Hungarian contribution to the Mars expedition: remote analysis using Earth analogues

Does life other than ourselves exist somewhere in the universe, and if so, how could we trace it? What conditions are necessary for the development of living organisms – whether similar to or different from the ones on Earth? Can we find extra-terrestrial wet environments being favourable for the development of life? These questions are exciting for scientists and laymen alike. This is why we “interrogate” planet Mars during an international expedition in which Hungarian researchers also take part.

The European Space Agency (ESA), in which Hungary has full-fledged membership since last year, is to launch the ExoMars space probe which will drop a rover on the Martian surface with an on-board mini laboratory. This will be the first device on Mars able to drill down to a depth of up to two meters and analyse the collected samples through six months searching for past or present traces of liquid water. This will be the first time ever we will get truly in-depth measurement data about the red planet’s surface, so even the tiniest bit of new information can come as an amazing revelation. The project involves the large-scale joint program of the European Cooperation in Science and Technology (COST), including the Hungarian research group operating in the Research Centre for Astronomy and Earth Sciences of the Hungarian Academy of Sciences (HAS) whose task will be to support the design of sampling and the interpretation of sample data. Their project designed to analyse the surface evolution of Mars was funded by the NRDI Office in the framework of the Researchers’ Thematic Applications Programme.

In a nutshell, research by analogues compares similar processes to find differences. This method can reveal how the outcome is influenced by certain changes in the parameters of the given process. For instance, the consequences of different gravities or different wind speeds on two different celestial bodies, in our specific case. In this comparative analysis the Earth analogue is an experiment performed under a set of parameters that can be altered step by step during the research process, helping understand similar processes far away.

We know that our planet's profile is shaped by geological processes governed by physical and chemical laws, and these processes are, in all likelihood, universal. If winds build sand dunes here on Earth, the ones on Mars may be formed similarly but under different circumstances: wind dynamics, atmosphere density, composition and temperature, surface material etc. are different there. However, these conditions can be easily modelled in a laboratory. Some of the parameters (e.g. the gas composition, density and temperature of the atmosphere) can be set in special chambers, while mineral transformations under the special Martian temperature, dryness and atmospheric conditions can be simulated in other chambers. Gravity is the only parameter that cannot be changed at will, but a smart researcher will design a set of experiments where this factor is negligible.

Other researchers have already modelled in laboratory tests how wind carries sediments on Mars through saltation (i.e. by temporary lifting) at a speed that may be only tenth as fast as the speed of the particles when they start to move. The Hungarian team plans to conduct similar tests examining the properties of sedimentary environments on Earth with methods similar to those used by the ExoMars rover. Domestic analogies are practical in analysing the surface of Mars as it is easy here to distinguish and examine sedimentary rocks transported by wind or water. If we find out how to distinguish wind-carried sand from water-carried sand, this knowledge will probably be applicable under Martian conditions as well. The characteristic differences between the two types of particle transport can be examined directly on Earth, and it is assumed that any change in the transport medium will result in a similar difference on Mars. The Hungarian team does not seek to find completely Mars-like sites on Earth; they try to find partial analogies to gain a better understanding of the past and present surface processes on the other planet, in preparation for the complex further analysis of future data arriving from the Mars mission.

“We want to demonstrate that planetary analogue research does not necessarily mean we have to go to deserts or the Arctic to simulate the extreme Martian conditions,” says Gábor Újvári and Ákos Kereszturi, the two researchers leading the Hungarian project. “With suitable equipment and methods we can find analogue sites for tests even in Hungary. The Hungarian researcher community is capable of contributing to space science with knowledge and methodological insights which can be useful for analysing and interpreting samples coming from Mars or other celestial bodies.”

In Hungary such sites are selected for testing where – thanks to domestic earth scientists – we have reliable knowledge about the accumulation conditions and environment of sediments. For example, we know whether a particular sampling site was shaped by wind or water, and the characteristics of the deposited particles can be examined in the laboratory. The results can be used to estimate the origin of sand on Mars without knowing its geological setting, merely on the basis of the photos about the particles sent by the probe. If the rover will carry out actual measurements on similar samples on Mars, we will be able to provide analogies for the interpretation of the sampling data. This will enable the incorporation of the measurement and analysis data from Mars into an overall picture, and the result of the comparison of remote data and domestic results can be extrapolated even to the circumstances under which the Martian sediments had been formed.

Scale is another advantage of research by analogue sites. The team performs drilling on the selected Hungarian sites, and then analyses the collected samples copying the method of the ExoMars rover. They even scan the wall of the drilling hole to enable future comparisons. However, while the tools of the rover must not exceed a few kilogrammes, on Earth we have enormous high-performance equipment and laboratories the size of a room at our disposal. While on Mars the rover can drill only narrow holes and analyse the samples collected from them, here on Earth scientists can examine similar sedimentary rocks in large and directly accessible soil sections using more precise equipment, thoroughly analysing the samples with Raman and IR spectroscopy and optical microscopy methods. The set of information collected from two types of sources using two types of methods will be connected, enabling more precise estimation of the characteristics of the geological environment based on the small amount of data received from Mars. The project will not only allow for more accurate interpretation of the Martian data on the basis of the analogies on

Earth, but experience gained this way will also help determine where to perform further drills on Mars.

The scientific work in the HAS Research Centre for Astronomy and Earth Sciences is a good example of how Hungarian researchers can connect to large scale space projects on the basis of their accumulated geological knowledge. Due to the cooperation, Hungary has access to advanced international technology which has the potential to give new momentum to innovation in general and also in the case of specific research projects.

The project is related to the COST TD 1308 international collaborative research program.

Partner institutions:

- HAS Research Centre for Astronomy and Earth Sciences, Konkoly Observatory
- HAS Research Centre for Astronomy and Earth Sciences, Research
- Instituto Nazionale de Astrofisica (INAF), Naples
- Centre national de la recherche scientifique (CNRS), Orléans
- Centro de Astrobiología (CAB), Madrid
- Deutsches Zentrum für Luft- und Raumfahrt (DLR), Berlin
- European Space Research and Technology Centre (ESTEC), Amsterdam

The researchers' previous relevant funded projects:

- 2012–2015: Analysing the signs of wet environments on Mars using Earth analogues – PD 116927 (HUF 15.360 million)
- 2013-2016: Understanding loess particle mobilization, transport and deposition by wind and loess grain size distributions: implications for Quaternary paleoclimate reconstructions – PD 108639 (HUF 10.745 million)

Funded project: NN 116927
Analyses of Martian sedimentary rocks using Earth analogues and connection to European space project
Duration: January 2016 – December 2018
Project leaders:

- **Gábor Újvári, research fellow at the Institute for Geological and Geochemical Research, Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences.**
- **Ákos Kereszturi, head of the Astrophysical and Geochemical Laboratory, Research Centre for Astronomy and Earth Science, Hungarian Academy of Sciences**

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