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Chemical identification of microfossils from Gunflint chert (1.88 Ga) with spaceborne Mass Spectrometer.

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In-situ chemical analysis on the surfaces of planetary bodies is a challenging endeavor which is of the primary importance of understanding their origin and evolution. Particular interest in this field lies within astrobiological context. Presence of habitable conditions which have been shown by reconstructions of early Martian environment raises questions about the possible development of early life forms analogous to the Terrestrial, and about subsequent preservation of organic matter in the sub-surface areas [1]. However, many aspects of these questions remain unknown.

In this contribution, we would show the first data to demonstrate that miniaturized spaceborne Laser Ablation Ionization Mass Spectrometer (LIMS) 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, which is considered to be a Martian analog sample in our study.

Measurements were performed using ultrafast ion source (operating in the femtosecond range) with multiple wavelengths (IR-775 nm, UV-387nm, UV-258nm), on two different regimes (single pulse, double pulse) and recently developed HV-Pulser mode for heavy elements scan. We conducted high-resolution multichannel depth profiling on different spots within the host area (Si-rich matrix) and dense microfossil assemblage zones. Furthermore, we developed a protocol for high sampling rate measurements with a total capacity around 6,4 Gs/s. Regarding questions related to the chemical identification of microfossil, LIMS system is shown to be sensitive to highlight elemental abundances down to the ppm level. By accurate analysis of elemental dynamics in depth profile, we could infer the presence of carbonate microinclusions inside host area and determine the location of fossil body and differentiate between genera by looking into the elemental variance. Measurements conducted on both the host and microfossils area are discussed in detail and compared with each other.

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