**BIOSIGNATURE DETECTION WITH RAMAN AND LIBS INSTRUMENTS: ENHANCING MISSION READINESS THROUGH *IN-SITU* ANALYSES ON ANDES ANALOGUES.**

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**Introduction:** Laser Raman Spectroscopy (LRS) and LIBS (laser-induced breakdown spectroscpy) are probably the most powerful tools available for *in-situ*, rapid, chemical and mineralogical characterizations in planetary applications. The science value of these techniques has been widely recognized within the planetary science community: a) two LRS instruments (SHERLOC and SuperCam) will fly on NASA's Mars 2020 mission; b) ESA's 2018 ExoMars rover features a laser Raman instrument (RLS); c) Curiosity's ChemCam instrument has returned over 500,000 LIBS spectra from Gale crater; d) SuperCam includes an enhanced version of ChemCam LIBS module.

In November 2016 our team carried out field work in Chile (see Cabrol et al. paper, this meeting). One goal of the 2016 field campaign was to integrate acquisition and processing hardware and software features for the real-time detection and characterization of organics, biomarkers, and associated geochemistry and mineralogy on Mars analog sites using techniques relevant to the ExoMars and Mars 2020 missions. For this purpose, we deployed LRS and LIBS instruments in different geo/bio/chemical environments.

**Field instruments**: The LRS instrument is a commercial EZRAMAN system featuring similar laser power and spectra sensitivity and resolution as the RLS instrument on ExoMars. LRS identifies individual molecular species and their chemical and structural nature. Our LIBS instrument (Fig 1) is an ultra-compact, handheld system we have developed, which provides rapid, fine-scale chemistry, water abundance, and mineral classification. The performance of this instrument can be adjusted to match that of ChemCam and SuperCam Mars LIBS systems.

**Figure 1**. Our LIBS instrument is a handheld unit that can perform identification/quantification of virtually all elements and some molecular species (CN, CH, CC). Relevant applications: elemental ID, mineralogy, scouting, and exploration.

**Performance assessment:** We were able to detect organic biosignatures: LRS and LIBS detected the presence of organic materials in all the sites we visited through the spectral signatures of: vibrations in CH, CN, CO, OH molecules (LRS); C and H atomic emissions and CC and CH molecular emissions (LIBS); b-carotene and chlorophyll in multiple samples through unique spectral signatures of the molecular bonds in the organic compounds; other bio-related materials included degraded carbon (kerogen), scytonemin, alanine, and other yet-unidentified amino-acids. We also characterized mineralogy/chemistry: LRS unambiguously characterized a broad range of minerals, and LIBS generated relative abundance of select elements, thus constraining mineralogy from chemical data. At the meeting we will elaborate several case studies that demonstrate the **detection/identification capabilities** of both techniques in several analog sites; discuss several potential **concepts of operation** for the *in-situ* characterization of organics, biomarkers, and associated geochemistry and mineralogy we tested in 2016 (Fig 2); and outline our 2017+ plans to **advance Raman/LIBS detection of biosignatures**.

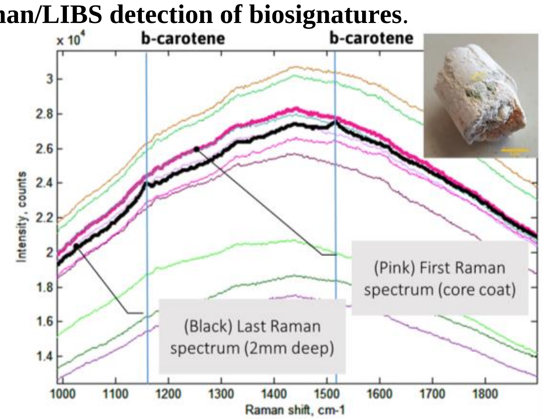


**Figure 2.** Case study. We analyzed a 10x2 cm core extracted using Honeybee Robotics core break-off system (see Zacny et al. paper, this meeting). We analyzed a single spot on core wall; spot was 100um across. We saw changes in relative intensity in exposed (purple) layer vs interior (protected) layers. These variations indicate different mineral distributions and demonstrate LIBS cleansing or de-coating. Beta-carotene (organic pigment, biosignature) signals appear in Raman spectra only after LIBS laser has removed core coating and exposed fresh core material. In Mars 2020, if we want to evaluate the suitability of a core for caching purposes based on potential for biosignature preservation, we need to remove the coating that inevitably forms around the core through drilling. LIBS provides an ideal tool for de-coating, with the advantage of returning chemical information as a function of depth.

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