RECENT FLUVIAL ACTIVITY IN AND NEAR MARTE VALLIS, MARS. D. M. Burr[1], A. S. McEwen[2], and P.D. Lanagan[2] [1]Department of Geosciences, University of Arizona (1040 E. Fourth St., Tucson, AZ 85721, dburr@pirl.lpl.arizona.edu) [2]Lunar and Planetary Laboratory, University of Arizona (1629 E. University Blvd., Tucson, AZ 85721).

Introduction: High-resolution (2-20 m/pixel) images from the Mars Orbital Camera (MOC) [1,2] on the Mars Global Surveyor (MGS) [3] have revealed new information about the large and well-preserved channels around the Elysium Basin/Cerberus Plains of Mars, and in Marte Vallis. These images support the suggestion [4,5] that flood waters originated from the highland remnants to the north of the Elysium Basin.

The pre-MGS view: The lower resolution (typically ~200 m/pixel) images of this region acquired prior to MGS primarily showed subtle variations in albedo and the large-scale topography. The images suggested geologically recent (Upper Amazonian) fluvial activity in the Elysium Basin and Marte Vallis. The published topographic map delineated a large depression [6] with a probable volume of 850,000 cubic km [7] from which Marte Vallis flowed. Based on this evidence, a variety of hypotheses were put forth. Scott and Chapman [7] suggested that this large lake was fed primarily from channels emanating from the Medusae Fossae Formation to the south, and overflowing of the lake created the Marte Vallis channels. Plescia [8] hypothesized that the channels came from local precipitation of volcanically released water. Tanaka [4] proposed the source as the Cerberus Rupes, which Tanaka and Scott [5] suggested tapped into aquifers in the remnant highlands to the north of the basin.

MGS evidence for recent fluvial activity: MOC and the Mars Orbital Laser Altimeter (MOLA) [9] evidence allows us to elaborate on and modify these pre-MGS views.

Fluvial geomorphology. The fluvial nature of the Marte Vallis outflow channel appears to be confirmed by MOC images [10] that show streamlined islands of several hundred meters to a couple of kilometers across, longitudinal grooves ten's of meters wide, and multi-level terraces on channel islands and margins. In conjunction with the anastomosing plan form of the channels, these features suggest channel formation by a high volume of low viscosity fluid that we hypothesize was sediment-laden water. Similar features also appear in MOC images to the north and west of the Elysium Basin, indicating the presence of some channels more substantial than previously supposed.

MOC images show that the central portion of the Cerberus plains and many channel floors are covered by apparently young and well-preserved flood lavas with a distinctive platy/ridged morphology [11].

We used Manning's equation modified for Martian gravity [12], with a roughness coefficient of 0.04, to calculate the volumetric discharge for three channels, two flowing into the Elysium Basin from highland remnants to the north and northwest, and Marte Vallis flowing from the Elysium Basin eastward. We measured channel widths from Viking and MOC images and estimated depths from MOC images of terraces. Channel slopes were measured from the MOLA 1 degree gridded topography. The results (Table 1) indicate a rough equivalence between the amount of water entering the basin via the two channels to the north, and the amount leaving the basin to the east through Marte Vallis.

Table 1. Estimates of Channel Discharge

Image Location	***Width***	***Depth***	***Slope***	***Discharge (cms)***
9.2N 204	25 km	75 m	0.0018	1.70E+07
16.1N 192	20 km	135 m	0.0020	3.90E+07
11.9N 179 (Marte Vallis)	69 km	95 m	0.0009	4.80E+07

Topography. One-degree MOLA topography [9] (Figure 1) indicates a broad, flat region that slopes gently and consistently down to the east. The only apparent closed depression, located in the southern Elysium Basin, has a maximum depth of 100 m and a radius of ~375 km, or a volume of ~10,000 cubic km.

Discussion: MOC images have not shown many smaller networks as would be expected from precipitation. Malin and Carr [13] have suggested that the global lack of such dendritic channels may be due to modification by eolian and mass-wasting processes. However, the lava and channel morphologies of the Elysium Basin region appear pristine. The dendritic channels, then, are likely absent from MOC images of the Elysium Basin because they did not form there. In addition, the anastomosing form of the channels suggests formation by exceptionally large flow. Thus, we believe that the MOC data fails to support the idea that the channel flood water derived from precipitation.

The closed depression revealed by MOLA is much smaller than that suggested by pre-MGS topographic maps. Furthermore, a lack of fluvial channels in the Medusae Fossae Formation does not support the hypothesis that this was the source of the Marte Vallis flood waters. In contrast, MOC images reveal that the channels north of the Cerberus Plains are larger than previously known, and the calculated discharges match the calculated discharge of Marte Vallis.

The two northern inflowing channels indicate that the water source was north of the Elysium Basin. While the first image in the table above accords with the hypothesis that the Cerberus Rupes were a source of the water, fluvial features north of Cerberus Rupes (as seen in the second image in the table above) show that they cannot be the only source. The channels originate in remnants of ancient highland terrain, suggesting that the water was emplaced in the crust during Mars' early history but was released recently, perhaps due to recent volcanic activity.

Conclusion: On the basis of the MGS data, and after Tanaka and Scott [5], we conclude that the flood water that eroded Marte Vallis derived primarily from the ancient highland remnants north of the Elysium Basin. This water may have originated from subsurface aquifers [12], facilitated in places by the Cerberus Rupes fractures [5] or from the melting of ground ice by volcanism [e.g. 14,15] which produced the Elysium Basin lava flows. Flowing into the Elysium Basin, this water would have filled up the shallow basin in ~5 days (assuming a triangular hydrograph) before flowing eastward through Marte Vallis at the same rate as the inflow. Eventually, the water would have debouched into western Amazonis Planitia.

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Figure 1. Contour map of MOLA altimetry overlain on Mars Digital Image Mosaic.