PROLONGED PONDING EPISODE IN C-NEWTON CRATER IN RECENT GEOLOGICAL TIMES ON MARS. N. A. Cabrol[1], E. A. Grin[1], and D. D. Wynn-Williams[2], [1]NASA Ames Research Center/SETI Institute. Space Science Division, MS 245-3, Moffett Field, CA 94035-1000, [2]British Antarctic Survey Natural Environment Research Council, High Cross, Madingley Road, Cambridge CB3 OET, UK.

Introduction: The drainage of a 7-km crater located at 41.1°S, 159.8°W (hereafter designated as C-Newton) in the Newton crater basin seems to have been associated to a complex ponding history. The MOC context image M11-00945 shows a series of four lobate ejecta craters of 2.5, 3.5, 4, and 17 km in diameter to the West and Northwest of the drained crater that might be related to the aquifer drainage in C-Newton. The preservation of their ejecta suggests that they could be either slightly younger or contemporary to the 7-km crater. The drainage occurs on the crater side oriented toward the nearby impacts, on the West and Northwest inner rim slopes. The South slope is not drained, as seen on MOC image M11-00944. The survey of the MOC image reveals convergent evidence for the presence of a recent lake.

Evidence of drainage- The gullies in the C-Newton crater have been discussed by Malin and Edgett (2000) who performed speculative scaling calculations to estimate the volume of water involving the discharge event. They concluded that about 2.5×10^6 liters of water were involved in each event, with nearly 100 channels active in the crater, giving a total of nearly 0.25 km^3 of water that must have been discharged into the crater basin in a short period of time. The well-preserved, sharp-edged shape of the fans and gullies could indicate that the material had been cemented in the process. The aprons morphology and their stratigraphic position in the crater correspond to an aerial deposition rather than a sub-aqueous setting, showing that at least the latest apron material deposition was disconnected from a possible body of water in the crater. On the other hand, we find strong indicators of the presence of a recent lake in this crater.

Evidence of ponding- The best evidence for the presence of a body of water is given by a flat and sinuous platform on top of which the more recent debris aprons are deposited. This platform stands as a large ~50 m-high terrace on the northern part of the basin, but can still be observed South as a more subtle and smaller feature. The 2.78 meter per pixel (m/pxl) resolution allows to generate rough bathymetric contours of the crater floor, for which we assumed a flat floor as a first order approach. As the Eastern hemisphere of the crater is not covered by MOC, we assume a symmetrical distribution of aqueous sediment for further calculations of water volume and depth. The floor is covered by a succession of layered deposits, which thickness reaches sometimes the resolution threshold. The same observation is made for the large platform, which detail is better seen in Fig. 1 and in the series of enlargements of the MOC image showing strong analogies with terrestrial lakeshores. The platform shows the typical raised shorelines associated with progressive retreat of a body of water toward the center of the crater. The retreat is shown by finely and regularly spaced streamlined layers, representing in average ~15-m-wide terraces. South of the platform, the layering is still visible but more difficult to track as it is obscured by a mix of buttes, and etched terrain of albedo brighter than the darker material (dust?) covering the platform. On the South part of the crater, terraces are progressively changing from a North to an East orientation and from a high to a low albedo. The fine layering and the organization of the terraces reveals a likely concentric pattern of retreat toward lower topographic points typical of evaporating bodies of water. At martian average temperature and pressure, the existence of a body of water competes with loss by evaporation, frost and sublimation. Assuming a maximum water height of 50-m (corresponding to the highest eroded terrace in the platform), it would first take between 5 to 10 years for this depth of water to freeze solid in current martian conditions at the relatively low latitude of Newton. This assumes a freezing rate of 5-10 m per year (Carr 1996). Sublimation rates are likely to be low because of the low temperatures on the surface of the ice, and because of the logarithmic dependence of the vapor pressure of water on temperature (Carr 1996). Assuming an ice sublimation rate of 0.01-0.1 cm yr^{-1} (Carr 1990), and no recharge, it would take between $5\cdot10^4$ to $5\cdot10^5$ years for the frozen lake to completely disappear. But what would be the origin of such lake? Taking the first order calculations of 0.25 km^3 of water and spreading it over the ~7 km^2 area, we obtain a layer of water averaging ~35-m over the whole crater. This result is extremely close to the estimation obtained for the platform of the upper streamlined terrace and would accommodate this higher elevation with only minor modification of the sediment/water ratio provided by Malin and Edgett. However, the stratigraphic position of the debris aprons appears to contradict the concurrence of gullies and lake. This contradiction is eliminated if the evaporation rate of the lake was such that the final gully discharge stage occurred on already dried floor deposits which were left while the lake was still retreating towards the center of the basin. The only other hypothesis would be that a lake was generated after the formation of the crater by regional aquifer pumping according mechanisms for aquifer discharge in crater basins described by Grin and Cabrol (1997) and Forsythe and Blackwelder (1997). In this case, the gully discharge episode would have occurred later in the basin's history. The first hypothesis implies that the gullies must be at least 50,000 to 500,000 years old, whereas they could be recent or even current in the second case.

Potential habitats -The long duration of water in Newton Crater would result in a typical ice-covered lake habitat as described for Epoch II of the McKay Mars hydrology model and analogous lakes in the Dry Valleys of Antarctica (McKay 1997, Wynn-Williams 1999). These present-day ice-capped often hypersaline lakes permit the penetration of solar radiation through the ice-cap and water column to warm the dense bottom water and sediments by trapping thermal energy. This enables shade-adapted halotolerant cyanobacteria to form a variety of stromatolitic communities (Wharton et al. 1994). Given time, these communities which can be over a meter thick could have developed in lakes such as Newton Crater on Mars (Wharton et al. 1995). However, they would have required and element of UV protection because the clarity of ice and the non-turbulent water column permits significant penetration of UV radiation to the lake bottom (Vincent et al. 1998). Nevertheless, on gradual desiccation, the ice-cap and water would have dissipated to leave an evaporite-encrusted stromatolitic lake bed containing the residues of photosynthetic bacteria and cyanobacteria and their fossil pigments (Overmann et al. 1993). Associated surrounding sedimentary sandstone rocks may contain endolithic microbial communities in probably the last habitat to contain moisture on the surface of Mars (Wynn-Williams and Edwards 2000). Analogous habitats have been studied in Antarctica (Russell et al. 1998, Doran 1998) with attention to their key biomolecules, especially pigments. These provide good Raman spectral signatures of biological synthesis which can be diagnosed *in situ* in field fresh samples of habitats (Wynn-Williams and Edwards, 2000) and could be diagnosed on Mars with a remote miniature Raman spectrometer (Dickensheets et al. 2000).