Geology gone wild!

While a layman will only see a very beautiful landscape, a geologist’s mind will be blown at this sight. The White Pocket area in Arizona has a really awesome geology – forget the usual horizontal layers, here we see swirls, folds, faults, offsets, all filled out with the craziest colors you could imagine. Understanding what’s happening here and the complex processes that gave birth to these fantastic shapes makes it all even more beautiful.
Greetings! We are well into the 2015-2016 academic year and yet we are still adapting to the many changes that took place over the summer. We have a new Dean of the Faculty of Science, Prof. Bruce Lennox, former Chair of Chemistry, and a new Provost (and V.P. Academic Affairs), Prof. Christopher Manfredi, former Dean of the Faculty of Arts. They and the rest of us are getting adjusted to their new postings and the challenges that face McGill over the next few years, including further budget cuts to the University operating budget. Unfortunately, we are not immune to the latter and will likely feel the pain in the months to come. On the flip side, two new faculty members joined the Department in August 2015: Prof. Natalya Gomez and Nicolas Cowan. Prof. Gomez, a Canada Research Chair Tier II, is a geophysicist whose research interests focus on geodynamics and sea-level variations in the context of climate change. Prof. Cowan is jointly appointed with the Physics Department and is housed in the new McGill Space Institute. He studies planetary climates on exoplanets, planets that orbit stars other than our Sun, using space telescopes and novel remote sensing methods. Look for a feature article about our two new hires in this newsletter. On the other hand, Prof. Eric Galbraith left McGill in August 2015 to take on a Full Professorship at the Catalan Institute for Advanced Research (ICREA) in Barcelona, Spain. We are currently recruiting/interviewing for a new tenure-track Assistant Professor in the field of “Global Biogeochemical Cycles” to replace Prof. Galbraith.

Since September 2015, the common first year curriculum of the Major and Honours program in Earth Sciences includes a mandatory field-methods course called “Geology in the Field” (EPSC-240) that is offered in the Fall term by Prof. Christie Rowe. To accommodate this course, we have dropped the optical mineralogy course (EPSC-312, Spectroscopy of Minerals) and included microscope work into the Introduction to Mineralogy (EPSC-210) and Introduction to Petrology (EPSC-212) courses.

Our Field School I course changed venue in May 2015 after many decades of mapping in Sutton, QC. The sale of the Schweitzer’s farm, which was our historic base, meant that costs were going up, and the coincident presence of 80+ geo-engineering students from Queens resulted in the area being overrun with mapping students, increasing friction with landowners. Hence, Field School I is now being run out of Las Vegas. Last spring, it included visits to the Valley of Fire state park and the Muddy Mountain Wilderness in Nevada as well as around Barstow, the Rainbow Basin, the Mosaic Canyon, the Mesquite Flat sand dunes and Ubehebe Crater in California (see details in this newsletter). All this at a fraction of the cost of the previous year in Sutton. In May 2016, we also plan to combine Field School II & III into a single 4-week 6-credit course in the Massif Central of France that will incorporate sedimentology, igneous/volcanic, metamorphic petrology as well as geophysical and geochemical methods. Over the last year, a number of elective field trips were also organized and took place within and outside formal courses, including visits to: Hawaii (Jeff McKenzie and the Earth System Science students), Peru (Willy Trip), the Colorado Mineral Belt (SEG-McGill Chapter), and South Africa (sponsored by Bob Wares). Read more about these field trips in this newsletter. Further trips are planned for the near future, including to the Pacific Northwest - October 2015 (John Stix’ Volcanology class) and Spain – February-March 2016 (Galen Halverson’s Sediments-to-Sequences class). These exciting new initiatives and field trips would not be possible without the undeterred support of our donors.
Renovations to FDA-201, the mineralogy laboratory, will start in the Winter of 2016 and by September 2016 we should have a modern teaching room, including eight workstations that will each accommodate 6 students, microscopes and their portable computers. The room will include new mineral collection storage cabinets, a central teaching platform and multiple video screens. A proposal will be submitted shortly to the University Laboratory Teaching Working Group for the purchase of 32 new petrographic microscopes.

Prof. Don Baker was the principal investigator on a $2.4M grant awarded by the Canadian Foundation for Innovations (CFI) for the upgrade of the McGill Electron Microprobe Facility. This includes the purchase of a new electron microprobe and scanning electron microscope. Renovations to the microprobe facility and installation of the new instruments are expected to be completed by September 2016. Prof. Kim Berlo was awarded a $554k CFI grant to purchase and interface a new LIBS (laser-induced breakdown spectroscopy) to our Thermo-Fisher Scientific iCAP Qc ICP-MS instrument. The LIBS should be operational by the Spring of 2016. This will be a unique facility in Canada that will allow the analysis of light elements in solids at unprecedented spatial resolution.

Several faculty, student and alumnus were recognized for their contributions to the geosciences. Prof. Don Baker was the recipient of the 2014 Peacock Medal from Mineralogical Association of Canada (MAC). Prof. Jeffrey McKenzie was the 2015 recipient of the Canadian Geophysical Union Young Scientist Award. Volker Moeller (Ph.D. candidate; Supervisor = AE (Willy) Williams-Jones) won the Best Poster Award at the 6th Annual PDAC-SEG the Student Minerals Colloquium (Ph.D. category). Dr. David Palmer (M.Sc. ’94, Ph.D.’99), President and Chief Executive Officer of Probe Mines Limited, was the recipient of the 2015 Bill Dennis Award for a Canadian mineral discovery or prospecting success. Read more about the latter two awards and Dave’s visit to McGill in the newsletter.

During the AGU-GAC-MAC-CGU Joint Assembly that was held in Montreal last spring, our Department hosted a very well attended EPS reception at Brasserie BENELUX. It was a pleasure to see so many of you there! We hope that many of you will be able to attend this year’s Homecoming Wine & Cheese Reception in the Department – begin at 4:00 pm on Friday, October 23, 2015.

Alfonso Mucci
Chair, Earth & Planetary Sciences
New Faculty

Natayla Gomez – Assistant Professor

I am a geophysicist by training and I joined the Earth and Planetary Sciences Department as a new faculty member in August, 2015. I work at the intersection between two rapidly progressing areas of research – solid Earth geophysics and climate change science – aiming to advance our understanding of the complex interactions between the solid Earth and climate systems. I did an undergraduate degree in Physics and an M.Sc. in Geophysics at the University of Toronto. I then moved to Boston to do a Ph.D. in the Department of Earth and Planetary Sciences at Harvard University. After completing my graduate studies, I worked as a postdoctoral fellow in the Center for Atmosphere Ocean Sciences at the Courant Institute of Applied Mathematics at New York University before moving back to Canada to start up at McGill.

The overarching objective of my research program is to model, measure and understand past, present and future interactions between sea level, ice sheets and the solid Earth. A critical task of climate change research is to constrain the response of present-day ice reservoirs, like the Greenland and Antarctic ice sheets, to climate warming and estimate their contribution to future
sea-level rise. My research contributes toward improving our understanding of past and future climate and ice mass changes by exploring the physics of sea-level changes and Earth deformation, accounting for this physics in state-of-the-art numerical models of ice-sheet evolution, and taking an integrated view of ice sheet – sea level – solid Earth interactions.

A challenge in modeling the ice, ocean and solid Earth systems is that they evolve on a wide range of timescales. Ice sheets, for example, are known to experience large-scale retreat and advance over 100,000 year ice age cycles; however, recent acceleration of the outlet glaciers that drain the Greenland and Antarctic ice sheets, and the breakup up of the surrounding ice shelves, have been observed to occur over the course of a year or less. The sea level and solid Earth responses to ice-sheet evolution and the interactions between these systems vary on different timescales as well. Very different modeling techniques are used to simulate large-scale ice-sheet evolution over the long timescales that characterize the ice age than are used to simulate rapid, regional ice cover changes. Accordingly, I am setting up powerful supercomputing infrastructure at McGill that will support my group’s development of innovative models capable of performing simulations with high spatial and temporal resolution over a range of timescales.

In addition to numerical modeling, my group will also be working with a wide variety of datasets related to ice-sheet evolution and sea-level change. These datasets include satellite gravity and altimetry measurements of sea-level changes, tide gauge data, GPS measurements of surface deformation, seismic data of the structure of the Earth’s interior, and geological records of past shorelines and ice extent. I also have plans to deploy new and innovative instrumentation to measure sea-level changes and ocean circulation in the oceans around fast flowing outlet glaciers in Greenland and Antarctica.

One of the exciting aspects of my field of research is how interdisciplinary it is. I collaborate with geologists, glaciologists, oceanographers, geochemists and other geophysicists and come up with innovative ways to communicate my results to policy makers, coastal zone management experts, students and the general. I have colleagues around the world, whose work involves anything from spending months at a time on the ice in Antarctica and Greenland, to working in community relations in the Canadian Arctic. Together, we contribute to the global effort to mitigate the impacts of global warming and delineate the edges of the Earth’s resilience in the face of ongoing climate change.

I’m thrilled to be starting a professorship in such a vibrant, friendly and diverse department and University! I look forward to teaching and mentoring students and interacting and collaborating with colleagues within the department and in the larger McGill community.
I joined the department of Earth and Planetary Sciences in the Fall of 2015. I study planetary climate using space telescopes and novel remote sensing methods. My group studies the thousands of planets that have been discovered in recent years orbiting other stars. These exoplanets are much more varied than the Solar System worlds, and despite their great distance from us---typically tens to hundreds of light years---we are able to infer their atmospheric temperature, composition, clouds, winds, and seasonal variations.

My group’s bread and butter is analyzing observations from NASA’s Spitzer Space Telescope. This infrared space observatory enables us to measure the dayside and nightside temperatures for dozens of worlds, and hence look for trends between insolation and wind velocity, or between cloudiness and surface gravity. Since Spitzer was not designed to perform these kinds of observations, we routinely push the instruments orders of magnitude beyond spec and I am generally interested in the problem of extracting signal from structured noise.

In view of next-generation instruments that will characterize temperate rocky exoplanets, I have thought about geochemical cycling and how this might affect the surface character of our planet—and by extension other terrestrial planets. My team is also working on the classic inverse problem of inferring a planet's obliquity and surface map based solely on the changing brightness and color of a pale blue dot. I am heavily involved in the design of experiment for the next-generation of NASA missions to characterize exoplanets.

I'm happy to be returning to McGill after 12 years: my undergraduate studies began in the physics department here. After a stint in nuclear physics at TRIUMF, I pursued a PhD in Astronomy at the University of Washington, followed by a postdoctoral fellowship at Northwestern University, and a year as an assistant professor at Amherst College. I'm looking forward to starting a vibrant and interdisciplinary group of geophysicists, climate scientists, and astronomers who will tackle big-picture questions in planetary science.
PDAC Honours Industry Leaders with 2015 PDAC Awards

The annual PDAC awards showcase the achievements of companies, individuals and groups in the mineral exploration and mining sector by highlighting the best in domestic and international mineral discovery, mine development, Aboriginal achievement, environmental and social responsibility, and distinguished service. Recipients of the 2015 annual awards were celebrated at the association’s Awards Evening on Monday, March 2 at the Fairmont Royal York Hotel during the PDAC 2015 Convention. Award recipients are selected by the PDAC’s Board of Directors based on the recommendations of the association’s awards committee. A summary of the awards and recipients are listed below.

Bill Dennis Award
Canadian mineral discovery or prospecting success

David Palmer (M.Sc. ’94, Ph.D.’99), President and Chief Executive Officer of Probe Mines Limited, is the recipient of this year’s Bill Dennis Award for a Canadian mineral discovery or prospecting success. David Palmer is receiving the award for the Borden Gold Project, a discovery located near Chapleau, Ontario. The Borden Gold Project is an exciting and important new gold discovery that continues to evolve, grow and improve with continued exploration.

Located in a previously unexplored area of Ontario, the discovery could potentially be the beginning of a significant new gold district in Canada. The company’s June 2014 technical report estimated a high-grade gold resources with potential for underground extraction in the Borden Gold Project totalling 1.60 million ounces of gold in the Indicated Resource category (9.3 million tonnes grading 5.39 grams of gold per tonne), and 0.43 million ounces of gold in the Inferred Resource category (3 million tonnes grading 4.37 grams of gold per tonne) at a 2.5 g/t Au cut-off. The deposit still remains open for expansion.
6th Annual PDAC-SEG Student Minerals Colloquium

The Laurentian University and Ottawa-Carleton Universities SEG Student Chapters, in partnership with PDAC, Abitibi Geophysics, Goodman School of Mines, SEG Canada Foundation, and the CMIC Exploration Footprints Network highlighted current research by BSc (Hons), MSc, and PhD students and PDFs across Canada in all disciplines with a link to mineral deposits including mapping, mineralogy, geochemistry, and environmental research at the 6th Annual PDAC-SEG Student Minerals Colloquium on Monday, March 01, 2015 in the Ballroom of the Fairmont Royal York Hotel.

Best Poster (Ph.D. category) was awarded to Volker Moeller (Ph.D. student) by Alan Gallen (Exploration Research Director - Canada Mining Innovation Council)
Willy Trip 2015
Peru Highlights

This year, the Willy Trip went to Peru for an unforgettable experience! We went from the desert to the Andes to the altiplano and back. Here are some highlights from the trip:

February 20th:
Our journey began with an evening flight from Montreal to Lima. On the flight, there was a buzz of excitement and anticipation for the trip that lay ahead (except when most of the group members fell asleep).

February 21st:
When we landed, the excitement flooded back past the grogginess. We spent the day driving along the coast and through the desert to Nazca, our first stop.

February 22nd:
We drove from Nazca to Abancay this day, with a few stops along the way.

Stop 1: Willy gave us all a brief overview of the geological context of Peru, with emphasis on the Andean orogeny.

Stop 2: Rare examples of rhyolitic flow banding

Stop 3: Onion-skin weathering

Roadside view outside of Nazca

February 23rd:
The drive from Abancay to Cusco provided us with many opportunities for geological stops. The highlight this day was a large dolomitized face where a reverse fault was visible. Hematite alteration and other visual clues lead us to conclude that this was a sedimentary sequence of a continental shelf environment.

February 24th:
Incan ruins were the highlight of the day. First, Sacsayhuamán where some of the boulders used to make the site weighed in at as much as 300 tonnes. Even at the ruins we found some interesting
geology, as we observed smooth surfaces left behind by glacial scouring. Next, we drove to Moray, where there are numerous concentric terraces with elevation differences that are theorized to have been used for experimental agriculture as the temperature could vary up to 20 degrees. Observations of the surrounding rock types, specifically marble found within the site, allowed us to conclude that this is a carbonate area. This helped shed light on how the site was created; we theorized that a cave likely collapsed, creating the bowl shape seen.
February 25th:
We started the day in Santa Teresa, and woke up early to take the train to Machu Picchu, however the bridges to the train station had been washed out by the Rio Vilcanota! After overcoming a few obstacles, we finally made it to the town of Aguas Calientes, where we stayed the night and enjoyed the hot springs. Relaxing in the water did not prevent a geology lesson though! Near the springs we saw some chemically altered outcrops and Willy explained the importance of cooling rates on grain size. We saw examples of xenoliths, xenocrysts, and phenocrysts, and learned to distinguish them. Lastly, we spoke about the importance of fluids and how they can deposit silica such as quartz filled veins, which we spotted in one of the rocks.

February 26th:
Machu Picchu was the highlight of this day. Most of the group hiked to the top of Huayna Picchu for some spectacular views of the site and of the Andes. We learned that Machu Picchu was built upon a graben that was formed by a gradual subsidence downward of the block created by two parallel running faults. We saw seismic evidence from the structures in the ruins. In one room, the blocks of rocks were shifted in a stair-stepping manner showing evidence of an earthquake. Also, the granitic composition of the surrounding rock lead to a distinct foliation of granites.
February 28th:
A visit to the San Rafael tin mine was the main attraction of this day. Here, we had an underground tour of the mine as well as a visit to their labs and refining center. The ore being mined here was tin, found in the mineral cassiterite. The ore body was found in an S-type granite intrusion, where the major tin mineralisation likely formed in the zone of maximum compression from the Nazca plate subducting under the North American plate. Underground, we were brought to an area with very fresh surfaces, which was being prepared to be mined. Here we observed metallic minerals such as pyrite, chalcopyrite and cassiterite. Other minerals found were tourmaline, quartz and chlorite. A hypothesis, made by Willy, is that tin preferentially deposits as Sn$_2^+$ rather than Sn$_4^+$ so the deposition could be controlled by an increase in $f\ O_2$ and a decrease in temperature. The conditions for which tin (or cassiterite) forms will be further studied by a student conducting a research project with Willy this summer, where these suggestions will be tested.

March 1st:
This day, we got to see the city of Puno and Lake Titicaca. We visited a large outcrop on the side of the lake which consisted of alternating layers of sand and silt, with the sand being the dominant lithology. The outcrop had a red colour that is indicative of continental deposition as the hematite present is oxidized. We continued driving south to get to Arequipa, though we quickly ran into more irresistible geological features. A highlight of the outcrops was a volcanic sequence with horizontal bedding varying in colour from white to grey to brown, making one almost believe that it was sedimentary! However, the proximity of large volcanoes such as El Misti and Ubinas convinced us that this outcrop was of volcanic origin. You could see clear unconformities in the outcrop caused by the abrupt nature of the volcanic eruptions. Another key feature was the fining-
upwards sequence that shows the heavier material being ejected first and the lighter ash settling later on, hence the graded sequence.

Volcanic sequence outside Arequipa near El Misti and Ubinas Volcanoes
March 2nd:
We spent the day in Arequipa while our cars were being repaired, and enjoyed taking in the Peruvian culture.

March 3rd:
We visited the spectacular open-pit Cu-Mo Cerro Verde mine. We first learned about the geology of the area and the types of alteration we would be seeing, where our knowledge of porphyry deposits from class allowed us to appreciate the complexity of the deposit. We were taken to a lookout where we saw the mine in action, and then to the core shack. There, we were shown samples of propylitic alteration and wonderful samples of pyrite, malachite and gypsum were on display.

March 4th:
The highlight of this day was a visit to the incredible Nazca lines. We took a short 30 minute plane ride and got to see not only the lines, but much of the surrounding desert and mountain region. Due to the nature of the flight, the hours following the plane tour saw many members of the group with queasy looks on their faces. Despite this, we pressed onwards to an oasis town called Huacachina near the city of Ica. Upon our arrival we drove out into the dunes and set up camp under the full moon.
March 5th:
After a restful night spent sleeping on the sand we woke up in our tents to the sun soaked dunes of Huacachina. We visited the small village and admired the oasis; our real adventure of the day was gearing up: sand buggies! Like a rollercoaster on sand, the experience was exhilarating! Sand flew everywhere, hats and glasses too. Committed to being covered in sand, we decided to give sand boarding a try, followed by an adrenaline packed race between the two buggies on the way back to the oasis. That night was spent in Paracas where many of us savoured traditional Peruvian dishes including ceviche and rice, followed by various kinds of seafood. The restaurant was set on a balcony opening out onto the beach where there was a live concert, seemingly to bid us a farewell on our last night in Peru.
March 6th:
As our final full day in Peru, we were all eager to make the best of it. In the Paracas municipality, we made arrangements for a boat ride to the Reserva Nacional Islas Ballestas. We met our boat at the port, and within a half hour we were heading out towards the renowned islands off of the Paracas peninsula. True to our hopes, the diversity of fauna was stunning. From dolphins that joined the boatside just minutes into the tour, to the penguins, sea lions and flocks of birds that take transient or permanent residence on the Reserva Nacional Islas Ballestas. Beneath the plentiful guano and along the island faces exposed to the ocean, we had the opportunity to see some beautiful geologic and geomorphic features. We drove away from Paracas with heavy hearts for the long haul back to Lima to catch our flight and return back to the dark snowy reality of Montreal.

Penguins at Reserva Nacional Islas Ballestas in Paracas peninsula

March 7th:
Our journey came to its close on this day, and while we were all sad to leave, we left inspired by some of the most incredible experiences of our lives. From picking apart diverse roadside outcrops, to examining the geology of the Machu Picchu landscape. From seeing the Andes and expansive deserts in the same day, to exploring a mine at 5000m above sea level. The Willy Trip 2015 brought all of us unforgettable and invaluable experiences that will carry through our careers and lives.

Thank you to everyone who supported this amazing trip from all of the Willy Trip participants! German Romero Acevedo, Eric Grandillo, Alexandre Krushnisky, Stephen Mastromonaco, Amy McNamara, Emily Griffiths, Paul Rakoczy, Catherine Ross, Konrad Chrzastowski, Ariane Loisel, Sophie Coulson, Mackenzie Muntwyler, Haylea Nisbet, Jake Casselman, Kassandra Sofonio, Alex Geen, David Martineau, Bo Suk Kim, Julie Halotel, Amelia Berot-Burns, Jade Sauve, Taylor Peacock, Torie Roseborough and last but not least, Anthony "Willy" Williams-Jones.
David Palmer
PDAC Prospector of the Year

The Bordon Deposit – Ontario’s most unexpected gold discovery!

Dave Palmer (M.Sc. ’94, Ph.D. ’99)
Thursday, March 26, 2015 - 3:30 pm
Redpath Museum Auditorium
1st row (left to right) – Christie Rowe, Jysotana Singh, Jennifer Abbott (Science Advancement), Ian Carvalho-Campos (B.Sc. '13, Rowan Wollenberg

2nd row (left to right) – Nick Harrichhausen, Naomi Barshi, Jethro Sanz-Robinson, Alexander Timofeev

3rd row (left to right) – Sri Utami
Left to right – Alain Garand (B.Sc. ’97, M.Sc. ’03), Nicolas Gaillard, Karin Siegel, Rowan Wollenberg, Dave Palmer, Nick Harrichhausen, and Willy Williams-Jones
Left to Right: Leo & Audrey Halverson (on sabbatical), Luc & Isaac Wing (lecture tour) – Downunder in Australia – Spring 2015 - Kings Park (Perth)
Luciano Venditelli’s (B.Sc. ’85) vineyard rock garden – grapes growing on dolomitic limestone
Field School I changed venue in 2015 after many decades of mapping in Sutton, QC. The sale of the Schweitzer's farm which was our historic base meant that costs were going up, and the coincidence of 80+ geo-engineering students from Queens resulted in the area being thoroughly overrun with mapping students, increasing friction with the landowners.

So, we flew to Las Vegas! We spent 2 nights in Valley of Fire state park, within radiantly colored Jurassic aeolian sandstone, familiarizing the students with mapping on aerial photos. We then moved into the Muddy Mountain Wilderness for a 4-day topographic map-based exercise in the Muddy Mountain Thrust, where Cambrian dolostones tectonically overly the Jurassic sandstone. Both are unconformably overlain by Miocene evaporites and lacustrine silts. This Sevier (Cretaceous) low-angle thrust is cut by both strike slip faults of the Las Vegas Valley Shear zone and Basin and Range normal faults, so there is a lot of structure to worry about!

We then drove into California and spent a day visiting interesting geology around Barstow, including very young basaltic cones (where at least one student discovered a passion for climbing through lava tubes) and visiting the silver mining ghost town at Calico. The next mapping exercise was in Rainbow Basin, a Miocene graben known for yellow, green, purple, white, black and red silts. Here, the students had to make a cross section from their maps including many small stratigraphic and structural problems.

The final leg of the trip started with a sight-seeing day driving into Death Valley. We stopped at the Trona towers (tufa formations on the bed of a Pleistocene lake) and tried to go into Death Valley via the Panamint Range - only to be stopped by a washed out road, a skewer of schist through a tire, and a National Park ranger. So, we went in via Stovepipe Wells, and climbed up Mosaic Canyon to see calc mylonites (a tectonized equivalent of the undeformed dolostones we had mapped in Muddy Mountain!). Running around the Mesquite Flat sand dunes helped everybody blow off some steam. The next day we ran down the walls of Ubehebe Crater, sliding in the pumice and ash, walked into Titus Canyon to see the famous megabreccias, and walked out onto the salt pans at Badwater, 86 m below sea level! From Badwater there is an incredible view of the Badwater detachment and the strike slip fault system along the eastern edge of the valley.

After camping at Furnace Creek, we stopped at an offset basalt cone and a welded ignimbrite on the way back to Las Vegas to clean up and store the camping gear for next year.
Very first day of mapping at Muddy Mountain, Nevada
Compasses and topo maps out – students head out to figure it out on their own ...
alite polygons at Badwater in Death Valley

Christie Rowe on Split Cinder Cone in Death Valley
This fieldtrip to the Colorado Mineral Belt was organized by the McGill SEG Student Chapter. It is aimed to provide opportunities for students to assess the dimensions, geology and mineralogical complexities of well-developed hydrothermal systems.

The deposits to be visited include epithermal vein and disseminated style deposits, carbonate-hosted manto/replacement, roll-front type uranium deposit and carbonatite-hosted REE deposit. Examination of open-pit exposures, drill cores and outcrops will focus on recognizing the characteristics of epithermal-type mineral assemblages, including study of the distribution and zoning of ore-forming minerals, variations in alteration assemblages, multiple mineralization events, hydrothermal processes and their geochemical signatures.

On the morning of May 17th, 2015 a group of seven students from the McGill SEG Student Chapter drove from the arid conditions of Denver into the mountains to the heavily fenced, snow-laden Climax Molybdenum mine at 11,360 feet above sea level. This would be the beginning of an unforgettable trip around the Colorado Mineral Belt. Upon our arrival, we met Dr. Vince Mathews who gave us an overview of the geology of Colorado and the history of molybdenum mining in the state. Molybdenum from the Climax mine was initially used during the First World War for making weaponry. Cannons that were crafted out of molybdenum alloys withstood higher temperatures than ordinary cannons and therefore didn’t melt during repeated gunfire. Vince then accompanied us to the historic Pb-Zn-Ag-Au mining district of Leadville where, after some scavenging around some old mine dumps, we found rock samples containing zinc mineralization in the form of hemimorphite and smithsonite. These are common oxidation products of the upper
part of the sphalerite-bearing orebody. We then visited Leadville’s mining museum where we saw a diverse number of exhibits ranging from samples of Colorado’s state mineral rhodochrosite to the historical carbide lamps used by the miners during Leadville’s mining bonanza. After this exciting first day we made our way to the town of Gunnison where we stayed the night.

On the morning of the next day we met with Prof. Allen Stork of the Colorado State University in Gunnison, who accompanied us to the Iron Hill carbonatite complex, a REE (rare earth element) deposit that is also rich in thorium and niobium. The large carbonatite had intruded the pre-existing Proterozoic granites, syenites and metamorphic rocks and was the main source of the REE mineralization in the region. Walking around the area, we encountered a variety of unusual rock types and minerals such as perovskite (which was commonly associated with magnetite). We were told that the owner of the land had initially thought of mining perovskite as a source of titanium but then realized that it was very difficult to remove titanium from the perovskite lattice. Consequently, Iron Hill remains a large, untapped source of titanium. After a long day in the field, where most of our group members got burned by the bright Colorado sun, we drove to Creede in search of a hamburger, a beer and some much needed rest.

Early on May 19th we awoke to snowfall outside our small wooden cabin in Creede. We drove further up the mountainside to visit the Bulldog mine, an intermediate sulphidation epithermal silver deposit. At the mine site, we were greeted by Jonathan Moore from Hecla Mining with whom we discussed the mining history of the region, the geochemical factors affecting ore deposition and good prospective sites for future exploration and drilling. After an intense discussion with the mine geologists about the formation of the ore deposit, we were taken to see drill core from different parts of the mine. As we left the Bulldog site, we caught a stunning view of the Snowshoe mountain resurgent dome in the Creede Caldera. Nicolas vehemently reminded us that the Creede Caldera is nested in the La Garita Caldera, which was formed from the largest known explosive eruption in Earth’s history. In the afternoon we visited the small but impressive historical underground mining museum of Creede.

The following morning we drove to the Black Canyon of the Gunnison National Park. The walls of the Canyon are black, not because they are made out of “Black Granite” (as the motel owner at Gunnison proudly proclaimed) but rather because the steepness of the canyon walls prevents light from entering, which means that the depths of the canyon are permanently shrouded in shadow. We saw the canyon from several different sites and contemplated the vast network of pegmatite dykes crosscutting the metamorphic basement rocks of the canyon and even caught a glance of the great unconformity: a 1.5 billion year old gap in the geologic record between the Precambrian basement rocks and the much younger Jurassic sedimentary sequence of the Black Canyon.

After staying a night in the scenic town of Ouray, we headed a short way up into the mountains in search of the Revenue Silver Mine. There we met up with the chief geologist of Fortune Minerals who gave us an explanation of the historic mining and geology of the area (the San Juan-Uncompahgre Caldera complex). We suited-up in the latest-fashion mining attire and walked about 3000 feet into the underground mine, where the main ore body is currently being exploited. Tetrahedrite is the main ore mineral in the veins lying within the high grade epithermal body, along
with sulfosalts. In the darkness of the mine, the overwhelming noise from the machinery and the underground ventilation system, we spotted a large quartz vein displaying sulfide mineralization on the surface. We frantically hammered the vein and were jubilant to see the distinctive metallic glint of massive sphalerite ore under the light of our headlamps. We returned to the surface along the well-used tracks of the mine in an ore cart; our pockets full of sphalerite and some silver ore that the safety officer of the mine had given us permission to collect. The experience inside the mine was memorable, but we were relieved to be greeted by the fresh air upon resurfacing.

After a relaxing stay at Ouray including some smaller hikes and a short trip to the historic mining town of Silverton, we made our way to Telluride in search of uranium the next day. For several days we had been looking forward to exploring the Uravan Mineral Belt, a sedimentary basin rich in uranium and vanadium mineralization. This region had once been the object of intensive uranium exploration during the 1940s as a result of the Manhattan Project and remained active into the late 1980’s, but exploration in the area has now diminished greatly. Our experience in the Uravan mineral belt surpassed our expectations, largely because we were joined by Dr. Anthony Kovschak (a.k.a Tony), a very experienced and enthusiastic uranium geochemist and sedimentologist who gave us a thorough tour of the region. We visited different parts of the Uravan mineral belt including the Morrison Formation which consists of mudstone and sandstone anticlines that are host to a variety of exotic uranium minerals. Tony explained how uranium is leached by hydrothermal fluids from the overlying rocks in the sedimentary sequence and is concentrated into the reduced, carbonaceous sediments below. This was clearly observable in the field, where we repeatedly located carbonaceous strata that were full of vividly coloured uranium-vanadium ore minerals such as tyuyamunite and carnotite. The day ended with a breathtaking drive from Uravan to Grand Junction where we encountered imposing windblown sandstones and salt diapirs along the way and were even lucky enough to witness the formation of a rainbow which served as the perfect background for such sights.

The next morning we awoke to an early coffee and waffles followed by a short drive to the Colorado National Monument Park near Grand Junction. The Colorado National monument is a high altitude desert filled with bizarre and beautiful monoliths and valleys formed from the erosion of red sandstone. After spending some quality time looking at the stratified rocks and structures of the Colorado National Monument we embarked on a long journey through the Rocky Mountain belt to arrive in the town of Cripple Creek, where we stayed the night.

The following day we drove from Cripple Creek to the nearby town of Victor to see the active open-pit Cripple Creek gold mine. The gold deposit is hosted within an Oligocene alkaline volcanic complex (the remains of an ancient volcano) and has been subject to a complex history of magmatic activity and hydrothermal alteration. Our tour of the mine included a look at the historic mineshafts that comprise much of Victor’s landscape as well as the operational gold mine itself. The open pit mine was busy, with ore trucks continually carrying piles of crushed rock from the mining site to the leach pad in the center of the pit. The walls of the pit were lined with thick black tubes that transport dilute sodium cyanide solution to the leach pad. This solution is used to leach gold from ground-up rocks extracted during blasting.
As the day progressed, we raced the clock to make it in time for our final destination of the trip, the Garden of the Gods. This was yet another place of great beauty, full of towering, oddly-shaped sandstones and limestones (the eroded remnants of ancient, tilted sediments) and would prove to be a suitable ending to our remarkable, action-packed journey through Colorado.

Figure 1. High altitude Leadville Ag-Zn-Au-Pb district

Figure 2. Riding the ore cart at the Revenue silver mine
Figure 3. Sandstone sequences of the Colorado National monument

Figure 4. Using a regional geologic map to decipher the rock units surrounding Ouray
Figure 5. Searching for uranium mineralization in the Uravan Mineral Belt

Figure 6. Uranium-vanadium mineralization (yellow) occurring in black, reduced carbonaceous material
We are very thankful to our sponsors Robert Wares, the McGill Earth & Planetary Science Department, The Society of Economic Geologists, Divex and AMIRA for their funding support that made this trip possible.

Jethro Sanz-Robinson (Ph.D. student) & Paola Reyes (M.Sc. student)

Edited by Karin Siegel (Ph.D. Student) & Alexander Timofeev (Ph.D. student)
Tour d’Afrique du Sud
June 2015

On June 15\textsuperscript{th} 2015 a McGill party of six departed from Cape Town, South Africa for a two-week geo-safari around the country. The party included McGill alumni, staff and students: Bob Wares, Jim Clark, Christie Rowe, Nick Harrichhausen, Noah Phillips and Nils Backeberg. During the two weeks the geo-safari covered over 6000 km, driving all the way back through Earth history. We looked at geology from the latest supercontinent break-up, when the Americas departed from Africa, till the earliest rocks-records with some of the oldest preserved sedimentary basins, which also happen to be well endowed with the world’s largest gold deposit – the Wits. South Africa is host to large economic deposits of a wide variety of commodities and we explored massive-sulphide deposits 1.8 km underground, open-pit iron ore mines, platinum and chromite mineralization in the iconic Bushveld layered igneous complex, the wits gold we observed at 3.2 km underground, and diamonds in Kimberley where the open-pit mine was dug entirely by hand. On top of world-class ore deposits the tour had a rich itinerary of geology, culture and wildlife (see highlights and pictures).

A big thank you goes to Bob Wares for having sponsored this field trip. If you are interested in your own personalized geo-safari through South Africa / Namibia, please contact Nils Backeberg (field trip organizer and leader) at nils.backeberg@gmail.com.

Bob Wares, Christie Rowe, Noah Phillips, Jim Clark, Nick Harrichhausen, & Nils Backeberg (Ph.D. ’15)
Geo-safari summary/highlights:

- The Aggeneys massive sulphide deposit
- Augrabies waterfall cutting through granite-gneiss basement
- Kolomela iron ore open pit mine – a red tinted world
- Driving onto a craton: going back in time…
- Pilanesberg alkaline igneous complex with stone age relics and wildlife
- The Bushveld layered igneous complex and Dwars River heritage site
- Barberton, the 3.5 billion year old greenstone belt
- Vredefort impact structure and pseudotachylites
- The Wits gold deposit, deepest mine in the world (down to 4 km)
- Kimberley diamond mine and eclogites
- Permian-Triassic fossils of the Karoo and *not-so-fossil* wildlife
- Cango Caves, limestone caving experience
- The Cape Fold Belt mountains, one of the world’s oldest mountain ranges
- Cape Vineyards and wine tasting on the edge of the mountains
- Cape Town geology in a day with Table Mountain and Darwin’s footstep
Jim Clark hunting for diamonds in potholes along the Orange River by Augrabies Falls

Bob Wares and the black chromite layers at the Dwars River heritage site of the Bushveld layered igneous complex
Christie Rowe
Pilanesberg Intrusive Complex (National Park)
having Sundowners ...
Noah, Christie and Jim looking at the spinifex textures of the 3.4 billion year old komatiites along the Komati River.

Jim standing for scale next to a quarried face of pseudotachylite from the Vredefort impact structure.
In the Pilanesberg national park combining geology with wildlife
“Dangerous animals may be encountered. You leave your vehicle at your own risk”
From left to right: Bob, Noah, Jim, Nick, Christie and Nils
A small highlight of the African wildlife we were lucky enough to enjoy during the geo-safari. In clockwise order from top left: Elephant herd with young babies and teenagers having fun along the road. Asses of Africa – the rump side of the wildlife is a common view, here a rhino and a giraffe showing us their contribution. Lioness basking in the sun in the Karoo national park.

Nils Rainer Backeberg (Ph.D. ’15)
nils.backeberg@gmail.com
Participants explored a few locations that provided an overview of the regional stratigraphy and geologic setting. Montreal lies within the St. Lawrence Lowland geological province and is characterized by the presence of the striking topographic feature on the island, Mont Royal. This mountain is part of the Monteregian Hills, igneous plugs intruded into the surrounding Paleozoic platform sedimentary rocks that, in this area, are more than 2 km thick! Finally, the morphology and young sedimentary rocks of the region reflect modification by recent glaciers (~18ka). From the look out on Mont Royal, you can see the regional geology overview – Monteregian Hills, glaciations, stratigraphy, tectonic setting during the Cambrian-Ordovician. The group made their way by bus to Hanson Brickyard – a very shallow quarry that is mainly excavated for brick-making material. The quarry works as a “ripoperation” where the bottom of the quarry is ploughed up twice a year and the material is allowed to weather for ~3 months. This effort, the quarry is deepened ~30-40cm per year and provides ~100,000 tons annually. The dark grey shales are part of the Nicolet River Formation within the Lorraine Group. Within the quarry wall, small Monteregian dikes can be seen cutting through the shales. The shale beds are host to abundant fossils: tribobites, brachiopods, crinoids, bivalves, gastropods, cephalopods, and graptolites.
From the quarry, the group travels to the Pointe de Buisson Archeological Park near the rapids between the St. Lawrence River and Lake St. Francis. This locality was an important Amerindian fishing and portage site. The park museum contains Amerindian artifacts as well as a Fossil Garden assembled largely by Pierre Groupx, and the newly building “Hans Hofmann Hall”, a dedication to the work Hans Hofmann (B.Sc. 58), McGill alumnist, professor and paleontologist. Of particular interest are the Climactichnites trace fossils withing the Potsdam Sandstone. Some of the largest and smallest of these trace fossils ever found are now located in the museum. Other features to note are mud-cracks, ripples, and cross-beds.
Metallogeny of rare earth elements and other rare metals, and Implications for mineral exploration

Tuesday, 6th of October, 8 A.M. to 4 P.M., Hôtel Bonaventure Montréal

This short course will focus on the metallogeny of Rare Earth Elements (REEs) and other Rare Metals (e.g., Ta, Nb, Sn, Zr, Be and Li). Rare elements are becoming increasingly important to society as they represent highly strategic resources used in numerous industrial sectors. Exploring for these commodities has become critical to ensure the uninterrupted supply to industry.

The course aims to provide an overview of the rare-element uses, ore genesis and mineral deposit features. The main aspects to be apprehended will include the geochemistry of rare elements (magmatic and hydrothermal behavior and processes) and the favourable environments for rare-element ore genesis, including (i) carbonatites; (ii) peralkaline (Si-undersaturated and granitic); and (iii) peraluminous granitic environments.

Descriptions of the main types of mineral deposits will be augmented by examples that have been the subject of detailed investigation by the speakers and their students (e.g., the Gallinas Mountains deposit in New Mexico, the Lofdal deposit in Namibia, the Wicheeda, Misery Lake, Nechalacho, Tanco, and Strange Lake deposits in Canada). These will be used as a framework to discuss the implications in terms of exploration (project targeting, favourable lithology and environment, geochemical and mineralogical prospecting…).

The one-day course is aimed at those who plan to learn more about and explore for such commodities, including young professionals and students, as well as managers who possess some geological background.

Dr. Anthony Williams-Jones, Professor of Economic Geology and Geochemistry, McGill University

Dr. Anthony Williams-Jones is Professor of Economic Geology and Geochemistry at McGill University and is an international leader in the development of the vapour transport model for porphyry/epithermal deposits and has made significant contributions to the development of genetic models for REE deposits, including experimental, theoretical, and field-based studies. He has been awarded the 2000 Derry Medal by MDD-GAC, the 2011 Logan Medal by GAC, the 2005 Peacock Medal by MAC, and the 2008 Bancroft and 2011 Miller medals by the RSC.

Dr. Robert Linnen, Robert Hodder Chair in Economic Geology, Department of Earth Sciences, Western University

Dr. Robert Linnen is the Robert Hodder Chair in Economic Geology at the Department of Earth Sciences at Western University (London, Ontario) and the Director of Resource Geoscience Western. His research focuses on intrusion-related mineralized. One area of expertise is precious metals, including gold and platinum group elements. The second area is critical metals such as Ta, Nb, W and REE. His research involves experimental studies to provide constraints on metal deposition and distribution and field studies, that combine geological constrains with experimental data to generate ore deposit models.

More information and registration at: https://aemq.org/fr/xplor/programmation_6oct2015
In Memoriam

John S. AUSTON (1937 – 2015)

AUSTON, John Saunders (Sandy) - August 9, 1937 – April 12, 2015 - John Auston, geologist, world traveller, philanthropist, avid photographer, beloved husband, brother, devoted father and grandfather, died Sunday morning in Vancouver after a long and valiant fight with non-Hodgkin's lymphoma. He was 77. John was born in Charlottetown, PEI, grew up in Montreal with his siblings David and Shirray, and attended McGill University, where he studied geology. A 40-year veteran of the mining industry, he spent much of his career in Toronto with the Selection Trust Group of London (which in 1981 became the minerals arm of British Petroleum). His working life took him and his family to Sydney, Australia; Denver, Colorado; Melbourne, Australia; and ultimately Vancouver. John was also President and CEO of Ashton Mining of Canada and, prior to that, President and CEO of Granges, Inc. In recent years, he sat on the boards of Cameco, Eldorado Gold and the BC Cancer Foundation. In addition to his esteemed mining career, John pursued many passions. His home office, filled with hundreds of books and over fifty photo albums, is evidence of his rich life, including his travels to over 30 countries, his large, boisterous family and his love of photography. One of his daughters told him his artful eye was so good, it made life look better than it was. But this was not how he viewed it. John loved everything about life, especially his beloved wife and life partner of 56 years, B.J. Auston; his four children, Victoria Auston (Jim Sinclair), Katy Southerland (Ned), John Auston, Jr., Genevieve Cole (Steve); and, his six grandchildren, Malcolm and Ellen Southerland, Julian Auston-Sinclair, Lucy, Josephine and Phoebe Cole. John guided them all with the highest of standards, the most moral of voices, and the greatest generosity of spirit. He was a sage and a philosopher too, a true Renaissance man. This enduring passion for living is part of what kept John alive and fighting for 14 years, tirelessly raising awareness and significant funding as a board member for the BC Cancer Foundation, resulting in a research award in his name. His lust for life, his unwavering ability to take the high road and the long view, the enormity of his lion-like heart and his willingness to give of it, will never be forgotten. We will work hard to carry forth his spirit and follow his fine example, all the while knowing that in his wake the world has lost some of its lustre and for now feels a little less grand. "Today while the blossoms still cling to the vine, I'll taste your strawberries and drink your sweet wine. A million tomorrows shall all pass away, 'ere I forget all the joy that is mine today." In lieu of flowers, please consider a donation to the BC Cancer Foundation or to the Paul Sugar Palliative Support Foundation. The BC Cancer Agency and the North Shore Hospice are two remarkable organizations full of caregivers whose skill and compassion lengthened and deepened the quality of John's life. Special thanks to Dr. Diego Villa and Dr. Joseph Connors for their many years of superior care. The Auston family is eternally grateful to all these many dedicated healthcare professionals. A celebration of John's life will be held in Vancouver at the end of May. To send a condolence to the family, please visit www.mcKenziefuneralservices.com.
It is with great sadness that we announce that Dr. Eric Laurence Hoffman, President and founder of Activation Laboratories Ltd. (Actlabs), passed away on 10 July 2015.

Eric was born in Montréal, Québec to parents Jenny and Kelly, and had 3 siblings, Barbara, Gordon, and Stanley. He received a BSc with First Class Honours with Great Distinction in Geology from McGill University in 1974, a MSc in Geology from McGill University in 1975, a PhD in Geology from the University of Toronto in 1978, and became a registered Professional Geoscientist (PGeo) in Ontario in 2002.

Eric was an economic geologist with over 30 years of experience in minerals exploration, analysis, and management. In 1978 he established Nuclear Activation Services Ltd., a partnership with McMaster University and the first commercial instrumental neutron activation laboratory in the world. In 1987, Eric established Activation Laboratories Ltd. (Actlabs) Group of Companies with a focus on commercializing innovative technologies with the highest quality standards to the minerals, metallurgy, petroleum, life sciences, environmental, forensics, materials testing, and agriculture industries, achieving global success by building and running a company with 27 laboratories and numerous employees in 12 countries. In 2014, Actlabs new 200,000 sq ft global headquarters was officially opened, a milestone for Actlabs growth and a symbol of how much he accomplished.

Eric received many honours and awards, including a 1971-72 JW McConnell Undergraduate Scholarship, a 1972-73, RPD Graham Undergraduate Scholarship; a 1973-74 Logan Undergraduate Scholarship; the 1974 Logan Gold Medal in Geology; 1974-75, 1975-76, 1976-77, and 1977-78 National Research Council of Canada Postgraduate Scholarships; 1978-79 and 1979-80 NRC Post-Doctoral Industrial Fellowships; a 2009 Canadian Innovation Leader award from Government of Canada, and the 2013 Gold Medal from the Association of Applied Geochemists. The AAG Gold Medal was awarded in recognition of Eric’s career as an industry leader in bringing novel analytical techniques to commercial fruition. He anticipated the evolving needs of the applied geochemist through technique design and instrument modification for a wide variety of sample media – key to longer term success as exploration has moved into progressively more difficult concealed terranes. He was a Fellow of the Geological Association of Canada and a Member of the Prospectors and Developers Association of Canada, the Northwest Mining Association, the Society of Economic Geologists, Canadian Mineral Analysts, the Association of Applied Geochemists, and the Professional Geologists of Ontario, and was member a CCRMP Advisory Group to CANMET.

Eric was greatly admired and deeply respected by all who knew him. He was an excellent businessman, a great innovator, a valuable contributor to the geochemistry community, a champion of geochemical research, and an icon of the Canadian mineral exploration scene. Eric published consistently throughout his career, was always in attendance at scientific meetings to present and
promote the latest in techniques and instrumentation in geochemical exploration. In addition to his close work with industry, hundreds of research papers in the peer-reviewed literature bear the mark of Actlabs’ contributions and Eric’s direct input. He was a strong supporter and sponsor of collaborative industry-university research projects in Canada and abroad. He will be missed by all who interacted with him for his drive and energy.

Eric leaves behind his wife of 38 years, Felyce, and his 3 children, Michael, Robbi, and Ariella. All four work at Actlabs and along with the rest of the Actlabs team continue to keep the company strong and thriving.

A scholarship fund has been established in Eric’s name in the Geology Department at the University of Toronto. Please contact Ariella Hoffman ariellahoffman@actlabs.com for more information.

Michael Lesher, Laurentian University
Matthew Leybourne, Laurentian University
Mark Hannington, Ottawa University
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Anne Kosowski
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Left Photo: Late Holocene moraine-dammed lakes in the Cordillera Huayhuash, Peru
Right Photo: Purgatoria Fault scarp in southern Peru

Jennifer Abbott or Kristen McGraw, Advancement, Faculty of Science, 3450 University Street, Montreal, QC H3A 0E8, (514) 398-4607, jennifer.abbott@mcgill.ca or kristen.mcgraw@mcgill.ca
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