A CRITICAL EVALUATION OF CRATER LAKE SYSTEMS IN MEMNONIA QUADRANGLE, MARS.

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Introduction: Martian craters with inner terraces and associations with inlet or outlet channels have previously been considered to be strong candidates for the sites of ancient Martian lakes [1-3]. However, terrace and channel features in western Memnonia have morphologies that are inconsistent with their formation as interconnected lacustrine and fluvial elements within a regional system.

Study Region: The area examined in this study is located in western Memnonia, a heavily cratered highland region characterized by a wide range of crater degradation [4]. The study region is ~250 x 350 km, and is centered on a "classic" terraced crater [3,5] (Fig.1) located at 174.8^{o} W and 14.6^{o} S. This crater is ~45 km wide and has an almost continuous inner terrace tilted toward the crater center with convex form, with maximum radial width of ~5 km. The crater has a sinuous and flat-floored inlet channel into which the main inner terrace of the crater extends for more than 10 km [3,5]. The crater has an outlet channel that extends northeastward into a valley that terminates near the highland-lowland boundary, ~160 km away. The outlet channel begins at a blunt amphitheater-like headwall (Fig.2) with a maximum channel width of ~1.8 km. The channel sinuously extends northeastward with a gradual decrease in depth corresponding to a reduction in local slope, disappearing about 40 km from the channel head in flat-floored valley fill that is present along most of the outlet valley; a channel re-appears further down the valley where slope increases, widening to ~3 km before narrowing and disappearing onto the northern lowlands.

Re-evaluation of the Lacustrine Hypothesis of Terrace and Channel Formation: New data from MOLA and MOC have inspired a re-evaluation of the lacustrine model for this region, previously suggested to account for the presence of crater terraces and associated inlet and outlet systems [e.g., 1-3,5]. MOLA topography show that the crater interior is bowl-shaped, inconsistent with formation by a sediment laden fluvial system, and MOC images show several characteristics suggesting a surface of volcanic rather than sedimentary origin. In addition, lacustrine models do not easily account for the nature of the system based on experience with terrace formation and channel patterns. Terraces in terrestrial lake deposits typically involve extensive lateral dimensions to develop the fetch necessary for significant wave cutting action. In this crater, with a fetch of only 45 km, it is doubtful that wave action could have formed terraces orders of magnitude larger than terrestrial counterparts. If the material surrounding the inner wall was weak enough to form the inner terrace under such conditions, then it is not logical for the terrace to extend 10 km up the inlet valley. The absence of a delta at the mouth of the inlet is inconsistent with formation of the terrace by sediments transported through the inlet.

Both the inlet and outlet channels display inconsistencies with a crater lake scenario. The outlet channel begins abruptly at full width, with no local development of a nick point or plunge pool as might be expected with continued overflow from a crater lake. The interior of the outflow valley is not fluvially dissected, yet such modification would be expected under the same environment that would have maintained a crater lake. Finally, the source region of the main inlet channel includes channels that originate at full widths of almost 1 km, from craters that in some cases lack tributaries or basins from which large amounts of runoff could have been captured.

Discussion: Although we are investigating how these terrace and channel features might have formed through processes such as sapping or flooding, the morphologies of many components of the system are consistent with formation by extrusive igneous processes (with crater fill formed by deposition and subsidence of materials erupted at the surface from a system of feeder dikes, and with channels formed as volcanic rilles). Evidence favoring this scenario includes: **1)** the floors of the main terraced crater (Fig.2) and of most craters in the region contain materials that are characterized by lobate margins, wrinkle-ridge deformation, peripheral moats, and preservation of a <300 m cratering record that is not visible in adjacent highlands; these properties are consistent with volcanic deposits that have subsided and are more resistant than surrounding materials; **2)** crater fill materials have surface textures that match those of Martian volcanic deposits located elsewhere (Fig.3); **3)** the formation of terraces by subsidence of volcanic materials, driven by processes such as devolatization or removal of magma support, is known for both the Earth and Moon [6] and could account for the existence of terraces in western Memnonia (Fig.4); **4)** the form of the outlet channel is similar to that of typical lunar volcanic rilles [e.g., 6-8]; the breach of crater rims by volcanic rilles has been recognized on the Moon (Fig.5), and should certainly be a viable Martian process; **5)** effusive volcanic activity within craters would account for Memnonia craters that have large outlet channels but that lack inlets.

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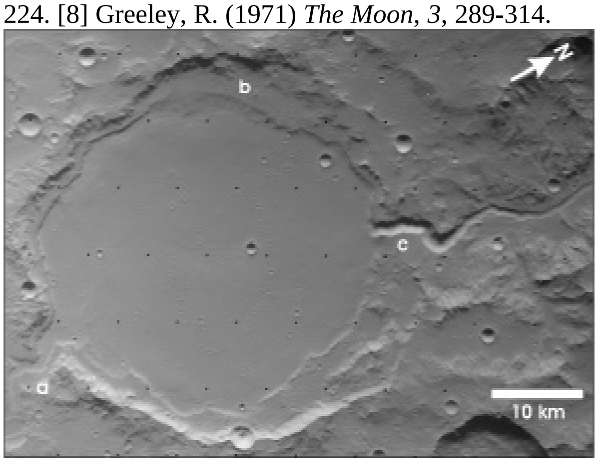

Fig.1 Main crater at center of study region; *a*: inlet; *b*: terrace; *c*: outlet (Viking Orbiter 438S12).

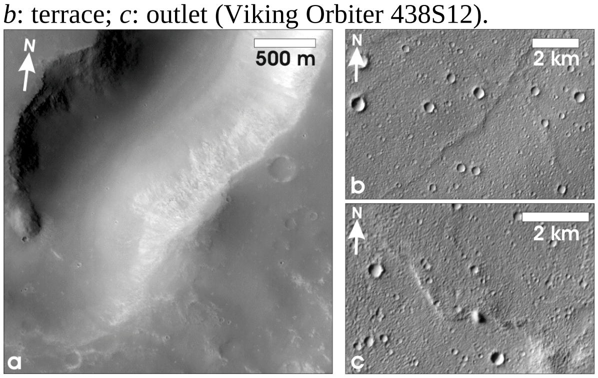

Fig.2 *a*: outlet head (MOC M0702911); *b*, *c*: wrinkle ridges and lobate features (Themis V04688002).

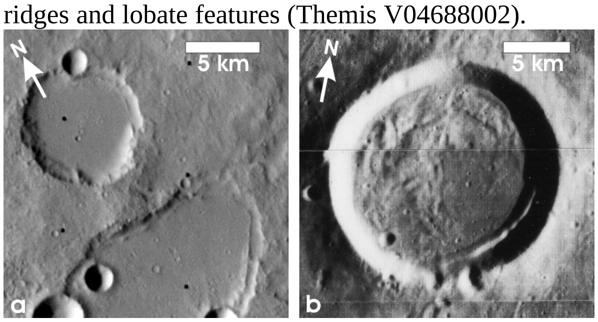

Fig.4 *a*: two terraced craters (Viking Orbiter 437S15; *b*: lunar terraced crater (Lunar Orbiter IV-195H2).

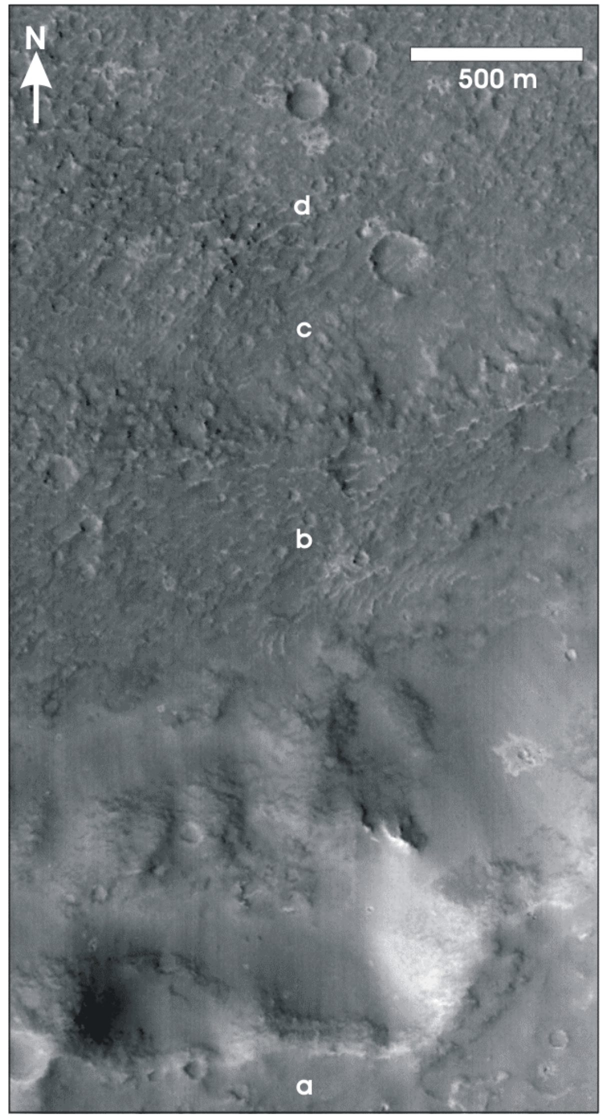

Fig.3 *a*: crater rim; *b*: terrace; *c*: bottom of terrace scarp; *d*: crater floor (MOC M0903914).

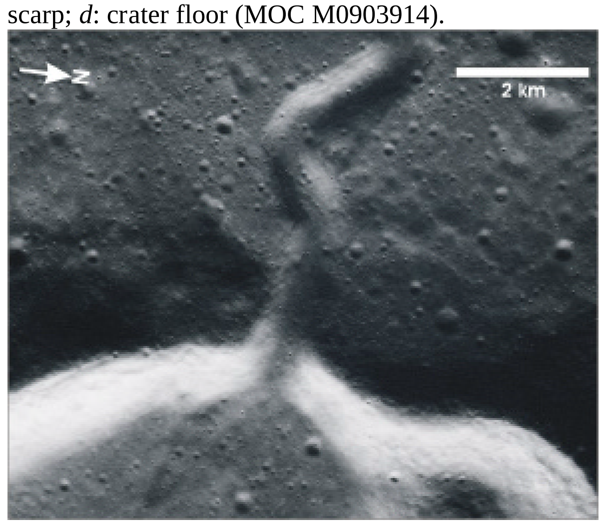

Fig. 5 Breach of lunar crater by rille (A15 Pan 0327).