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Detection of single cell microbial life artificially inoculated in mudstone analogue material using a miniature LIMS system

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In situ detection and identification of signatures of life on Mars, past or present, is one of the most challenging and important tasks in current space science and astrobiology. However, the detection is extremely challenging and depends on numerous parameters, starting from the selection of field site for material sampling to the application of appropriate instrumentation for analysis. From previous and ongoing space exploration missions on Mars we know that for a positive localisation and identification of potentially available signatures of life a combined and complementary instrumentation effort is required. In this contribution, we discuss the latest results towards detection and identification of the biogenic chemical fingerprint of single cell microbial life, artificially inoculated in Mars analogue mudstone material using our miniature high-sensitivity Laser Ablation Ionisation Mass Spectrometer (LIMS).

The LIMS system employed in this study consists of a miniature reflectron-type time-of-flight mass analyser (160 mm x Ø 60 mm) that is coupled to a femtosecond laser system (λ = 775 nm, τ ~190 fs) used to induce the ablation and ionisation of sample material [1]. For the localisation of microbial life structures, the mudstone material was spot-wise chemically analysed in depth and monitoring biogenic elements, such as carbon, phosphorus, sulphur [2, 3].

The host matrix was artificially produced using commercially available minerals that resemble the chemical composition of Martian mudstone [4]. A total of 14 mudstone samples were chemically investigated of which only one half contained a low number density of artificially inoculated microbes. The individual samples were treated differently, from anaerobic to aerobic, wet to dry, irradiated to un-irradiated using a gamma-ray source. The measurements described in this contribution show that the different sample treatments did not result in the detection of significant elemental differences between samples. However, the monitoring of major and minor biogenic elements, such as e.g., carbon, sulphur allows for localisation of the biogenic element fingerprint of single cell microbes. The presented studies are of high interest for future high-resolution instrumentation concepts for in situ detection of signs of life.

References

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