SPACE LIFE SCIENCES SYMPOSIUM (A1)
Astrobiology and Exploration (5)

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TESTING RAMAN SPECTROSCOPY FOR THE TRACE ANALYSIS OF BIOMARKERS FOR MARS EXOBIOLOGICAL STUDIES

Abstract

Within the future payloads designed by ESA and NASA for several missions focussing on life detection on Mars, Raman spectroscopy has been proposed as an important non-destructive analytical tool for the in-situ identification of biomarkers on planetary and moon surfaces or near sub-surfaces. Raman spectroscopy is an ideal technique for the identification of biomolecules and minerals for astrobiological applications. Raman spectroscopic instrumentation has been shown to be potentially valuable for the in-situ detection of spectral biomarkers originating from rock samples containing remnants of terrestrial endolithic colonisation. A potential limitation for the use of Raman spectroscopic techniques is the detection of trace amounts of biomolecules in rock matrices.

Portable Raman systems equipped with 785 nm lasers permit the detection of pure organic minerals, aminoacids, carboxylic acids, as well as NH-containing compounds outdoors at –20C and at an altitude of 3300 m. The detection of beta-carotene and aminoacids has been achieved in the field using a portable Raman system in admixture with crystalline powders of sulphates and halite.

Laboratory systems (514.5 nm laser excitation) permit the detection of these biomolecules at even lower concentrations at sub-ppm level of the order of 0.1 to 1 mg kg-1. The comparative evaluation of laboratory versus field measurements permits the identification of critical issues for future field applications and directs attention to the improvements needed in the instrumentation. A comparison between systems using different laser excitation wavelengths shows excellent results especially for 785 nm laser excitation. The results of this study will inform the acquisition parameters necessary for the deployment of robotic miniaturised Raman spectrosocpic instrumentation intended for the detection of spectral signatures of extant or relict life on Mars. With respect to the “habitability potential” of evaporitic rocks found on Mars, we can assume that if beta-carotene could have been synthesized by potential Martian biota it could then have been subsequently preserved in subsurface evaporites in detectable amounts for Raman spectroscopic analysis equipped with a 785 or 514.5 nm laser excitation.