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Small volcanic edifices in Niger and Dao Valles, Mars?

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Abstract

This work describes structures on the floor of the Niger–Dao Valles channel complex. Based on morphology they are interpreted as possible or probable volcanic edifices. Our findings expand the identified regional volcanic activity to smaller scales.

1. Introduction

Niger and Dao Valles are large channels on the smoothened eastern rim of the Hellas basin on Mars. Niger 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. The channels are located just next to the ~300x500 km Hadriaca Patera volcano.

The channels are believed to have formed due to the release of subsurface volatiles mobilized by volcanic heating [1–5]. The channels have later been extensively modified, 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 existence of volcanic vents near the channels is not entirely unexpected. Hadriaca is surrounded by a network of radial and ring dikes, extending well beyond the channels [5]; a trough on the Dao floor may be the result of a magmatic intrusion [9]; and the entire region exhibits large scale evidence of volcanic activity [10]. This work describes a number of features resembling volcanic edifices: summit pitted knobs on the Dao Vallis head floor, and a shield-like structure in Niger Vallis.

2. Description

(1) The feature in Niger Vallis (located at 35.8°S, 91.4°E; Fig. 1) is a circular shield-like structure, ~100 m high and ~6.5 km in diameter. A shallow ~800 m diameter semi-circular trough is located near the summit. The flanks of the shield are characterized by shallow troughs radiating from the summit. In the E-SE they separate downslope oriented lobe-like structures; in the W-SW the troughs extend down to the surrounding terrain; in the N the troughs are mostly subdued (possibly an illumination effect?). The entire structure is located on top of a mesa, inside a roughly concentric 35x30 km system of depressions, mesas and fractures in Niger Vallis (Fig. 2).

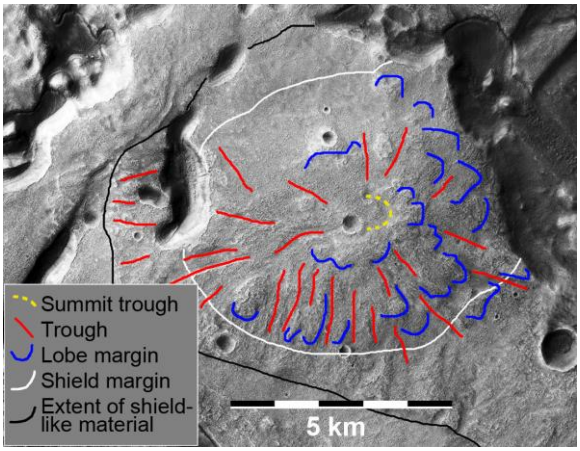

Figure 1. The Niger Vallis shield structure. CTX image P13_006158_1443_XN_35S268W.

(2) The Dao Vallis floor is characterized by hundreds of small knobs, most rendered featureless by scree and talus deposits. However, a number of otherwise regular looking knobs exhibit tens to a few hundred m wide pits on their summits, occasionally flanks. Example locations: 33.4°S, 93.0°E; 33.9°S, 92.3°E; 34.0°S, 92.6°E.

3. Interpretation

All the Dao Vallis floor knobs and mesas have similar appearances, and they have traditionally been interpreted as remnants of collapsed materials during Dao formation. In our view this indeed is the most likely scenario, and the interpretation for the summit pits is just conveniently located impact craters. However, it may also be interesting to study an alternative hypothesis: the pitted knobs do closely resemble volcanic cones, both in size and shape.

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, with slope angles reaching 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.

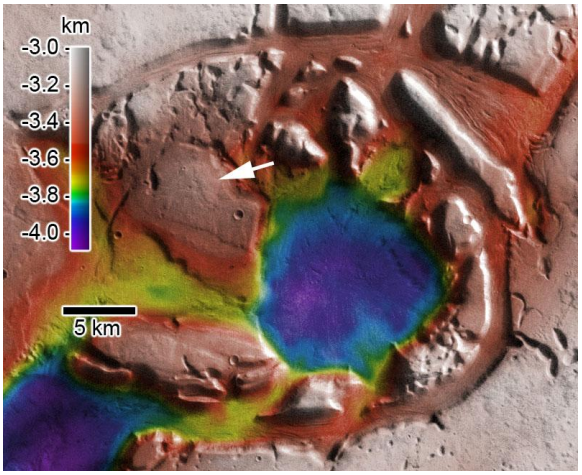

Figure 2. System of structures surrounding the shield (arrow). HRSC orbit 528 nadir image with DTM.

The shield is located on the edge of a large circular fracture system heavily modified by at least fluvial and tectonic activity. 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. The latter idea is circumstantially supported by the similar location of the shield and a semi-circular trough on the other side (Fig. 2); both are 11.5 km from the system centre, and, in this scenario, interpreted as surface expressions of a ring dike.

The discussed 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 regional distribution of the 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 appear to be cut by local fracturing associated with the formation of Niger Vallis. It is thus feasible that similar features did form in the past, but most of them have been destroyed, covered or modified beyond recognition by later processes. Some examples may have survived, and wait for identification.

Acknowledgements

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