Combining Chemistry and Morphology to Assess Biosignatures. R. Bhartia[1] G.P. Wanger[2], V.J. Orphan[3], M.D. Fries[4], A. Rowe[2], K. Nealson[2], W.J. Abbey[1], L. Beegle[1] [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena Ca 91109 rbhartia@jpl.nasa.gov. [2]University Of Southern California, [3]California Institute of Technology, [4]Johnson Space Center.

Introduction: *In situ* biosignatures detection is arguably more important now than ever. It is a central activity on several terrestrial and planetary missions targeting the Earth's deep biosphere, Mars, moons of Jupiter (including Europa), moons of Saturn (Titan and Enceladus), and small bodies such as asteroids or comets.

In situ instrumentation for biosignature detection spans a wide range of analytical and spectroscopic methods that capitalize on amino acid distribution, chirality, lipid composition, isotopic fractionation, or textures that persist in the environment [1,2]. Many of the exsiting analytical instruments are bulk analysis methods and while highly sensitive, these require sample acquisition and sample processing [1,3,4]. While these methods are possible with human interaction, robotic implementation adds significant complexity and introduces potential problems of sample to sample contamination and decreased efficiency in extraction of the target biosignatures [3,5,6]. Furthermore, while bulk analysis methods can extract biosignatures of interest from large samples, the effect is a dilution of the sample where trace concentrations require hundreds of milligrams of sample. In many cases this amount of sample is unavailable or the acquisition is impractical. However, by combining with triaging spectroscopic methods, biosignatures can be targeted on a surface and preserve spatial context (including mineralogy, textures, and organic distribution). This combines chemistry can morphology to provide perspective of the origins of the potential biosignature, e.g. whether it was possibly formed by an abiotic catalyzer (i.e. FeNiS), represents contamination, or is suggestive of a biogenic origin [7-9]2.

Approach: There are a number of spectroscopic methods that can be used for biosignatures detection but to provide chemistry and morphology at multiple spatial scales (meters to microns) we have employed a dual spectroscopic approach that captilizes on high sensitivty deep UV native fluorescence detection and high specificity deep UV Raman analaysis[10,11]. These techniques work in concert and have the added benefit of being used in a single compact instrument design [12].

Using this methodology we are beginning to characterize the spatial distriubiton of organics, minerals, and potential biosignatures from the marine and continental subsurface, modern and ancient Mars analogs, meteroites, and laboratory standards. This has led to a preliminary analysis of microbial distribution, the minerals they prepicipate, as well as methods to understand the features native to the surface versus contamination from sample acquisition or storage.

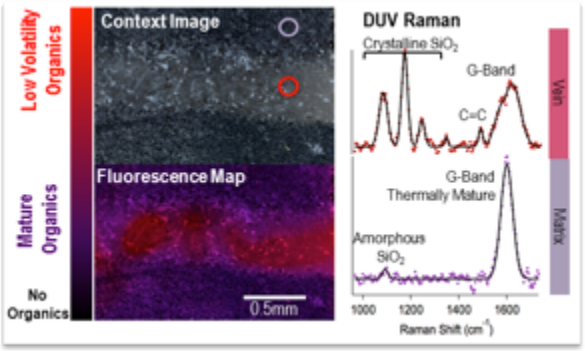
Example: Using the our lab testbed, an analysis of a piece of the astrobiologically interesting chert obtained from the Fig Tree Group [13-15] is presented. A small piece of fig tree, on the order of a few centimeters, was cleaned using O2 plasma.

A context image of the sample is acquired. Using the internal scanning mirror, a 50 micron laser spot is systematically rastered over the surface. On the same CCD, spectra in the range 250-360 nm are obtained. Analysis of the fluorescence region (>270 nm) identifies regions where organic material is present. Analysis of the fluorescence spectra identifies number of aromatic rings present, and identifies regions of high organic content. In order to achieve high sensitivity, multiple laser shots can then be targeted on a spot to obtain characteristic Raman spectra. The Raman spectra shown on the right are from the two circles shown in the context image.

By studying the data we can conclude that our analysis indicates that:

- The chert has not been altered uniformly—pressure/temperature exposures are evident from carbon maturity variation
- Majority of matrix is thermally mature carbon—anthracitic to sub-bituminous
- An intrusion of silica with much younger carbon invaded the main matrix

Potential for biosignature preservation in the matrix



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