CANADIAN ASTROBIOLOGY TRAINING PROGRAM

2012 Annual Meeting

29 August 2012 - 30 August 2012

McMaster University
Hamilton, Ontario

McMaster University

McGill

Western University · Canada

University of Toronto

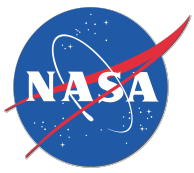
The University of Winnipeg

Welcome

Welcome to the Canadian Astrobiology Training Program (CATP) 2012 Annual Meeting. This interdisciplinary, multi-institutional gathering of minds allows us to explore the variety of fields and specific research areas involved in astrobiology, as well as to hear about some of the most up-to-date progress in the field, including Curiosity/MSL.

Over this two-day conference, there will be a total of 14 contributed talks given by students and postdocs, 1 invited presentation by Ray Jaywardhana, and 1 focus talk given by Ed Cloutis. There will also be two separate call-ins, one from the Astrobiology Graduate Conference and one from the MSL team. Thursday morning will feature a tour of the MDA Space Sciences division.

A warm round of applause for everyone involved in making this annual meeting happen: Lyle Whyte and the CATP Co-Is; the local organizing committee, chair Greg Slater, Alyssa Cobb, Sarah Soles, and Danielle Simkus; and especially to our CATP supporters, NSERC CRSNG, and CATP partners, MDA, CSA, NASA, Ames Research Center, MPB.



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Schedule

CANADIAN ASTROBIOLOGY TRAINING PROGRAM

2012 Annual Meeting

McMaster University, Hamilton, Ontario

29-30 August 2012, McMaster University

The meeting venue is the Michael DeGroote Centre for Learning and Discovery (MDCL) Building, Room 1110. For a map of McMaster University's campus, please refer to pages 24-25.

Tuesday, 28 August 2012, MDCL lobby

7:00pm - 9:00pm – Informal Icebreaker at Kelsey's Restaurant
875 Main Street West, Hamilton

The schedule for Wednesday begins on the next page.

Wednesday, 29 August

8:30am-9:15am: Coffee and pastries available in MDCL lobby outside room 1110

NOTE FOR PRESENTERS: During this time please bring your presentations via USB to MDCL 1110. Audio/visual assistance will be waiting to assist you in uploading your talk to one of two computers, a Windows and a Mac.

9:15am-9:45am: Welcome & Introductory Statements given by Lyle Whyte and CATP Co-Investigators

9:45am-10:45am: Astrobiology Graduate Conference call-in from California Institute of Technology
CATP attendees: Alyssa Cobb, Jesse Colangelo-Lillis, Guillaume Lamarche-Gagnon, Pablo Sobron, Sarah Soles, Jessica Stromberg

10:45am-11:00am: COFFEE

11:00am-12:00pm: Guest Speaker Ray Jaywardhana – exoplanets

12:00pm-1:00pm: LUNCH & group photo

CATP Presentations Session 1: 1:00pm-3:00pm

1:00pm	Alex Rupert	MicroXRD applications in astrobiology
1:15pm	Haley Sapers	Characterization of putative ichnofossils in impact glass using STXM
1:30pm	Jared Shivak	Aqueous alteration of Nakhla: Implications for habitability of Martian rocks
1:45pm	Darren Fernandes	Equip planets for life: Amino acid synthesis in meteorites
2:00pm	Alex Pontefract	Creating habitat: The role of meteorite impacts in promoting microbial growth within crystalline rocks
2:15pm	Dirk Schumann	Mineralogical characterization of modern conical stromatolites from Lake Untersee, East Antarctica
2:30pm	Lori Ziolkowski	Contemporary microbes in hypersaline springs that contain fossil carbon
2:45pm	Danielle Simkus	Life in the deep terrestrial subsurface: Lipid and carbon isotopic signatures

3:00pm-3:30pm: COFFEE

CATP Presentations Session 2: 3:30pm-4:00pm

3:30pm	Emma Bertran	Fractionation of sulfer isotopes by a QmoABC deletion mutant of *Desulfovibrio vulgaris* Hildenborough and insights on metabolic stability
3:45pm	Marcel Georgin	Quantification of quantum dot blinking

4:00pm-5:00pm: Mars Science Laboratory (MSL) call-in with John Moores (CATP PDF) and Richard Levielle (CSA)

5:30pm-9:00pm: Group BBQ at the Phoenix

Thursday, 30 August

7:45am: Meet out front of Visitor's Inn and load cars for drive to MDA

9:00am-1:00pm: Tour of MDA Space Sciences for CATP trainees. Lunch included at MDA

9:00am-1:00pm: Update meeting for CATP Co-Is and collaborators; chaired by Greg Slater

CATP Presentations Session 3: 2:30pm-3:30pm

2:30pm	Melissa Battler	Mineralogy of Arctic cold spring deposits and detection from orbit (as potential targets for preserved biological material)
2:45pm	Yasuhiro Hasegawa	Planet traps and the composition of planets
3:00pm	Tanya Harrison	The role of high-resolution imaging in planetary geology and astrobiology
3:15pm	Raymond Francis	Autonomous natural scene segmentation

3:30pm-4:00pm: COFFEE

4:00pm-5:00pm: Optical spectroscopy techniques – astrobiological applications focus talk given by Ed Cloutis

Talks

Session 1

Name: Alex Rupert
Affiliation: Western University
Email: alexnrupert@gmail.com
Presentation: Contributed talk
Title: **MicroXRD applications in astrobiology**
Abstract: MicroXRD is a versatile tool for the analysis of geologic samples. It can be used to study specimens in situ and therefore does not require powdering of valuable samples. The types and sizes of samples are not as limited as other methods of analysis; both large specimens and single grains can be analyzed. These two facts make microXRD very valuable for astrobiological purposes. The data that is acquired from the microXRD can be used to corroborate petrographic observations and chemical analyses to identify mineral species. It can also analyze crystal structure and help determine the amount of strain an object has gone through, which is very useful in the study of meteorites and impact events. It is also useful for classifying texture, structure, and composition of terrestrial samples which can then be used as an analog for extraterrestrial samples. This method of analysis has been used by many CATP students at the University of Western Ontario proving its value in the field of astrobiology.

Name: Haley Sapers
Affiliation: Western University
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Presentation: Contributed talk
Title: **Characterization of putative ichnofossils in impact glass using STXM**
Authors: H. M. Sapers, N. R. Banerjee, G. R. Osinski, D. Schumann
Abstract: Impact cratering is a ubiquitous geological process on solid planetary bodies. Any hypervelocity impact into a water-rich target has the potential to generate hydrothermal systems. Impact-induced hydrothermal systems share many characteristics with submarine volcanic hydrothermal systems including the presence of chemical and thermal disequilibria for microbial metabolism. Recent research suggests that such impact-induced environments may be conducive to microbial colonization. In submarine volcanic environments, bioalteration of basaltic glasses produces characteristic tubular and granular aggregate textures. Our examination of glasses from the Ries impact structure, Germany, has revealed tubular textures with remarkably similar morphologies to textures observed in volcanic glasses. Here we use syncrotron near edge fine structure (NEXAFS) spectroscopy combined with scanning transmission X-ray microscopy (STXM) to asses the biogencity of the Ries tubular features. NEXAFS spectroscopy at the Fe L_2- and L_3-edges and C K- edge are used to probe potential biosignatures. Fe L_2- and L_3- edge spectroscopy is used to differentiate between Fe oxidation states while spectral data at the C K-edge is sensitive to organic bonding structure. Transition metals, such as Fe, play a significant role in microbial metabolism. Autotrophic microorganism exploit redox disequilibrium gaining energy required for growth through cascades of oxidation-reduction reactions. Fe speciation composite maps based on NEXAFS stacks at the Fe $L_{2,3}$- edges show distinct patterns of reduced and oxidized Fe around the tubular features consistent with biological processing. Maps based on C K-edge spectroscopy show organically bound C lining the inside of hollow tubules. Spectral features associated with the tubules include peaks at $\sim$285 eV and $\sim$288 eV tentatively interpreted as aromatic and carbonyl groups respectively, consistent with the presence of a variety of organic molecules such as protein. This study of the Ries impact glass constitutes the first high-resolution biogeochemical study of an impact crater. Impact cratering is a significant and ubiquitous geological process on terrestrial bodies in the Solar System as well as on the early Earth, as such the discovery of biogenic features in impact glass has profound implications for early life on Earth and the early evolution of life on Earth as well as the search for life on other planets.

Name: Jared Shivak
Affiliation: Western University
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Presentation: Contributed talk
Title: **Aqueous alteration of Nakhla: Implications for habitability of Martian rocks**

Abstract: The action of aqueous solutions on Mars has been well established through the study of alteration mineral assemblages present in many Martian meteorites, such as the nakhlites. Minor minerals, including halite and carbonates, indicate the presence of aqueous brines. These fluids have altered the primary mineral phases present in the Martian meteorites, including olivine and pyroxenes as well as glassy materials, into various Fe and Mg rich phases. These alteration products have been collectively referred to as "iddingsite", and mass balance of geochemical data has suggested the presence of smectite and illite as two of the main components. The characterization of such phases in Nakhla has improved our understanding of the Martian alteration environment and provides information on the conditions accompanying habitability and evolution of life on Mars. Textural relationships show closely knit networks of "iddingsite" material filling fractures within and surrounding olivine grains and spaces opened in the rock. It is primarily associated with the alteration of olivine, but as olivine makes up approximately 10-15% of the rock it is likely that pyroxene alteration may be significant as well. The "iddingsite" phases are shown to be Fe and Mg rich, but less so than olivine grains. The alteration process therefore involves a relative decrease in Fe & Mg and a relative increase in Si, Al & alkalis. This alteration assemblage indicates that the alteration took place in an aqueous setting at slightly acidic to circumneutral pH conditions, possibly over an extended period of time as suggested by kinetics. Olivine, pyroxene and glassy mesostasis material are the primary phases in Nakhla, all of which have been identified as potential substrates for microbial life. Fe is abundant in olivine and pyroxene, and S is abundant in the predominantly pyrrhotite sulfide phase. These provide readily available energy sources for microbial metabolism. Liquid water, in the form of a brine, was present during alteration that could provide nutrients to endolithic life if it were present in the rocks. In addition, the Fe-enriched alteration fluids would provide an environment for microbial metabolism in their own right. The above characteristics and environmental factors make such altered Martian meteorites, which represent the only known samples of the Martian bedrock, similar to terrestrial igneous rocks which are known to be substrates for biological activity in aqueous environments.

Name: Darren Fernandes
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Presentation: Contributed talk
Title: **Equip planets for life: Amino acid synthesis in meteorites**
Abstract: Carbonaceous meteorites have been shown to have significant quantities of amino acids, which are the building blocks of proteins. In light of these discoveries, it is widely believed that carbonaceous meteorites brought biological compounds to early Earth and played a major role in the development of life. Nevertheless, the mechanisms behind amino acid synthesis in meteorites are still not fully understood. Using equilibrium thermodynamics, we show that the amino acids present in carbonaceous meteorites are consistent with the Strecker synthesis mechanism in meteoritic parent bodies. Parent bodies in the early solar system would have gathered large amounts of water, HCN, ammonia and aldehydes – all of which were abundant in the early solar media. These chemicals would have then reacted via the Strecker mechanisms to create the amino acids we see in meteorites today. This has various implications to the development of early life and the genetic code.

Name: Alex Pontefract
Affiliation: Western University
Email: apontefr@uwo.ca
Presentation: Contributed talk
Title: **Creating habitat: The role of meteorite impacts in promoting microbial growth within crystalline rocks**

Authors: A. Pontefract, G.R. Osinski, C.S. Cockell, A. Singleton and G. Southam

Abstract: Meteorite impacts occur throughout our solar system and are a fundamental geological process on rocky and icy planetary bodies. Though initially detrimental to biology, an impact event can favourably change the availability and habitability of a substrate for endolithic organisms, which are then able to (re)colonize micro-fractures and pore spaces created during the impact. This study shows how shocked gneisses from the 39 Ma, 23 km diameter Haughton impact structure, Devon Island, Canada, offer significant refuge for endolithic communities, and investigates the relationship between shock metamorphism and microbial biomass. The colonization of rocks by endolithic communities is an advantageous trait, especially in environments such as hot or cold deserts, where temperature shifts, low water availability and high UV indices pose a significant problem. On Mars, similar conditions (albeit, more extreme) prevail. In these instances, impact structures could provide refuge to endolithic organisms. Singleton et al. showed that, unlike sedimentary targets, the porosity of crystalline samples (specifically gneisses) increases proportionally until vaporization. The question then is: does microbial biomass trend with this increase in porosity, or are there other factors determining abundance? To answer this question, cell counts/g rock were conducted, along with SEM and Confocal Scanning Laser Microscopy (CSLM) to identify "hot-spots" of microbial growth. Average cell abundance was found to increase with shock level fitting a 4th order polynomial distribution with an $R^2 = 0.97$. Area counts from in situ live/dead CSLM images also correlated with these results, showing increased colonization with increasing shock level, also revealing patterns in sub-surface growth within shocked lithologies. We found that microbial biomass is not directly proportional to porosity due to the fact that in levels 2 through 4, microfractures that can be colonized are only just starting to form and translucence at this stage is not at a level that can support larger populations of phototrophs, similarly limiting heterotrophic growth. Porosity and translucency increase exponentially after this point, corresponding to an increase in biomass. We show that crystalline substrates can become habitats for endolithic organisms through the process of impact metamorphism, providing an excellent refuge in extreme environments.

Name: Dirk Schumann
Affiliation: McGill University
Email: dirk.schumann@mail.mcgill.ca
Presentation: Contributed Talk
Title: **Mineralogical characterization of modern conical stromatolites from Lake Untersee, East Antarctica**
Authors: Dirk Schumann, Dale Andersen, Marcus Kunzmann, Neil Banerjee, S. Kelly Sears, Hojatollah Vali
Abstract: Lake Untersee is the largest and deepest (>160 m) freshwater lake in East Antarctica. With a perennial ice cover, it has a water column that is well mixed, generally and supersaturated with dissolved oxygen with the exception of a small anoxic basin in the southwestern part of the lake. The water is highly alkaline (pH 10.3 - 10.8) and the lake sediments contain some of the highest concentrations of methane of any natural body of water on Earth. The lake floor is covered with photosynthetic microbial mat communities at depths of at least 100 m^2. The mats are composed of filamentous cyanophytes that form both small, cm-scale cuspate pinnacles and conical stromatolites that rise up to 50 cm above the lake floor. Conical stromatolites are characterized by their alternating lamina of organic material and clay-sized sediments. As conical stromatolites are not found in any other modern environment they may be an analog for the growth of some of the oldest well described Archean stromatolites. Up to date, no detailed electron microscopy based investigations of these mats and their associated sediments have been done so far and the exact role of biological activity in the mineralization within these mats has yet to be established. We have used XRD, TEM, and SEM to investigate the mineralogy, internal micro-textures as well as the possible role of biological activity in their formation. XRD analyses as well as SEM- and TEM-EDS analyses indicate that the predominant minerals in the sediment lamina of the conical stromalites are feldspar, quartz, kaolinite, mica, calcite and smectite-group minerals. The detrital feldspar, quartz, mica and rock fragment particles are embedded in a matrix of clay-minerals. TEM images show thin rims of clay-mineral phases around altered feldspar and rock fragment grains. Calcite also occurs in some lamina as both single crystals and aggregates up to 2 mm long and as concretions of irregular shape up to 1 cm long. The presence of these crystals and concretions has not been reported in previous studies and their mechanism of formation remains to be established. Their shape and the way in which they grow in the sediment lamina suggest an authigenic origin within these microbial mats. We will also present the results of C and O isotope measurements that will help to shed light on the genesis of these calcite crystals and concretions.

Name: Lori A. Ziolkowski
Affiliation: McMaster University
Email: lorized@gmail.com
Presentation: Contributed talk
Title: **Contemporary microbes in hypersaline springs that contain fossil carbon**
Authors: Lori A. Ziolkowski, Nadia C.S. Mykytczuk, Lyle Whyte, Greg F. Slater
Abstract: On Axel Heiberg Island, near 80°N in the Canadian Arctic, perennial hypersaline springs provide a unique environment for cold-active microbes. The neutral pH Gypsum Hill springs originate in a gypsum diaper and flow through 600 m of continuous permafrost before reaching the surface at ∼6 °C, 7.5 % NaCl, low dissolved inorganic carbon and rich in both sulfate and sulfide (Pollard et al., 2009). In the first part of the year while ambient temperatures dip as low as -40 °C, filamentous streamers are abundant under the snow covered run-off channels. These microbial assemblages are not present during the summer, when the snow cover has melted. Culture- and molecular-based analyses of the 16S rRNA gene indicated that the streamers are dominated by a chemolithoautotrophic sulfur-oxidizing *Thiomicrospira* species and under *in situ* conditions the streamers oxidized sulfide and thiosulfate and also fixed CO_2 (Perreault et al., 2008). We characterized the isotopic composition (^{13}C and ^{14}C) of the microbial community biomarkers as phospholipid fatty acid (PLFA) and glycolipid fatty acid (GLFA) methyl esters. These components represent the cell membranes of the viable microbial community, which are quickly hydrolyzed after cell death and provide insight into the carbon cycling of the organisms. Even though isotopic measurements of the bulk biomass indicate carbon and nitrogen limitation within the system, the streamers are rich in biomass with greater than 10^9 cells/g. While the PLFA and GLFA profiles were similar, indicating a predominantly gram-negative bacteria community, the ^{13}C composition of these two lipid types was different. The PLFA ^{13}C indicated a dominant autotrophic signal, while the ^{13}C of the GLFA had a more heterotrophic signal. While the streamers grow yearly, their ^{14}C age based on the lipid results was 6400 years, indicating utilization of a carbon source that is ^{14}C depleted. We hypothesize that these microbes are using ^{14}C depleted dissolved inorganic carbon carried by the groundwater. This is a unique system where the C utilized by a surface microbial community is in fact not from the atmosphere and indicates that communities in extreme environments can be using geologically derived substrates.

Name: Danielle Simkus
Affiliation: McMaster University
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Presentation: Contributed talk
Title: **Life in the deep terrestrial subsurface: Lipid and carbon isotopic signatures**

Abstract: Microbial communities living within Earth's deep terrestrial subsurface environments provide insight into the ultimate limits for life as we know it, as well as the possibility for life occurring in the subsurface of other planetary bodies. These subsurface microbial systems are now believed to be ubiquitous to a depth of several kilometres in the Earth's continental crust; however, their role in the global carbon cycle is still poorly understood (Fredrickson and Balkwill, 2006). This is largely due to sampling limitations in the subsurface and difficulties involved in extracting microbial biosignatures without introducing contaminants (Onstott et al., 2003). For my Master's research project, I am using a combination of phospholipid fatty acid (PLFA) analysis and carbon isotopic analysis to investigate the structure and extent of microbial communities living within two deep terrestrial subsurface systems: (1) Deep fracture water systems in the Witwatersrand Basin of South Africa, and (2) Rock cores sampled from the Michigan Basin in Ontario, Canada.

Session 2

Name: Emma Bertran
Affiliation: McGill University
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Presentation: Contributed talk
Title: **Fractionation of sulfur isotopes by a QmoABC deletion mutant of *Desulfovibrio vulgaris* Hildenborough and insights on metabolic stability**

Abstract: Sulfate reducing bacteria are the main actors of the sulfur cycle. Indeed, this group of δ-proteobacteria actively reduce extracellular sulfate into sulfide. This highly tuned metabolism, known as dissimilatory sulfate reduction, is isotopically selective, preferring lighter isotopes than heavier ones. The resulting signal is born by sedimentary sulfides and is used in order to infer past environmental conditions and detect early microbial life. Fractionation of sulfur isotopes during microbial sulfate reduction has been described by the widely accepted Rees model, according to which the total sulfur isotope effect produced by one bacterium is derived from the summed isotopic effects of each step in the metabolic reaction network weighed by the relative fluxes through all preceding steps. This model has been used to interpret isotopic results of culture experiments with sulfate reducers, thus inferring the values of the isotopic effects associated with each step. Despite the fact that these assignments are preliminary and theoretical, they have spread throughout the literature. However, in order to fully understand this metabolism, it is essential to produce experimental values as well. The present study will provide with insights on the activity of a deletion mutant strain of *Desulfovibrio vulgaris* Hildenbourough. This bacterium is missing its QmoABC gene, and is thus incapable of reducing sulfate, only sulfite. Therefore, analysis of fractionation factors in excess sulfite by this bacterium makes it possible, for the first time, to obtain experimental information regarding the isotopic effect associated with this particular step. Exploitation of this mutant also offers the possibility to explore the degree of metabolic stability of the sulfate reduction pathway via experimental evolution.

Name: Marcel Georgin
Affiliation: McGill University
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Presentation: Contributed talk
Title: **Quantification of quantum dot blinking**
Abstract: Quantum dots (QD's) are fluorescent semi-conductor nanocrystals which have a peak emission at a particular wavelength which is characterized by both the composition and size of the dot. The goal of this project was to characterize QD blinking, quantify the effects of β-mercaptoethanol on QD blinking and photobleaching, as well as using the photoluminescent liftime of QDs as an indirect method of characterizing blinking. Blinking is the event when a single QD absorbs a photon but does not reemit another but rather goes to a dark state and disspates the energy through non-radiative means.β -mercaptoethanol has been shown to reduce blinking however its effects on the luminescence of QD's made of different materials is poorly characterized. QD's have the potential to be molecular markers and allow a range of observations from atomic physics at the macroscopic scale to in-vitro tracking. Therefore it is important to be able to understand and model the blinking behavior.

Session 3

Name: Melissa Battler
Affiliation: Western University
Email: melissa.battler@gmail.com
Presentation: Contributed Talk
Title: **Mineralogy of Arctic cold spring deposits and detection from orbit (as potential targets for preserved biological material)**
Abstract: This talk will give an overview of the mineralogy of two cold spring sites in Canadian Mars analogue environments, with Mars analogue mineralogy: The jarositic seep-emplaced Golden Deposit, Northwest Territories; and saline perennial springs on Axel Heiberg Island, Nunavut. XRD data will be compared to reflectance and raman spectroscopy data. Springs exist in many types of settings on Earth and are host to a variety of microbial communities, which are often associated with and sometimes preserved within mineral deposits. There is mounting evidence for spring deposits on Mars, which could potentially have hosted life at some time during Mars' past. But before we can easily identify spring deposits on the surface of Mars with our limited datasets, we must gain a better understanding of spring deposits in Mars analogue settings on Earth. Specifically, it is critical to determine what different types of springs will look like from orbital data.

Name: Yasuhiro Hasegawa
Affiliation: McMaster University
Email: hasegay@mcmaster.ca
Presentation: Contributed Talk
Title: **Planet traps and the composition of planets**
Abstract: The composition of planets is one of the fundamental parameters for constraining development of life there. The advent of new telescope, known as Kepler, has provided us with remarkable opportunities to address this issue observationally. From the theoretical point of view, however, it is very difficult to give reliable constraints on planetary compositions based on standard theories of planet formation that is thought to take place in protoplanetary disks. The complexity lies in that planet formation do not proceed in situ. In fact, planet formation involves planetary migration - radial movements of growing planetary cores due to tidal interactions with their natal disks. I will present the most recent results of my PhD thesis work, wherein planet traps - specific sites in protoplanetary disks where planetary growth predominantly takes place - are intensively investigated. We will discuss the consequences of planet traps on the population of gas giants and the suggestions on their compositions.

Name: Tanya Harrison
Affiliation: Western University
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Presentation: Contributed talk
Title: **The role of high-resolution imaging in planetary geology and astrobiology**

Abstract: High-resolution images of the martian surface with the Mars Global Surveyor (MGS) narrow-angle Mars Orbiter Camera (MOC NA, 1.4–12 m/pixel), and the Mars Reconnaissance Orbiter (MRO) High Resolution Imaging Science Experiment (HiRISE, 0.25–1 m/pixel) have revealed a much more dynamic and complex Mars than that envisioned in the days of the Viking missions. However, the scientific community and mission planning committees have not always appreciated the value of, and need for, high-resolution imaging of planetary surfaces. With the (now cancelled) 2016 joint NASA/ESA Mars Trace Gas Orbiter (TGO) mission however, camera resolution was planned to take a step backwards with the High-Resolution Stereo Color Imager (HiSCI) at a resolution of only 2 m/pixel. Image pixel scales alone do not necessarily convey to the scientific community how these images can be utilized. For this research project, I intend to demonstrate the need and usefulness for ultra-high resolution (<0.25 m/pixel) imaging and to show what quantitative geology can be done at these resolutions that is not capable with current datasets. This will entail aerial imaging of terrestrial analogue sites (e.g., a Mars-like place on Earth) and acquiring RGB colour images at varying resolutions. The demonstration would include acquiring data with the imager in the field, making measurements and conducting both qualitative and quantitative studies of the features of interest, and comparing the results from the datasets at the various resolutions. A good candidate analogue site for this would be the Haughton impact structure on Devon Island. This location hosts gullies that have been cited as an analogue to those on Mars, providing a good geologic setting for quantitative calculations of flow properties from the aerial data. Haughton also provides an astrobiologically significant setting, with evidence for past hydrothermal and paleolacustrine environments. Therefore, this site could allow for testing whether ultra-high resolution orbital imaging could be used to search for signs of past or present life to a better degree than in existing martian datasets, either used alone or in conjunction with a high-resolution spectrometer. The scientific capabilities of ultra-high resolution imaging would be compared to that of ground-based imaging in an effort to provide a cost-benefit analysis of an ultra-high resolution orbital camera versus the high cost and risk of martian rover, lander, and human-based missions.

Name: Raymond Francis
Affiliation: Western University
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Presentation: Contributed Talk
Title: **Autonomous natural scene segmentation**
Abstract: Time and data budget constraints restrict the amount of scientific work that can be achieved on planetary missions. Future missions will rely to an increasing extent on the ability of the spacecraft to make autonomous decisions about data acquisition or transmission, or even to perform some of the data interpretation. A key part of this capability will be autonomous image interpretation. This presentation will describe current efforts in automated image processing for atmospheric studies as part of the Mars Science Laboratory mission. The works aims to develop an algorithm to extract wind information from sequences of images of clouds in the martian sky. Together with surface measurements, these efforts have implications for atmospheric dynamics, and thus for moisture and material transport, giving clues to the water cycle and to the potential for preservation of biomarkers near the rover landing site. A second project is also described, which aims to develop techniques for automated segmentation of geological scenes, to assist in the search for geological features of interest. Finding geological features of astrobiological relevance in imagery would aid in the selection of sites of investigation, and greatly improve the performance of life-detection missions using contact instruments requiring precise positioning and having limited lifetimes.

Name: Ed Cloutis
Affiliation: University of Winnipeg
Email: e.cloutis@uwinnipeg.ca
Presentation: Focus talk
Title: **Optical spectroscopy techniques - astrobiological applications**
Abstract: Searching for the presence of past or extant life on or under planetary surfaces is a difficult process. A variety of investigative techniques are available to aid in this search. Among the most promising are various types of optical spectroscopies, including reflectance, Raman, and UV-induced fluorescence. These techniques are complementary to one another because they are sensitive to different aspects of biological/organic molecules. As an example, reflectance spectroscopy is very sensitive to the presence of heterogeneous molecules, i.e., those that contain two or more different atoms (e.g., C-H, C-O). Raman spectroscopy is most sensitive to homogeneous molecules, such as C=C and aromatic molecules. UV-induced fluorescence is most sensitive to pi-bonded carbon-bearing molecules, such as polycyclic aromatic hydrocarbons. The physics behind each of these techniques, their applications, and advantages and limitations will be discussed.

CATP Members and/or Meeting Participants

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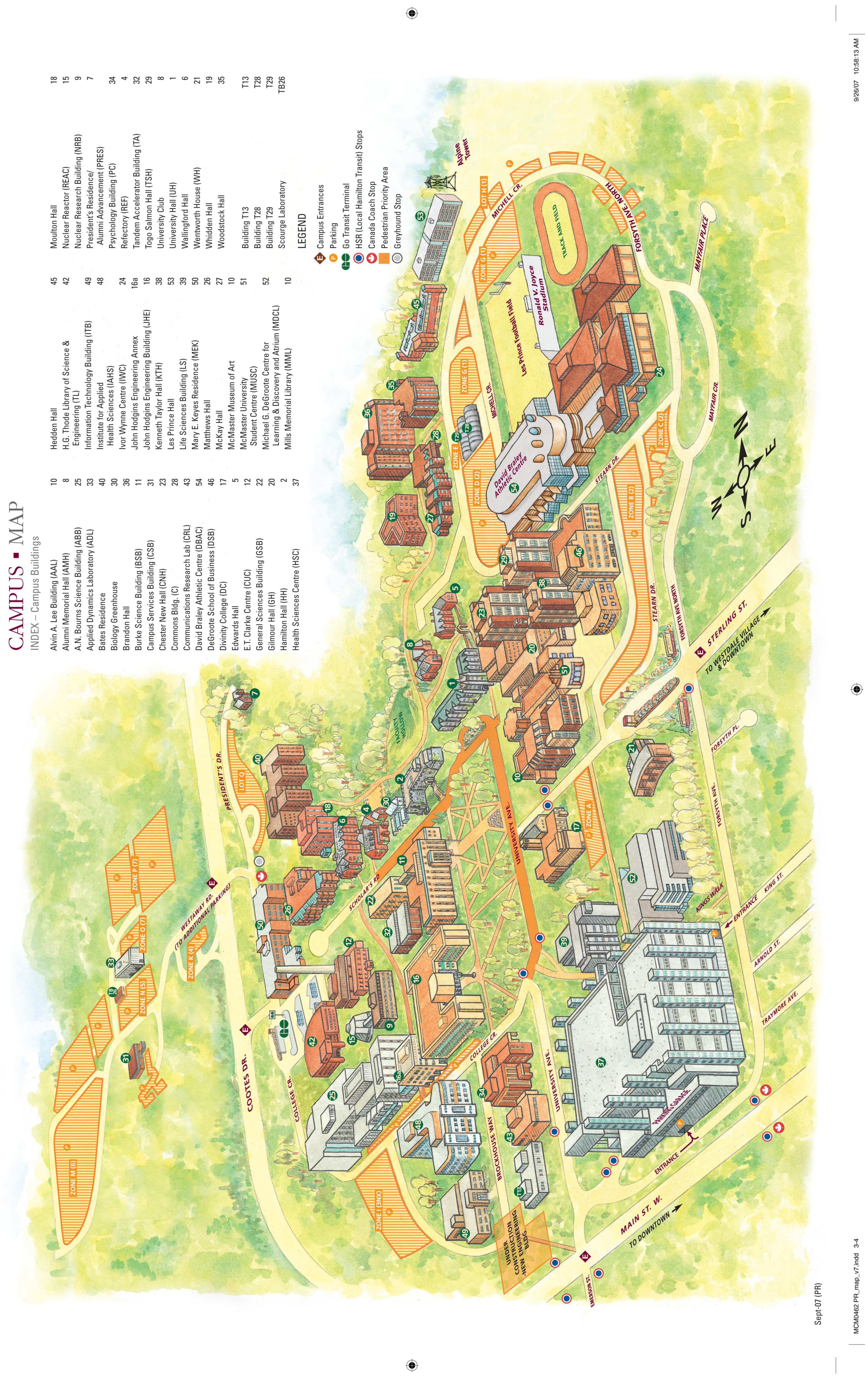
Maps

West Hamilton and Downtown

McMaster University Campus



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