WHITE BOOK ON THE RED PLANET – EDUCATION TOOL IN HUNGARY. F. Horvai[1,2] [1]Nagy Karoly Astronomical Foundation, H-1011 Budapest, Székely u. 2-4., [2]Hungarian Space Office (Email: horvai@nkalap.hu).

Introduction: The aim of this abstract is twofold: 1. to give a short overview on a specific approach to present great sum of information on planet Mars, 2. to provide examples on an undergraduate educational material that could be used in planetary science to present interdisciplinary connections at university level. This material is supported by previous works [1,2] in Hungary, including educational material development [3], visualization in planetary science [4,5], partly with new tools [6,7,8] and at new courses [9].]

Discussion: Mars related educational materials were first published only as online ppt slide series that were "tested" for 3 semesters at two universities with more than 50 studetns. Based on the experiences, a printed textbook version was compiled mainly for undergraduates. Its basic characteristics are listed below.

*Presentation of scientific content***:** The structure of this text book somewhat differs from the "regular" books published in recent years on Mars. The sequence of chapters start from the interior (structure, tectonism, volcanism), than gives an overview of the atmosphere, climate and H_2O reservoirs from a physical point of view (energy budget, material circulations, cycles, etc.). Based on this background the surface characterization is presented in climatic context (see below). In this approach first the effects (insolation, temperature, wind, humidity etc.) are discussed, then the produced surface structures are presented. Some interesting issues of the presentation are summarized below.

Size/mass/volume comparison is often used as a basic tool, but it is rarely visualized for the whole planet. Below simple examples can be seen, indicating the two planets with different colors (Figure 1.).

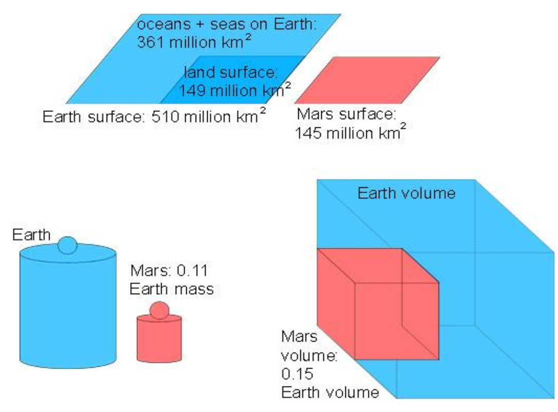

Figure 1. Surface area (top), mass (bottom left) and volume (bottom right) comparison of Earth (blue) and Mars (red)

Causal relationship, logical context: Important characteristic of this textbook is it presents various knowledge on Mars in a context where different "elements" or modules are crosslinked to each other, showing the causal relationship between them. The focus is on the relationship between climate and surface evolution, including the formation and realization of morphological and chemical changes. An example on such connections between climatic factors, including insolation, temperature, humidity and winds, plus the ice related surface changes are visible in Figure 2.

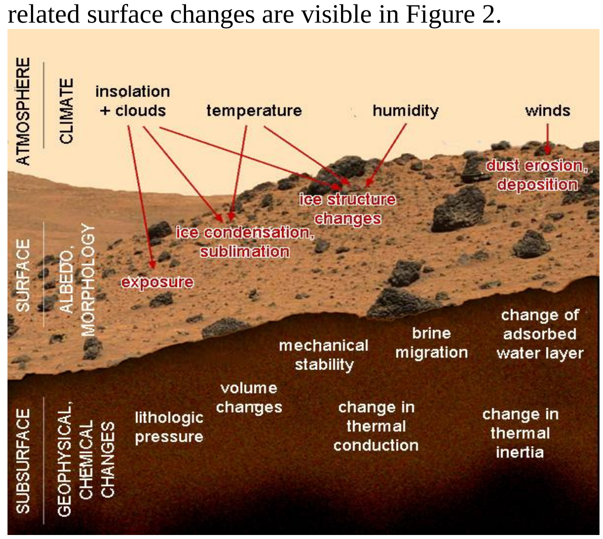

Figure 2. Example for the visualization how different effects change the surface and shallow subsurface while interact with each other

Climatic zonal approach: The longest chapter is to present surface features grouped into morphological categories. Although the majority of the surface of Mars could be interpreted as a periglacial/glacial terrain at certain times during its evolution, several features show nice zonal occurrence (Figure 3.).

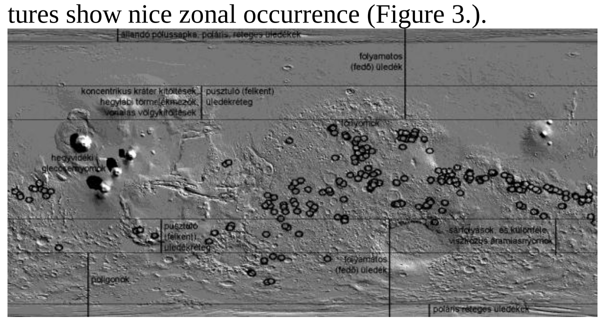

Figure 3. Surface structure types with zonal context

Sediments, history and astrobiology: After the discussion of the climatid and zonal surface context, three chapters integrate the already presented knowledge to synthesize them. The first of them is the sedimentary chapter that contains both the chemical description and main components, morphology plus mineralogy of important sedimentary types (Table 1.).

The second chapter of this last part gives an overview of the geological history, providing context for the activity of surface structures and processes presented earlier in the textbook. The last chapter is about astrobiology, to summarize the possibility of the appearance of life (building on water, UV radiation and organic metrial related sections), the possible presence of life today and the best locations where one should search for biomarkers (Figure 4.).

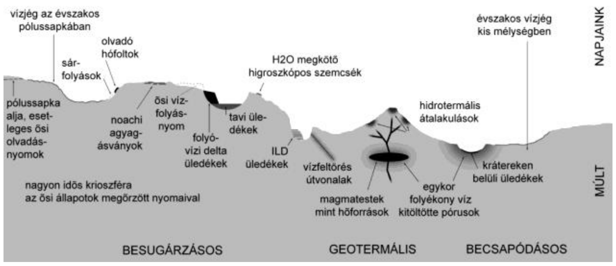

Figure 4. Overview of locations important for astrobiology on Mars on a hypotheric south (left) – north (right) cross sectional profile of Mars, focusing on the possible presence of liquid water or brines, connected to the insolation (left), geothermal (center), and impact (right) related formation of liquid water.

Conslusion: Due to the structure and organization of topics, this text book provided a useful tool for the students in 1. to see the planet together with the interacting agents on it, 2. to present these connections and interactions as they provide opportunities where unanswered questions can be analyzed. It also provides many links for future research with large number of recent publications. The next aim at the the two Hungarian universities where this textbook was used, is to develop how Mars related topics and modules could be integrated into other disciplines (physics, chemistry, mineralogy etc.) at undergraduate level.

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References: [1] Kereszturi A., Hyder D. 2012. Journal of Geography in Higher Education 36, 499-525., [2] Horvai F. 2012. 43rd LPSC #1733., [3] Kereszturi A. 2011. Asztrobiológia, MCSE, Budapest, [4] Kereszturi A. 2010. chapter in Astrobiology: Physical Origin, Biological Evolution and Spatial Distribution, ed. Hegedűs S. and Csonka J., Nova Publishers, 131-141., [5] Kereszturi A. 2004. 35th LPSC #1070., [6] Mizser, A., Kereszturi A. 2003. 34th LPSC #1114., [7] Hargitai H. 2012. Interpret. of Surf. Feat. of Mars. Ed: Zentai & Nunez, Maps for the Future, Lecture Notes in Geoinf. & Cartogr 5., Springer, [8] Hargitai H. & Shingareva K.B. 2011. Lecture Notes in Geoinformation and Cartography 6, 275-288., [9] Kereszturi A., Pentek K. 2012. 43rd LPSC #1778.

Table 1. "Unofficial" sedimentary unit groups on Mars

name	formation	occurrence, characteristics	age
deltaic sediments	river transported into standing body of water	only at few channels	mainly 4.0–3.2 billion years
mantling sediment	by atmospheric fallout and condenstation, dust + water ice formation together	meter thick, covers all surface structures at middle and high latitude	0.1–10 million years
lacustrine sediments	deposition from standing bodies of water	no obvious spatial occurrence, younger are more often at lower latitudes	mostly >3.6 million years, but 0,7 billion year also
polar layered deposits	atmospheric fallout + ice condensation	above 70° latitude	0.1–100 million years
polar caps	condenation and/or snowing of ice from the atmosphere	mainly water ice, layered structure	0.1–1 million years
interior layered deposits	lacustrine or atmospheric fallout or volcanic origin material	mainly int he trenches of Valles Marineris and few other low latitude depressions	4.0–2.5 million years
Vastitas Borealis formation	glacial of lacustrine deposits ont he top of basaltic lavas	most of the northern lowlands, at the termination zone of outflow channels, with glacial and periglacial structures	3.0–2.0 billion years, top layers are only 0,1 million years old
duricrust	atmospheric H2O condensation plus sulphate and ferric oxide formation	top layer of regolith, possibly at any part of the surface except loose dust and polar ice covereds regions	0.1–10 million years
Medusa Fossae formation	poorly known origin, possibly porous volcanic sediments or fine glacial debris, probably not lake relatedsediment	equatorial region at the high-land/lowland boundary, 100–1000 m thick, fragmented, erodible, follows the topography	younger than 2.0 million years
sediment at the floor of Hellas masin	poorly known origin, probably water transported with glacial and periglacial processes	variable morphology, somewhere resemble to PLD, based on thermal inertia composed of dust particle side debris	3.8–3.5 billion years