the south of the large impact crater
- Impact craters with raised, asymmetric ejecta are present both on the braided debris region and on the inverted channel upper surface
- "Stepping" in the channel edge and incised layering and mesas in the crater floor indicating multiple layers within both the channel and the debrid
- Large deposits of aeolian material are found in the northern crater.

Discussion: From available evidence, including the branching planview pattern, the topography and the surface textures of the debris regions we interpret the inverted relief feature as a relict fluvial channel. Based upon surface texture similarities, we hypothesize that the material which appears to "resurface" the floor of the crater to the north is the same material from which the channel is formed and that it flowed northward into the crater, having ponded against and then breached its southern rim.

It remains ambiguous whether the channel flow itself was sub-aerial or sub-surface and we suggest that the system may have resulted from a combination of processes including sapping and ice-melt, as indicated by the association of the highest order channels with apparent amphitheatre-shaped headscarps,.

Conclusion: We conclude that the network formed as a result of mobilization of volatiles released from within the Medusae Fossae Formation. These Medusae Fossae Formation materials could be ice-rich volcanic ash deposits [1] or cyclical deposits of ice/dust laid down in periods of high obliquity [8]. What triggered this local melt is unknown.

References: [1] Burr et al., 2010, Journal of Geophysical Research 115, E07011. [2] Zimbelman and Griffin, 2010, Icarus 205 (1), 198-210. [3] Pain and Ollier, 1995, Geomorphology 12, 151-165. [4] Williams et al., 2009 [5] Williams, 2007 [6] Burr and Enga, 2007, [7] Burr at el., 2009, [8] Head & Kreslavsky, 2004, Lunar and Planetary Science XXXV Abstract #1635.

Figure 1: Overview of the geomorphological study area. Note branching ridge system in the southern depression and the dark mantling material in the northwest of the northern impact crater. (CTX image P16_007394_1748_XN_05S180W, HiRISE images PSP_007394_1750 and PSP_008185_1750).

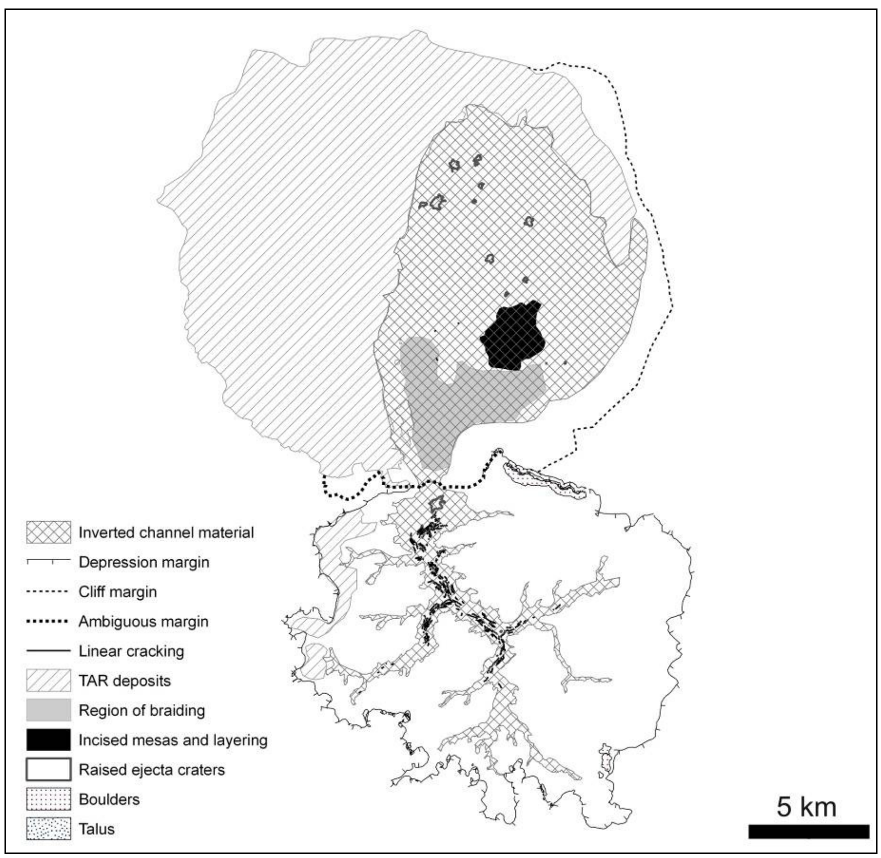

Figure 2: Simple geomorphological map of the study area showing the main features. Non-shaded areas are interpreted to be simple Medusa Fossae Formation materials.