

YOUNG MID-LATITUDE MARTIAN VALLEYS: EVIDENCE FROM NEWTON AND GORGONUM BASINS. A. D. Howard¹ and J. M. Moore², ¹Department of Environmental Sciences, University of Virginia, Charlottesville, VA, ah6p@virginia.edu, ²NASA Ames Research Center, MS 245-3, Moffett Field, CA, 94035, jeff.moore@nasa.gov.

Introduction: The mid-latitudes of Mars feature distinctive landforms, including mantling deposits, glacial and periglacial landforms, young gullies on steep slopes, and sparse, shallowly-incised, fresh-appearing valleys. These mid-latitude valleys (MLVs) are distinct from the older, late Noachian to early Hesperian valley systems which are deeply dissected and generally of much larger spatial extent, and more degraded. Although some MLVs involve rejuvenation of older valley networks, many MLVs are eroded into smooth or rolling slopes and intercrater terrain. The MLVs range from a few meters to more than 300 m in width, with nearly parallel valley walls and planforms that are locally sinuous. Valley floors appear to be nearly flat, sometimes exhibiting faint lineations. These features suggest that the MLVs in many cases are incised channels that were occupied at least intermittently by flows over the entire valley bottom.

Particularly diagnostic MLVs occupy parts of the floors of the ~ 300 km Newton (41°S 202°E) and the ~240 km Gorgonum (37°S 189°E) basins.

Newton Basin: The MLVs in Newton basin are atypically long for late-stage valleys (**Fig. 1**). Most valleys source on the steep slopes of the upper interior crater rim and flow up to 75 km across the smooth basin interior almost to the basin center (red in **Fig. 1**). Segments of incised channels alternate with smooth, inferred alluvial deposits on lower gradient parts of the basin floor (purple in **Fig. 1**). Some of the alluvial portions exhibit braided fluvial textures or distributaries (pink in **Fig. 1**). MLV density is highest on the steep northern and western basin floor slopes. Flat deposits occupy the lowest part of the Newton floor and part of the floor of the crater on Newton's north rim (green in **Fig. 1**). Extensive aeolian activity in the eastern basin floor may have buried or eroded some MLVs.

Gorgonum Basin: Gorgonum basin also exhibits MLVs (red in **Fig. 2**), but these are limited to the upper interior slopes above the 0 m contour. Flat-topped benches at about -300m (between the pink and green lines in **Fig 2**) exhibit a wandering scarp front at the basin interior edge, dropping sharply to the basin center at about -400m. Fields of light-colored knobs [1] occupy portions of the basin floor, which is typical of basin centers in this region (excepting Newton). Knobs interior of the 0 m contour appear blanketed by dark-toned deposits and individual knobs often appear fractured and there are fields of small knobs (yellow in **Fig. 2**) that may be knobs that have been fractured and

perhaps translocated. Impact craters that straddle the 0 m contour exhibit eroded ejecta interior of the contour. A distinctive low ridge follows the 0 m contour around much of the basin floor.

Age relationships:

Relative ages: MLV's in Newton post-date formation of the smooth surface of the basin interior and most of the large craters superimposed on the smooth deposits. Where present on the interior crater rim MLVs locally constitute a minor late stage reactivation of valley networks of presumed Noachian age. Unlike the MLVs, the Noachian valleys do not extend onto the smooth basin interior deposits. The MLVs also post-date wrinkle ridge formation on the floor of Newton because they are deflected by the ridges. In Gorgonum basin MLVs are superimposed on smooth basin-floor deposits but occur only above the 0 m contour. The deposits interior of the 0 m contour bury and thus post-date Sirenum Fossae grabens. In summary, the MLV formation and formation of Gorgonum features below 0 m occurred late in martian history.

Crater ages: The interior of Newton basin is fully covered by ~6 m/pixel CTX images, permitting counting of craters larger than a few tens of meters. The smooth interior floor of Newton Basin exhibits an age close to the Noachian-Hesperian boundary. Using the buffered counting technique of [2] we estimated the age of about 1100 km of valleys/channels on the interior of Newton basin, finding a late Hesperian to early Amazonian age based on superimposed craters > 1 km in size. Craters less than 4 km in diameter exhibiting well defined ejecta or sharply defined rims suggest an effective age at about the mid to early Amazonian transition, indicating active ongoing crater degradation processes at these latitudes. Crater counts on the benches and interior floor of Gorgonum basin suggests an early Amazonian age with strong degradation of small craters. This age is roughly equivalent to the Newton basin MLVs.

Discussion and Interpretation: The smooth interior deposits of Newton and Gorgonum basins date to about the Noachian Hesperian boundary as do most of the valley networks [2]. Valley networks on the rim of Newton and Gorgonum terminate at these smooth deposits at about the 0 m contour in Newton and the +1 km level in Gorgonum. The abruptness of valley network terminations at these levels and the smooth interior deposits suggests that these basins were occupied by deep lakes. Gorgonum and other large,

interconnected mid-latitude lakes around the 180°E longitude range (e.g. Atlantis and Ariadnes basins) may have overflowed to deepen Ma'adim Valles [3, 4]. Subsequently these lakes became desiccated and deformed by wrinkle ridge formation and formation of the Sirenum Fossae grabens. The 1 km high dome in the center of the Newton basin floor (Fig. 1) is associated with one prominent wrinkle ridge and may be a diapiric structure within the deep lake sediments. The deposition and presumed erosion of the knobs in Gorgonum basin appear to predate at least the last episode of deep lakes in the basin.

During the late Hesperian to early Amazonian fluvial activity briefly returned to the Newton-Gorgonum region in the form of MLV incision. Most of the MLVs are sourced from the upper rims of Newton and Gorgonum basin. A shallow lake may have briefly occupied the Newton basin below -1200 m depositing the sediment indicated in green in Fig. 1. The unusual geomorphic features at elevations below 0 m in Gorgonum basin have been interpreted as indicative of occupation by an ice-covered lake [5]. Ice in this lake may have been up to 300 m thick with the convolute, flat-topped benches at -300m forming at the contact between the ice and unfrozen water/brine below. The ice may have formed the low bench at 0 m at the lake margins, eroded ejecta of craters straddling this contour, deposited sediment on knobs interior to this contour, and may have fractured and deformed submerged knobs. The restriction of MLVs in Gorgonum to above the 0 m contour suggests that the ice-covered lake post-dates, or more likely, was concomitant with MLV activity and fed by the MLVs.

The sourcing of most MLVs at the upper basin interior rims suggests water derived from episodic melting of snow or ice deposits accumulated on the basin rims rather than from distributed rainfall. The absence of obvious glacial features suggests either that the deposits were less than a few hundred meters thick or were cold-based but subject to episodic melting, perhaps during optimal orbital and obliquity configurations, during intensive volcanism releasing greenhouse gasses, or as a result of a brief episode of warming from a basin-scale impact somewhere on Mars. The location of most MLVs to the northern and western basin slopes suggests a possible aspect control to ice accumulation or melting. MLV activity occurred about at the same time as formation of the major outflow channels. A possible scenario is that delivery of water to the northern lowlands provided, through evaporation and sublimation, water that temporarily accumulated in the mid-southern latitudes as widespread ice deposits whose partial melting formed the MLVs and small, dominantly ice-covered lakes such as in Gorgonum (e.g., [6, 7]).

References: [1] Moore, J. M., Howard, A. D. (2003) *LPS XXIV*, Abstract 1402. [2] Fassett, C. I., Head, J. W., III (2008) *Icarus*, 198, 61-89. [3] Irwin, R. P., III *et al.* (2004) *JGR*, 109, E12009, doi:10.1029/2004JE002248. [4] Irwin, R. P., III *et al.* (2002) *Science*, 296, 2209-12. [5] Howard, A. D., Moore, J. M. (2004) *GRL*, 31, L01702, doi:10.1029/2003GL018925. [6] Baker, V. R. *et al.* (1991) *Nature*, 352, 589-94. [7] Moore, J. M. *et al.* (1995) *J. Geophys. Res.*, 100, 5433-47.

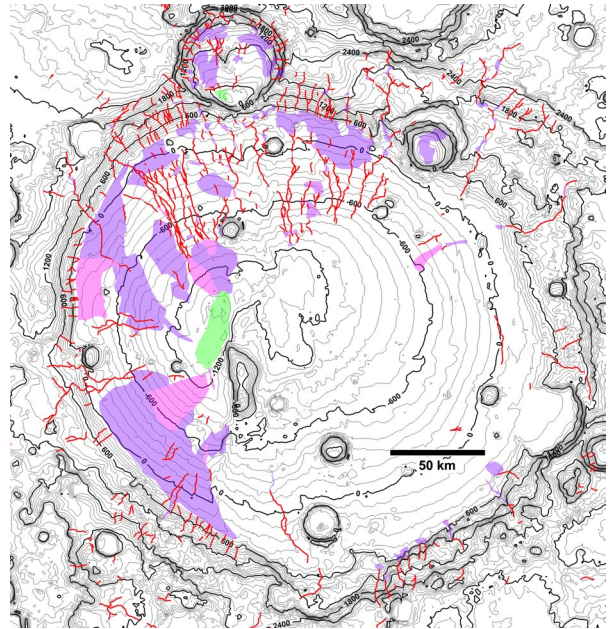


Fig. 1. Interpretive map of late-stage fluvial features in Newton Basin. See text for explanation.

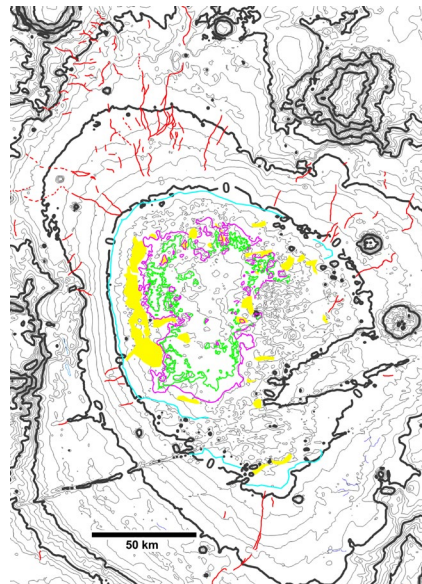


Fig. 2. Interpretive map of fluvial and possible lacustrine features in Gorgonum Basin. See text for explanation.