Laser-induced breakdown spectroscopy of cyanobacteria in carbonate matrices under simulated Martian environment

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The finding on the Martian surface of hydrated salt minerals, like carbonates and sulphates, and their interpretation as deriving from the desiccation of old bodies of water, has provided an evidence of liquid water activity on the surface of Mars [1]. These evaporite environments and their saline deposits are now a chief goal for planetary missions devoted to the search for fossil Martian life. Such minerals have the possibility of trapping and preserving over geologic times a biological record made up of halophilic extremophiles [1]. The existence of species of cyanobacteria that inhabit rock substrates on Earth, capable of growing in environments considered extreme, makes them ideal organisms for studying biological responses in different environmental conditions [2]. One possible organism detection strategy consists in the study of the most relevant emission lines and molecular bands attributed to presence of life by laser-induced breakdown spectroscopy (LIBS). However, the detection of these species can be complex as LIBS is sensitive to environmental conditions, such as the atmosphere composition and pressure, and could contribute to this signal [3].
In the present study, several species of cyanobacteria with dissimilar extremophilic characteristics [4] (tolerance to desiccation and salinity) were examined by LIBS. The identification and discrimination of cyanobacteria on carbonate substrates was based on organic signal emissions (C, C_2, CN...) and the presence of other microelements (Fe, Si, Cu, K…). For this purpose, and to evaluate the influence of the surrounding atmosphere on the plasma composition and its contribution on LIBS signal, a set of samples including *Arthrospira platensis* (commercial), *Microcystys aeruginosa* (cultured) and *Chroococcidiopsis* sp. (natural samples) was analyzed under i) Mars-analogue atmosphere and ii) low air vacuum (7mbar).

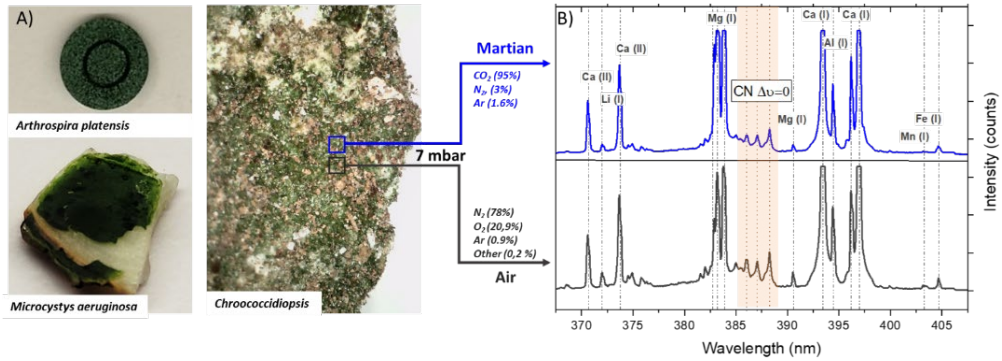

Figure A) Species of cyanobacteria characterized by LIBS B) LIBS spectra of the cyanobacteria *Chroococcidiopsis* sp. collected in Nerja Cave, acquired at reduced pressure (7mb) in both air and Martian atmospheres.

[1] R. Barbieri, N. Stivaletta, Continental evaporites and the search for evidence of life on Mars, *Geol. J*. (2011) 46:513-524. Doi:10.1002/gj.1326

[2] D. Billi, A. Wilmotte, C.P. McKay, Desert strains of Chroococcidiopsis: a platform to investigate genetic diversity in extreme environments and explore survival potential beyond Earth, EPSC Abstracts, (2010) 5:267.

[3] T. Delgado, L. García-Gómez, L. M. Cabalín, J. J. Laserna, Detectability and discrimination of biomarker organic precursors in a low-pressure CO_2 atmosphere by LIBS, *J. Anal. At. Spectrom.* (2020) 35:1947-1955. Doi:10.039/D0JA00167H.

[4] V. Malavasi, S. Soru, G. Cao, Extremophile Microalgae: the potential for biotechnological application. *J.Phycol*. (2020) 56: 559-573. Doi: 10.1111/jpy.12965