FLUVIAL PROCESSES MODIFICATIONS OF THE IMPACT CRATERS IN THE GREATER HELLAS REGION, MARS. M. Aittola[1], V.-P. Kostama[1], H. Lahtela[1] and J. Raitala[1]. [1]Astronomy, Dept. of Physical Sciences, PO Box 3000, FIN-90014 University of Oulu, Finland. <jouko.raitala@oulu.fi>

Introduction: The way how each of the impact crater appear on the Mars surface has been effected by numerous factors beginning from the size, mass, velocity, type, and impact angle of the approaching projectile [1]. These all have effected the impact energy delivered into the surface. The bedrock properties have then resulted in additional effects. Pre-existing faults and fractures have contributed to the formation of an amount of polygonal craters [2]. Permafrost-saturated layers are melted to splash around the crater to form rampart ejectas instead of usual ejecta fields and secondary craters [3,4]. Some impacts may even have hit into shallow water areas resulting in almost immediate rim erosion due to the back-surge forces [5]. In addition to these major phenomena there may have been numerous more delicate variations due to local projectile-bedrock combinations. Various post-impact deformation processes may then have changed the appearance of an impact crater even in an amount which may make it difficult to identify any original crater characteristics in great details [6,7]. The changes in the crater appearances can, however, be looked in a positive way to provide crucial information of the local surface geology, bedrock properties and, more generally, of the whole post-impact geological evolution of the area studied [2,4,5]. This is why we have characterized and studied in details the various crater deformation types found from within the large Hellas area. It is one of the possible previous water body areas on Mars and lies also close to the southern permafrost and the south pole environment.

Craters modified by recent fluvial processes: A liquid material has been found important in deforming layered crater rims even rather recently [8]. Such flow features may begin from within alcove depressions or source wells, resulting in lengthy channel-like downslope erosion, and ending in apron-like cumulation pilings.

Craters eroded by rim channels: In the relatively more-remote past, the small-scale rim-eroding flows have been much more common [3] as can be seen from numerous craters locating on the western highlands of the greater Hellas area. Their interior slopes are full of rim-related fluvial channels the length classes of which are from 10 to a few tens of kilometers only. The one-to-a-few km wide channels originate either from the rim formation or from within the surrounding highlands. The floors of such craters display a relative smoothness which, together with the fact that the flows have eroded an amount of rim material and moved it downslope, the most probably indicates the existence of sedimentated flow-related floor material representing the period of time of larger fluvial activity. In a certain places there are later delta- or apron-type masses in the channel ends on the top of the smoother interior sediments indicating the effects of the later flow units with lesser amount of liquid material (Fig. 1).

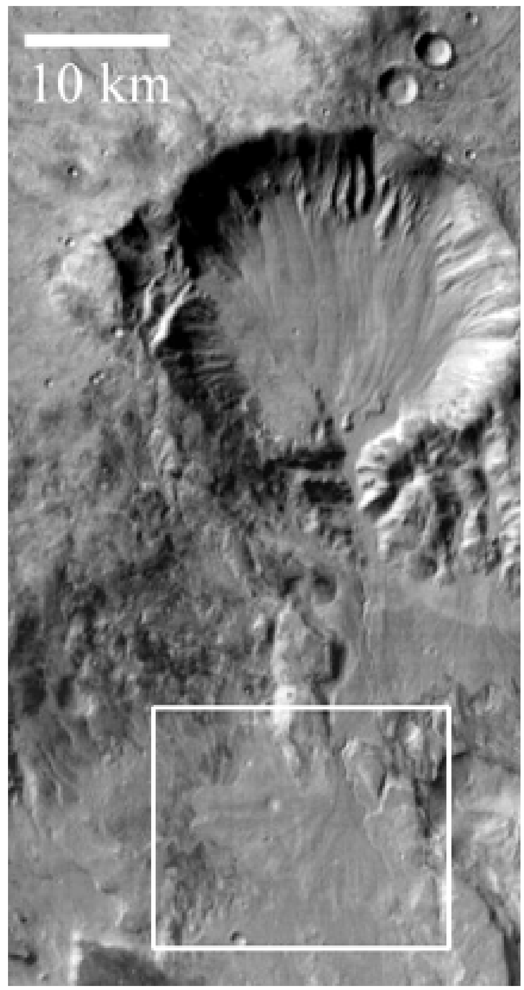

Figure 1. The fluvial modifications of a crater near Terby Crater. Notice the delta-like formation within the box. This figure is part of THEMIS-IR image I01571002.

Changes by smooth layered floors and outflow channels: The fact that some crater floors consist of layered units can be seen from some MOC and THEMIS-VIS images which show etched terraces and deposits with full of parallel horizontal layers (Fig. 2). Reasons for the layering may be versatile, but in cases where there are adjoining reasonable-size flow channels into the crater a realistic additional alternative for layering could be the existence of flow-related sedimentation. This is particularly obvious in the cases where there have been several sediment-feeding channels, smooth crater interior, and an additional outflow channel representing the site and time when the crater-locked ponded flow material finally broke its way through the lowest or weakest part of the rim after a short or lengthy period of reservoir time (Fig. 3). Anyway, the time has been long enough for substantial amount of sedimentation. In these cases the channels and the amount of liquidized material have been been larger than in the previous case.

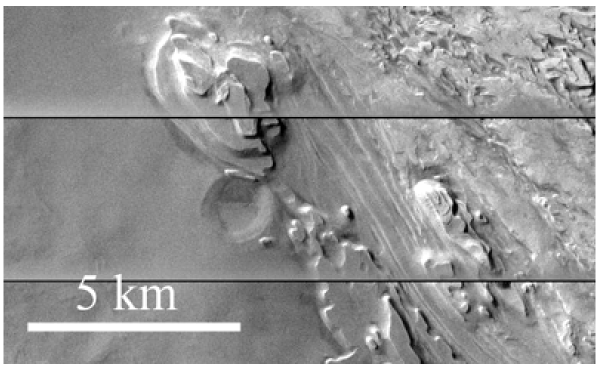

Figure 2. Terraces and layering within Spallanzani Crater, Hellas region. Image is taken from THEMIS-VIS image V01820003.

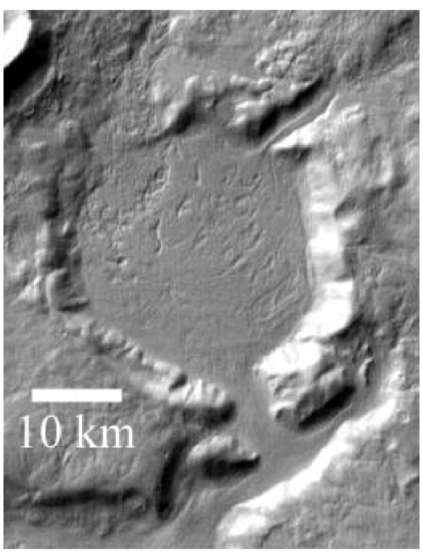

Figure 3. Crater with apparent "feeding" channel and substantially larger outflow channel from THEMIS-IR image I01982002.

Modifications by crater-destroying flows: In some cases there are major channels which have cut across the craters and other surface units mostly unaffected by these structures and units [cf. also 7]. The Fig. 4 gives an example of such case. The deep erosion channel curves across the eroded low-rim crater with an otherwise smooth interior. An interesting detail is seen on the crater floor beside the main channel where the numerous small sapping-type channels indicate the existence of layered interior material and previous groundliquid flows along some interlayer sufaces.

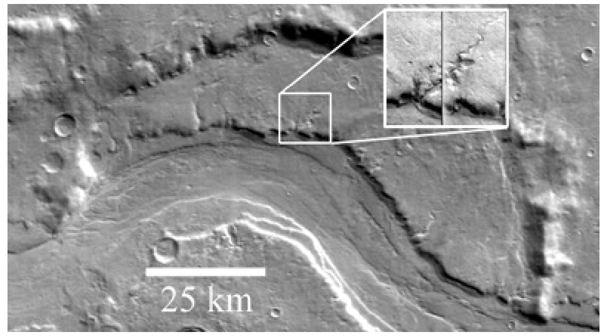

Figure 4. Example of a crater cut-through. Notice the small sapping-type channels. This is a part of THEMIS-IR image I01571002. Detail is from THEMIS-VIS image V01657003.

Conclusions: Many craters locating within the greater Hellas Basin area have undergone substantial fluvial processes, but many of their surviving geologic features are enough well preserved. The good state of preservation is due partly to the relative youth of the craters or partly to Martian relative dryness. Fluvial and other erosion and sedimentation processes in the Martian environment have been particularly sluggish due to the relative rarity in the availability of liquid water. The absence of permanent water cover limits the weathering of surface materials, while it optimizes the site's exposure for geologic surveys by remote-sensing. This allows to estimate that the effects related to permafrost, water, erosion and sedimentation have been far more important within the greater Hellas area than what was earlier assumed using the previous data sets which have had defects either in resolution or in areal coverage. The still-cumulating MOC and THEMIS-VIS data are steps to the right direction but the more complete realization of the effect of fluvial processes will still wait for more complete coverage possibly acquired by the MEX HRSC camera.

References: [1] Melosh, H.J. (1989) *Impact Cratering. A Geologic Process,* Oxford Univ. Press, 245 pp. [2] Öhman, T. et al. (2003) *LPSC 34*, pdf #1311. [3] Mouginis-Mark, P.J. (1987) *Icarus* 45:268-286. [4] Stewart et al. (2001) *LPSC 32*, pdf #2092. [5] Ormö J. and P. Muinonen (2000) *LPSC 31,* pdf #1266. [6] Öhman T. et al. (2002) *LPSC 33*, pdf #1270. [7] Raitala J. et al. (2003) *LPSC 34*, pdf #1057. [8] Malin, M.C. and K.S. Edgett (2000) *Science* 1288, 2330-2334.