RELEVANCE OF MAPPING METER-SCALE BACKGROUND TERRAINS ON MARS USING HIRISE IMAGES. M. A. Ettahri[1] and H. Hargitai[2], [1]ELTE Eötvös Loránd University, Doctoral School of Earth Science. Budapest Hungary.[2]ELTE Eötvös Loránd University, Budapest Hungary. Contact: *amine.ettahri@gmail.com*

Abstract: Mars is a key target for planetary exploration, therefore this study provides an opportunity to examine specific terrains on the Martian surface with a meter scale resolution. Surface background terrain arouse a great interest from geological point of view, therefore we define them as flat plains populated by bedrock outcrops and surface layers commonly undisturbed by mass wasting landforms and slopes. They are referred to as regolith surface, and result from complex interactions between climate and lithology. The nature of these surfaces tells us much about the history of the planet. From orbit we can attempt to map the distribution of these terrain types.

This project aims to produce a characterization system for a number of identified terrain types using the highest resolution data yet available on any another planet obtained from the High Resolution Imaging System Experiment (HiRISE) [1], the work process will create a database for the upcoming mapping phase in order to further investigate the properties and possible relationships between mapped background terrain elements and regional and/or global correlations of related disciplines such as climatology.

Introduction: Planetary scientists, especially Mars geomorphologists focus their studies on landform characterization and understand different processes shaping its surface from impact cratering, volcanism and aeolian processes, whereas, featureless terrains draw less interest despite their relevance in other fields. Both exposed bedrocks and regolith surface are considered scientific objectives of primary importance for geologists on Earth, since there is a complex relationship between the background terrain and the features laying on it. Studies on Mars are conducted on erosion patterns, polygonal patterned ground, in addition to thematic correlations between ground patterns and weather studies, (e. g in the case of dust devil patterns dust that may be related to new weather discoveries).

For that, in the context of planetary geology, every new influx of data can lead to drastic changes in the interpretation of an existing observational data base.

The use of remote sensing techniques and high resolution imaging as the advantageous technique to study such layers and HiRISE experiment is allowing a meter scale analysis of Martian terrain which is perfect for mapping terrain types and making local correlations.

Interest of this study: The importance of this work relies first on the novel approach of Grid mapping [2] proven to be effective for analyzing feature distribution on meter scales up to planetary scales. Therefore, in our study, this method is supported by the most detailed image dataset yet available for the red planet, which significantly increases the potential to find out unprecedented results and/or confirm some already existing hypothesis related to climate, geology or landing sites selection. Studying background layers highlights undisturbed soil and bedrock properties apart from the already known properties of specific features and slope processes. Secondly, this study may reveal a distinctive age difference between the old inter crater terrain or feature's age and the awaited study of undisturbed terrain, these latter may hold the longest records of air falls from pyroclastic deposits[3].

Furthermore rock abundances and rock types may reveal how fragmented the surface terrain is and whether it is a soil bedrock or regolith. Furthermore, Permafrost/periglacial features[4] include mounds and patterned ground that can reveal ice pores and cryoturbation depth.

It is best known to the planetary exploration community that flat and boulderless terrains are mostly appreciated for landing sites [5], this is an additional argument to favor this type of surface to be further evaluated for geologic interest. The features analyzed in this study are human-scale forms that potential future astronauts or rovers would be interacting with.

Finally, the outcome of this study is critical to find possible correlations between latitudes, terrain types, or other factors. A correlation of terrain type, material or geographic zone with meter scale features would enable creating a potential human-scale "view" of the expected "background" landscape on flat, topographically featureless terrain similar to acquired rover image based maps[6].

Materials and Methods: The base work of this study relies on the use of NASA's most detailed camera ever sent to another planet on board of the Mars Reconnaissance Orbiter. The High Resolution Imaging Science Experiment or 'HiRISE'[1] is producing 25cm/resolution scale images that can be derived to obtain 1meter/pixel Digital Terrain Model 'DTM'[7], the use of such detailed datasets allow an accurate characterization and topographic analysis of any target terrain type available. The typical target terrains are considered to be undisturbed, flat and topographically featureless surfaces, remotely situated from mountains, craters, lava channels and any type of disturbing "anomalies", as the objective is to characterize generic background surface.

Following a grid pattern of the Martian surface, the data acquisition phase relies on making observations on most generic terrain types and identify and characterize a set of classes as a database. Following the grid mapping method [2] our study can be used both in regional and global scales. After identifying types that have a recurring tendency or special behavior we can list them according to their importance and order of appearance.

In order to study the selected terrains, a two approaches method has to be adopted:

Classification: following a list of criteria and responding to relevant questions about landscape sharpness, rock sizes and abundance in addition to their organizational pattern. The organization of patterned ground in geometrical structure or randomly is relevant to geological events as well as the presence of Aeolian or remnant features. The abundance of desert pavements[8] and cracks refers to the paleo-environment of the region.

Quantification: After the identification of terrain classes present in the image, we would estimate their coverage percentage on the image according to their abundance (Absent/ Present/Abundant).

The availability of HiRISE DTMs will provide an estimation of the vertical roughness (from 3D HiRISE) value within the given area. We would also estimate the average dimensions of each Pattern unit type.

The study is currently in the data acquisition stage, we've suggested a list of topographically flat featureless terrain types that are relevant such as: Boulder fields[9], Boulder Halo[10], Desert pavement[8], Knobby terrains[11], Lag deposit[12], Non-sorted patterned ground [13], Sorted Patterned Ground[14], Polygonal Patterned Ground[15], [16] Softened terrain, and more.

Mapping phase: The creation of an extensive database of terrain types and their meter scale qualitative and quantitative properties is a major key to characterize potential future landing sites. As soon as the material is available on data sheets, the mapping process can take place on a Geographic Information System (GIS) software, the choice for ArcGIS is adopted for its features and tools adapted to planetary science and georeferencing features.

The numeric approach used for the mapping phase is referred to as Grid Mapping[2] using information distribution on cells over a geographic area. Results can visualized in two methods: either Graphically in map products or statistically in numbers and graphs Consider only grids where landforms clearly exists (present and dominant).

Grid maps allow us to investigate relations between the distribution of landforms and topographic parameters (e.g., elevation, slopes inclination, and latitude). The method can be easily applied to other parameters too, like thermal inertia, temperatures and dust cover. Progressive data input into cells allows to create a local or global grid cell that traces the latitudinal placement and abundance of various features in a spatial context, the results can be used to predict ground ice depth on Mars. Such product maps are a novel tool to quickly identify dominant processes (climate, lithology… etc) responsible for generating regolith and shaping the surface, while they can reveal valuable information regarding relative ages and evolution processes. The results may as well bring explanation to complex occurring phenomena's if paired an compared with existing data from other disciplines as climatology, sedimentology or astrobiology.

Expected Results: The outcome of this study is a global map of meter scale Martian featureless terrain types, generated from observations and measurements done on HiRISE images the closest to pre-defined grid points. Our data can be correlated with geological units [17], regolith H2O content[18], climatic maps (using TES data and climate models from The Mars Climate Database (MCD). [19] and many other datasets.

Depending on the sampling rate and mapping scale the results can be exploited and recreated in order to predict the potential human scale features on any combination of latitude and lithology on Mars.

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