SIGNIFICANCE OF CRATER LAKES ON MARS THAT WERE FILLED AND OVERTOPPED BY GROUNDWATER. Neil Coleman, University of Pittsburgh at Johnstown (Department of Energy & Earth Resources, Johnstown, PA 15904; ncoleman@pitt.edu).

Introduction: Evidence of paleolakes in many Martian craters clearly demonstrates the former abundance of liquid water at the surface. Some lakes, like the paleolake in Gusev Crater, were filled by influxes of surface water. Other lakes formed in craters with no surface inlets and in such cases groundwater was the only plausible water source. For example, the 78-km Morella Crater (Fig. 1) has no inflow channels, but a large breach exists in its eastern rim where Elaver Vallis begins. Morella held a Hesperian lake that was filled and overflowed by groundwater [1].

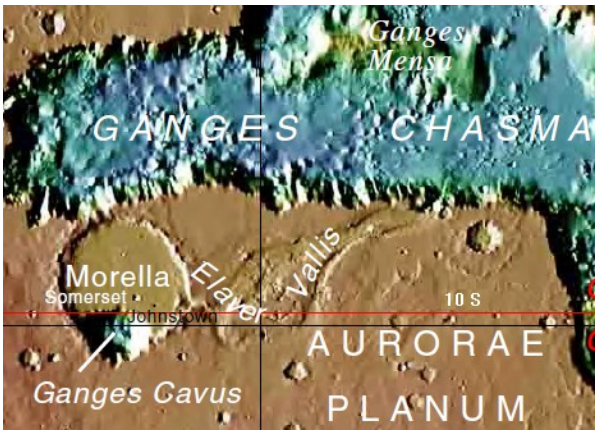

Figure 1. Location of Morella Crater, which overtopped and breached causing a megaflood that eroded the Elaver Vallis channels.

If the rim of Morella Crater had been high enough, the paleolake surface would have risen until the pressure at the base of the lake water column equaled the pressure in the subcryosphere aquifer system. The crater acted like an enormous standpipe that gradually filled with groundwater. However, the water level in the lake overtopped the crater rim before reaching the height of the groundwater potentiometric surface. The lake level rose to >1771 m, *much* higher than the initial outflow elevation of 1080 m on the floor of Morella [1]. In this way paleolakes can provide key insights about pressures in the regional aquifer.

Crater Lakes in Margaritifer Terra: *Warner et al.* [2] identified four single-outlet craters that formerly contained lakes. Other craters in this region with outflow channels include Galilaei and Barsukov Craters (Figs. 2-4) and the 200-km-wide crater known as Aram Chaos (Fig. 2). Numerous chaos occur in this region, including Hydraotes, Chryse, Hydaspis, Aureum, Aurorae, and Iani Chaos, and associated outflow channels. Barsukov Crater has multiple breaches, including one at the source of Silinka Vallis (Fig. 4). The presence of multiple chaos and craters with outflow channels in this low-lying region indicates widespread conditions favorable for groundwater breakouts from a confined aquifer.

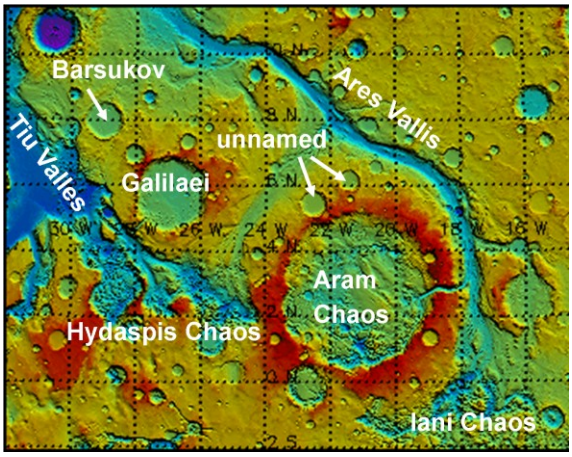

Figure 2. Craters in Margaritifer Terra with outlet channels, including two unnamed ones noted by [2].

Galilaei Crater has an outflow channel 1 km deep that formed when an enclosed lake overtopped at -1925 m, breaching the crater rim and catastrophically draining the paleolake (Fig. 3).

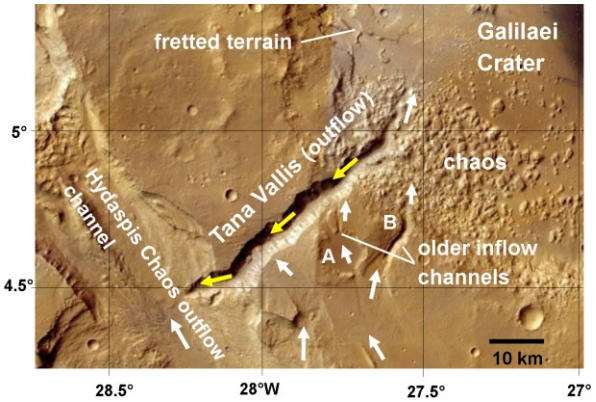

Figure 3. Tana Vallis outflow channel (yellow arrows). White arrows show older channels that issued from Hydaspis Chaos. Chaos and fretted terrain in Galilaei may result from groundwater flows.

Cross-cutting relations confirm that the flooding from Galilaei Crater post-dates the flows in Ares Vallis and also flows in the channels that emerged from Hydaspis Chaos (Fig. 3).

The region that includes Galilaei Crater and various chaos is surrounded on three sides by terrain 4 km higher, i.e., in Lunae Planum, Noachis Terra, and Meridiani. Presuming at least partial interconnection of the basaltic aquifer system at regional scales, groundwater pressures beneath the low-lying areas would have increased considerably over time, eventually building overpressures sufficient to rupture the aquifer cryospheric seal, producing chaotic terrain and outflow channels. The magnitude of the overpressures can only be approximated without knowing more about the aquifer system, the cryosphere thickness, and where and how recharge occurred at that time.

Most of the large chaos in the Galilaei Crater region are associated with the outflow channels that emerged from the eastern Valles Marineris and with Ares Vallis, the longest channel system on Mars. Galilaei Crater and Aram Chaos are situated between the Tiu Valles channel system to the west and Ares Vallis to the east (Fig. 2).

In 2002, *Carr* [3] documented the elevations of water-worn features on Mars and discussed how groundwater discharges could occur at relatively high elevations on Mars. The elevations of groundwater discharges in different regions provide key data to constrain models of former groundwater recharge and flow. Crater lakes filled and overtopped by groundwater provide the best available data on former aquifer pressures.

References: [1] Coleman, N. M. (2013) *JGR*, doi:10.1029/2012JE004193. [2] Warner, N. et al. (2010) *JGR*, doi:10.1029/2009JE003522. [3] Carr, M. H. (2002) *JGR,* doi:10.1029/2002JE001845. [4] Christensen et al., *THEMIS public releases*, http://THEMIS-data.asu.edu/.

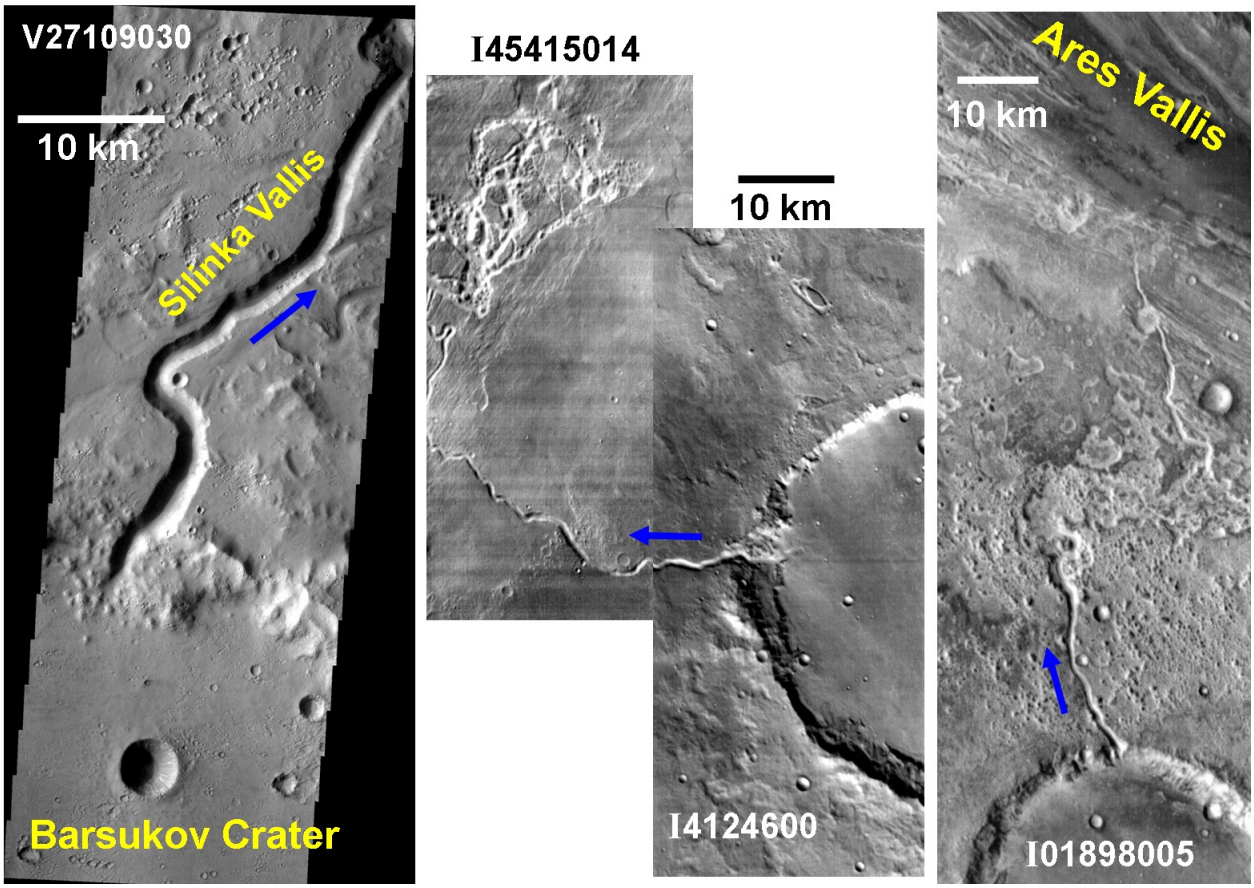

Figure 4. Along with Aram Chaos, three other craters near Galilaei Crater have breached rims and outflow channels. Barsukov and the two unnamed craters are labeled in Figure 2. Blue arrows show flow directions. Left panel: Barsukov is 100 km NW of Galilaei Crater. Center panel: This unnamed crater has coordinates 5.4°N, 22.6°W. Right panel: Unnamed crater at bottom is at 6.2°N, 21.5°W. THEMIS image credit: [4].