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Viscous Flows Formed The Branched Ridges Of Antoniadi Crater, Mars

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Antoniadi basin is a 330 km diameter Noachian basin localized in the East of Arabia Terra that contains a network of ridges with a tree-like organization. Branched ridges, such as these can form by a variety of processes including the inversion of fluvial deposits, thus potentially highlighting aqueous processes of interest for understanding Mars' climate evolution. Here, we test this hypothesis by analyzing in details data from Colour and Stereo Surface Imaging System (CaSSIS), High Resolution Imaging Science Experiment (HiRISE) and High Resolution Stereo Camera (HRSC).

Branched ridges are up to 10 km long and from 10 to 200 m wide without obvious organization in width. The branched ridges texture is rubbly with the occurrence of blocks up to ~1 m in size and a complete lack of layering. A HiRISE elevation model shows the local slope is of 0.2° toward South, and thus contrary to the apparent network organization (assuming tributary flows). There is no indication of exhumation of these ridges from layers below the current plains surface. Our observations are not consistent with the interpretation of digitate landforms such as inverted channels: (i) The rubbly texture lacking any layering at meter scale is distinct from inverted channels as observed elsewhere on Mars. (ii) Heads of presumed inverted channels display a lobate shape unlike river springs. (iii) There is no increase in width from small branches toward North as expected for channels with increasing discharge rates downstream. (iv) The slope toward South is contrary to the inferred flow direction to the North. The detailed analysis of these branched ridges shows many characteristics difficult to reconcile with inverted channels formed by fluvial channels flowing northward. Subglacial drainages are known to locally flow against topography, but they are rarely dendritic. Assuming that deposition occurred along the current slope, thus from North to South, the organization of the network requires a control by distributary channels rather than tributary ones. Distributary channels are possible for fluvial flows, but generally limited to braiding regimes or deltaic deposits, of which no further evidence is observed here. The lobate digitate shapes of the degree 1 branches are actually more in line with deposits of viscous flows, thus as terminal branches. Such an interpretation is consistent with lava or mudflows that formed along the current topography. The next step in this study will be to

determine more precisely the rheology of these unusual flows.

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