MORPHOLOGIC DEVELOPMENT OF HARMAKHIS VALLIS, MARS. Leslie F. Bleamaster, III and David A. Crown, Planetary Science Institute, 1700 E. Ft. Lowell Rd., Ste. 106, Tucson, AZ 85719; lbleamas@psi.edu.

Introduction: Harmakhis Vallis is one of three major vallis systems that dissect the cratered highlands and volcanic and sedimentary plains of the eastern Hellas region of Mars. Along with Dao and Reull Valles, Harmakhis Vallis represents a stage in regional geologic history intermediate to formation of channels and valleys within highland terrains in the Late Noachian and Early Hesperian Epochs and debris apron and gully formation in the Amazonian Period [1-5]. Previous analyses, based on Viking Orbiter images, describe these large outflow channels as forming by a combination of plains collapse, subsurface flow and surface runoff, and late stage enlargement by wall collapse and mass movement [1-3]. The current study of Harmakhis Vallis utilizes MOC images, MOLA topographic data, TES data, and THEMIS daytime and nighttime images to evaluate and refine the geologic history of Harmakhis Vallis and its surroundings.

Increases in spatial resolution confirm and advance the idea that much of Harmakhis Vallis has experienced significant small-scale modification and degradation (structural collapse and mass movement, sapping, mantling, and surface flow) [6]. These processes serve to cover the canyon floor, thus limiting the degree of primary feature preservation and any evidence of catastrophic formation (e.g., streamlined islands, scoured ground). Despite the young overprint, the eastern Hellas region preserves landforms and deposits from much of Mars' history as well as local evidence of persistent volatile-driven processes. This may provide insight into the role of structural control on the locations of circum-Hellas channels and canyons, the role of volcanism in melting ground ice, and the evaluation of potential Martian lacustrine and glacial activity [7,8].

Morphology: Harmakhis Vallis is ~800 km-long, trends ~N45E (sub-parallel to Dao Vallis), and is located ~250 km south of Dao Vallis and immediately west of Reull Vallis. The Harmakhis Vallis system can be divided into three segments based on morphologic characteristics: the canyon head (*H*) (or source depression) in the NE, the central main canyon (*C*), and a subdued sinuous terminus (*T*) in the SW (Fig. 1 Top).

The canyon head is characterized by a 40 km x 80 km x 1.2 km steep-walled depression situated at the confluence of the cratered highlands (west), the channeled plains (east), and the terminus of Reull Vallis. Floor materials within the depression display a smooth to mottled texture and consist of coherent blocks, rounded knobs, and unconsolidated material. The unconsolidated materials originate from both the interior walls of the depression as well as from the surrounding pitted plains and debris aprons [1]. The presence of medial ridges, transverse fractures, and lobate fronts all suggest a significant component of down slope mobilization and flow of material (sediment, water/ice).

The main canyon (8-60 km wide) cuts the Amazonian/Hesperian channeled plains rim unit [1] and displays hybrid morphology similar to various aspects of both Dao and Reull Valles. As with Dao Vallis, small channels parallel the main canyon [9,10]. The Harmakhis Vallis main canyon captures small parallel channels and truncates channels oriented N-S. In places where Harmakhis Vallis captures the smaller channels, slumped, fractured remnants and irregular blocks of plains material are preserved. Fracturing of the plains, slumping, and eventual collapse of the canyon wall serves to widen the main canyon [11].

Similar to Reull Vallis, Harmakhis Vallis displays inner channels and benches consistent with the interpretation that the canyon systems are long-lived and preserve protracted histories. Somewhat different than Reull Vallis however, the inner channels of Harmakhis Vallis appear not to be superimposed upon existing surface units, but undercut the unconsolidated floor materials. This may be explained by flow of material (sediment, water/ice) from the walls of the canyon toward the center of the floor of Harmakhis Vallis and melting of ice within or at the base of the unconsolidated deposits. Lateral migration and collection of liquid water may result in flow downslope toward Hellas basin protected by the overlying unconsolidated material, in a manner similar to that suggested for gully formation [12]. This down-canyon flow within Harmakhis Vallis floor materials may be concentrated where debris masses from adjacent walls meet near the center of the canyon. If the overlying material is removed, the resulting morphology may be that of a fluvial inner channel.

The canyon terminus branches into multiple, slightly more sinuous, channels upon reaching the Hellas Basin floor and gentler slopes. There are no obvious terminal deposits.

Morphometry: Comparison of Dao and Harmakhis Valles illustrates numerous similarities. The macro-scale morphometry of Harmakhis nearly mirrors that of Dao Vallis, with a steep-walled depression near their canyon heads, a generally straight central canyon containing numerous sites of wall collapse and widening, and a subdued sinuous channel near their terminations in Hellas basin. Each of these morphologically distinct segments correlates within a range of elevations (source depression > -3100 m, straight canyon between -3100 m and -5600 m, and sinuous channel below -5600 m). The same canyon head elevation and depression depth for Harmakhis and Dao Valles suggests that the location of these "source" depressions and the morphology of the exiting canyons may be controlled by the depth to a volatile rich layer within the substrate. They may also be related to regional high-water/ice stands as suggested by [8].

Longitudinal profiles of both Dao and Harmakhis Valles display highly variable floor surfaces (fig. 1 Bottom). This suggests that much of the floor topography is the result of post-main canyon formation processes, which are dominated by collapse and sapping rather than catastrophic flooding and surface flow [11].

MOLA topographic data also corroborate high-resolution image analyses. The Harmakhis Vallis canyon head floor slopes gently to the west; this is consistent with debris infilling from the highlands to the east as observed in MOC image V00996004 [13]. Unlike Dao Vallis, which preserves a relatively flat source depression floor, the Harmakhis Vallis canyon head is located among the cratered highlands and numerous high-relief massifs that serve as the source for material shed into this local basin.

Future Work: THEMIS IR data provide daytime/nighttime comparisons that help determine the thermo-physical characteristics of various materials within Harmakhis Vallis. This may allow source/sink associations to be made between wall and floor materials. Processing of THEMIS multi-spectral data may also shed light on the materials within and around Harmakhis Vallis.

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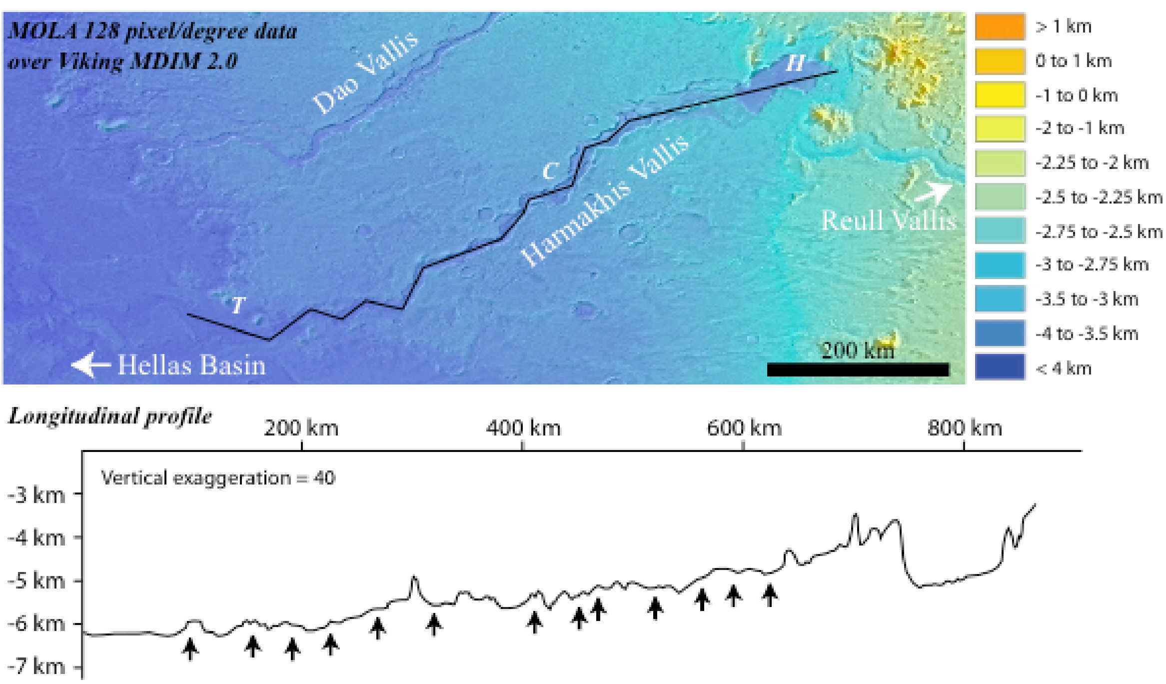

Figure 1. (Top) Merged data product for Harmakhis Vallis and surrounding area. (Bottom) Longitudinal profile of Harmakhis Vallis illustrates the prominent steep-walled canyon head (source depression) and highly variable canyon floor heights that may represent slump blocks from the adjacent plains and failure of canyon walls. Arrows depict segment breaks along the profile.