PLANETARY SCIENCE AS A TOOL TO INTEGRATE INSTRUMENTAL, LABORATORY AND MODELLING ASPECTS UNDER RESEARCH ACTIVITY IN HUNGARY. F. Horvai (Károly Nagy Astronomical Foundation, Hungary, e-mail: horvai@hso.hu).

Introduction: This work is to overview several different, mostly instrument and technology related aspects of planetary science activities, partly realized in Hungary, which support science-technology synergy. General research activities, computer based modelling, laboratory and field works are discussed below briefly, (where field activities cover also any observations) to provide examples in a structured way on how these topics support cross-domain activities connected to the research on the solid materials of Solar System bodies.

Methods: Topics of already published works of solid bodies are listed below, which emerged in the last decade in a moderately small national research community, in Hungary. Although more topics might also have been evaluated here, and further approaches to evaluate and group them could be also relevant, the presented overview is still useful to demonstrate which technology related aspects emerge during the activities. The Discussion section provides a possible way of classification technology related aspects to identify and demonstrate their importance in research works

Results: A brief overview of selected topics are presented below, which all have technological and methodological relevance in planetary science.

Computer based interpretation by modelling helps to explain different dynamic processes, like temporal and spatial occurrence of water ice and possibility of liquid water on Mars [1], as well as non-solid but plasma related electromagnetic processes of whistler propagation have been done [2, 3]. Numerical calculations based *thermodynamical modelling* could support the understanding of cyclic processes on planets with climatic variability [4], occurrence of expected chemical reactions [5], mineral alterations [6] and mechanical consequences [7] on various planetary surfaces.

Wide range of computer based *GIS topics* are covered in planetary science, including improved crater based age estimation [8] and statistical analaysis of surface features [9, 10] to understand their origin [Hargitai H. & Kereszturi A. (2015) *Encyclopaedia of Planetary Landforms*, Springer]. Planetary mapping exploits the joint evaluation of different types of datasets [11] and global shape analysis [12]. Numerical analysis of surface feature evaluation have been improved recently [13], supported by the possibility to overlay different datasets with wide surface coverage at high spatial resolution [14].

Laboratory analysis of meteorite samples is a specific topic where instrument based analysis improves the understanding of shock effects [15, 16], improving the correlation between different observational techniques [17], and topics where laboratory data could be linked to remote sensing based analysis [18]. These laboratory technologies might have corresponding insitu instruments on missions, providing knowledge on the interior evolution of planetesimals [19, 20, 21, 22] including melting [23] and alteration processes [24, 25,26], which could be linked to Solar System scale events, especially to NEOs and their future analysis [27].

Analogue research links the instrument related field site activities to the improvement of planetary science, including for example the analysis of subsurface ice occurrence [28] to better understand Mars, and also plan traversing there effectively [29]. The research on samples collected at field sites and analysed in laboratory helps to improve missions' instruments capabilities on a target oriented way [30, 31].

A specific and rich topic of laboratory and field sites related activities support *asztrobiology research*, with strong relevance in planetary science [32], focusing on the estimation and evaluation of past wet conditions [33, 34], on exploration strategies for different objects [35], including extrasolar bodies [36, 37]. Laboratory activities support the better understanding of survival under harsh conditions [38, 39, 40], searching for ideal locations in the Martian environment [41]. Simulated carbonaceous dust production also has astrobiology relevance as a precursor for organic matter formation [42].

Evaluation of landing sites mostly for Mars requires a synergy between engineering and scientific needs [43], with specific focus on subsurface access [44, 45]. Traversing possibilities [46] and liquid water formation locations [47] are also relevant to consider.

Planetary mission instrument design and development are supported by the unique conditions that are present at various planetary surfaces and interiors. Here for example laboratory improvement in infrared spectroscopy of asteroid and meteorite surfaces [48, 49] or support the planning of further asteroid analysis [50] are among the important aspects. The connection of modelling results with instrumental capabilities helps the understanding where to focus during specific observations, for example during the search for signatures of liquid water on Mars [51] and how to reconstruct paleo-environment conditions there [52], or evaluate impact consequences on solid surfaces [53] for landing site selection too [54].

Discussion: Reviewing the above example activities (mostly have been done in Hungary) demonstrates how many different technology and industrial aspects could be involved in and linked to planetary science research. The published activities as references listed in this work can be roughly situated in a triangle diagram (Figure 1) according to the contribution of three activity groups of technology: laboratory work, computer based modelling and field instrument usage.

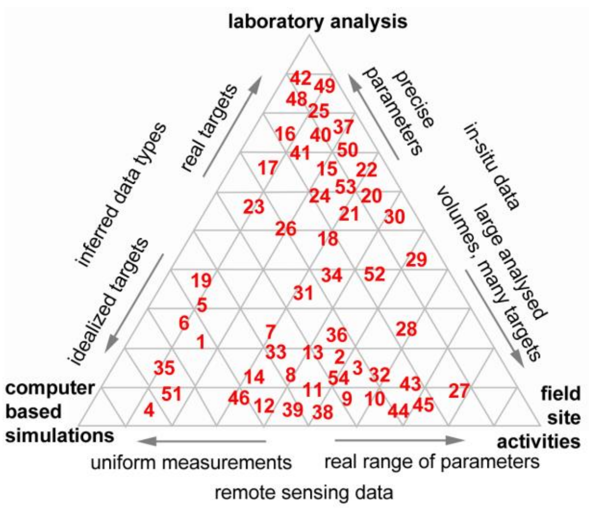

Figure 1. Arrangement of the research topics cited in this work, with specific focus on their technological "components" regarding computer- laboratory- and field activity based aspects.

Conclusion: The indicated technology related aspects could be already foreseen during the planning of specific planetary science research projects to survey possible industrial contributions beforehand. These aspects fit well to the earlier national attempts on the implementation of planetary science to the education [55]. In Hungary researchers are beginning to use the above approach recently, to make contact with industry. There is a wide range of topics, where industrial aspects should be identified, confirming the importance of collaboration with corresponding companies.

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