

**MARS ANALOG FLUVIAL AND DESERT PROCESSES IN THE PLIOCENE HUNGARY STUDIED WITH HUNVEYOR.** Sz. Bérczi<sup>1</sup>, Gy. Hudoba<sup>2</sup>, S. Hegyi<sup>3</sup>, <sup>1</sup>Eötvös University, Institute of Physics, Dept. of Materials Physics, Cosmic Materials Space Research Group, H-1117, Budapest, Pázmány P. s. 1/a, Hungary, (berczisani@ludens.elte.hu), <sup>2</sup>Budapest Polytechnic, Kandó Kálmán College of Engineering, H-6000, Székesfehérvár, Budai út 45. <sup>3</sup>Pécs University, Dept. Informatics and G. Technology, H-7624 Pécs, Ifjúság u. 6. Hungary.

### Introduction

Opportunity observed sedimentary sequence of layers in the Endurance crater which have been summarized as Burns Formation, which mostly consists of eolian and water sedimented layers. We looked for comparable sedimentary Mars analog sites in Hungary where fluvial deposits formed various layers during the desert-like climate in Hungary. These layers deposited during the Pliocene. With the Hunveyor-Husar space probe model we visited two of them: 1) Galgahéviz, 2) Vértesacsza. We observed the planar, or low-angle cross-stratified sedimentary bedrock layers of sand and loess formed by the wind and river flows. We compared these Hungarian Pliocene sedimentation sequences with layers and events of Burns Formation of Mars.

Discovering and determining sedimentary layers on Mars by Opportunity's observations on the Meridiani site opened new perspectives in the local geological field work on Mars. Mapping the Burns Formation [1] in the Endurance crater gave the first local sedimentation sequence on Mars. The planar- and low-angle cross-stratified sand layers were connected to wind-blown and water-moved sediment deposition events. Meridiani layers were formed in wet and dry periods [2]. Earlier the sharp edged rocks formed in dry windy periods were also observed by Spirit. [irodalom]. Both field geologic phenomena were signs of the recent and earlier desert-like and wet periods alternately changing in the Martian climate. Similar events determined the period in the Pliocene in Hungary. In our planetary analog site study program we visited such desert-like remnant sites in Hungary with the Hunveyor space probe model in order to compare strata and events between the two planetary environments.

### Geologic history: Filling in of the Pannon Lake.

The Carpathian Mountains and the basin surrounded by them were formed from the Cretaceous till the Miocene in the collision of the continental Europe with smaller continental fragments of Tisza, Pelso and Dacia microplates. Earlier the Tethys Sea occupied the regions between the northern and southern continents, but during the Paleogene the Pannonian Basin gradually separated from the Tethys Sea and first formed the Central Paratethys which then became isolated and formed the Lake Pannon. From Middle to Late Miocene Lake Pannon began to become fulfilled in by

lacustrine, river-delta and fluvial sediments and finally the Pannonian Basin got a sediment sequence with the following final stratification: marine-lacustrine-fluvial-marsh layers. Later, during Pliocene and Pleistocene the Pannonian Basin had got more alluvial filling by the rivers which transported silt and clay from the neighbour heights.

### Desert-like climatic period after the drying out of the Pannonian Basin during the Pliocene

The Mars-analog wet and drying out processes were active in the Carpathian Basin in the late Miocene and in the Pliocene [3]. In the Pliocene desert like dry climate was dominant [4,5]. Both periods had left markers which were visited in our program. During the withdrawal of the Pannon lake waterflow crossbedded sediments in rivers and planar-stratified and low-angle cross-stratified sand layers by the winds were formed [6]. Such places can be found in Hungary in the central hilly region, North-East and South-West from Budapest (along Rákos-creek Valley, Galga Valley, Zagyva Valley up to Salgótarján), in the Gödöllő Hills, in the northern part of Cserhát-Mountains (Ipoly-Valley) and of Mátra-Mountains (up to Pétervására), in Transdanubia, in Somogy County Hills (Marcali-Ridge) and in Vas County (Bérbaltavár) (Fig. 1.). The sediments form outcrops at cut hillsides and road cuts (Galgahéviz, Gödöllő, Isaszeg), sand-pits (Egyházásdengеле), outcrops in protected natural parks (Sóshartyán, Hencse-hill, Oligocene seaside sedimentary sequence park) and in erosional valleys (Vértesacsza, Csönget-Valley).



Fig. 1. Neogene sediments in Hungary. Three visited sites: Vértesacsza (left from the center, black triangle), Galgahéviz (right from the center, black triangle), Nógrád (open triangle).

We visited such cut walls of the Pliocene sediments with planar-, and low-angle stratified and cross-bedded

stratifications. Like as in Mars the paleo environment is also marked by the angular rocks formed by winds in a dry climate. Rocks similar to Adirondack are called sharp pebbles, or dreikanter. We also visited sites of the dreikanter in Hungary (Nógrád, Bakony-Mts.)

### Galgahévíz and Vértesacsza

From the alluvial plains of the Pliocene and Pleistocene, the earlier sediments were uplifted in the Quaternary and the layers deposited during the streaming water can be observed at outcrops at boundary of the Pannonian Basin (Fig. 1.)



Fig. 2. Hunveyor-4 at Galgahévíz (Pest County, Hungary) wall of Pliocene sediments.

Various facies of sand deposits (trough cross-bedded, cross-laminated, and parallel bedded) were observed both at the Galgahévíz site and at the Vértesacsza- Csönget-Valley site (Fig. 2 and Fig. 3.).



Fig. 3. Pliocene cross-bedded sand wall at Vértesacsza, Csönget-Valley (Fejér County, Hungary).

The observed facies units were corresponded to events and localities in the stream where the depositing sediments follow the main streamlines of the riverbed [10]. Trough cross-bedded sand facies were corresponding to dunes building with feathery ridge in the deeper region of the streambed. In the thin streaming region the sediments formed planar cross-laminated sand layers at the linear ridged dunes. At the stream-side region fine pattern of ripple sediments. The best analog to Martian Burns Formation is the trough cross-bedded sand facies, which formed on places where large space of streaming sediments resulted in dynamic rearrangement of the feathering dune system [7,8].

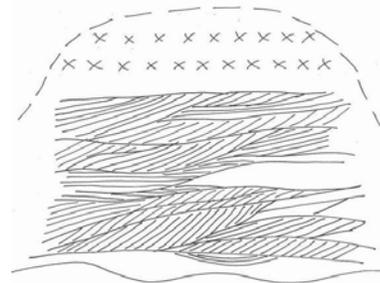


Fig. 3. Observed cross-bedded sand strata at Vértesacsza, Csönget-Valley.

### Summary

With Hunveyor models we visited and studied Mars sedimentary analog sites in Hungary: at Galgahévíz and at Vértesacsza. We observed the facies of the sedimentary bedrock layers formed by the wind and river flows. Analog events were the cross-bedding, cross-laminated facies of the sediments in a deep and thinner streambed region of the flow. However, the greater period in the Pannonian Basin belonged to the wet sedimentation and shorter arid climatic period developed, while in Mars the dry period was dominating over the short wet periods.

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