GEOLOGY OF CENTRAL NOACHIS TERRA, MARS. M. Aittola[1], J. Korteniemi[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, University 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) to the West of the Hellas basin. The region has been generally described as ancient highland terrain with large, eroded craters modified by e.g. fluvial and aeolian processes [1]. Impact craters in the whole Noachis Terra exhibit many intracrater dunefields [1,2], as well as several examples of depressions and collapses on the crater floors [3,4]. The studied area is situated on the highlands revealing, however, large elevation differences (~1.5 - ~4.2 km. Although the intracrater dune fields are thought to be the most significant accumulations of sand on the planet [5], and dunes were first identified in the Noachis area [6], there is only one field on the floor of crater (at 45°S, 28.5°E) in the study area.

Data and methods: In this study we outline the general characteristics of the region, making an analysis of the major geological features found by using the freshest available data sets. We used the THEMIS and MOC images 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 seem to be 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, which interpretation was concluded also from the study of polygonal craters in the Hellas [7]. This orientation can be seen also tectonics and collapses inside the craters.

Channels: The region does not have any large-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, such as the several channels found in the study area (Fig. 1). They terminate mostly in local low elevations, i.e. impact craters or basins. These have usually smooth interiors, which appear dark in THEMIS day-IR images and bright in night-IR. There are also two candidates for lake chains, which are not uncommon features in the Hellas region [8].

Deposits and depressions: The lowlands associated with the channels exhibit a distinct albedo, seen especially well in THEMIS IR images. Two examples are found, one in the Northern part of the study area (Fig. 2; 37.4°S, 28.1°E) and the other in the South (43.7°S, 24.9°E). In Viking images both appear smoother than the surrounding highland. The basins are generally darker than the surroundings in THEMIS day images, but have also some small albedo variations. 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].

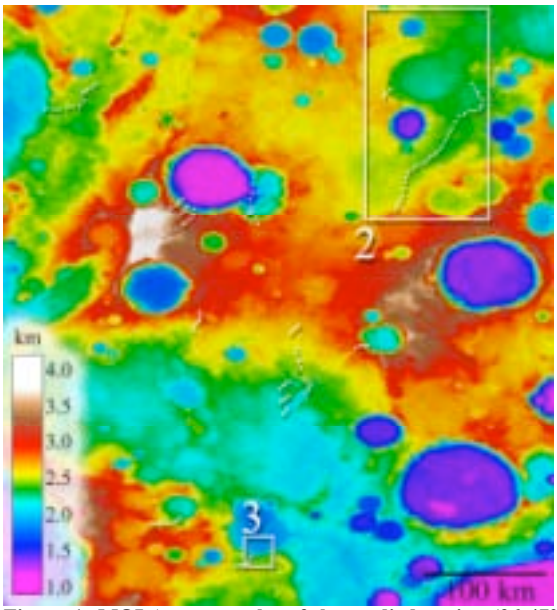

Figure 1: MOLA topography of the studied region (36-47°S, 20-30°E). The dotted lines are channels (mapped from Viking images). Deposits at the end of a long channel, in a depression, is shown in more detail in Fig. 2 (large box). Fig. 3 is a close-up of the small box area.

The basin deposits are without doubt different from the surrounding smooth areas as well as the highlands. The incoming channels give a reason to suggest that these deposits are probably the accumulations of liquid(s) and transported sediments, which flowed down carving the channels on their way to the topographically lower areas. In that case, the deposits must be consolidated material. Unfortunately there are no complete hi-res image sets for the studied region (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, while the highlands exhibit many more craters of similar size, indicating that its surface is older.

The intercrater plains that appear bright (warm) in night-IR have been explained also 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 addition, it is proposed that in Noachis Terra sand is not transported far from its origins, ruling out a distant source of sand [2]. However, there are (almost) no dune fields in the study area.

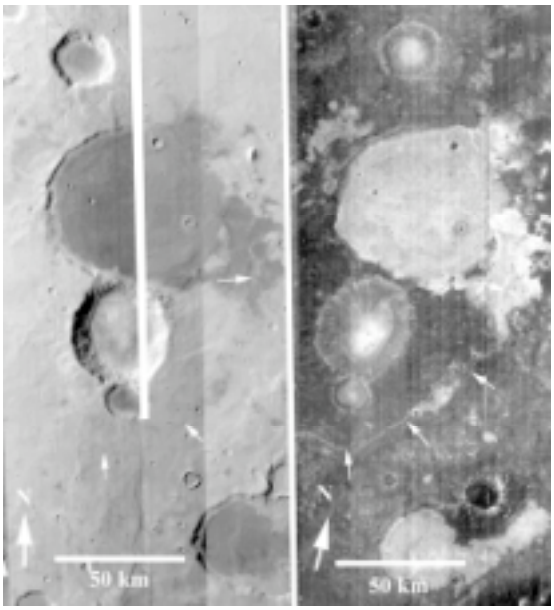

Figure 2: Deposit in crater floor (THEMIS IR mosaics). a) In day-IR the deposit appears dark. Channel leading to the deposit (arrows) shows up only vaguely at best. b) In night-IR the deposit is very bright, and the channel is clearly visible.

Pingos: 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 several small (diam. 20-120 m; Fig. 3) peaks or 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 that material, 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 these crater-floor mounds.

Discussion and Conclusions: 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.

Although the studied area does not show evidence of massive outbursts of local water, there is clear proof of small-scale water-related 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.

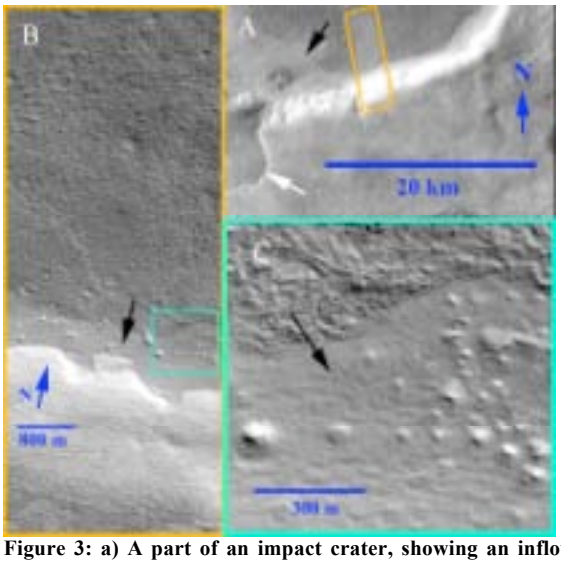

Figure 3: a) A part of an impact crater, showing an inflow channel (white arrow) and associated deposits (black arrows). THEMIS I06466002. b) High-res. image (MOC R1900276) of the area next to the rim reveals that the deposit is covered with small mounds. c) Close-up of the deposit's contact with the 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] Greeley et al. (1992), *in: Mars*, Univ. Arizona Press, Tuscon. [6] Cutts & Smith (1973), *JGR, 78,* 4139-4154. [7] Öhman et al. (2005), *in: Impact tectonics*, Springer, Berlin-Heidelberg. [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.