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Detection of indigenous organic matter in rocks from the interpretation of carbon molecular forms in the laser-induced plasma

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Oil shale, a sedimentary rock containing organic matter and a variety of inorganic minerals including carbonates and kerogens, serves as a significant source of organic material on Earth [1]. Kerogen, the most abundant form of organic matter, differs in chemical composition based on the microorganisms that contributed to its formation [2]. Laser-induced breakdown spectroscopy (LIBS) is a powerful analytical technique used on the Mars rover, allowing elemental characterization of Martian rocks, soils, and sediments.
This study presents the first-ever detection of natural organic matter in oil shale using LIBS under simulated Martian conditions. Through an analysis of emitting species including CN and C2, LIBS successfully identifies the presence of organic compounds in this sedimentary rock. The ability to detect and characterize natural organic matter in oil shale, known for its potential to suggest the existence of ancient life, holds significant relevance in astrobiology. Furthermore, this information contributes to the identification of biosignatures and aids in the development of planetary exploration strategies.
Oil shale samples were analyzed using LIBS under simulated Martian conditions after being crushed, pressed into pellets, and subjected to pyrolysis to remove organic matter. The analysis revealed significant changes in the infrared spectra, confirming the absence of aliphatic hydrocarbons after pyrolysis [3]. The LIBS results demonstrated the presence of molecular species associated with hydrocarbons, such as CN and C2, through distinct spectral emissions. The absence of these emissions in the pyrolyzed sample further supported the detection of organic matter originating from kerogen.
This novel study establishes the feasibility of detecting natural organic compounds in sedimentary rocks through LIBS analysis. The exploration of terrestrial analogues like oil shale provides essential insights into the search for biosignatures on Mars and informs the development of effective planetary exploration strategies.

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