FINDING THE ORGANICS: A COMPACT NON-CONTACT, NON-INVASIVE TRACE ORGANIC AND MINERALOGICAL MAPPING ARM INSTRUMENT.

R. Bhartia[1], W. F. Hug[2], L.P. DeFlores[1], M.D. Fries[3], R. D. Reid[2], A. Allwood[1], W. Abbey[1], E. C. Salas[2], L. Beegle[1]
[1]Jet Propulsion Laboratory/California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109, rbhartia@jpl.nasa.gov, [2]Photon Systems Inc. 1512 Industrial Park St., Covina, CA 91722, [3]Planetary Science Institute, San Diego, CA

Introduction: The detection of native organic species and/or biosignatures (organic or mineralogical) on planetary bodies remains a high-priority science goal. The current analysis paradigm for organic detection typically relies on the use of ingestion-based methods such as the SAM GC/MS on MSL. For mineralogical identification, the in-situ gold standard is the CHEMIN XRD, also on MSL. These state-of-the-art analytical systems can provide a comprehensive organic and mineral inventory of a sample. However, while highly analytical and sensitive, these methods require complicated sample handling and processing. This process not only greatly increases mission cost, risk and operational complexity, it destroys any fine-scale spatial context that can be used to describe formation processes and is an important component in assessing biogenicity.

The next-generation instrument we describe here (GORILA – Geochemical and Organic analysis by Raman Imaging and Laser Autofluorescence) is a low mass, arm-mounted instrument capable of high sensitivity analysis of organic compounds in their mineralogical and spatial context at a fraction of the cost and complexity of current methods. Furthermore, it can preform spatial 2D mapping of organics utilizing deep UV native fluorescence[1] and resonance Raman with visible Raman spectroscopy[2-5] for correlated mineralogical 2D mapping [6,7] while consuming only <15W and weighing <3kg. GORILA is suitable for in-situ exploration rovers/lander, sample cache missions, and/or to triage and select targets for sample return. This instrument has been funded under both NASA ASTID and Planetary Protection Research Program funding, to rapidly and accurately detect, characterize, and spatially map water/hydrated minerals, microorganisms, trace organics and inorganic compounds, directly on surfaces with little to no preprocessing (ex abrading/ratting). These measurements are vital for both human exploration and scientific investigations [7]

Over the last decade, we have focused on developing in-situ instruments for life and trace organics detection based on Deep UV native fluorescence and Raman spectroscopy for non-contact, non-destructive analysis of opaque and rough natural surfaces. Enabled by the advent of compact deep UV laser sources <250 nm, the methodology has been used to map the distribution of trace organics, biosignatures, and living organisms, over multiple spatial scales; from the macroscopic (cm^2 – mm^2) to microscopic (μm^2) [8- 11]. GORILA provides a methodology by which both the organic *and* mineralogical data can be correlated within the constraints of a MER-sized rover/lander mission to Mars.

Instrument Definition: The Martian surface coupled to the constraints of rover/lander and in-situ instrument operations provides a unique set of challenges that define the instrumentation. GORILA's complementary design couples the detection capabilities of deep UV and visible excitation to alleviate concerns of ambient light, enabling daytime operations, and background "mineral" fluorescence. In addition, the instrument methodology simplifies rover/lander arm operations by using a fiber-less, focus tolerant design.

In-situ Organic and Mineralogical Analysis: GORILA is a fusion of instruments and consists of two integrated modules, a deep UV native fluorescence and *resonance* Raman module and a high throughput visible Raman module. The fluorescence response from deep UV excitation enables sub-ppb detection and spatial mapping of aromatic organics ranging from simple, single ring features to large fused aromatic compounds without the interference from mineral fluorescence [1,9-11]. For mapping other non-fluorescent organic compounds, such as aliphatics, the deep UV enables detection of these with enhanced Raman scattering through resonance effects for key vibrational bonds (CN, CH, NHx, C=O, C=C, and NOx, and OH) with enhancements of over tradition visible or NIR Raman scattering. The visible Raman module will provide correlated mineralogical maps and enable multispectral analysis of condensed carbons.

We will present the current capability of the fused organic and mineralogical analyzes through examples of recent in-situ and laboratory results including samples from the terrestrial surface and subsurface environments and analysis of meteorites. We will also discuss the challenges and solutions of integrating the fused geochemical/organic chemistry capability and an organic-only detection capability into near-term and future Mars missions.

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