INFERRING HYDRAULICS FROM GEOMORPHOLOGY FOR ATHABASCA VALLES, MARS. D. M. Burr[1], L. Keszthelyi[1], [1]USGS Astrogeology Program (2255 N Gemini Dr. Flagstaff AZ 86001, dmburr@usgs.gov),

Introduction: Athabasca Valles, southeast of Elysium Mons, appear to be one of the youngest outflow channel systems on Mars [1,2]. Its pristine appearance offers an exceptional opportunity to investigate outflow channel geomorphology. MOC, THEMIS and MOLA data provide tools for that investigation. Here we summarize past and on-going research into Athabasca Valles hydraulics based on analysis of the channel system's geomorphology.

Distributary channel system: Athabasca Valles is long-known to be a distributary channel system [3], with several distributary channels extending from the main channel apparent in early MOC and MOLA data [4]. Inspection of MOC and THEMIS images available to date shows a seemingly ever-increasing number of distributary channels [5]. However, small water channels and lava channels can appear similar, and we're working to develop appropriate criteria to distinguish the two.

Zone of deposition in a temporary backwater: Viking, MOC and MOLA data showed a clustering of streamlined forms upslope of the large in-channel crater near 9.35N 155.89E on the northwestern side of the channel (at the southwestern end of the red box in Fig. 1). This clustering was hypothesized to have resulted from deposition of sediment in a zone of stagnant or ponded backwater on the upstream side of this crater and its now-eroded ejecta [6]. Subsequent streamlining of the deposited sediment in the lee of resistant obstacles by the efflux of the ponded water would be the final step in the formation of the streamlined forms.

Various evidence supports this hypothesis. Similar elevations relative to the geoid of two interpreted high-water marks ~35 km apart suggest a ~35-km-wide horizontal – i.e. ponded – water surface [6]. The diversion of flow around the crater (apparent in Fig. 1 and 2 and MOC images) indicates that the crater affected the flow; such diversion generally slows flow, and would thereby cause deposition of bedload or suspended sediment. The hypothesized depositional streamlined forms are heavily concentrated here, and no such concentration is apparent elsewhere in the channel (see [5]). Other depositional bedforms –i.e. diluvial dunes – are also located in this reach [7]. The first major distributary channels originate across the channel from the crater (see [5]), an effect reasonably attributed to a rise in elevation of the floodwater during ponding.

Terrestrial examples: This concentration of depositional fluvial forms in a hydraulic basin occurs on Earth. Large (10-km-scale) sedimentary streamlined forms and extensive slackwater deposits occur in the Pasco Basin in the Channeled Scabland, where Missoula floodwater backed up behind the narrow Wallula Gap [8,9]. Likewise, diluvial dunes similar to those in this Athabasca reach occur in a Siberian basin inundated by Pleistocene catastrophic floods [10]. Although the cause of the terrestrial ponding (i.e., preexisiting narrow fluvially carved basin outlets) differs from that in Athabasca Vallis (i.e., encroachment by the crater and its ejecta), the hydraulic effect would have been the same: decreased flow and consequent deposition of sediment.

MOLA data show that the southeastern part of this reach is consistently a few meters deeper than northwestern part. This is consonnant with the hypothesized backwater. The water ponding up behind the crater on the northwester side of the channel would have resulted in deposition and a slight increase in the channel floor elevation. Conversely, the faster flowing water on the southeastern side could have slightly incised the southeastern channel.

Apparent non-deposition at the mouth of the channel: Another likely locus of sediment deposition is the mouths of channels, where the expansion of the flow decreases its transport capacity and competence. This accounts, for example, for deltas at the mouths of rivers, as well as "expansion bars" and large boulder deposits such as those of the Ephrata Fan in the Channeled Scabland [8]. Thus, we expected to see sediment deposits at the mouth of Athabasca Vallis, where the main channel empties into the eastern Cerberus plains (see Figure 1).

Available images show only a couple of sizable streamlined forms, comparable to those discussed above. These do not appear to have any obstacle at their upslope end, in constrast to the streamlined forms discussed above, which all have upslope obstacles. This suggests that indeed these features formed through a decrease in flow competence. A few smaller streamlined forms are scattered behind impact craters in this distal region. However, other expected depositional bedforms such as promiment streamlined forms, deltas or alluvial fans, or dunes, were not visible.

This apparent lack of deposition may indicate the channeling of the floodwater continued through a topographic channel now buried by lava. Alternatively, expansion-induced deposition may have occurred, but the deposits are now buried beneath lava. Rootless cones farther south [11] indicate that lava embayed the region where the floodwater would have emptied into the eastern Cerberus plains. If thick enough, this lava could have buried either a channel or sediment deposits. A separate possibility is that the water flow did expand, but had deposited much of its sediment load further upstream, namely, upstream of the crater near 9.35N 155.89E, so that distal deposition was limited.

References: [1] Tanaka, K. L. (1986) *JGR*, 91, 139-158. [2] Burr D.M. et al. (2002) *Icarus* 159, 53-73. [3] Tanaka K.L and Scott D.H. (1986) *LPS XVII*, 865-866. [4] Burr D.M. et al. (2002) *GRL*, 29, p13. [5] Keszthelyi L. et al. (2004) *LPS XXXV*. [6] Burr D.M. (2003) *Hydro. Sci. J.* 48, 655-664. [7] Burr D.M. et al. (2004) *LPS XXXV*. [8] Baker V.R. (1973) *GSA Spec. Paper* 144. [9] Bjornstad et al. (2001) *J. Geol.* 109, 695-713. [10] Carling, P.A. (1996) *Sedimentology* 43, 647-664. [11] Lanagan et al. (2001) *GRL* 28, 2365-2367.

Figure 1: Mosaic of THEMIS day IR images covering Athabasca Valles. The red box denotes the area of hypothesized deposition where the large majority of streamlined forms cluster; the crater near 9.35N 155.89E is at the southwestern end of this box. The white box denotes the area of expect deposition due to flow expansion where only a few depositional features are observed.

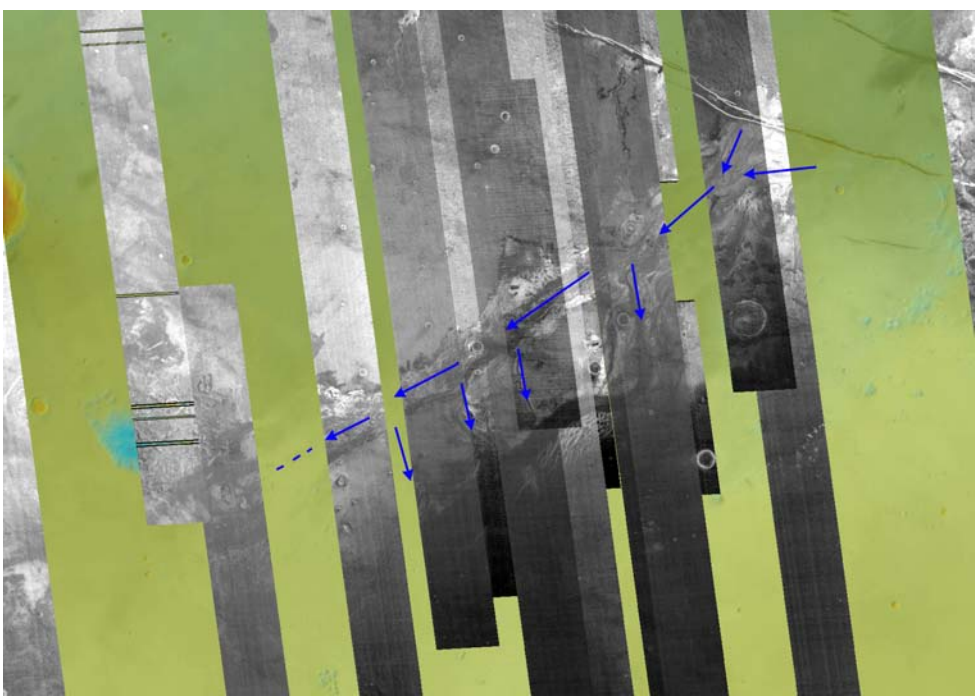

Figure 2: Mosaic of THEMIS night IR images covering the same area of Athabasca Valles as in Figure 1. The blue arrows indicate the general direction of water flow.