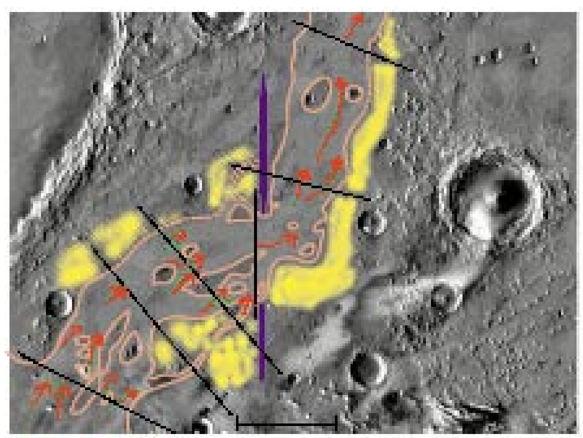
MORPHOLOGY OF THE MARTE VALLES CHANNEL SYSTEM, MARS. S.C. Moller[1], K.E. Poulter[2], E.B. Grosfils[1], S.E.H. Sakimoto[3], C.V. Mendelson[4], and J.E. Bleacher[5]. [1]Pomona College (smoller@pomona.edu, egrosfils@pomona.edu); [2]Colorado College, Colorado Springs, CO 80903; [3]UMBC at NASA's GSFC, Geodynamics Branch, Code 921, Greenbelt, MD 20771; [4]Beloit College, Beloit, WI 53511; [5]Ariz. State Univ., Tempe, AZ 85287.

INTRODUCTION: We are interested in the origins and evolution of the fluvial channels of Marte Valles, which is located along the southeastern edge of Orcus Patera in the Elysium region of Mars (portion of channel shown in Figure 1). Although ancient highland fluvial networks and the dramatic outflow channels such as Kasei Valles on the dichotomy boundary have been intensively studied [1,2], relatively little effort has been devoted to studying some of the low-relief drainage systems in the northern lowlands. The high-resolution topography data from the Mars Orbiter Laser Altimeter (MOLA) instrument [3,4], flown on the Mars Global Surveyor (MGS) spacecraft, allow us to more carefully study lowland channels that were difficult or impossible to distinguish with USGS topography.

The Marte Valles channel system looks similar in shape if not in scale to the outflow channels of Kasei Valles, which are hypothesized to be the result of catastrophic flooding. Baker and Milton [5] propose the Channeled Scabland of Washington, site of the glacial Lake Missoula outburst floods, as a terrestrial analogue for the Martian outflow channels. A more recent study of Kasei Valles with MOLA data, however, suggests evidence of repeated flooding over a greater period of time [6]. Subsequent research has suggested several possible source mechanisms for Martian outflow channels: episodic aquifer release [7], pluton-driven hydrothermal systems [8], or volcanic-induced localized precipitation [9]. Marte Valles' proximity to both Elysium Mons and the dichotomy boundary, combined with the probable presence of ground ice [10,11], makes any of these mechanisms plausible. With high-resolution MOLA data now available, detailed study allows us to measure channel morphology, estimate channel bankfull cross-sectional areas, and better constrain possible methods of formation.

METHODS: The key data set for our study is the gridded compilation of MOLA tracks. Previous topography data, accurate to one kilometer, could not be used to obtain meaningful channel parameters for well-constrained flow calculations. Using the program *Gridview* [12] to analyze the high-resolution MOLA grid (64 pixels/degree in longitude and 256 pixels/degree in latitude), we can calculate cross-sectional channel area and channel gradient with elevation data precise to within a meter, and thus for the first time quantify the channel morphology. The most useful data extracted from the MOLA grid are cross-channel profiles, which we overlaid on Viking image mosaics (I-1334 MC-8 NW, I-1332 MC-8 SW, I-1582 MC-15 SE, and I-1385 MC-15 NE) to determine the general channel shape. Using both regional topography and individual profiles, we gain a better understanding of the morphology of the fluvial system as a whole.

RESULTS: *Channel Map*. Figure 1 is a Viking mosaic of the Marte Valles channel system within our study area. The fluvial channels shown outlined on the map are a compilation of MOLA grid and profile data as well as albedo variations from the Viking mosaics. Lava flows have previously been mapped in this area [9] using Viking images but without the MOLA data to supplement the albedo observations. The variations themselves are not sufficient for mapping, as they do not necessarily correspond to fluvial channel boundaries. Our mapped fluvial channels indicate the traceable and clearly identifiable flow paths, beginning in the Cerberus plains and continuing through the southern portion of Marte Valles (arrows indicate measured down-channel gradients).



100 km

Figure 1: Viking image mosaic covering approximately 7-17°N, 172-182°W. Superimposed are the channel boundaries (peach), with flow directions indicated by arrows (red). Shaded areas (yellow) indicate inferred resurfacing adjacent to the channel; narrow, broken, elongate N-S ellipse (purple) marks wrinkle ridge remnants. Profiles were taken along the five black lines which cross the channel.

Profile Maps. The cross-channel profiles generated in *Gridview* are superimposed on Viking mosaics. The south channel area reveals a relatively flat, sparsely cratered area with no defined channels except in the extreme northeast corner. Downstream, the channels become identifiable in the topography, and in many cases correspond with light albedo patterns in Viking images. The channels split and merge around numerous streamlined islands; these islands contain craters visible in Viking images. The channels converge, narrow and deepen as they pass through the remains of an eroded wrinkle ridge (between 177ºW and 178ºW), after which the channels widen and turn north toward the Amazonis Basin. Here, the channels are less clearly incised, and the indeterminate resurfaced area bounding the channel is widespread. MOLA topography data are extremely useful in mapping this section, as albedo variations are not necessarily related to the traceable channel system. The channels become more evident as they narrow and deepen at the outlet of the system in the northeast corner of the map.

Regional Gradients. Regional profiles were taken with a northeast-southwest strike along the channels and the surrounding land surfaces. The most conspicuous result is that the eroded, apparently resurfaced region between Orcus Patera and the Marte Valles channels shows no discernible slope, despite running next to the channels themselves, which have a slope of 0.017º. The channel system is clearly distinguishable from the overall study area on the basis of these regional profiles, indicating significant downcutting and erosion unrelated to the regional landscape.

Cross-Channel Profiles. From the cross-channel profiles (locations shown in Figure 1), we determined channel upper elevation limits and cross-sectional areas. The profiles show a consistent decrease in upper channel limits and a general trend toward increasing cross-sectional area moving downstream. Due to the uncertainty in defining an exact upper channel limit, the area measurements are approximations. Based on the differing areas we calculated when we varied the upper channel boundary within a range of several meters, we assign a conservative uncertainty of +/- one-third to each area value.

DISCUSSION: The available evidence, topographic and photographic, does not yet point to one clear method of channel formation. There is ample evidence of catastrophic flooding through the channels; the anastamosing channels and streamlined bedforms are evident from the Viking images. There are, however, terraces separated by only a few meters, indicating more constant flow at a variety of depths. Moreover, a single source without an increase in input downstream, such as a catastrophic flood, should result in channels with a more or less constant area, which we do not observe. Looking at the average areas, there is a general increase in channel area downstream.

Our hypothesis of channel formation accounts for the evidence of catastrophic flooding, but is a bit more complicated. The originally released water flowed across the plains south of Orcus Patera and pooled behind the wrinkle ridge (see Fig. 1). We suggest this ponding accounts for the lack of slope of the resurfaced area along the western edge of the channels. The wrinkle-ridge dam was eventually breached, causing a catastrophic flow that broadened out in the lower channel area and drained to the northeast through a more restricted path. The area flooded by this outbreak includes the designated resurfaced ground outside the channel boundaries. Subsequent lava flows used the channels as a path from their source to the Amazonis basin. Some of these lava flows have been dated to as recently as 10 million years ago [13] and are thought to be the youngest volcanics on Mars. These lava flows are interwoven with sedimentary deposits, indicating that fluvial and volcanic processes alternated repeatedly during the active life of the channels

Although we did not identify an origin for the water, Elysium Mons and the Cerberus Rupes vents are likely sources of volcano-ground ice interactions. The relationship between the two volcanic features is not sufficiently clear to differentiate their respective effects on the study area; Cerberus Rupes has been tentatively cited, but not clearly proven, to be the source of the Marte Valles lava flows [13]. The morphology of the channels, with increasing cross-sectional area downstream, suggests multiple sources of input. Before a complete chronology can be established, more study of the cause-and-effect relationship between volcanism and channel modification is necessary.

REFERENCES [1] Baker V. R. (1982) *The Channels of Mars.* [2] Komatsu G. and Baker V. R. (1997) *JGR E, 102,* 4151-4160. [3] Zuber M. T. et al. (1997) *JGR. 97,* 7781-7797. [4] Smith D. E. et al. (1998) *Science 279*, 1686-1692. [5] Baker V. R. and Milton D. J. (1974) *Icarus 23*, 27-41. [6] Williams R. M. et al. (2000) *GRL 27*, 1073-1076. [7] Carr M. H. (1979) *JGR 84*, 2995-3006. [8] Gulick V. C. (1998) *JGR 103,* 19,365-19,387. [9] Plescia J. B. (1993) *Icarus 10*, 20-32. [10] Brakenridge G. R. (1990) *JGR 95*, 17,289-17,308. [11] Carr M. H. (1996) *Water on Mars.* [12] Roark et al. (2000) *LPS XXXI*, #2026. [13] Hartmann W. K. and Berman D. C. (2000) *JGR 105*, 15,011-15,025.