***Life detection and biomarkers***

Life detection encompasses all measurements seeking to find life, including searching for biomarkers and establishing context. Biomarkers are features of a planet or atmosphere that are created through biological processes. These types of features are indicative of life, in the sense that the biomarker would not be present in the absence of life. Atmospheric biomarkers include oxygen, ozone, nitrous oxide, and methane. Water is often mentioned in this group due to the importance of its spectral features but is not a valid biomarker.

Biomarkers measurements directly ask features characteristic of life such as complicated organic matter not known to be formed through only chemical reactions, or concentrations of biologically necessary or useful elements as evidence of ongoing or past biological processes. Establishing context encompasses the measurements seeking to determine the properties and methods such as habitability or competing for abiotic mechanisms inherent both to the environment investigated and to the environments through which the sample provenance can be traced.

Soil organic matter (SOM) is a complex, heterogeneous mixture of predominantly plant and microbial origin. Structural investigations of macromolecular SOM are based on non-destructive spectroscopic techniques such as NMR spectroscopy and yield mainly bulk data about the abundances of functional groups and carbon bonds, but reveal little information about the molecular composition

Low molecular weight (LMW) biomarkers can be used to trace the source and stage of soil organic matter. However, methods that selectively isolate these groups of compounds are underdeveloped.

The sequential extraction and chemical degradation of soils are advantageous for the determination of the LMW compounds in SOM. The applied methods involving solvent extraction (TSE), base hydrolysis (BHY) and acid hydrolysis (AHY), and CuO oxidation (CUO) and the analysis of the fractions with Gas chromatography-mass spectrometry (GC-MS) yield valuable information regarding lipids, phenols, LMW carbohydrates and amino compounds in soils. GC-MS is an instrumental technique, comprising a gas chromatograph (GC) coupled to a mass spectrometer (MS), by which complex mixtures of chemicals may be separated, identified and quantified. This makes it ideal for the analysis of the hundreds of relatively low molecular weight compounds found in environmental materials.

Another way to find biomarkers is by using images of soil and doing analysis on them. Image analysis can be defined as the extraction of useful information from images utilizing digital image processing techniques. Using image analysis, it is possible to find patterns and boundaries, track objects, analyze colours, etc. with an automated method ideal for a rover. Applications of these methods are Dye Tracing, Pore Space Analysis. Another form of image analysis is with the help of ComputerVision and Neural Networks. Using images of soil, we can train a model to detect the properties of the soil.

***Computational Devices***