Simultaneous LIBS-Acoustic detection for mineral differentiation. Imaging and stand-off studies under Terrestrial and Martian atmospheric conditions

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Abstract

The combination of data simultaneously generated by laser-induced breakdown spectroscopy (LIBS) and laser-induced acoustics (LIAc) is a topic of many potential applications as both phenomena cover different sample traits. LIAc could add information concerning some physico-chemical parameters elusive to LIBS. Results indicated a strong dependence of the generated acoustic wave with physical properties such as the hardness of the material, and therefore the ablation rate, the density, and the thermal conductivity[1-3] Moreover, LIAc is undergoing a renaissance period increased using this analytical tandem in planetary exploration as the NASA M2020 mission Perseverance rover includes a microphone that has been used for the recording of laser sparks as it can be synchronized to the LIBS laser included in the SuperCam instrument[4.] This paper presents two complementary approaches to the use of LiAc in the study of mineral samples.

This work presents an exploratory description of the potential applications of the use of LIAc in combination with LIBS. First, a study of several parameters wich could influence the acoustic signal, such as size, density and relative position of the sample, is included. Moreover, LIAc is studied in the particular field of mineral analysis from various approaches. LIBS data and simultaneously acquired acoustic recordings were pre-processed to develop a mid-level data fusion strategy, based on a combination of LIBS - PCA and acoustic features to create a new sample descriptor allowing better dsicrimination of samples with extremely similar LIBS spectra. Furthermore, it is studied whether the frequency spectrum of the acoustic signal contains information about the sample mineral phases, complementing the results from acoustic energy intensity presented in the previous section. Both approaches were carried out under Earth and Mars-like atmospheric conditions. Furthermore, a novel application in this field, the use of LiAc for combined LIBS-Acoustics studies for imaging, will also be presented (Fig 1).

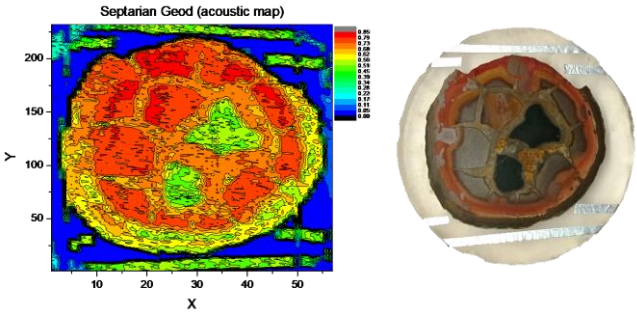

Figure 1. *Septarian Geode Acoustic map*

The presented approaches provide a new set of analytical tools based on LIBS and LiAc for the discrimination of mineral samples by simultaneously studying the optical emission of the laser-generated plasma and the acoustic signal in time and frequency domain.

Keywords

LIBS; Laser Induced Acoustic; Mineral discrimination; Mars

References

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