MORPHOLOGICAL ANALYSIS OF THE SOUTHWESTERN DRAINAGE SYSTEM OF HADRIACUS MONS, MARS. H. I. Hargitai[1] and V. C. Gulick[2], [1]NASA Ames Research Center/ NPP, MS 239-20, Moffett Field, CA 94035, USA, henrik.i.hargitai@nasa.gov, [2] NASA Ames Research Center/ SETI Institute, MS 239-20, Moffett Field, CA 94035, USA, virginia.c.gulick@nasa.gov

Introduction: The Navua Valles and an unnamed channel we describe here are drainage systems that terminate at the same, northeastern embayment of the floor of Hellas Basin on Mars. These channels are 1–1.5 km wide, which is much smaller than the prominent Dao Vallis, 6-7 km in width, south of these channels. Our analysis shows that the majority of the dissected valleys on the southwestern flanks of Hadriacus Mons, commonly with a 100-300 m wide channel at their bottoms, lead to an unnamed channel we refer to as Channel D* in our previous study [1], and not to Dao Vallis. Channel D and the dissected flank of the highland patera are integrated, but they form a discontinuous drainage system, split into segments by elongated deposits and unchanneled valley reaches. Since this 1.5 km wide channel lies at the end of the Hadriacus Mons main fluvial pathway, it supports previous studies [2,3,4], where Dao Vallis is thought to be formed fluvially, but reached its present size by subsequent collapse and enlargement by catastrophic flood processes. The larger source area of Channel D suggest that Dao Vallis was less prominent than Channel D when it formed.

Description: Channel D is the main outlet towards Hellas Basin for the dissected southwestern flank of Hadriacus Mons. These flanks are situated on the slopes of Hellas Basin, sloping in the same direction, thus this side is the major flank of the volcano. Drainage density in this region is 0.037 km/km^2 (Fig. 1), with channels having a total length of 3147 km (Fig. 2). Channel D has two distinct segments: the northern source branch displays distinct fluvial morphological characterisitics, while the southern, minor branch is likely volcanic; both sourced from Hadriacus Mons.

The dissected flank. The upper section of the drainage area consists of several disconnected, small (100-300 m wide) channels that run in about 10 subparallel valleys on the flank of Hadriacus Mons. The channels may terminate in depositional reaches and there may be unchanneled valley segments between the channeled parts. We interpret these terminal deposits as fluvially transported material. The channels disappear and reappear again downhill several times along their extent. This is consistent with channels flowing over volcanic terrains consisting of permeable lava flows interbedded with ash or other less permeable, more easily erodible layers. Water flowing in channels over permeable basalt flow would readily infiltrate and flow along less permeable zones in the subsurface. As subsurface water flowing along these less permeable layers intersect with the surface further downslope, a channel segment forms again. The age estimate for these slopes is 1.5 Ga [6].

There are numerous, approximately 500 m wide sinuous ridges in the uppermost part of the drainage basin, connected to Hadriacus Patera (Fig. 2), likely volcanic features. The area is also criss-crossed by wrinkle ridge-like features. While the uppermost valleys are unchanneled, the valleys show knobby terrain about 50 km from the caldera rim and they become channeled about 40 km lower. We interpret knobby terrain as a terrain of pingos. The knobs are typically cone to mound shaped but some are collapsed.

The Northern branch. Downstream from the dissected slopes, the channels become wider but are still discontinuous. An isolated segment is terminated in an unnamed crater where elongated deposits cross the crater floor. Another channel downstream crosses the ejecta of Poti crater, and terminates in a multi-branch depositional reach. This reach joins the confluence of the northern and southern branches of Channel D.

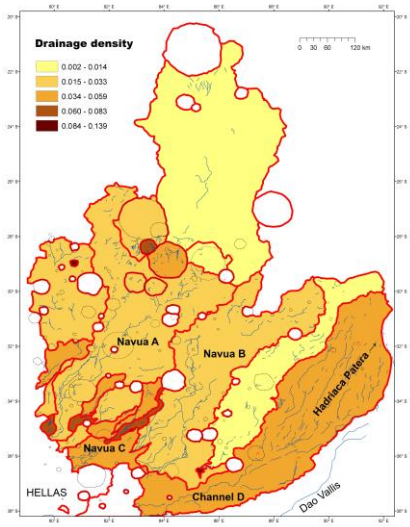

Figure 1. Drainage basins and their drainage densities in NE Hellas, west of Hadriacus Mons.

The Southern branch. The southern branch of Channel D is connected to long, sinuous chains of very elongate to circular pit craters, adjacent to other sinuous and anabranching channels and straight troughs. This assemblage of features is similar those seen at the slopes of Elysium Mons, especially at the Stygis Catena region. We interpret the pit chain features as the surface expressions of subsurface lava tubes. Straight troughs, some of which cross drainage divides, are

likely surface manifestations of dikes [e.g., 5] which also support a volcanic interpretation. The Southern branch of Channel D is more degraded, underlies, and is thus older than the Northern branch, and probably formed during the Noachian-Hesperian volcanic phase of the patera.

The main channel. The main part of Channel D is largely a single, wide, flat channel on the basin floor. Channel dimensions are similar to the major Navua Valles system to the northwest [1]. It is partially flooded by lobate materal with high thermal inertia, which we interpret as lava flows. The channel floor ascends 150 m in this flooded portion. Channel D's floor age from crater counting is 1.37±0.32 Ga, resurfaced at 383±45 ma.

The terminus. The terminus of Channel D is a complex area of different deposits that radiate into the plains forming lobate margins, similar to the terminus of Navua C [1]. The proximal, and also distal, uppermost layer has high thermal inertia and no flow lines. We interpret it as terminal volcanic material. Low thermal inertia material underlies it, showing lobate termini and flowlines. We interpret these lobate margins as fluvial deposits. There is an approximately 50 km long, 5 km wide arc of elevated terrain, which has an intricate wrinkle ridge like cliff of 5-20 m at its distal end.

Conclusion: We interpret the northern, discontinuous channel sequence of Channel D as sourced from Hadriacus Mons' fluvial activity involving surface and subsurface flow. The age estimate for these Hadriacus slopes is 1.5 Ga [6] which – within error bars - is consistent with Channel D floor age, suggesting that Channel D deposits formed when Hadriacus Mons' slopes were eroded. However, the discontinuities and intermediate deposits suggest that the Hadriacus Mons materials likely did not reach the Channel D termini but instead were deposited at the flanks of the volcano. Likely infiltration and surface flow of snowmelt formed the Northern channels of this drainage basin while the shorter, and older, southern branch was likely initiated by volcanic processes. The main branch of Channel D likely transported both volcanic and fluvial materials.

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References: [1] Hargitai HI, Gulick V (2015) AGU Fall Meeting, EP51A-0900, [2] Bleamaster LF, Crown DA (2004) LPSC XXXV #1825, [3] Crown DA., Bleamaster LF III, Mest SC (2005), J. Geophys. Res., 110, E12S22, doi:10.1029/2005JE002496, [4] Wilson SA, Moore JM, Howard AD, Wilhelms DE (2010) in: Lakes on Mars. DOI: 10.1016/B978-0-444-52854-4.00007-6 [5] Wilson L, Head JW (2002) J of Geophys. Res., 107 (E8) 0.1029/2001je001593, [6] Williams DA, Greeley R, Zuschneid W, Werner SC, Neukum G, Crown DA, Gregg TKP, Gwinner K, Raitala J (2007) J. Geophys. Res., 112, E10004, doi:10.1029/2007JE002924

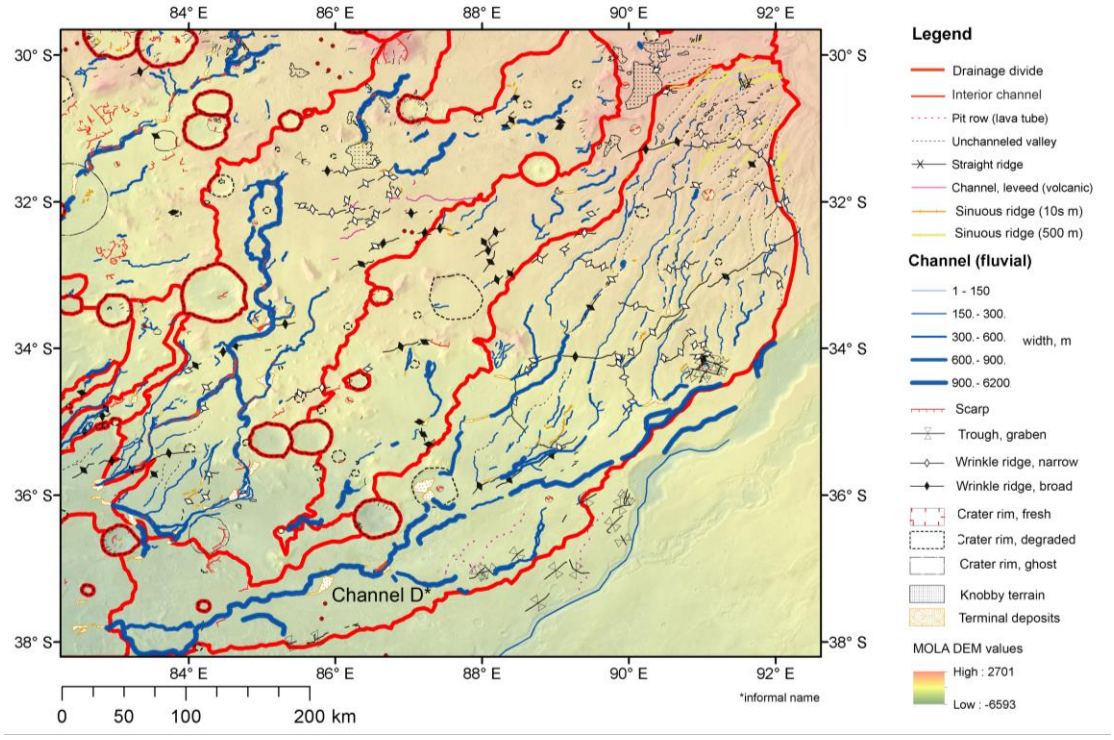

Figure 2. Drainage and structural feature map of the Navua Valles region, northestern Hellas, Mars. The main outlet channel of Hadriacus Mons is "Channel D", north of Dao Vallis. Informal names are from [1].