WATER AND ICE IN CENTRAL NOACHIS TERRA, MARS? J. Korteniemi[1], M. Aittola[1], T. Öhman[2], T. Törmänen[1] and J. Raitala[1], [1]Division of Astronomy, Department of Physical Sciences, P.O. Box 3000, 90014 University of Oulu, Finland (jarmo.korteniemi@oulu.fi), [2]Department of Geosciences, Univ. of Oulu, Finland.

Introduction: The studied area (Fig. 1) is located in the central part of the Noachis Terra on Mars (36-47°S, 20-30°E). The region is part of the southern highlands W of the Hellas basin, and has been generally described as ancient terrain with large, eroded craters modified by e.g. fluvial and aeolian processes [1]. Impact craters in the whole Noachis Terra exhibit many, mainly intracrater dunefields [1,2], as well as several examples of depressions and collapses on the crater floors [3,4].

Data and methods: We have studied the area using the freshest data sets available – THEMIS and MOC – in conjunction with Viking imagery, to find out what input they can give to the geological analysis of this highland region. The topography is determined from the MOLA 128 pixel/degree DTM.

Tectonics: The Noachis region has a large SW-NE graben system ~2000 km to the (N)W from Hellas basin [1]. All tectonic structures in our study area are roughly parallel to 1) the graben set, 2) Hellas basin and 3) Hellespontus Montes. This may indicate that the local tectonics is controlled by the Hellas impact event. This interpretation was concluded from the study of polygonal craters in the Hellas area [5].

A large 102-km crater (at 45°S, 28.5°E) exhibits depressions on its floor. The depression walls are layered, steep and up to 300 m high. Additionally, they are often straight and follow the regional trends [3], radial to Hellas basin and the main tectonic lines.

Aeolian features: The intracrater dune fields of the southern, mid and high latitudes – including Noachis Terra – are thought to be the most significant accumulations of sand on the planet [6], and dunes were first identified in the Noachis Quadrangle [7]. Therefore, the dune fields in the region have been targets of a number of studies [e.g. 2 and references therein]. An interesting observation is that there are almost no dune fields in the studied area, despite their regional abundance. The only dune field lies on the floor of the aforementioned 102-km crater.

Water activity: The region does not have any huge-scale fluvial features such as giant outflow channels like the E side of Hellas. However, it does exhibit evidences for a multitude of small-scale fluvial activity. The most prominent examples are the several channels found in the study area (dotted lines in Fig. 1). They terminate mostly in local low elevations, such as impact craters or other basins. These have usually smooth interiors, which appear dark in THEMIS day-IR images and bright in night-IR. There are also few candidates for lake chains, which are not uncommon features in the Hellas region [8].

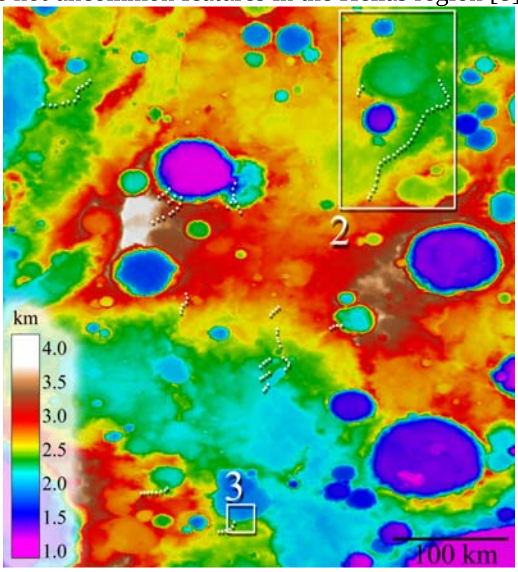

Figure 1: MOLA topography of the studied region (36-47°S, 20-30°E). The dotted lines are channels (mapped from Viking images). Deposits at the end of a long channel, in a depression, is shown in more detail in Fig. 2 (large box). Fig. 3 is a close-up of the small box area.

Deposits in depressions: The topographical depressions associated with the channels exhibit a distinct albedo, seen especially well in THEMIS IR images. Two examples are shown, one in the N part of the study area (Fig. 2a; 37.4°S, 28.1°E) and the other in the S (Fig. 2b; 43.7°S, 24.9°E). In Viking images both appear smoother than the surrounding higher terrain. The basins are rather polymorphous in THEMIS day images, as they are generally darker than the surroundings, but have also some albedo variations within the lowland. The darkest areas (in day-IR) appear very bright in night-IR. These regions are the ones directly connected to the incoming fluvial channels. THEMIS images indicate the thermophysical properties of the deposits, showing that the 'night-bright' basin material is not fine grained but rather rocky or consolidated. The channels also show up bright in night-IR, probably caused by a concentration of coarse – and thus warm – material on the slopes relative to flat surfaces [9].

The basin deposits are without doubt different from 1) the surrounding smooth area as well as 2) the highlands. The incoming channels give a reason to suggest that these deposits are probably the accumulations of liquid(s) which used the channels as routes to topographically lower areas. If that is the case, the deposits must be consolidated material, as it is bright in night-IR. Unfortunately there are no complete high-res image sets (THEMIS VIS, HRSC or MOC). Thus crater statistical age determination has not been done. However, based on crater mapping, there are just a few 10-40 km craters superposing the smooth basins; the highlands in turn exhibit many more craters of similar size, indicating that its surface is older.

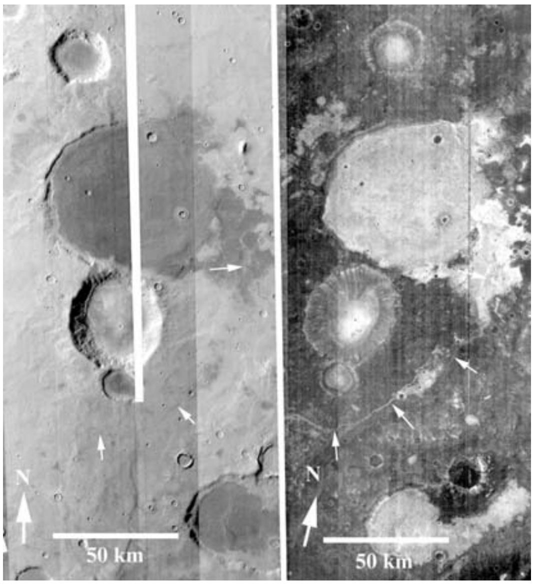

Figure 2: Deposit in crater floor (THEMIS IR mosaics). a) In day-IR the deposit appears dark. Channel leading to the deposit (arrows) shows up only vaguely at best. b) In night-IR the deposit is very bright, and the channel is clearly visible.

The intercrater plains that appear bright (warm) in night-IR have also been explained by widespread sedimentation across Noachis [2]. These areas would thus represent remnants of Noachis-wide sedimentary unit(s) which have later been exhumed. However, this idea does not consider the incoming channels. In the same paper it is proposed that in Noachis Terra sand is not transported far from its origins, ruling out a distant source of sand. If this is the case, where did the material overlying the night-bright deposits move – there are (almost) no dunes in the study area?

Evidence of ice: Pingos are described as cone-shaped mounds with cores of ice. They are formed by the upward expansion of freezing water surrounded by permafrost. Studies have proposed that there are evidences of pingo-like structures on the Martian landscape, e.g. within a fluvial channel [10]. It has also been proposed that the central mounds of craters could have pingo-like origins [11,12].

There are small (diam. 20-120 m; Fig. 3) mounds inside a crater (45.98°S, 24.41°E). The origin of the material unit they reside on seems to be a channel which breaches the crater rim in SW. The peaks are strictly connected to material apparently accumulated from the channel, and do not appear elsewhere on the crater floor. If the channel has offered a source of additional water, the mounds may very well have been created as hydrostatic pingos. Loss of local water, permafrost aggradation and the formation of a sub-surface ice core could have formed the peaks.

Discussion and Conclusions: Although the studied area does not show evidence of massive outbursts of local water, there is clear proof of small-scale water activity in the region. The most evident examples are the channels, which are usually associated with craters and basins. As a result, crater lakes and even lake chains probably formed. The channel-associated deposits in the lowlands, pingo-like features and the collapses on the crater floor may all indicate that there have been and probably still are reasonable amounts of water/ice/permafrost below the surface. Thus this area should be of great interest to future investigations, e.g. by the OMEGA, HRSC and MARSIS instruments on the Mars Express probe.

According to this preliminary study, Noachis Terra has been modified by several processes, which have characterized the unforeseeably varied geological history of the region. The after-effect of the Hellas impact event is evident, as can be seen from the orientation of the tectonic structures.

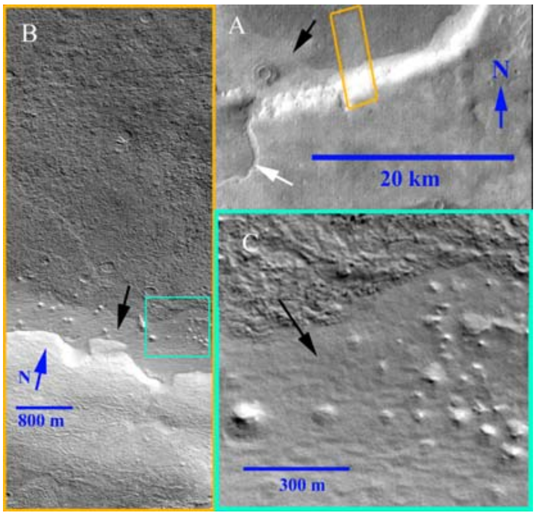

Figure 3: a) A part of an impact crater, showing an inflow channel (white arrow) and associated deposits (black arrows). THEMIS I06466002. b) High-res. image (MOC R1900276) of the area next to the rim reveals that the deposit is covered with small mounds. c) Close-up of the deposit's contact with the crater floor shows the different textures of material units.

References: [1] Petersen (1977), *USGS* Misc. Geol. Inv. I-910. [2] Fenton (2005), *JGR, 110,* E6, E06005. [3] Korteniemi et al. (2003), *Vernadsky-Brown 38*, #048. [4] Korteniemi et al. (2005), *JGR*, in press. [5] Öhman et al. (2005), *in: Impact tectonics*, Springer, Berlin-Heidelberg. [6] Greeley et al. (1992), *in: Mars*, Univ. Arizona Press, Tuscon. [7] Cutts & Smith (1973), *JGR, 78,* 4139-4154. [8] Lahtela et al. (2005), *LPS 36,* #1683. [9] Christensen et al. (2003), *Science,300,*5628,2056-2061. [10] Burr et al. (2004),*AGU FM*,#P13A-0982. [11] Sakimoto (2005), *LPS 36*,#2099. [12] Soare et al. (2005), *Icarus, 174,* 2,373-382.