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In-situ analysis of 1.9 Ga chert with a miniature mass spectrometer for space: Chemical profiling of microfossils preserved in the host mineral

Rustam Lukmanov (1), Marek Tulej (1), Reto Wiesendanger (1), Andreas Riedo (2) and Peter Wurz (1).
(1) Institute of Physics, University of Bern, Switzerland, (2) Sackler Laboratory for Astrophysics Leiden Observatory, University of Leiden, Leiden, Netherlands; (Rustam.lukmanov@space.unibe.ch)

Abstract

In-situ chemical analysis on the surfaces of planetary bodies is a challenging endeavor that requires set of specific parameters to comply with for onboard instrumentation. This applies to the quality of information gathered from a wide range of samples, to the size and power consumption of the instrument and to the ability to operate within harsh conditions. Particular interest in this field lies within astrobiological context. Recent studies have shown, that the ability of cherts to preserve and encapsulate organic material from extensive heating and rapid degradation makes them an attractive target to look for remnants of organic material, similar to possibly preserved organic matter within Martian sedimentary successions [1]. In this contribution, we would show the first data to demonstrate that miniaturized spaceborne Laser Ablation Ionization Mass Spectrometer (LMS) combined with the vacuum-compatible microscope is a system capable of delivering highly sensitive chemical information [2,3]. We collected data on spatial scales at the micrometer level, from Precambrian chert sample (Gunflint formation, 1.88 Ga) with a dense population of microfossils. Measurements are performed using ultrafast ion source (operating in the femtosecond range) with multiple wavelengths (IR-775 nm, UV-387nm, UV-258nm), with two different regimes (single pulse, double pulse) and recently developed HV-Pulser mode for heavy elements scan.

Introduction

In-situ mass-spectrometry on the surfaces of planetary bodies is a promising technique which is of considerable interest for landed missions. Sensitive elemental and isotopic studies with high lateral and depth resolution are considered to be the critical component for identification of single minerals, the host minerals of the fossils, and also for identification of putative microscopic fossils, which are usually preserved through permineralization [1], [4].

Chemical profiling of Gunflint chert with LMS.

We conducted high-resolution multichannel chemical depth profiling on the 1.9 Ga Gunflint chert sample from Schreiber beach, Ontario, Canada. To compare data, we examined different spots within the host area (Si-rich matrix) and dense microfossil assemblage zones using IR-775 nm, UV-387 nm, and UV-258 nm femtosecond laser for ion formation. Additionally, we tested the performance of the newly established double pulse UV-258 nm laser source. We will present high-resolution chemical depth profiles, elemental ratios from different zones and will discuss in detail the analysis of major to trace element abundances in the depth profiles. Altogether, chemical and optical material probing on a microscale provide us with an ability to target an area of interest and unambiguously differentiate between microfossils and inorganic host areas with the LMS suite.

References

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