Identifying Biomarkers and Habitability Indicators on Polygonal Structures using Laser Mass Spectrometry

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The search for signatures of extra-terrestrial life, past or present, has been a fundamental driving force for space science. Recently, the search has been promoted by measurements of the Martian surface from several space missions, having led to an increase in the understanding of Mars and its environmental history. Yet, the question of the ideal exploration site for the search of life remains unanswered. The current missions focus on formerly subaqueous environments, such as deltaic structure and water bodies [1]. These exploration sites are capable of burying organic matter, due to the typical rapid sedimentation; however, the biosignature preservation in those high-energy settings is often compromised by oxidizing fluids and gases [2]. In contrast, quiescent settings, such as lakes, are more suited to preserve biomarkers. As many of these ancient water bodies were saline, they formed salt deposits when they dried out and the dissolved salt precipitated. During precipitation, biomarkers can be buried and thereby shielded from the harsh environment, such as the radiation. On the surface of Mars, significant amounts of salt deposits have been identified, displaying prominent surface features such as a polygonal structure, visible from orbit (e.g. HiRISE imaging). The same polygon structures are also found in salt depositions on Earth, like in Atacama desert or in the Boulby Mine, UK, both Mars analogue sites. This contribution presents results of a recently performed study on those polygonal structures found in the halite of the Boulby Mine [3]. The measurements were conducted using a space-prototype laser ablation ionisation mass spectrometer (LIMS) designed at the University of Bern for *in situ* space research [4]. The LIMS instrument consists of a miniature reflectron-type time-of-flight mass analyser (160 mm x Ø 60 mm) and a femtosecond pulsed laser system (wavelength λ = 258 nm, laser pulse width of τ ~190 fs, pulse repetition rate of 1 kHz) for the ablation and ionisation of solid material [5]. The polygons contain two optically distinct features: the light interior and the dark edges, for both of which, the chemical composition was determined and compared. A special emphasis was put on the comparison of CHNOPS element abundances, as they serve as biomarkers. The recorded data show that the edges of polygonal structured salt deposits are preferential sites for element accumulation, with a significant increase in CHNOPS elements and other minor and trace elements necessary for the formation and maintenance of life. Therefore, such polygonal structures are promising sites for the detection of signatures of life for future *in situ* space exploration missions. The measurement procedure and results will be discussed in regard to possible future missions for the search of life on Mars.

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