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Polygonal patterns on Mars and Earth: Automated characterization as a basis for comparison

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Introduction

There are countless examples of geometric patterns on the surface of terrestrial planets, with diverse origins and dimensions. In some cases, and in planets where the presence of ice in the ground is established (such as the Earth and Mars), there exist polygonal networks that are related to the seasonal contraction and expansion of that ground ice. The study of these networks can provide important information about climate evolution on planets where water is present and plays an important role in shaping the landscape. Though their visual appearance is extremely varied, these networks can be accurately mapped and then characterized by the extraction of a number of quantitative parameters that allow for an objective comparison between them and the establishment of relations with the precise mechanisms responsible for their origin and evolution. Given the dimensions and complexity of the networks, this is a daunting task for a human operator; thus, it is a small surprise that most analysis of this type are done on a relatively small number of polygons, with limited statistical significance [1]. Still, the digital treatment of images of the networks is possible, thus automating the most tiresome steps of mapping and measuring the polygons.

Network mapping and characterization

We have developed such a methodology, and applied it to the study of polygonal networks on Mars. Our methodology is based on the watershed transform [2], a procedure that divides an image into separate basins that in this case correspond to the individual polygons in a network (Figure 1). This first phase, concerned with the mapping of a network, is followed by the application of an algorithm that allows for its topologic and geometric characterization [3].

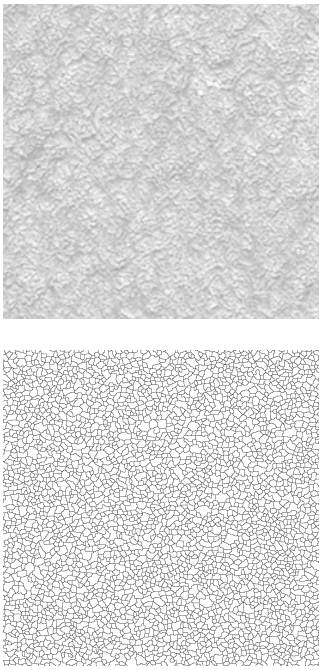

Figure 1: Example of automated mapping of small-scale polygonal network on Mars (part of HiRISE image PSP-008591-2485)

Though the methodology has already produced very good results, presented in other works [4,5], we aim at a full validation of the mapping phase, so far dependent on the expert analysis of images of the surface of the planet, acquired by orbital instruments – a situation that can easily leave a number of issues dependent on individual subjective judgment. Thus, we aim to conduct an in situ analysis of an example of terrestrial analogues, in the Svalbard islands. This has been the subject of a research project proposal, which awaits evaluation by the national funding entity. We plan to employ the established methodology for the analysis of satellite imagery, applying any

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adaptations that the terrestrial environment requires, and to complement it with a detailed study of the polygonal network on the ground which will involve precise mapping and measuring. This will also be helped by the use of a miniaturized aerial system that will acquire images at short range, allowing for a complete comparison between satellite imagery, high-resolution images and direct mapping. This effort for a full validation of the mapping phase will pay off with a higher degree of confidence on the results obtained when collecting topologic and geometric parameters for the characterization of the polygonal networks. Furthermore, its application to terrestrial analogues can be envisaged with no qualms. This will in turn allow for an objective comparison between polygonal networks on Earth and Mars, and for the extraction of conclusions on the conditions that lead to the formation of this kind of feature on both planets. Of particular interest would be the characterization of the conditions that permit the origin of similar types of networks on the two planets, while there are clear and evident differences between examples of networks that occur on the same planet.

References

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