

DIFFERENT LEVELS OF EROSION DURING THE FORMATION OF DAO, NIGER AND HARMAKHIS VALLES ON MARS. V. -P. Kostama¹, M. A. Ivanov^{1,2}, J. Raitala¹, J. Kortenien¹, and T. Törmänen¹; 1 - University of Oulu, Oulu, Finland, 2 - Vernadsky Inst., RAS, Moscow, Russia. petri.kostama@oulu.fi.

Introduction: Dao, Niger and Harmakhis Valles are concentrated within the SW extension of Hesperia Planum [1-9]. These valles deeply incise the stack of lava flows, and, thus, postdate formation of the lava plains. All these channels begin in broad alcove-like regions and flow down the regional slope toward Hellas Planitia. The distance between Dao and Harmakhis Valles suggests that their sources were independent of each other. Niger Vallis, however, is close to Dao Vallis and continues its general trend. This could be interpreted as evidence that these channels may have shared the same source. In order to clarify the relative timing of formation of the sources of the channels, and episodes of volcanism within Hesperia Planum, we analyzed the topographic and morphologic characteristics of the head areas of the channels using the MOLA gridded topography (1/128° resolution) and suite of imagery data such as Viking, MOC, THEMIS, and HRSC.

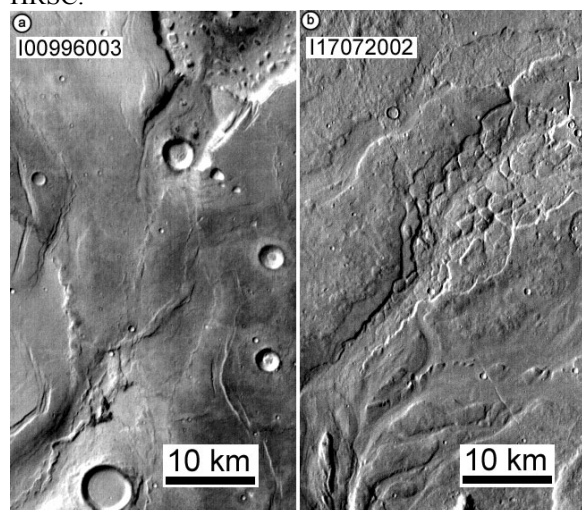


Figure 1. Details from THEMIS images of the source regions of Niger Vallis and the “small channel” between Niger and Harmakhis Valles.

Morphology of the source regions of the channels: The canyons of Dao and Harmakhis Valles begin in deep (2-2.5 km) elongated alcoves with steep walls and flat floors. The absence of tributaries converging to the alcoves suggests that the head areas of Dao and Harmakhis have formed due to massive melting of ice in the subsurface sources. The source area of Niger Vallis is different and consists of individual circular, steep-sided, and flat-floored depressions interconnected by shallow and gentle trough-like moats, the edges of which are punctuated by low scarps and fractures (Fig. 1a). Within the moats, the surface is similar to the surrounding lava plains but is sagged down up to several hundred meters. These features strongly suggest a subsurface source of Niger Vallis. Within the plains between Dao and Harmakhis there is a system of smaller and much shallower channels that appear to begin in a chaos-like area (Fig. 1b). The source region of the channels has a shallow (~500 m) and broad (tens of km) depression filled by fragments of collapsed lava plateau that are cut by short dummy channels. At the SW edge of the area, the channels produce anastomosing pattern and finally merge and form a single sinuous channel that runs toward Harmakhis Vallis. These characteristics of the head area are consistent with and strongly suggest the presence of a subsurface source.

A layered structure on the walls of all channel source areas is clearly seen in the MOC images of the valles walls (Fig. 2). The layers appear to be sub-horizontal and strongly resemble structure of the classical volcanic plateaus of Mars such as Lunae Planum and Syrtis Major where they are cut either by deep canyons or high scarps [e.g. 10]. We interpret the layering on the walls of Dao, Niger, and Harmakhis Valles as the evidence that these channels cut through the thick stack of lava flows within the SW extension of Hesperia Planum.

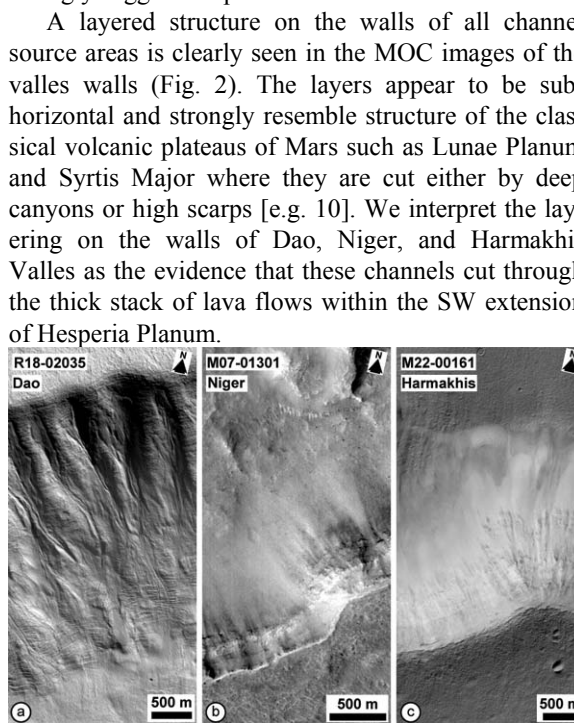


Figure 2. The layered structure of the walls of the valles of eastern Hellas region from MOC images.

Topographic characteristics of the channels: A topographic profile across the general trend of the channels (Fig. 3) shows that the floors of the heads of Dao and Harmakhis Valles occur at about the same level, -5 km. The floor of the upper portion of Niger

Vallis is at about -4 km and the floor of the uppermost source depression of Niger is at about -2.8 km; the head area of the smaller channel is at ~ -2.6 km. The topographic profiles along the thalwegs of Dao and Niger Valles shows that the floor of Niger is about 1 km higher than the floor of Dao everywhere where these channels run near each other.

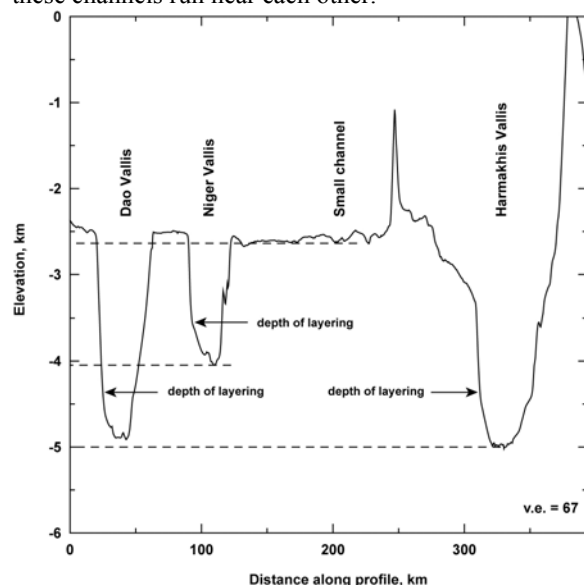


Figure 3. The depths of the source regions. The floors of Dao and Harmakhis Valles appear to be at the same level. Niger Vallis and the “small channel” originate clearly from much higher topographic levels.

Discussion: The characteristics of the head areas of the canyons and channels in the SW extension of Hesperia Planum suggest that these fluvial features formed due to melting of subsurface ice. In this scenario, the hypsometric levels of the floors of the head areas indicate the maximum depth to which the accumulations of ice were extended. Dao and Harmakhis Valles demonstrate the deepest source depressions that may cut through entire stack of lavas and extend to the pre-Hesperian materials. This indicates that packs of ice accumulated either before emplacement of the Hesperian lava plains or at the beginning of volcanism at Hesperia Planum. The entire floor of Niger Vallis is systematically and significantly higher than Dao Vallis. This means that the source accumulations of ice in the Niger area were deposited at higher topographic levels. The exposed layered structure on the walls of Dao extends significantly, ~ 0.5 km deeper than the floor of Niger Vallis. This implies that a significant portion of the Hesperian lava plateau was already formed before the deposition of ice responsible for the formation of Niger Vallis took place. The system of small channels between Niger and Harmakhis Valles

has a shallow (~ 500 m deep) source area that is located about 1.5 km higher than the floor of Niger Vallis. These channels indicate the third level of ice accumulation when almost the whole stack of lava flows was formed. The lobate aprons, lineated valley fill within the canyons, and viscous flows at their walls [11,12] may correspond to the fourth level of ice accumulation that postdated formation of the lava plateau.

Conclusions: The distinctly different levels at which the source areas of the large canyons and smaller channels occur suggest that deposition of ice competed with the emplacement of lava flows during formation of Hesperia Planum. The three levels may mark episodes of enhanced deposition of ice, which later was buried under new lava flows. The buried packs of ice melted when the main phase of plains-forming volcanism at Hesperia was completed due to heating related to the late and perhaps localized episodes of volcanic activity. The heat source could be provided by late volcanic activity at Hadriaca Patera (Dao and Niger) and at a possible volcanic province in the western Promethei Terra south of Harmakhis Vallis [13, Raitala et al., 2008, *in preparation*].

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