Cone-chains in Isidis Planitia, Mars. T. M. Pithawala[1] and R.R. Ghent[1] [1]Department of Geology, University of Toronto; Earth Sciences Centre, 22 Russell St., Toronto, ON M5S 3B1, taronish.pithawala@utoronto.ca.

Introduction: Isidis Planitia is one of the many areas on Mars containing "thumbprint terrain" (TPT), a term coined to reflect the resemblance in Viking images to fingerprints. Other instances of TPT occur in Argyre, Hellas, Arcadia Planitia, and Utopia Planitia. The terrain is found where Greeley and Guest (1987) have defined the Hesperian Ridged Plains (Hvr) unit. However, the landforms comprising the TPT in Isidis are markedly different in morphology from those found in the northern plains. The purpose of this study is to conduct a systematic examination of the putative TPT in Isidis Planitia using high-resolution imagery, and to propose a hypothesis for its genesis.

Northern Plains TPT Morphology**:** Landforms associated with TPT include branching troughs and medial ridges forming whorled lobes, and mounds (either flat-topped or rounded), most with basal scarps or terraces. Based on Viking data, TPT was described as consisting of parallel, en echelon, or nested sets of regularly spaced curvilinear ridges or aligned hills [1]. The ridges were estimated to be 0.5-2.5 km wide and 1-40 km long, with a characteristic spacing of 2-6 km. Whorled lobes of TPT are 75-150 km wide, with heights ranging from 10-200 m. That study identified 22 areas of TPT, between 3000 and 420 000 km^2 in the Northern Plains at elevations between 0 and -2 km. In Utopia Planitia, TPT also includes branching troughs and medial ridges [5]. TPT is also closely associated with troughs in at least nine other areas of the Northern Plains [1].

Northern Plains TPT Origin**:** MOLA topography data support the hypothesis that TPT and associated trough systems in Utopia and Arcadia Planitae were formed by glacial mechanisms [1,2,3]. Possible mechanisms include formation of ridges as moraines and troughs as eskers formed in association with wet-based continental glaciers. Alternatively, the absence of drumlin fields suggests that the glaciers responsible for forming the topography may have been cold-based and thus did not deform the substrate in a manner so as to form drumlins [4]. A puzzling characteristic of Mars' alleged glacial landscapes is that they are morphologically pristine, though they must be at least hundreds of millions of years old [1].

Isidis TPT: The physical appearance of the Isidis features differs from that of the TPT found in the Northern Plains. Two types of ridges have been described on the floor of Isidis; wrinkle ridges and curvilinear ridges that comprise the putative TPT. Wrinkle ridges in the Isidis basin are oriented radially and concentric to the basin structure, form cells of ~180 km in diameter, and occur throughout the basin floor over a range of elevations. They are on the order of 75-150 m high and less than ~70 km wide [6].

In this study, we focus on the curvilinear ridges and associated features, using THEMIS daytime IR data to create a map to highlight feature orientation. Curvilinear ridges are on the order of 10-50 m high, and less than ~5 km wide, with a large number ≤1km wide. Ridges consist of connected cones with central depressions (30-50% of basal diameter). Cones are often connected to each other midway through their height but are sometimes seen sharing portions of their rims as well. Basal diameters of the cones vary from 600-1000 m (nearly twice the size of cones seen in northern plains TPT) [6].

Spatial patterns: Ridges proximal to each other lie in sub-parallel to parallel orientations. Our mapping of TPT features in Isidis Planitia shows four domains of distinct morphology (Figure 1). Domain 1 consists of chain-like ridges of cones concentrated in the southern and western regions of the basin. Domain 2 consists of isolated cones localized within the center of the basin. Domain 3 can be considered the Syrtis Major – Isidis Planitia transition zone and consists of clusters of knobs, mesas, and large single scarps [7]. Domain 4 consists of smooth terrain lacking a significant number of cones, or knobs and mesas. This region lies west of the transition zone and along the outer regions of the basin.

The most detailed mapping to date in this study has been completed for Domains 1 and 2. In Domain 1, an apparent pattern emerges along a boundary trending E-W at ~12° N. Cone-chains located north of this boundary show a preferential N-S alignment, convex toward the east. Cone-chains located south of the boundary show a preferential E-W alignment, convex toward the south. Cone-chains occupy the region previously mapped as Hvr [8].

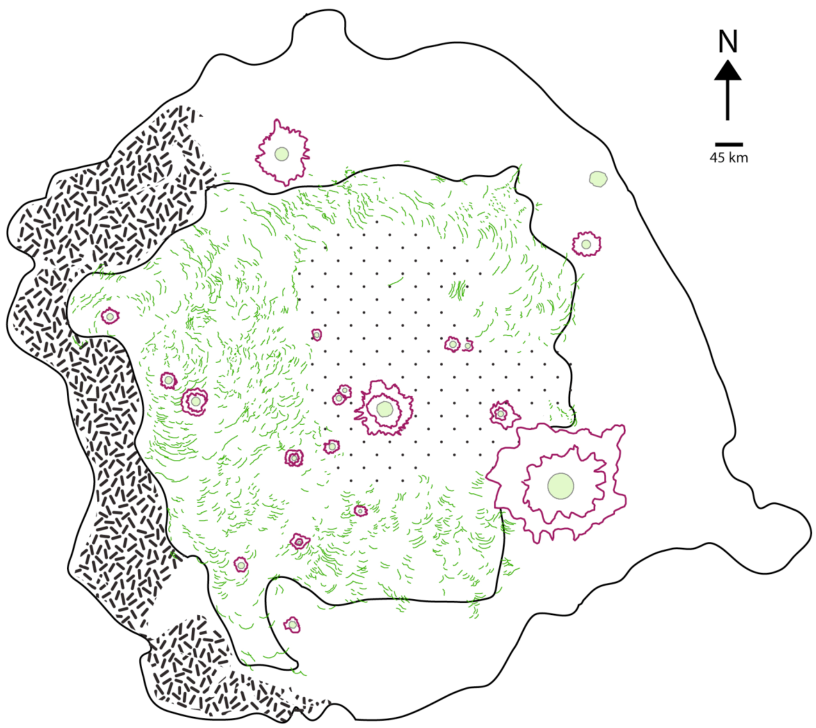

Figure 1. Sketch map showing Domains 1-4 in Isidis Planitia. Criteria for distinguishing between TPT features are as follows. Cones (Domain 2, stippled pattern): positive structures, circular base and central depression at peak. Isolated cones are not connected, nor are they spaced such that they form chains or arrays. Chains (Domain 1, mapped in green): mostly arcuate, positive ridge-like structures consisting of several cones either closely spaced to form a line, or physically linked along their heights. Syrtis-Isidis Transition Zone (Domain 3, hash marks): clusters of knobs and mesas arranged in flow-like features. Smooth Plains Material (Domain 4, white): smooth terrain lacking a significant number of cones, knobs and mesas. Crater rims are drawn in green, their ejecta in purple. Basin center is 88°27'E, 13°13'N.

Origin of the Isidis TPT features: Previous studies indicate that the Isidis basin is occupied by lava flows from Syrtis Major and by Vastitas Borealis Formation (VBF) materials [7]. We discuss 3 possible mechanisms for the genesis of the small-scale terrain in Isidis Planitia.

1. Glacial processes have been hypothesized to cause TPT in the Isidis basin. However, their large size and their sub-parallel to parallel orientations make these cone-chains distinct from the glacial TPT in the Northern Plains of Mars.

2. The cone chains are surficial expressions of an intrusive sill complex originating from nearby Syrtis Major [9, 10]. This idea would allow for the chains to be oriented without regard to the tilt of the basin, or any putative lava flow directions. It also could explain the curvilinear shape of the chains. However, there is little evidence of lava emanating from the cones as would be expected if the cones were vents aligned with the edges of sills. Furthermore, this model does not explain the genesis of the isolated cones in Domain 2.

3. Viscous lava flow fronts advancing from Syrtis Major into the basin interact with VBF material and form rootless cones. This accounts for the lack of lava originating from the cones themselves. Two distinct flow fields could explain the observed dichotomy in cone-chain alignment, and the shape of viscous lava flow fronts could account for the curvilinear shape of the chains. The isolated cones in the centre of the basin could be formed by pooling of lava such that fronts are indistinguishable. However, current topography shows that the lowest elevation in the basin occurs at the SW corner, and not at the centre.

A combination of both models 2 and 3 is also a candidate for the genesis of TPT in Isidis. We are continuing to investigate the details of the latter two models by analyzing additional datasets and terrestrial analogues.

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