The History of Water Discharge in the Margaritifer Sinus region of Mars. J. A. Grant[1] , and T. J. Parker[2], [1]Center for Earth and Planetary Studies, National Air and Space Museum, MRC 315, Smithsonian Institution, Washington, DC 20560, grantj@nasm.si.edu, [2]Jet Propulsion Laboratory, California Institute of Technology, Mail Stop 183-501, 4800 Oak Grove Dr., Pasadena, CA 91109, timothy.j.parker@jpl.nasa.gov.

Introduction: Margaritifer Sinus straddles the Chryse Trough [1-3] and preserves the highest valley and channel densities on Mars [3-9]. Drainage on the western side of the trough is dominated by the Uzboi-Holden-Ladon-Margaritifer (UHLM) Valles system draining northward out of Argyre [7, 10, 11]. Drainage on the eastern side of the trough is relegated to the extensive Samara and Parana-Loire valley systems. The UHLM drainage basin extends southward to the south polar cap and covers 11 million km^2 or approximately 8% of Mars [12]. By contrast, the Samara and Parana-Loire Valles basins cover more than 540,000 km^2, an area equivalent to ~85% of the watershed of the Colorado River on the Earth [5, 6].

These systems converge on Margaritifer Basin, a confluence plain straddling the trough axis and located just south of Margaritifer Chaos and Ares Valles (Fig. 1). Geologic and drainage mapping confirms the relative timing of channel and valley formation and permits assessment of relationships between discharge events.

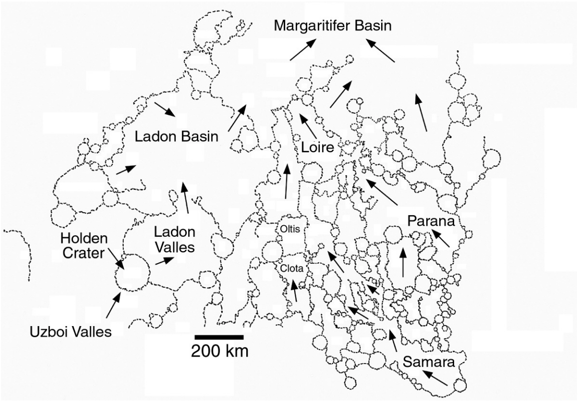

Figure 1. Drainage Basins in Margaritifer Sinus defined via stereo mapping with Viking Orbiter Images.

Uzboi-Holden-Ladon-Margaritifer Valles: Evolution of the UHLM system occurred during multiple stages and resulted in segmented channels characterized by multiple terraces [13]. Location and orientation of incised segments is controlled by the location of ancient multi-ringed impact basins [14] with deposition occurring within Holden and Ladon basins (Fig. 1).

Flow out of Argyre through the UHLM system had begun by the late-Noachian and persisted into early Hesperian times [6, 13]. Multiple stages of discharge are indicated by preservation of at least five distinct terraces along Ladon Valles [13, 15] and a comparable number along Margaritifer Valles where it discharges into Margaritifer Basin. Although formation of crater Holden temporarily interrupted the system, waning stages of flow related to discharge from Nirgal Vallis resulted in breaching of the southern crater rim and ponding and deposition within the crater [13]. Late stage discharge from crater Holden was subsurface and led to chaotic terrain formation between the crater and Ladon Valles [13].

Samara and Parana-Loire Valles: Samara and Parana-Loire Valles also formed by the late-Noachian and remained active into the early Hesperian. Like the UHLM system, valley location and orientation is significantly influenced by the degraded multi-ringed basins [14]. For example, Parana Valles heads along Noachis basin and drains into Parana Basin, a mostly filled crater approximately 150 km in diameter (Fig. 2). Loire Valles heads at the western margin of Parana Basin (Fig.2) and continues to the margin of Margaritifer Basin (Fig. 3).

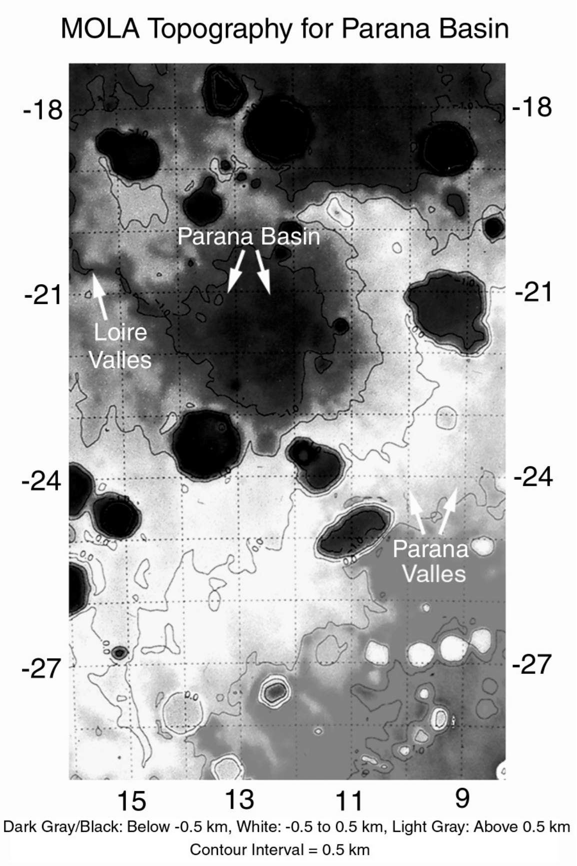

Figure 2. Gridded MOLA data for Parana Basin.

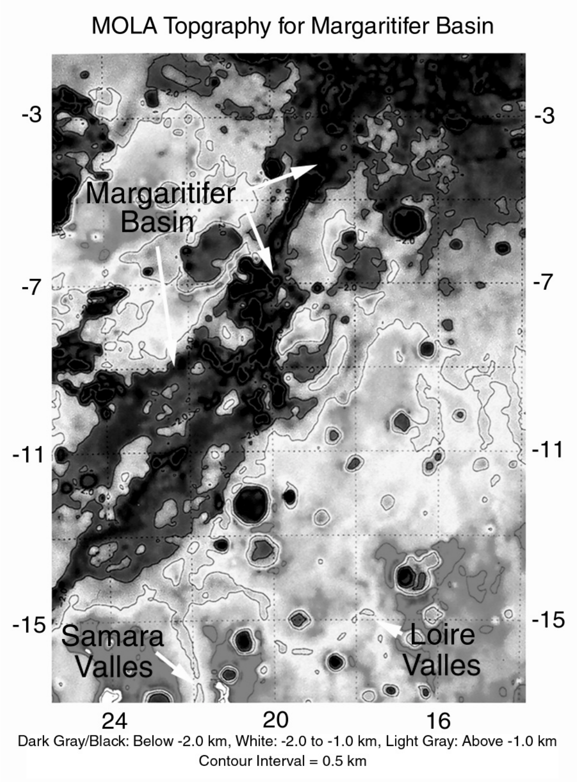

Figure 3. Gridded MOLA data for Margaritifer Basin.

Preserved drainage densities in the Samara and Parana-Loire basins are between 0.03-0.11 km/km^2, but mapping confirms that some drainage segments were destroyed by post-valley resurfacing (*e.g*., southwest of Parana Valles in Fig. 2). Hence, actual drainage densities are slightly higher. Valley systems are well integrated and possess tributaries that head near divides. In addition, basin relief ratios and ruggedness numbers are 0.001-0.13 and 0.005-0.086, respectively. Down valley width and cross-section are also relatively invariant and imply little downstream increase in discharge [6].

Although not indicative of valley origin by runoff vs. sapping, the above values imply limited runoff from highly permeable substrates possessing high storage capacity. As proposed in [6], parameters are consistent with mostly localized ground-water discharge enabled by surface-fed recharge. High surface-infiltration capacities would require that most precipitation would directly enter the subsurface with subsequent discharge at exposed relief along layers/aquitards.

Margaritifer Basin Ponding: The UHLM channel system and the Samara and Parana-Loire valleys all converge in the vicinity of 23^{0}W, 13^{0}S (Fig. 3). Discharge from the UHLM occurred through a complex series of distributaries arranged at varying, but generally lower elevations than the outlet from Samara and Parana-Loire. These UHLM distributaries appear to truncate the shared Samara and Parana-Loire outlet (Fig. 3) and suggest that the latest UHLM discharge post-dated that from Samara and Parana-Loire.

Ponding in Margaritifer Basin extended well to the northeast and into the vicinity of Margaritifer Chaos, the head of Ares Valles, and Sinus Meridiani [7, 10]. The distribution of numerous remnants of cratered uplands (e.g., Fig. 3) and valleys that terminate along the basin margin and whose mouths are embayed by basin-filling sediments confirm the extent of ponding. Moreover, the basin fill possesses a fairly uniform character and there is an absence of lobate structures or morphology that might suggest a volcanic versus fluvial origin. Collectively, these observations indicate that discharge from the UHLM, Samara, and Parana-Loire systems produced extensive ponding at a local base level of approximately –2 km (MOLA datum).

Fate of Water: The ultimate fate of the water released from the UHLM and Samara and Parana-Loire valley systems remains unknown. For example, it is possible that the water debouched into a hypothesized high-standing ocean fringing nearby Sinus Meridiani [16]. Nevertheless, it is likely that ponding in Margaritifer Basin resulted in subsurface infiltration and water storage. Subsequent release [17] beginning in early-to-mid Hesperian [6] would have formed Margaritifer Chaos and provided water for incisement of Ares Valles. Hence, there appears to have been a long history of water discharge and storage in the Margaritifer Sinus region.

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