POTENTIAL VOLCANIC CONSTRUCTS ASSOCIATED WITH FLUVIAL CHANNELS IN THE HESPERIA-HELLAS TROUGH, MARS. J. Korteniemi and S. Kukkonen, Department of Physics, PO Box 3000, 90014 University of Oulu, Finland, <jarmo.korteniemi @ oulu.fi>.

Introduction: Niger and Dao Valles are large outflow channels that cut the smoothened eastern rim of the Hellas impact basin on Mars. Niger Vallis is characterized by a set of broad and shallow troughs connecting circular and elongated depressions. It is a tributary of Dao, which is a much better defined channel originating from a distinct head depression. Both are believed to have formed due to the release of subsurface volatiles, possibly mobilized by volcanic heating [1–5]. The channels have been extensively modified later, most noticeably by lineated valley fill (LVF) which covers most of their floors [6–7]. However, patches of the floor are still uncovered and exhibit features predating the LVF [8].

The channels are located south of the ~300x500 km Hadriaca Patera volcano. It is surrounded by a network of radial and ring dikes, extending well beyond the Dao and Niger [5]. A trough on the Dao head floor may be the result of a magmatic intrusion [9]. The entire region exhibits large scale evidence of volcanic activity [10].

This work describes a number of features resembling volcanic edifices closely related to the channels: Summit pitted knobs on the Dao Vallis head floor, and a single shield-like structure in Niger Vallis [11].

Description: *(1) Knobs in Dao Vallis.* The floor of the Dao Vallis head is characterized by hundreds of small knobs and mesas (Fig. 1a). The number of 0.1–10 km diameter knobs is ~500. The highest ones are generally sharp crested with a conical shape, flanks rendered featureless by scree and talus deposits. Most of the lower knobs have hummocky tops. The cones are embayed by younger LVF and mass wasting deposits, originating from the canyon walls.

Fifteen roughly conical 0.5–2.3 km wide knobs exhibit pits on or close to their summits (Fig. 1b–c). The pit widths vary between 50 and 850 m, or 5 and 50 % of the knob diameter (average ~18 %).

(2) Shield structure in Niger Vallis. The feature in Niger Vallis (located at 35.90°S, 91.45°E) is a circular shield-like structure, ~100 m high and ~6.5 km in diameter (Fig. 2). A shallow ~800 m diameter semicircular trough is located near the summit. The shield flanks are characterized by shallow troughs radiating from the summit. In the E-SE sector they separate downslope oriented lobe-like structures; in the W-SW sector the troughs extend down to the surrounding terrain; in the N sector the troughs are mostly subdued (possibly an illumination effect?). The entire structure is located on top of a mesa, which is part of a roughly concentric 35x30 km system of depressions, mesas and fractures in Niger Vallis (Fig. 3).

Interpretation: *(1)* All the ~500 Dao Vallis floor knobs have similar appearances, with the exception of the few summit pits. Traditionally, all the knobs been interpreted as remnants of collapsed materials during Dao formation. This is still a scenario well worth considering, as the summit pits may be just conveniently located impact craters. However, the knob distribution gives an alternative hint: The pitted knobs are concentrated in the northern part of the Dao head, whereas pitless ones of the same size are more abundant in its central parts. The pitted knobs closely resemble, and may have a similar origin, as the volcanic cones found in e.g. Syria Planum in both size and shape (Fig. 4.). Given that the region is highly volcanic [5], we suggest that the pitted knobs are either volcanic vents (cinder or ash cones), or rootless cones resulting from lava and water-rich soil interaction.

(2) The Niger shield is an entirely different story. Its flank troughs are probably partly caused by water carving the easily erodible surface materials. In places (best shown in the east) the flank morphology closely resembles lobes of viscous material flowing down the flanks and solidifying in place. Mass wasting is unlikely to have occurred in a large scale on the hill, whose slope angles reach only ~2°. The Niger shield bears close resemblance to the much larger patera-type volcanoes in the region. It is low-relief and the flanks have erosional troughs, with downhill flowing material lobes. We interpret the shield to be a volcanic edifice, composed of easily erodable pyroclastic materials, similar to the paterae.

The shield is located on the edge of a large circular fracture system, heavily modified by at least fluvial and tectonic activity (Fig. 3). Absolute interpretation of the system is impossible with current data. However, in our view the system may either be the site of an old impact, a crater fractured by magmatic intrusions [see e.g. 5], or possibly a volcanic caldera. Both the shield and a long circular trough are 11.5 km from the system centre. In a magmatic intrusion scenario we interpret them as surface expressions of a ring dike.

The morphology and topography can also be interpreted differently. The Niger shield may be a randomly placed and eroded pile of volatile-rich regolith, and the lobes and troughs may be unusual clumps of impact ejecta from the crater near the summit. Or, if the shield is indeed composed of pyroclastic materials, the source

may have been Hadriaca Patera instead of a local eruption. However, these hypotheses seem unlikely, as they require a more widely spread distribution of the said materials. No features in the vicinity show the same characteristics in the same scale as the shield (radial troughs, lobed flanks, shield-like topography). The shield is unique, most likely built up from the centre outwards. The shield flanks are cut by local fracturing associated with the formation of Niger Vallis. Additional similar features may have been destroyed, covered or modified beyond recognition in the same processes.

Conclusions: We describe several previously unrecognized constructs in the Dao–Niger system. Based on morphology we interpret them as probable volcanic edifices. Our findings expand the identified regional volcanic activity to smaller scales. Further studies for hypothesis confirmation are in progress.

References: [1] Crown D. A. et al. (1992) *Icarus, 100*, 1–25. [2] Crown D. A. et al. (2005) *JGR, 110*, E12S22. [3] Harrison K. P. & Grimm R. E. (2009) *JGR, 114*, E04004. [4] Kostama V. -P. et al. (2010), *EPSL, 294*, 321–331. [5] Korteniemi J. et al. (2010) *EPSL, 294*, 466–478. [6] Squyres, S. W. (1979) *JGR, 84*, 8087–8096. [7] Squyres, S. W. et al. (1987) *Icarus, 70*, 385–408. [8] Korteniemi J. & Kukkonen S. (2013) *LPSC 44*, #2815. [9] Korteniemi J. & Kukkonen S. (2012) *LPSC 43*, #2034. [10] Williams D.A. et al. (2010) *EPSL, 294*, 3–4, 492–505. [11] Korteniemi J. & Kukkonen S. (2013) *EPSC*, # 779.

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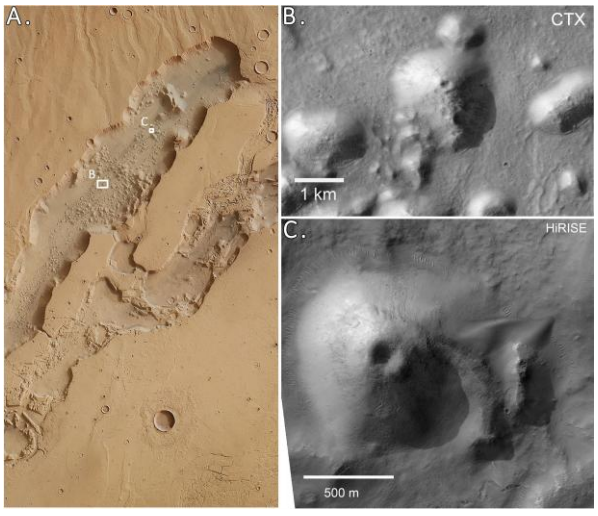

Figure 1. A) HRSC mosaic of the Dao Vallis head shows the hundreds of small knobs. B) A more detailed study shows that some of the cones have a pit on or C) close to their summits (locations are shown by rectangles in Fig. 1a).

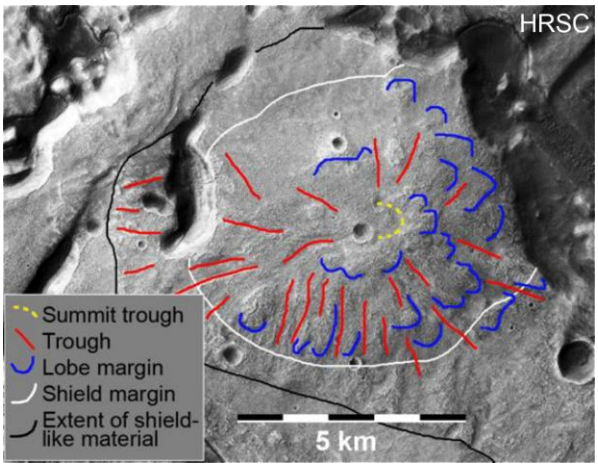

Figure 2. Detailed sketch map of the shield structure located in Niger Vallis (see text and Fig. 3 for location).

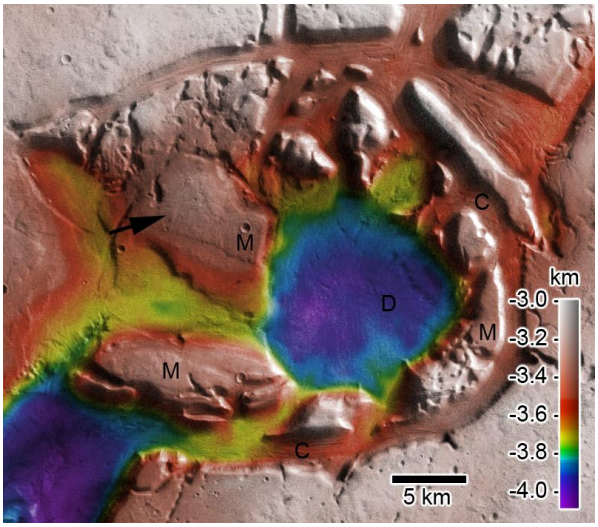

Figure 3. Topographic (HRSC DTM) map of the area surrounding the shield feature (black arrow) in Niger Vallis. The complex system consists of a circular central depression (D) surrounded by mesas (M) and a circular trough (C). Niger Vallis flow direction is from top-right to bottom-left.

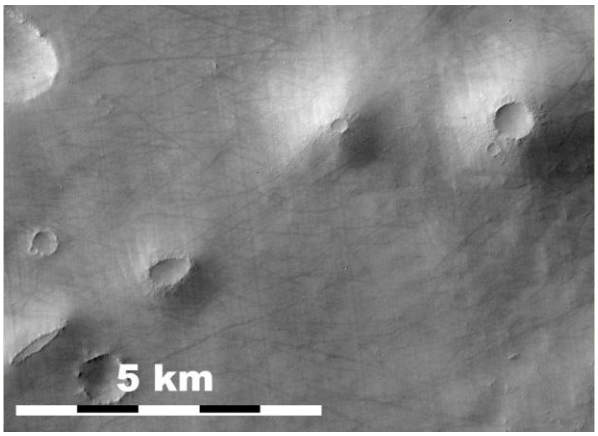

Figure 4. A CTX detail of volcanic cones on Syria Planum.