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Session 2. Advances in Astrobiological Instrumentation Development

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Astrobiology science goals are important in defining the science requirements for many future planetary and astronomical missions. These goals include not only the direct search for evidence of life, but also the characterization of planetary environments to assess past or present habitability. This session aims to bring together astrobiology scientists and engineers to address these requirements and to aid their translation into instruments and instrumentation suites. We invite original contributions that discuss instrument design, development and testing for astrobiologically relevant space missions, whether they involve remote or *in situ* analyses. We also welcome presentations that propose new approaches or analytical methods of astrobiological interest from currently deployed instruments or that could be the basis of future instruments, as well as reviews of the current state of instrumentation.

2-01-P. Astrobiology from Europan Orbit

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The flux of chemical compounds introduced into the tenuous Europan atmosphere due to energetic charged particle sputtering of the surface ice directly reflects the composition of the ice. In particular, any organic compounds, formed in the sub-ice ocean and entrained in the icy crust, will enter the atmosphere in this sputtering process. This provides the opportunity to remotely determine the surface ice composition through an analysis of the composition of the Europan sputter atmosphere and provides an opportunity to look for astrobiological signatures from Europan orbit. We have developed a preliminary design for an orbiter-based radar spectrometer that can measure minor species in the Europan atmosphere. The radar is sensitive to the total column of molecules between the spacecraft and the surface. Based on conventional radar concepts at longer wavelengths, the instrument concept includes, onboard an orbiter, a transmitter illuminating a spot on the surface and a heterodyne receiver detecting the back-scattered radiation. All molecules in the atmosphere with an electric or magnetic dipole absorb radiation at the millimeter and submillimeter wavelengths at which the spectrometer will operate. Our calculations show that polar species, such as organic N- and S-containing compounds and inorganic salts, if present at ppm levels in the ice, will be detectable. Detection sensitivity is orders of magnitude larger than traditional limb thermal emission spectrometry. In addition, the radar spectrometer observations provide insight into the physical characteristics of the environment (sputter velocities, magnetic field), the surface, and the range between the surface and satellite.

2-02-O. Novel Subcritical Water Extraction Methods for Studying the Mechanisms of Biomarker Preservation in Minerals and Ices

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Biomarkers, such as amino acids, are preserved inside mineral matrices and ices for many years. If there is, or ever was, life on Mars and Europa, the biomarkers are likely to be found inside the regolith and ice. Consequently, the successful achievement of life-detection missions' goals will greatly depend on sample preparation instruments designed to efficiently extract potential biomarkers with minimum change of their original properties. Here we will present our subcritical water extractor (SCWE) (Amashukeli *et al.*, *J. Geophys. Res.*, 2007) technology and methods developed for extraction of biomarkers from various mineral matrices and ices that may constitute martian regolith and Europa's ocean ice. The results of work will enable the formulation of the mechanisms by which biomarkers are preserved inside the minerals and ices. Furthermore, the extraction data will enable future definitions and developments of the sample processing instruments that will provide extracts containing biomarkers to a variety of analytical instruments. Data will also provide additional information that may aid the selection process of the potential martian sampling sites for the future life-detection missions.

2-03-P. Peptide Nucleic Acids: from the "Pre-RNA World" to Biosensor Applications in Astrobiology

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Peptide nucleic acid (PNA) is a nucleic acid analogue characterized by a chemically stable pseudopeptidic backbone that lacks sugar motifs, carries no charges and has no chiral centers. As a consequence, PNA has been proposed as a suitable candidate to have preceded RNA at the first stages of molecular evolution, in the so-called "Pre-RNA world". In the context of the origin and early evolution of genetic information, it is also relevant to the role that inorganic surfaces could have played, both in the catalysis of the polymerization of macromolecules, and in the stabilization of such polymers. Therefore, we have investigated the interaction of single stranded PNAs (ssPNAs) on metal surfaces, as a first approach for understanding the role played by surfaces and nucleic acids during pre-cellular evolution. We have reported that ssPNA chains of up to 7 nm long can spontaneously self-assemble on certain surfaces, rendering ordered layers of standing-up molecules with maximized capability to interact with complementary target molecules. Self-assembled monolayers of ssPNA on surfaces are stable in pure water and salty buffers, resist desiccation/re-hydration cycles, remain insensitive to biological or chemical degradation, and show an outstanding resistance to high energy radiation. Interestingly, the use of surface characterization techniques has shown that layers of PNA adsorbed on surfaces maintain their capability for recognizing complementary nucleic acids with enough specificity to discriminate even a point mutation in target DNA or RNA. These structural and functional results have encouraged the use of PNA molecules as optimized probes in biosensors useful for astrobiological applications.

2-04-P. A Nanoelectronic Chemical Sensor for *In Situ* Liquid Chromatography

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The ability to chemically analyze liquid samples *in situ* will be critical to detecting and characterizing biologically significant organic species in the exploration of the Solar System, including Mars, Enceladus, and Europa. One powerful technique for such analysis is liquid chromatography (LC); when combined with advanced derivatization techniques and an appropriate detector, LC can be used to determine the presence and chirality of complex organic molecules, such as amino acids [Glavin, D.P., Dworkin, J.P., *et al.* (2006) *Meteorit. Planet. Sci.* 41: 889–902.] and lipids. Towards a miniaturized LC system for use on planetary surfaces, we are developing a nanoscale chemical sensor based on a silicon nanowire field effect transistor that promises sensitivity in the range of tens of femtomoles. The compact, low mass, low power, fully electronic nature of the sensor suggests that high redundancy or multiplexing will be possible in a simple, scalable package. Furthermore, recent work reported in the literature suggests that this technology is compatible with surface functionalization approaches, such as molecularly imprinted polymers or self-assembled monolayers of chemical complements, to enable highly specific detection of targeted molecules in future development. We will report on recent efforts to fabricate and characterize silicon nanowire transistors and discuss implications for the realization of a sensitive and adaptable chemical sensor technology.

2-05-O. Astrobiology Sample Analysis Program (ASAP) for Advanced Life Detection Instrumentation Development and Calibration

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Scientific ground-truth measurements for near-term Mars missions are essential for validating current *in situ* flight instrumentation and for the development of advanced instrumentation technologies for life-detection missions over the next decade. The NASA Astrobiology Institute (NAI) has recently funded a consortium of researchers called the Astrobiology Sample Analysis Program (ASAP) to analyze an identical set of homogenized martian analog materials in a "round-robin" style using both state-of-the-art laboratory techniques as well as *in situ* flight instrumentation, including the SAM gas chromatograph mass spectrometer and CHEMIN X-ray diffraction/fluorescence instruments on the 2009 Mars Science Laboratory, and the Urey and MOMA organic analyzers under development for the 2013 ExoMars missions. The analog samples studied included an Atacama Desert soil from Chile, the Murchison meteorite, a gypsum sample from the 2007 AMASE Mars analog site, jarosite from Panoche Valley, CA, a hydrothermal sample from Rio Tinto, Spain, and a "blind" sample collected during the 2007 MSL slow-motion field test in New Mexico. Each sample was distributed to the team for analysis to: (1) determine the nature and inventory of organic compounds, (2) measure the bulk carbon and nitrogen isotopic composition, (3) investigate elemental abundances, mineralogy and matrix, and (4) search for biological activity. The experimental results obtained from the ASAP Mars analog research consortium will be used to i) build a framework for understanding the biogeochemistry of martian analogs, ii) help calibrate current spaceflight instrumentation, and iii) enhance the scientific return from upcoming missions.

2-06-O. Spectropolarimetry: A Stellar and Circumstellar Probe

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The near-star environment around young stars is very dynamic with winds, disks, and outflows. These processes are involved in star and planet formation, and influence the formation and habitability of planets around host stars. The planets can also be influenced by stellar processes. Even for the closest young stars, this will not be imaged even after the completion of the next generation of telescopes decades from now, and other proxies must be used. The polarization of light across individual spectral lines is such a proxy that contains information about the geometry, density, and thermodynamic properties of circumstellar material on these small spatial scales as well as magnetic field information about the host star. We have recently built and calibrated a high-resolution spectropolarimeter for the 3.67 m AEOS telescope. We used this instrument to monitor many young intermediate-mass stars, and have developed a new model based solely on radiative processes for interpreting these results. We have also used the ESPaDOnS spectropolarimeter on the 3.6m CFHT telescope to perform a star-spots & magnetic fields study of low-mass stars, as well as other programs. In the context of astrobiology, these instruments provide a way to measure many properties of young stars, and help understand the circumstellar environment. We will present the instrumental capabilities as well as results of a few programs to illustrate this rapidly developing technique.

2-07-P. The Microbial Detection Array (MiDA)—Prototype Test Results

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MiDA, a life detection prototype, developed under the 2005 NASA Astrobiology Science and Technology Instrument Development (ASTID) program, employs electrochemical sensor arrays to simultaneously monitor two heat-sterilized, aqueous sample solutions for time-dependent chemical composition changes, using Ion-Selective Electrodes (ISE). One of the otherwise identical two chambers is ultimately inoculated with a very small, non-sterilized portion of the native sample, potentially leading to growth and subsequent detectable metabolism-induced changes in that chamber only. Relative changes can be used as an indicator for life, with minimal assumptions about the organisms and their metabolic pathways. The ISE sensors were developed with emphasis on small size, the use of a single non-interfering universal reference electrode and sensitivity to the most likely ions affected by metabolism in an aqueous solution. Biological tests are under way using a variety of organisms to characterize typical response-curves in isolated and mixed cultures, as well as using native samples with unknown organisms, in both defined media and 'water-only' added to the sample material. Developed hardware includes both bench top growth chambers for integrated sensor and biology testing, as well as an integrated prototype field unit, demonstrating and characterizing key technologies, and identifying missing technologies necessary for fully autonomous flight instrument development. For the prototype, where cost was prohibitive, manual user intervention was implemented to demonstrate the integrated science operations. However, design concepts were already developed, and will be presented, for such key elements as autonomous sample receipt and metering, inoculation, the valving between the outside vacuum, the autoclave and the temperature-sensitive reaction chambers, as well as minimizing loss of sample materials during transfer between components of the instrument.

2-08-O. CLUPI: CLose-UP Imager on the ExoMars Mission Rover, Tool for Identifying Potential Biofabrics on Mars

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The CLose-UP Imager (CLUPI) imaging experiment is designed to obtain high-resolution colour and stereo images of rocks from the European Mission ExoMars rover (Pasteur payload). The CLUPI is a robotic equivalent of one of the most useful instruments a field geologist carries: the hand lens. Imaging surfaces of rocks, soils and wind drift deposits is crucial for the understanding of the geological context of any site where the rover will be active on Mars. The purpose of the CLUPI is to look at a surface area of about 4 cm × 2.6 cm at a focus distance of 10 cm. With a resolution of approx. 15 micrometer/pixel, many characteristics of rock surfaces and internal structures can be visualized, such as crystals in igneous rocks, fracture mineralization, secondary minerals, details of the surface morphology, sediment components, sedimentary structures, and soil particles. It is conceivable that even textures resulting from ancient biological activity can be seen, such as fine lamination due to microbial mats (stromatolites) and textures resulting from colonies of filamentous microbes. CLUPI is a powerful, highly integrated, miniaturized (208 g), low-power, robust imaging system with no mobile parts, able to operate at very low temperature (−120°C). The opto-mechanical interfaces will be a titanium smart assembly capable of sustaining a wide range in temperature. The concept benefits from well-proven heritage: Proba, Rosetta, MarsExpress and Smart-1 mission The close-up imager CLUPI on the ExoMars Rover will be described together with its capabilities to provide important information that can offer significant contributions to the understanding of the geological environment and that could identify outstanding potential biofabrics (stromatolites) of past life on Mars.

2-09-P. Automated Sample Preparation for Life Detection Technologies

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Sample preparation technology presents a significant challenge to the advancement of *in situ* life detection instruments being developed for future robotic missions. Techniques and instruments have been adapted from the medical and biotechnology industries to detect key biosignatures and are currently being successfully utilized in various planetary analogue environments. However, several of these life detection techniques involve some level of sample extraction and/or preparation and hence require a substantial amount of human interaction prior to analysis. An autonomous sample preparation system must be incorporated so that these methods can be considered for in situ analytical suites on future robotic missions. A prototype autonomous system was designed and constructed to evaluate the critical sample preparation functions that would be required for support of life detection instrumentation. The Limulus Amebocyte Lysate (LAL) assay, which detects lipids specific to gram-negative bacteria, has a simple extraction protocol and thus was selected as the model detection technique to be tested with the first-generation prototype. The LAL assay was also selected because there was already a compact, portable assay technology that was commercially available and could be easily integrated with the prototype sample preparation system. The design evolution, challenges, and construction of the prototype sample preparation system will be presented as will results from experiments conducted on geological samples obtained from the Rio Tinto subsurface environment.

2-10-O. Exploration of the Habitability of Mars with the SAM Suite Investigation on the 2009 Mars Science Laboratory

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The 2009 Mars Science Laboratory (MSL), with a substantially larger payload capability than any other Mars rover to date, is designed to quantitatively assess a local region on Mars as a potential habitat for present or past life. Its goals are (1) to assess past or present biological potential of a target environment, (2) to characterize geology and geochemistry at the MSL landing site, and (3) to investigate planetary processes that influence habitability. The Sample Analysis at Mars (SAM) Suite, currently in its final stages of integration and test, enables a sensitive search for organic molecules and chemical and isotopic analysis of martian volatiles. MSL contact and remote surface and subsurface survey instruments establish context for these measurements and facilitate sample identification and selection. The SAM instruments are a gas chromatograph (GC), a mass spectrometer (MS), and a tunable laser spectrometer (TLS). These together with supporting sample manipulation and gas processing devices are designed to analyze either the atmospheric composition or gases extracted from solid phase samples such as rocks and fines. For example, one of the core SAM experiment-sequences heats a small powdered sample of a Mars rock or soil from ambient to ~1300 K in a controlled manner while continuously monitoring evolved gases. This is followed by GCMS analysis of released organics. The general chemical survey is complemented by a specific search for molecular classes that may be relevant to life including atmospheric methane and its carbon isotope with the TLS and bio-markers with the GCMS.

2-11-O. Lab-on-a-Chip: From Astrobiology to the International Space Station

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The continual and long-term habitation of enclosed environments, such as Antarctic stations, nuclear submarines and space stations, raises unique engineering, medical and operational challenges. There is no easy way out and no easy way to get supplies in. This situation elevates the importance of monitoring technology that can rapidly detect events within the habitat that affect crew safety such as fire, release of toxic chemicals and hazardous microorganisms. Traditional methods to monitor microorganisms on the International Space Station (ISS) have consisted of culturing samples for 3–5 days and eventual sample-return to Earth. To augment these culture methods with new, rapid molecular techniques, we developed the Lab-on-a-Chip Application Development–Portable Test System (LOCAD-PTS). The system consists of a hand-held spectrophotometer, a series of interchangeable cartridges and a surface sampling/dilution kit that enables crew to collect samples and detect a range of biological molecules, all within 15 minutes. LOCAD-PTS was launched to the ISS aboard Space Shuttle Discovery in December 2006, where it was operated for the first time during March–May 2007. The surfaces of five separate sites in the US Lab and Node 1 of ISS were analyzed for endotoxin, using cartridges that employ the Limulus Amebocyte Lysate (LAL) assay; results of these tests will be presented. LOCAD-PTS will remain permanently onboard ISS with new cartridges scheduled for launch in February and October of 2008 for the detection of fungi (β-glucan) and Gram-positive bacteria (lipoteichoic acid), respectively.

2-12-P. Next Generation LOCAD-PTS Cartridge Development

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As future exploration missions to other planets unfold, advanced technologies capable of detecting low-level biochemical signatures remain necessary tools. Furthermore, the ability to analyze samples at the point of collection in near real-time is particularly desirable. In order to address the requirements for rapid, precise detection of a variety of biochemical molecules, the Lab-On-a-Chip Application Development—Portable Test System (LOCAD-PTS), based on the Endosafe™-PTS technology marketed by Charles River Laboratories, was developed and is currently operating aboard the International Space Station (ISS). This system uses a capillary action cartridge technology capable of detecting small quantities of the bacterial compound lipopolysaccharide (LPS). We present data describing a progression of continuing technology development—from expanding the detection capabilities of the current PTS unit to increasing the number of compounds that can be detected by using protein microarrays. To highlight the adaptability of the cartridge format, we present kinetic and reproducibility data demonstrating the concentration of the fungal cell wall compound beta-glucan. To expand the number of compounds tested simultaneously, we provide preliminary data from a modified PTS cartridge design housing a protein microarray with features designed to detect four biochemical signatures. Additionally, we present data from a Mars analog environment where PTS technology was used to validate the sterility of astrobiological sampling protocols. Collectively, the data demonstrate that these new cartridges expand the number of compounds detected by LOCAD-PTS, while maintaining the rapid, *in situ* analysis characteristic of the instrument.

2-13-P. Protein-Based Sensors to Detect Chemical Markers of Life

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We are developing optical sensors for small organic molecules that are associated with living things. Specific organic chemical compounds, such as amino acids and carbohydrates, are attractive targets as biomarkers in extraterrestrial environments because of the central roles they occupy in terrestrial biochemistry. These compounds, however, are also produced by abiotic processes. In order to distinguish biological compounds from those of abiotic origin, it is necessary to examine characteristics like stereochemistry and isotopic ratios. The sensors we are developing are based on a family of proteins that microbes use to sense nutrients in their surroundings. Each member of this family binds a specific analyte with stereochemical specificity. These proteins undergo a conformational change on ligand binding. By attaching two different fluorophores to specific sites on the protein, it is possible to couple a spectral change to analyte binding using fluorescence resonance energy transfer. This spectral change can be readily detected using compact, inexpensive, off-the-shelf technology. We have produced three sensors for amino acids based on this approach using proteins derived from mesophilic and thermophilic organisms, and are in the process of producing additional sensors for carbohydrates like glucose. This technology will make it possible to detect enantiomeric excesses in biological compounds that are indicative of past or present living organisms.

2-14-O. The Mars Oxidant Instrument

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Under development for a potential contribution to the ESA's ExoMars mission, the Mars Oxidant Instrument (MOI) uses a sensor array to characterize the chemical processes that modify organic compounds in the martian environment. As part of the Urey instrument package, MOI provides a simple yet robust method of assessing the oxidant characteristics of sample material and evaluating how oxidation reactions may have altered the original organic components. MOI measures the reaction rates of films that have different sensitivities to oxidants expected to be present in the martian surface environment. By controlling the temperature of these films and their exposure to dust, ultraviolet light and water vapor, MOI will evaluate organic degradation pathways that may take place at sampled localities on Mars. These data will provide important insights into the observed organic matter inventory and the potential for survival of various classes of organic compounds under martian environmental conditions. In combination with a direct search for organic compounds by other payload instruments, MOI will allow the characterization of martian carbon chemistry *in situ*. These results will be especially critical in the case of a failure to detect organic components by other instruments, or the detection of modified organic intermediates. A key to understanding carbon chemistry on Mars lies not only in identifying soil oxidants, but also in characterizing the dominant reaction mechanisms and kinetics of oxidative processes that are occurring on the planet. These processes may have decomposed or modified any organic material that might have survived from an early biotic period.

2-15-O. Remote Raman System for Astromineralogical and Astrobiological Applications

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Remote Raman spectroscopy has demonstrated its potential in the identification of minerals and organics at distances ranging from several meters to more than 200 meters. The possibility of remote characterization of materials offers particular advantages over the contact mode in robotic missions with landers or rovers in planetary exploration. This remote characterization can also be useful for detecting hydrocarbon plumes and gas hydrates on planetary surfaces. In the case of the future sample return missions, the remote target identification could be crucial in a rapid operation mode, identifying the potential samples to be selected. We describe a remote Raman system for field applications working in the range of 3 to 25 meters. The system consists of a compact Raman spectrometer illuminated by a 532 nm Nd:YAG pulsed laser, which is coupled to a small telescope using optical fibre. The detection is gated (ICCD camera) and the system is fully computer controlled in its operation mode. Results obtained in the laboratory and in field operations in Río Tinto (Spain) and in the Artic (Svalbard Islands) during AMASE 2007 expedition are presented and discussed.

2-16-P. Progress in Life Marker Chip Technology for Detection of Life on Mars

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Detection of life on Mars or other astrobiology targets will rely on the detection of biomarkers: physical or chemical structures that can be associated with life. A Life Marker Chip instrument is being developed by an international consortium for operation on Mars and for other missions. This instrument uses immuno-assay techniques to detect relevant molecular biomarkers. This paper describes the typical targets it will search for, its operating principle and the status of its development. 63 biomarker targets have been identified and assays have been developed for a limited subset. Assay sensitivity is typically at the level of ppb to ppm depending on the target. The detection is performed on silicon waveguides where the binding of target molecules is measured using fluorophores excited by a laser. Breadboard demonstrators have been built of key components of the instrument and results from these breadboards will be presented, along with plans for future development.

2-17-P. Towards a Remote Sensing Capability for Life's Chiral Signature

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A unique characteristic of life is its macroscopic homochirality. This offers the potential of a remote sensing diagnostic since a chiral signature can be revealed with circular polarization observations. A collaborative effort is being undertaken between STScI, COMB and NIST in which we are exploring the quantitative circular polarization signal produced by primitive photosynthetic and phototrophic astrobiologically relevant microorganisms, cyanobacteria and haloarchea, and comparing that to the signal from macroscopic vegetation and abiotic minerals. With these laboratory measurements, we aim to understand whether circular polarization offers the promise of a viable remote sensing technique for the detection of life signatures and thereby develop a model for further exploration. By concentrating on photosynthesis and phototrophy, we maximize observability from an astronomical perspective, since photosynthesis and phototrophy is typically a surface phenomenon requiring atmospheric transparency and high stellar flux. From a biological perspective, we maximize the likely polarization signal since circular dichroism is greatest in the strong electronic transitions that define photosynthetic absorption bands.

2-18-P. Microarray Design for Microbial Monitoring and Space Exploration

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Microorganisms interfere with, or are crucial to goals and systems for space flight. Consequently, the development of effective microbial monitoring technologies is critical for mission safety and success. Recognizing the need for early microbial identification, we developed molecular-based technologies for microbial monitoring. Our group designed a resequencing microarray with Affymetrix for the identification of microorganisms relevant to human space. In molecular biology, microarrays have become an ubiquitous tool, due to their potential to simultaneously interrogate large quantities of genetic information in a single experiment. The custom array design interrogates ^{16}S or ^{18}S rRNA and rpoB (DNA-directed RNA polymerase subunit) gene sequences in 157 organisms, probing 527829 base pairs of sequence on a single array. It includes gene sequences with potential relevance to specific areas of space exploration: pathogens, extremophiles, and common microorganisms from the three domains of life bacteria, archaea, and eukaryota. DNA is hybridized onto the array, and, depending on the DNA present, characteristic patterns of fluorescent responses are expected as a result. We have developed a novel algorithm for the classification of microbes. We report three main findings: First, the microarray was capable of identifying the sample organisms added to the array. Second, MicroID can distinguish among species from the same family. Third, we are currently using a base-pair distance tiling array, but our results show that only 1 percent of random chosen probes of the current design are necessary for correct recognition. Therefore, the chip could be reduced in size or more organisms could be added.

2-19-P. *In Situ* Assessment of Potential Biogenicity Using Image Analysis

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Image analysis provides a fast, inexpensive, non-invasive way to rank samples according to their potential scientific value—a useful feature in a data-rich environment. We describe a technique to classify images of rock samples as targets of interest with respect to biogenicity: are the samples likely to contain evidence for life, or not? Using a data cluster model constructed from terrestrial rock samples with known properties, we analyzed the potential biogenicity of stromatolites found on Earth and several rocks imaged by the Mars Exploration Rovers. Twelve properties directly measured from the digital images (gzip and png compression ratios, entropy, energy ratio, and 8 Gray-Level Co-occurrence Matrix features) were used in the data cluster model based on a suite of known rocks and minerals. Two macroscopically similar Earth stromatolites (laminated columnar branching structures), one of known biogenic origin and the other of known abiotic origin, were classified using the cluster analysis. All but one of the Mars samples were classified as abiotic. One sample (Humphrey) was flagged as meriting further observation and analysis; this rock was previously identified as containing evidence of ancient flowing water. While conclusive judgments about biogenicity are unlikely to be made solely on the basis of image features, this analysis can provide a "first cut" estimate of the importance of a follow-up search for other biosignatures (*e.g.*, isotopic or chemical analysis). Given a ranked list of potential targets, more expensive analyses, in terms of integration time or consumables, can be focused on targets with maximal potential interest.

2-20-P. Tunable Laser Spectrometer (TLS) for the Sample Analysis at Mars (SAM) Suite on the 2009 Mars Science Laboratory (MSL) Mission

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The Tunable Laser Spectrometer (TLS) is one of three instruments (QMS, GC, TLS) that make up the Sample Analysis at Mars (SAM) analytical chemistry lab on NASA's 2009 Mars Science Laboratory (MSL) mission. TLS has unprecedented capability for measuring methane, water vapor, and carbon dioxide abundances in the martian atmosphere and evolved from heated soil samples. In addition, TLS will measure the $^{13}C/^{12}C$ isotope ratios in both CH_4 and CO_2, and the $^{16}O/^{17}O/^{18}O$ isotope ratios in CO_2. Using an interband-cascade and a tunable diode laser, TLS is capable of determining atmospheric methane abundance to 2 percent accuracy and to a lower limit of 1 part-per-trillion with SAM pre-concentration. The instrument and test data results are described.