NEAR-IR REFLECTANCE SPECTROSCOPY OF BIOVERMICULATION PATTERNS IN A SULFURIC CAVE ENVIRONMENT.

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Introduction: The development of *in situ* instrumentation for the detection of biomarkers on planetary surfaces is critical for the search for evidence of present or past life in our solar system [1]. A wide range of techniques have been developed for, and employed in the characterization of, extraterrestrial surfaces in an effort to identify potential biomarkers. In this work we focus on one technology in particular – near infrared (NIR) reflectance spectroscopy – as a means of characterizing host rock environments as potential habitats for microbial life and searching for identifiable biosignatures in those habitats.

We developed the Portable Acousto-optic Spectrometer for Astrobiology (PASA), a NIR point spectrometer intended for rapid bulk mineralogical identification of samples using an acousto-optic tunable filter (AOTF) as the wavelength selecting element [2, 3]. We demonstrated the capabilities of this instrument in several field sites that could serve as terrestrial analogs for extreme environments elsewhere in the solar system. Here we summarize the field testing and performance of PASA as a tool for characterization of biovermiculation patterns resulting from microbial mat growth on cave walls. A reflectance spectroscopy approach complements methods such as culture-based surveys and molecular and isotopic methods [4] by providing bulk mineralogical properties of the host rock as well as the microbial mats. Previous geochemistry studies suggest that biovermiculations play a role in carbonate dissolution, which has implications for cave formation as well as for the detection of possible biosignatures in extraterrestrial environments [5].

Instrument Description: PASA employs a broadband infrared light source that is transmistted through the AOTF crystal. As a result of diffraction processes that take place within the crystal, a narrow wavelength band of light emerges. The narrowband light then is reflected off a sample mirror, hits the sample, is reflected back to a detector mirror, and is then directed to an HgCdTe detector. The reflectance of the sample is thus measured as a function of wavelength, yielding an infrared spectrum spanning 1.6–3.6 μm with a spectral resolution ($R = \lambda/\Delta\lambda$) of ~ 267-383. The instrument is lightweight, portable, and battery powered, allowing for operations in remote field sites.

Field Site Description: We used PASA for the study of biovermiculation patterns in Cueva de Villa Luz (CVL) in Tabasco, Mexico, on 19-20 December 2013. Our participation was one component of a larger, more comprehensive expedition to CVL whose objective was to study the bizarre microbial life forms that inhabit CVL using a range of instrumentation and planetary protection protocols developed for life detection missions in our solar system. CVL is a sulfur-rich cave undergoing active speleogenesis, with toxic levels of H_2S and CO. We obtained *in situ* PASA spectra of several prominent biovermiculation mats throughout the cave (Fig. 1).

Figure 1. Biovermiculation in Cueva de Villa Luz.

Results: We will present NIR reflectance spectra of the biovermiculation mats and will compare them to spectra of a) known reference materials, b) the host rock in CVL, and c) other studies of biovermiculations (e.g. [5]). This will elucidate the geochemical nature of the biopatterns and will provide insight into their efficacy as a biosignature for future extraterrestrial exploration efforts.

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