FENG-SHUI ON MARS – HISTORY OF GEOMORPHOLOGICAL EFFECTS OF WATER AND WIND. Kereszturi, Á.[1] and Sik, A.[2], Department of Physical Geography, Eötvös Loránd University, H-1083 Budapest, Ludovika tér 2., Hungary; [1](kru@iris.geobio.elte.hu), [2](sikandras@freemail.hu)

Introduction: The purpose of our work was partly the analysis of this theme from a geographic point of view and the interpretation of the up-to-date scientific literature which – in our hope – could be one of the base works of Hungarian education of it. Our sources were home pages (mainly MPF [1], MGS [2]), scientific journals, the abstracts of the XXX. Lunar and Planetary Science Conference and a geologic map [3]. Because of these factors it is not so much a self-employed work but a systematic summarizing of information on a specific area. We divided our analysis into the great periods of "Mars-history" as the Noachian (4,5-3,5 billion years), Hesperian (3,5-2,7 billion years) and Amazonian (2,7 billion years-present).

Noachian – era of water: During the Heavy Bombardment and the formation of the crust there were great sum of outgassed water in the atmosphere or at the surface [4]. In the Noachian one of the most widespread water fingerprints are the runoff channels [5]. Their morphology suggests the conditions were suitable for the existence of liquid water below the surface and possible on the surface during their formation. We examined the distribution of the runoff channels and relation to craters and find that there are many craters with one relatively great runoff channel. In the good climatic conditions the liquid water slowly flowed in the regolith and formed ancient lakes in the deep craters. If one crater's wall was cutted by a channel some part of the water flowed out or inside based on the topographic conditions feeding or draining out the lakes. Beside the runoff channels are several greater channel like feature with wide and plain beds and uncertain edge, they are probably more ancient features. The other consequence of the climatic conditions is the assumed northern ocean.

Hesperian – era of ice: In this period the atmosphere was colder and had smaller pressure. The water freezed into the top of the regolith but the underneath artesian water several times broken up into the surface. The subsurface water system's pressure was mostly caused by the freezing northern ocean. Similar freezing happened in other great paleolakes (Hellas, Argyre, etc.) but the water did not break up that places. The northern outflow channels' chaotic regions are within nearly 20° from the equator. The Hellas and Argyre basin were at too high latitude, produced too small pressure and had too thick criosphere that prevent the artesian water from the breakup. Water erosion and sedimentation forms are best visible at the northern outflow channels. We examined the complex structure and the connection of the certain surface features in and around these outflow channels.

Some of them are presented on the example of Kasei, Shabalana, Tiu and Simud Vallis (see figure). The origin of the channels are chaotic terrains, one channel usually has several chaos. We find evidence for multiple flood episodes based on the different channels at different height (Fig. 1. A, B, C in chronological order) which is supported by the new results on their somewhat gradual formation [6] At B the fluvial sediment contained great mass of water which slowly flowed in the tectonic lines related to the Tharsis bulge (Fig. 1. D). There are examples for the forming of runoff-like channels with sapping (Fig. 1. E) and collapse of the possible water lost sediment at (Fig. 1. F) and "inverse piedmont" at (Fig. 1. G). Some pedestal craters proves the existence of this water or water ice in the sediment, just like at other ice rich places [7]. Around the Shabalana, Simud and Tiu Vallis are earlier (Fig. 2. A, B) and later (Fig. 2. C, D) channels. Several terraces formed during the flows which is caused by the episodic floods or the gradual decrease of the last flood's discharge. There are multiple terraces at (Fig. 2. E, F). We found the most southward terraces at (Fig. 2. G) and no terraces in a somewhat later flood from the crater (Fig. 2. H) There are evidence for the loss of subsurface water at other places like closed depressions and thermocarst features [8].

Amazonian – era of wind: The earlier trend continued and the freezing front went deeper and deeper into the regolith. Because of the contact with the atmosphere the upper layer was dried out. The wind became the dominant geomorphic agent (beside the currently active possible subsurface ice-creeping [9]), which probably was an active process before but without any long-lasting or recognizable mark [10].

There are many evidences of the current aeolian activity [11]. Many landforms are not covered by the fine atmospheric dust because of the fast surface changes. On certain landforms are traces of fresh slidings, sharp ridges and edges but there are no microforms, confirm the changes. Comparising the MGS and the 20-year-earlier Viking Orbiter images little movements also can be revealed. The most convincing are the polar region observations: the springtime retreating ice cover shows dark patched pattern where the patches are the outcropping dune material. The winds blow out this dark material to the same direction from each patch upon the ice cover, which can be no older than half a Martian year (Fig. 3.). Therefore the aeolian activity is younger, which is not exclude the existence of relict forms.

The effect of the wind is depend on four important factors [12]: 1) the atmospheric processes, determining the direction and intensity of winds, 2) the material covering the surface, 3) the local orography and the 4) possible vegetation on the area, for which should not be calculated on Mars. All the more the attrition and/or alteration, from which the former is the more efficient on the planet (can be caused by insolation, frost shattering or salt weathering against the latter one, which needs liquid water, so this could be dominant in the previous periods).

The surface can be divided into darker and lighter (reddish) regions. The darker ones areas covered by lava flows or fine clasts (with aeolian landforms or without, like thick mantles). The lighter ones covered by dust without obvious landforms [13]. The aeolian landforms are dominant the most of the planet, these are between lava flows, on the bed of channels, in certain craters and around the ice caps. The most typical erg (700000 km^2) is bordering the Northern cap, called North Polar Sand Sea (or Olympia Planitia, 76-83°N, 110-260°W) [14].

The aeolian activity has three types: erosion, transportation (traction, saltation or suspension) and deposition. The most obvious aeolian landforms are [10, 15]: wind streaks (brighter or darker than the surroundings, yardangs, other types of forms eroded by winds (together forms of erosion);

ripple marks, barchans and barchanoid forms, transverse dunes, which are usually darker than their surroundings, but already known lighter ones from the MGS-images [16] (together forms of transportation and/or accumulation); mantles without obvious landforms (probably caused by desert pavement or crust [17]).

The best known Martian area is the MPF landing site. The available information is thorough enough to analyze its morphology as detailed as on Earth and to reconstruction of the surface evolution. Originally the area was covered by fluvial sediments from the floods of the Ares and Tiu Vallis between 3,5-1,8 billion years ago [18]. Later was resurfaced by the wind (and some impact events [19]), developing its actual morphology. This has been lasting for a long time and nowadays is active too. Meanwhile the wind regime is changed indicated by the direction of ventifacts and eroded small crater rims, which orientation are different from that of the current aeolian forms [20]. This probably was caused by the changing of the global circulation, in connection with the fluctuation of the planet's orbital elements [20]. Based on the circulation models, during the mission's period sweep the weakest trade-like winds at the site, with velocity below 8 m/s [15]. (Temporarily occurs greater wind speeds because of dust devils or dust storms.) The erosion is the dominant against the accumulation [21] resulted in the lack of the uppermost 5-7 cm layer of the soil [22]. The erosion rate is estimated 0,1-0,01 nm/year [18], so not surprising that during the 83-day-long mission there was any changes at the area. The local, mainly sand- and aleurite-sized sediment [23] is probably fluvial in origin (similar to the most of the sand areas of Earth), but we suppose that most of the sand is not fluvial on the planet, based on the location of the outflow channels.

Experimental and future works: Our work contributed to the construction of the environment of the Hunveyor experimental probe [24, 25] for the reason it could operate among realistic landforms and rock types.

We have been dealing with the surface morphology of Mars for several years [26], which we will continue in any case based on the new and results. We expected many up-to-date data from the Mars Climate Orbiter and the Mars Polar Lander space probes, but because of their tragic lost we have to wait two more years, until the arriving of the Mars Surveyor 2001.

References:

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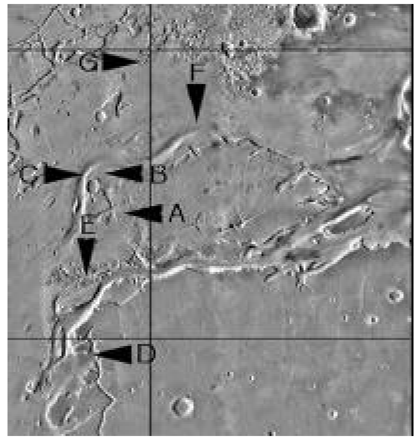

Figure 1.

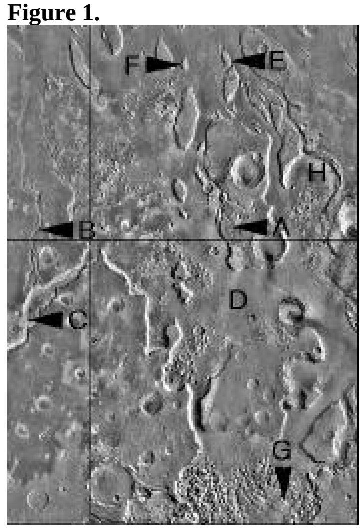

Figure 2.

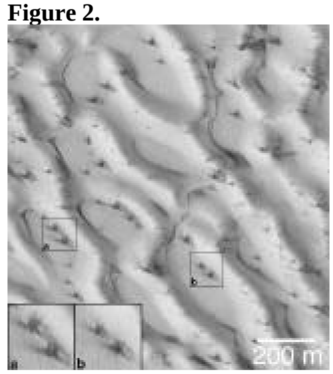

Figure 3. MGS MOC Release No. MOC2-169.