EPSC Abstracts,
Vol. 4, EPSC2009-309, 2009
European Planetary Science Congress,

Integration of Mars research into the education: synthesis at university level

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Abstract

Methods and examples are summarized on Mars specific educational aspects, related to the courses *Climatic planetomorphology* and the *Geology of Mars*. The experiences show that several topics could be easily integrated among the other natural science courses, while there are problematic fields too with well known topics, widely analyzed by the scientific community. This situation requires the use of new methods in the education.

Introduction

Because of the great sum of available data, and various similarities to surface features on Earth, the best topics to integrate planetary science into education are related to Mars, where various fields are close to Earth sciences [1].

In the last years several methods were tested in the education of planetary science at the Eötvös University in Budapest [2,3,4], mostly by KAVÜCS Group, and also by cooperating institutes and projects [5,6]. The author kept two courses dedicated to the present knowledge on Mars: *Climatic planetomorphology* [7] and *Geology of Mars* [8], dealing mostly with climate and volatile related aspects, and internal processes plus mineralogy respectively. Digital booklets by the author [9,10] and his colleagues [11,12], as well as planetary maps [13] were also published in order to help the students.

Methods

During the two above mentioned courses various equipments were used: online DTMs from MEX [14] with HRSC data explorer [15], Google Maps and MARTIAN software [16], Google Mars with 3D sharad radargrams [17], the Hungarian virtual Mars globe [18] etc. We also encouraged students to realize scientific research, keep short lectures and presentations, and the group as a whole to produce a poster. To analyze the affectivity of the methods, various tests were written by the students.

Discussion

Some examples for the methods are listed below:

1. Value estimation: To review the students' general knowledge on the surface conditions on Mars, they had to estimate various parameters. The characteristic errors in the estimation pointed to the missing or problematic issues in the education. A simple with the estimated and real values for temperatures is visible below in Fig. 1.

Location / period	Average estimated value (°C)	Real value (°C)
Global average	-17	-63
Equator, summer noon	20	7
Equator, summer midnight	-30	-70
CO_2 polar cap, winter, midnight	-95	-120
CO_2 polar cap, summer, noon	-30	-120
H_2O polar cap summer noon	-35	-70

Fig. 1. Characteristic average temperature values estimated by students and measured by probes

2. Digital Terrain Models: During the course MEX data based digital terrain models were used to analyze surface features, and their connections with the terrain, drainage pattern [*19*], etc. (Fig. 2.)

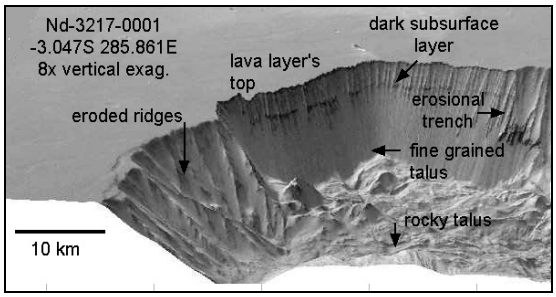

Fig. 2. Example MEX HRSC DTM for analysis of morphology at the wall of Valles Marineris [*20*]

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3. Student research work aimed at the deeper understanding of small fields was found useful to understand the processing of datasets of certain detectors, like TES in temperature, albedo, and spectral analysis for Dokka crater [21], as well as CRISM to identify surface minerals and composition-morphology correlation of sediments in Terby crater [22].

4. Remote Mars analogue work: During the Hungaromars2008 expedition a crew of eight persons worked for two weeks at the Mars Desert Research Station [6]. Students contributed remotely in the work, like to run the meteorology station [23], or to collect data from Husar 2D autonomous rover [24]. Such works are useful not only in the planning of future missions [25] but also in the interpretation of Mars surface observations.

5. *Poster making* aimed to summarize the knowledge learned during the course, and put it into context. The poster production was found to be an effective method and also made the group to work together [26], synthesizing the available knowledge (Fig. 3.).

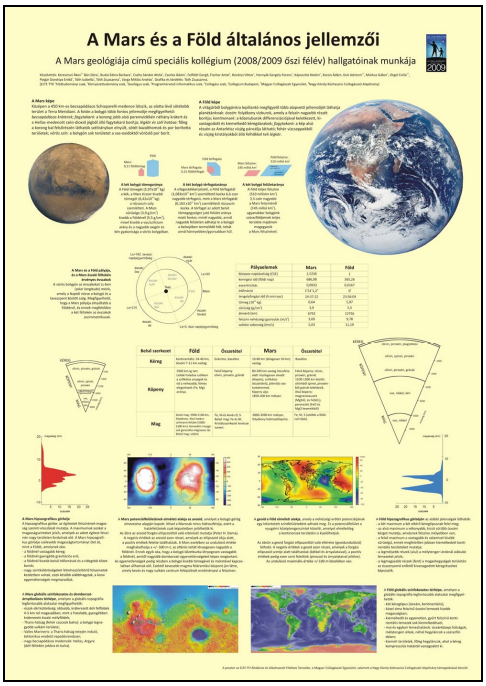

Fig. 3. Poster compiled by the students on the comparison of Mars (left) and Earth (right)

Conclusion

The same methods as used in Earth sciences are successful in the education of planetary science related to Mars, above all in geomorphology, structural geology, meteorology and astronomy. Unfortunately there are problematic issues also, especially related to mineralogy, petrography, physics, chemistry, above all in their application to environments substantially different from those are present on Earth. Another problem is that only few public applications are available to use spacecraft datasets (like JMARS [27]) on the web. We are searching for partners above all in Mars related topics to extend the fields where Mars research could be integrated into higher education.

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