McGill University

Earth & Planetary Sciences

Alumni Newsletter #23 January 2020

In 2008 and 2009, renewed exploration by Osisko Mining revealed an untapped new gold deposit, estimated at approximately 9 million ounces, beneath the town of Malartic. QC. The company would become Canada's largest ever open pit gold mine. The mine was developed within just six years after the first exploration drillholes in 2005. The first gold pour was in April 2011, and commercial production began in May 2011.

Chemical Formula: Au
Locality: Many places in the world.
Name Origin: Anglo Saxon, of uncertain origin.

Gold is a chemical element with symbol Au (from Latin: aurum) and atomic number 79. It is a bright yellow dense, soft, malleable and ductile metal. The properties remain when exposed to air or water. Chemically, gold is a transition metal and a group 11 element. It is one of the least reactive chemical elements, and is solid under standard conditions. The metal therefore occurs often in free elemental (native) form, as nuggets or grains, in rocks, in veins and in alluvial deposits. It occurs in a solid solution series with the native element silver (as electrum) and also

naturally alloyed with copper and palladium. Less commonly, it occurs in minerals as gold compounds, often with tellurium (gold tellurides).

Gold's atomic number of 79 makes it one of the higher atomic number elements that occur naturally in the universe, and is traditionally thought to have been produced in supernova nucleosynthesis to seed the dust from which the Solar System formed. Because the Earth was molten when it was just formed, almost all of the gold present in the Earth sank into the planetary core. Therefore most of the gold that is present today in the Earth's crust and mantle is thought to have been delivered to Earth later, by asteroid impacts during the late heavy bombardment, about 4 billion years ago.

Gold resists attacks by individual acids, but it can be dissolved by aqua regia (nitro-hydrochloric acid), so named because it dissolves gold into a soluble gold tetrachloride cation. Gold compounds also dissolve in alkaline solutions of cyanide, which have been used in mining. It dissolves in mercury, forming amalgam alloys; it is insoluble in nitric acid, which dissolves silver and base metals, a property that has long been used to confirm the presence of gold in items, giving rise to the term acid test.

Physical Properties

Cleavage: None
Color: Yellow, Pale yellow, Orange, Yellow white, Reddish white.
Density: 16 – 19.3, Average = 17.64
Diaphaneity: Opaque
Fracture: Hackly – Jagged, torn surfaces, (e.g. fractured metals).
Hardness: 2.5-3 – Finger Nail-Calcite
Luminescence: Non-fluorescent.
Luster: Metallic
Magnetism: Nonmagnetic
Streak: yellow

Canadian Malartic Mine - 2018

Note from the Chair

Dear EPS Friends,

As the decade comes to an end, I find myself reflecting on our Department's achievements over the past 10 years. We have hired outstanding new faculty, had retirements, and continue to graduate amazing undergrad graduate and graduate students. The important constant over the past decade has been our EPS alumni and friends who are steadfastly engaged and supporting our Departmental mission. Looking to the next decade, there will be more need than ever for geoscience training, expertise and research.

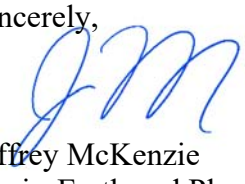
This past year we welcome back Prof. Eric Galbraith (B.Sc. 1997). Eric studies how we can use numerical models to understand the Earth System. I'm also excited to announce that Kristyn Rodzinyak (M.Sc. 2013) has joined EPS as our Outreach and Recruitment Administrator. Kristyn is going to help us tell Montreal and world about all the amazing things that happen in EPS. Join me in welcoming Eric and Kristyn!

Thank you again for all your support of the Department over the past year – it is great to see such generosity and engagement with our department. And, please continue to join me in in supporting the department (visit http://eps.mcgill.ca and click on 'give now'). And, you can also participate on March 11, 2020 through the #McGill24 online campaign.

If you are attending PDAC or live in the Toronto area, please come to our annual alumni event on the evening of Monday, March 2, 2020. It is a fun evening; catching up with friends and meeting more members of our EPS Community.

As always, I'm available to talk about the department – you can contact me at jeffrey.mckenzie@mcgill.ca.

Sincerely,



Jeffrey McKenzie
Chair, Earth and Planetary Sciences

January 1, 2020

New Faculty

Eric Galbraith – Full Professor

Eric rejoined the Department in August 2019 as a Full Professor and studies Earth System science, focusing on the dynamical relationships that link climate, biogeochemical cycles, ecosystems and humans. His work uses a combination of large datasets, simple theory and numerical Earth system models to identify novel processes and quantitative relationships. The overall goal is to provide new insights on how the systems function, by studying them through their interactions, rather than in isolation. Current work applies approaches from climate and biogeochemical numerical modeling to the coupling of humans and ecosystems, using theory from macroecology and the social sciences, in order to provide new perspectives on sustainability issues.

New Staff

Kristyn Rodzinyak *(M.Sc. ’13)* – Wares Outreach Administrator

I’m super happy to be back in the EPS family. I finished my masters looking at sulfur isotopes in North Western Ontario and Devon Island in 2013 with Boswell Wing and Richard Léveillé. I worked with the Canadian Space Agency before completing a Young Graduate Trainee with the European Space Agency creating educational materials to teach math and sciences to K-12. I also spent some time in Tampa at USF learning about phosphorous. Other than playing with rocks, I like to dance, climb rocks, cook, and play music.

Let me know if you want to be involved in mentorship programs or outreach activities!

EPSC 530 Volcanology
Costa Rica Field Trip
3-10 March 2019

This past reading week, the students of the Volcanology class participated in an exciting field trip to Costa Rica to learn about past and present volcanic systems in the region. The trip was packed with outcrop visits, interesting acidic water mixing phenomenon, bubbling mudpots, geothermal well sampling, hikes through the jungle, and testing water temperatures from hot springs to cold springs to the ocean.

Day 1 - Rincon de la Vieja and Miravalles Ignimbrites

We arrived late the previous day having only time for dinner before heading to bed. The next morning, we drove out to the edge of the Canas Dulces caldera to get an overview of the volcanic history of the region. There are actually several caldera systems here which have cut into one another over time. We visited many outcrops where the ignimbrite deposits from some of the caldera forming events can be seen up close. We even saw a re-worked deposit with accretionary lapilli from a phreatomagmatic eruption (interaction with water) and rounded pumices which had been transported in delta-like setting (image on left).

Day 2 - Tenorio Volcano

On the second day of our trip we hiked through the Tenorio Volcano National Park seeing lots of native wildlife as well as some spectacular geology. We got a chance to see spider monkeys, caught a brief glimpse of a coati as well as a central american whiptail lizards and some snakes. The goal of the hike was to see the amazing chemical mixing that occurs when the neutral Rio Buenavista river and the acidic Quebrada Agria stream meet forming the Rio Celeste river. The rapid change in acidity causes the particle size of the aluminosilicates in the water to increase which then refract the light producing the beautiful azure water. On the way we hiked down to the Celeste waterfall and up to the Tenorio volcano lookout where we could see the Tenorio Volcanic Complex consisting of Tenorio Uno, Tenorio Dos and Cerro Montezuma. After our hike we decided to visit some geothermal hot springs but they were unfortunately closed so we headed back to our lodge for a swim under the stars.

Day 3 - Rincon de la Vieja Geothermal Hike

Day 3 of the field trip was devoted to a long hike through the Rincon de la Vieja National Park. We started hiking early in the morning, following a leafy trail that led us through a densely packed forest to an opening area with the smell of bad eggs. As volcanologists, we soon found out two major areas with ongoing volcanic degassing, i.e. on a stream and in a pit. Maximum degassing in the area occurred in the subsurface within the pit, as marked by the large bubbles and violent bubbling. Although it was a dry season and the water level was shallow, we still decided to measure the temperature of degassing. Our instruments were a thermocouple and a smart temperature detector device that we carried throughout the hike. The two instruments generated similar readings for degassing temperatures with the pit temperature being slightly warmer than the stream temperature.

Day 4 - Geothermal Power Plant

After the visit of the geothermal power plant, a group of us decided to visit the nearby Las Hornillas hot springs, located at the base of Miravalles volcano. The site features two mud baths and three thermal pools, as well as a small path across an active geothermal area. After covering ourselves with mud from head to toe, we climbed the stairs to the active geothermal field, which we quickly realized is not a great idea bare feet. So we headed back down, rinsed off and jumped into the hot pool to relax for a bit.

Day 5 - Gas Sampling

This day was spent driving to different geothermal well sites and observing the gas sampling procedure done by ICE on a regular basis. While a simple procedure, this experience clearly highlighted the overwhelming amount of work that is put in by the company to maintain such a vast network of piping around the country. Even more surprising is the amount of wildlife surrounding the pipes, showing that with the right intentions, energy can be generated consistently and cleanly without harming the environment.

Day 6 - Samara Beach Day

After the long walks in the forest, high winds, and above 30°C temperatures, we finally had the chance to swim in the Pacific ocean, in the Samara beach. To our surprise, the water was tepid, so in a matter of seconds we all went in! Our last two days were long days of swimming and playing with the waves, as many of us hadn't gone to the ocean for a long time. Two of us even had surfing lessons, and seriously considered staying in Costa Rica and becoming professional surfers. At the first night in the Samara beach, we discovered an amazing small restaurant runned by a family, with amazing food and amazing piñas coladas… we went back the second night. Highly recommended!

Day 7 - Going Home

With the possible exceptions of airport dogs detecting U.S. dollars (a rather small amount) from one student's wallet in Costa Rica and a bit of wait to explain why we were carrying a methane detector in Miami; everything went smoothly.

Conclusion

We would like to thank the ICE Miravalles Geothermal Camp, especially Jessica Arias, for giving us a tour of the facilities. We are grateful for the generous support provided by the Department of Earth and Planetary Sciences which made this opportunity possible. Of course we also thank Dr. John Stix for organizing this amazing experience!

Willy Trip – Kenya & Tanzania

March 2019

The March 2019 Willy Trip to Kenya and Tanzania, sees our travel path intersecting the large scale geological structure of the East African Rift Zone. The active continental system is a developing divergent plate boundary wherein the African Plate is splitting into two plates - referred to as the Nubian and the Somali plate. This rift zone is comprised of two main lines, the Eastern and Western branches — the Willy trip this year intersects the Eastern branch which runs over a distance of 2200km from the Afar triangle in the north and ends in Tanzania to the south. The overall morphology of the rift zone is a series of adjacent individual tectonic basins with each succession of graben basins generally being bordered on the two sides by high relief-leading to an almost continuous parallel mountain lines and plateaus. As we travel through this rift zone, surface expressions we may observe include but are not limited to: Horst-graben topography, dyke swarms, various faults and volcanism.

Along our path, the Willy Trip itinerary brings the group to multiple points of interest, these include: Lake Naivasha and Hells Gate National Park, Ol Doinyo Lengai and Natron Lake, Ngorongoro crater and Lake Manyara, Olduvai gorge and active Tanzanite mines. Lake Naivasha and Hells Gate national park is

named for the intense geothermal activity which occurs within the parks borders. Located within this park are two extinct volcanoes, Olkaria and Hobley's, which are a part of the Olkaria volcanic complex which is comprised of roughly 80 individual alkali rhyolite centers. Also, within Hell's gate national park is the Hells gate gorge which is a narrow gorge lined on either side by red cliffs which contain two volcanics plugs: Fischer's Tower (25m tall) and the Central Tower. Traversing through the gorge, one is able to witness the gorges water eroded walls (evidence of a tributary that once fed a prehistoric lake), waterfalls, hot water springs, obsidian caves and colourful strata.

Ol Doinyo Lengai, or as Willy likes to call it the world's only Baking-Sodavolcano, is currently the only active natrocarbonatite volcano in the world. The carbonate magma that erupts from this volcano are at temperatures of 480-600C and have extremely low viscosity (similar to that of running water). The lava of Ol Doinyo erupts dark grey to black in colour and cools and solidifies as stark white, giving the summit of this 2,962m high volcano a unique appearance. It is suspected that the carbonate magma of Ol Doinyo Lengai is a result of the separation of a carbonate liquid from an alkaline silicate magma. Ngorongoro Crater, located within the Serengeti National park in Northern Tanzania, is one of the worlds largest volcanic calderas and formed approximately 2-3 million years ago. The caldera is approximately 610 feet deep and the floor covers 60 square kilometres. The crater is best known because the floor of the caldera is covered primarily by savannah and as a result is host to a large suite of animals. Lake Manyara located 80km South-East of the Ngorongoro crater is an alkaline with a pH near 9.5, however, this pH fluctuates depending on the season. Olduvai Gorge, made famous by the works of Mary and Louis Leakey is an important paleoanthropological site in the world for understanding human evolution. The site contains many hominid (or hominid-like) species being found to have occupied the gorge throughout history, this includes: Homo Habilis, Australopithecine, Homo Erectus, and Homo Sapiens.

Jenna Randazzo (B.Sc. student) and Maude Lemieux-Dion (B.Sc. student)

South Australia Field Trip

EPSC 550: Advanced Earth System History

May 2019

Australia Field Trip lead by Galen Halverson and Jeff McKenzie
Student Participants: Carlyn Allary, Arvid Gonzalez, Aube Gourdeau, Anna Hayden, Melanie King, Maude Lemieux-Dion, ShansHan Li, Jenna Randazzo, Maggie Whelan, William Wong, and Audrey Woo.

This was a field-based course targeting upper level undergraduate students in the Earth and Planetary Sciences and Earth Systems Sciences programs. The course included three days of workshops and a 13-day field trip in South Australia. The course was designed to introduce students to issues in Earth system science, applied to the present and the past. Topics covered in the course included issues regarding energy and water supplies for agriculture and urban use in an arid, urban environment, present and past consequences of human impact and faunal diversity of Australia, active tectonics, and the role of geology and soils in wine production. The course also explored past changes and perturbations in the Earth system, including geological evidence for global glaciations in the late Proterozoic (ca. 700 million years ago), the early evolution of animals, and mountain building events associated with the assembly of Gondwana. Students became familiar with diverse topics in Earth systems science and Earth systems history and the tools that scientists use to explore current and past phenomena and interconnections in the Earth system. Students received specific training in the application of advanced field and analytical techniques to interrogate the stratigraphic record and the geology of South Australia. Students also received practical training in fieldwork in remote settings.

The field trip was 13-days (including driving days) and covered diverse topics:

- Active tectonics in an urban setting
- Hydrogeology of the Adelaide region: overuse of available water resources, salt incursion, impacts of climate change
- Geology of the McLaren Vale wine region, including cool water carbonates, evidence of Cenozoic rifting between Antarctica and Australia, Permian glacial deposits
- The Cambrian Delamerian orogen
- The Lower Murray River and records of Holocene climate change
- The Coorong Lagoon: a rare occurrence of modern dolomite precipitation
- Pleistocene sand dunes and uplift of the South Australian coast
- Naracoorte Cave: Record of Australia's megafaunal extinction
- Mount Gambier volcanics
- The Flinders Ranges: from Snowball Earth to early animals
- Arkaroola Geological Park

Itinerary/Schedule

02-May	Thursday	Students leave for Australia (Galen Arrives in Adelaide)
03-May	Friday	En route to Australia
04-May	Saturday	Students arrive in Adelaide; Day off
05-May	Sunday	Optional: South Australia Museum; Cleland Conversvation Park
06-May	Monday	Workshops at University of Adelaide; Wine Terroir Course, Australia Wine Centre
07-May	Tuesday	Workshops/presentations at Flinders;
08-May	Wednesday	Hydrogeology of the Adelaide region
09-May	Thursday	Active tectonics & geology of the McLaren Vale wine region with Drew Lubiniecki (U Adelaide)
10-May	Friday	Transect of the Cambrian Delamerian orogeny with John Foden (U Adelaide)
11-May	Saturday	Welcome to Country; The lower Murray River Wetlands and the Coorong Lagoon
12-May	Sunday	Pleistocene dunes, Woakwine Cutting; Mount Gambier Volcanics, Naracoorte Cave tour
13-May	Monday	Drive to the southern Flinders Ranges; lunch and shopping in Burra
14-May	Tuesday	Holowilena iron formation and Sturtian glaciation at Holowilena South;
15-May	Wednesday	Brachina Gorge: From Snowball Earth to the Cambrian radiation; Ediacaran GSSP
16-May	Thursday	Trezona Formation; Acraman Impact; Wonoka Canyons
17-May	Friday	Arkaroola: Sturtian glacials and cap; Tapley Hill Formation to Balcanoona
18-May	Saturday	Arkaroola: Balcanoona Reef; Cretaceous glacial deposits
19-May	Sunday	Gammon Ranges: Skillogallee Fm. And Elatina tidal rhythmites
20-May	Monday	Drive to Clare Valley
21-May	Tuesday	Drive to Adelaide; Fieldtrip Finished; Optional stay at Adelaide Caravan Park

Tanzania Field Trip

McGill Student Chapter of the Society of Economic Geologists

May 2019

Figure 1. Group photo at the base of Ol doinyo Lengai

This year, our student chapter visited Tanzania for two weeks, exploring the various ore deposits, geology, and national parks. Throughout the trip, we visited several gold mines, a nickel laterite deposit, a diamond mine, and world-famous tanzanite deposits.

Starting on the eastern coast of Tanzania in Dar es Salaam, 9 McGill graduate students and 2 Canadian industry geologists arrived mostly jet lagged but in good spirits. We were greeted by an excited group of Tanzanian geology students and Professor Ronald Massawa at the University of Dar es Salaam's Geology Department. After introductions and a few presentations about the geology of Tanzania, we were off. With 9 McGill students, 2 Canadian industry geologist eight graduate students from the University of Dar es Salaam, Professor Ronald, two industry geologists from Acacia Mining, and three drivers, we all managed to fit into three vehicles.

The first two days were spent driving across the country, much of the ore geology on our itinerary was in the western and northern parts of the country. We stopped at the Geological Survey of Tanzania to visit their specular rock and mineral exhibit plus a local artisanal gold mine. Driven by sheer willpower, local miners have come together to mine shallow gold-quartz-vein mineralization.

Figure 3. The first group photo of the 2019 SEG McGill-UDSM group. Photo taken outside the Geological Survey of Tanania's rock and mineral museum

Figure 2. View of open pit mining at the Williams diamond mine

Our first mine visit was the Williamson Diamond Mine in Mwadui. This visit had great historical significance as the deposit was discovered by a McGill alumnus – Dr. John Williamson, in 1940. It has

had continuous operation since making it one of the oldest operating diamond mines in the world. Furthermore, with 146 square kilometres of kimberlite pipe at surface level, it is the largest diamond-bearing volcanic pipe in the world. The Williamson Diamond mine is a low-grade high tonnage operation, typically producing 6 carats per hundred tons of ore. However, significantly larger diamonds have been procured from the pit – including the Williamson pink diamond at 54.5 carats, which was presented to then-Princess Elizabeth and Prince Phillip upon their wedding in 1947. A 388-carat diamond was discovered in 1990.

The next few days were spent visiting different gold deposits in the area. The Geita Gold mine, operated by AngloGold Ashanti, represents a classic Archean mesothermal orebody hosted in banded iron formation (BIF). Gold-bearing fluids travelled along a contact between BIF and diorites. Currently, a well established open-pit operation, we visited their mining and processes districts.

The North Mara goldfield is composed of the Buzwagi and Bulyanhulu gold mines. Buzwagi is a low-grade shear hosted quartz vein deposit hosted in porphyritic granite, whereas Bulyanhulu mines narrow veins of gold-silver-copper mineralization. In some cases, secondary processes have created veins of gold.

Figure 4. Visible gold in diamond drill core at North Mara Gold Mine

For some in our chapter, this was their first time going underground. Underground visits are critical experiences for new geologists, and the mine provided a complete safety induction. Students got to experience riding in a shaft elevator and were able to practice mapping an underground face. The mining districts of Geita and North Mara are like the geology of the Abitibi greenstone terranes in Canada. Given many students obtain employment in the Abitibi, this experience provides students additional insight into this style of gold deposit formation.

Departing the gold region, we travelled inland towards the Dutwa Region, where we visited a nickel-laterite deposit in the exploration stage. This was an excellent opportunity to see the starting stages of the mining cycle. Geologists provided a detailed presentation on the lithology and controls of mineralization. We had the chance to see a complete section in the drill core. A vigorous debate broke out between

industry and academic groups on the nature of secondary Ni-enrichment and the potential for granitic fluids to be involved in the formation of the deposit.

Figure 5. Students inspecting drill core from the Dutwa Nickel Laterite Deposit

Next on our trip was to visit Ol donyo Lengai, the only natrocarbonatite volcano on the planet, we also visited the Serengeti National Park, the Ngorongoro Crater, and Lake Natron. The collaboration between industry and universities allowed us to sleep in the Serengeti National Park for a fraction of the typical cost. Seeing the sunrise over the Serengeti Plains, with giraffe, hyena, and lions roaming, is part of what makes SEG trips an unforgettable experience.

On our way back to Dar es Salaam, we visited the Tanzanite Mines at Merelani Hills. This s a rare opportunity. Tanzanite is only found in this small region near Mount Kilimanjaro. After being shown the evaluation process by a local gemologist, we were taken underground. Nearly 1.1km underground and hosted in graphite schist, it was a hot and dirty yet truly
rewarding experience.

Figure 6. SEG President Kyle Henderson and Erin Gibbons with Tazanite miners 1.1 km underground at Merelani Hills Tazanite Mine

This trip would not be possible without the local professors and geologist, willingly to take the time to help plan and execute the journey. These trips offer students the opportunity to visit and experience different cultures and see spectacular geology. This trip provided students with the opportunity to see various stages of the mining cycle, the exploration stages right through to development and processing. Our SEG chapter has a broad diversity of student backgrounds, and for some, it was their first time experiencing a mine and the geology of economic deposits. It provided critical experience in viewing/logging diamond drill core, open pit mining processing, exploration strategies, and underground workings. We are incredibly grateful for the support from the Earth and Planetary Sciences department.

McGill Student Chapter of the Society of Economic Geologists

Hello! This is a facebook group for the SEG McGill Chapter!
https://www.facebook.com/groups/275449812580300/
We will be posting events, talks and trip information which the SEG McGill chapter will be hosting!
Stay tuned!

If you have any questions please contact us at: seg.eps.mcgill@gmail.com

McGill Student Chapter of SEG
Department of Earth & Planetary Sciences
McGill University
Frank Dawson Adams, 3450 University street, Montreal, QC, H3A-2A7
Telephone: (514) - 398 - 6767
Fax: (514) - 398 – 4680

Spring 2019 Convocation

Earth System Science graduates: Ty Amorosano, Charlotte Cockburn, and Leon Koegel

In the News

Geology rocks, eh!
Eric Mountjoy Rock Garden
New Interpretive garden opens at Jasper Museum

Anita Mountjoy and her nephew Keith Mountjoy in the new interpretive geology garden outside the Jasper Museum and Archives. | F. Dragon photos

The building blocks of the Rockies are showcased in new exhibit at Jasper museum. The geological display and garden has been built in memory of one of the world's foremost experts on geology in the Rocky Mountains and the go-to authority on Jasper National Park, Eric Mountjoy. Eric Mountjoy began mapping the park in detail in 1958. He spent two summers exploring the rugged Miette map-area, collecting rock specimens, making notes and collecting aerial photographs. His geological map was immediately published by the Geological Survey of Canada, and he went on to produce seven more geo-

maps of other parts of the park. Eric Mountjoy died in 2010, but his legacy will last as long as the rocks he studied. Jasper museum received a bequest from the Mountjoy family in 2015 to provide geological education or research in Jasper. And after years of solid work from Jasper Yellowhead Historical Society, the exhibit is finally open.

Eric's wife, Anita, cut the opening ribbon Monday morning and described the new exhibit as "truly a garden of beauty". "This is a special, special day for me," she said through tears. "Eric would be delighted. He loved his profession."

The rock garden was mostly the work of Roger McQueen, Eric Mountjoy's second year PhD partner, and Ben Gadd, a Rockies naturalist, writer, interpretive guide. The duo were thanked at the grand opening by Jasper Yellowhead Historical Society member Warren Waxer, Jasper National Park acting superintendent Moira McKinnon and mayor Richard Ireland. Ireland said he had walked through the geology garden a couple of days before the opening and "was absolutely stunned by the range of emotions I felt. "The experience I had was like the water bubbling through the Miette formation for which Dr Mountjoy is best known," he said. "I felt a sense of pride in the museum for doing this, and thankfulness that in this part of the country we get to experience and present both human history and natural history."

Fuchsia Dragon | *reporter@fitzhugh.ca*

Robert François Martin

Robert François Martin was born in Ottawa, Ontario, Canada, in 1941 to Joseph Benoit Martin and Antoinette Bouvier. His father, a former school teacher, used to quiz him regularly about spelling in both English and French. This prepared him well for his extensive later work as an editor and obviated the need for computer-based spellchecking programs! He has three children and five grandchildren ranging in age from one to twenty.

Martin earned a BSc degree in geology from the University of Ottawa in 1963. He then earned an MS degree in geochemistry from Pennsylvania State University in 1966 and continued at Stanford University, earning a PhD in geology in 1969 (advisors: Frank Tuttle and Dick Jahns). He joined the faculty of the Department of Earth and Planetary Sciences at McGill University in 1970 and moved through the academic ranks to professor in 1984. He has been emeritus professor since 2008. He chaired his department from 1984 to 1987.

In 1978 Martin became, with Louis Cabri, coeditor of *The Canadian Mineralogist* and in 1982 editor-in-chief. He continued in this position for more than three decades, maintaining a journal with the highest standards in editorial form and scientific content. He has been a "hands-on" editor, reading and commenting on every aspect of scientific articles and helping authors get their message across with a precision to match the level of precision of the scientific data being reported. In retirement he has continued to serve as the series editor for the Special Publications of The Canadian Mineralogist, with No. 14 (Horváth et al. 2019) currently in preparation. He was the main author of No. 13, *Minerals with a French Connection* (2017).

Studies of the mineralogy of igneous and metamorphic rocks are a central focus of Martin's scholarly work, although his research interests are very broad. One hundred forty-four archival publications beginning in 1969 and continuing to the present day form an impressive and compelling body of scholarly work. He has mentored twenty-seven graduate students who have earned MSc and PhD degrees.

Martin is a lifetime member of the Mineralogical Association of Canada, a fellow of the Mineralogical Society of America, and a member of the *Société de Minéralogie et de Cristallographie* and the Mineralogical Society of Great Britain and Ireland. For his distinguished public service he has received the Berry Medal of the Mineralogical Association of Canada (2001), the Distinguished Public Service Medal of the Mineralogical Society of America (2004), and the Ambrose Medal of the Geological Association of Canada (2007).

Martin's interest in geology began as a pre-teen when he liked to dig fossils from limestone exposed in cliffs across the street from his home. As an undergraduate, he was infected by the enthusiasm of Prof. Donald Hogarth for minerals, in particular euhedral diopside crystals in an orange matrix in Grenville assemblages. But he put that aside to focus on granites, pegmatites, and feldspar mineralogy. During his career his interests broadened to include hydrothermally mediated metasomatic overprints as igneous rocks cool. At present, he is investigating granulitic terranes in collisional belts in Madagascar, Sri Lanka, and close to home in which melting reactions have produced liquids of granitic, nepheline syenitic, "amphibolic," carbonate, oxide, and sulfide composition. He is finally addressing the origin of euhedral crystals of diopside, fluorapatite, and phlogopite in Grenville Marble.

Besides geological and mineralogical research, Martin enjoys detective work, choral singing, and traveling.

Martinite from the type locality, Poudrette quarry, Mont Saint-Hilaire, Québec, Canada; 1.5-mm field of view. *Photo by Stephan Wolfsried*

Martinite, (Na,□,Ca)12Ca4(Si,S,B)14B2O38(OH,Cl)2F2·4H2O, is a very complex and exceedingly rare fluorborosilicate found only at a single locality, the Poudrette quarry, Mont Saint-Hilaire, Québec. The mineral was originally found in September 1991 by Gilles Haineault, Peter Tarassoff, and László Horváth on level 5 in the extreme southern corner of the Poudrette quarry. Additional material was found in 1992 and 1993 on level 6 just below the original find. Martinite was ultimately described and published by Andrew MacDonald and George Chao in 2007, after being designated as UK92 in the interim (Wight and Chao 1995). The mineral occurred in a small volume of sodalitolite segregations that also yielded the type material for eight other new species: abenakiite-(Ce), gaultite, griceite, nalipoite, rouvilleite, silinaite, steedeite, and nolzeite.

Martinite occurs in cavities in sodalite less than 1cm across as vitreous, colorless, transparent, tabular to lamellar, pseudohexagonal to pseudotrigonal crystals. More rarely, it is pale purple. The crystals are usually smaller than 1 mm across and 10 μm thick. The largest observed crystal is nearly 2 mm across. Crystals are tabular on (001) with perfect {001} cleavage; the thin plates have a distinctly micaceous appearance. Commonly, martinite forms fan-shaped or rosette-like aggregates. Associated minerals include albite, aegirine, ussingite, serandite, a eudialite-group mineral, vuonnemite, erdite, villiaumite, makatite, rasvumite, sazinite-(Ce), sazhinite-(La), litvinskite, kapustinite, molybdenite, lueshite, terskite, lintisite, galena, sphalerite, langite, posnjakite, UK55, UK73, and UK82, among others.

The mineral was named in honor of Robert François Martin, professor of geology at McGill University, Montreal, Québec, and longtime editor of *The Canadian Mineralogist.* Martin is a prominent investigator of feldspars, granitic pegmatites, A-type granites, and granulite-grade marble.

Rocks & Minerals, 94:4, 374-375
Who's Who in Mineral Names: Robert Francois Martin
Written by Steven C. Chamberlain
Photo by Russell Proulx.

Rethinking the way science is taught

The Office of Science Education is enhancing undergraduate science education with targeted writing exercises aimed at building students' ability to develop and convey their ideas

The Office of Science Education (OSE) was established in 2018 to promote innovative, evidence-ased approaches to teaching and learning in McGill's Faculty of Science. One of the OSE's first projects focused on a skill not traditionally at the forefront of science education: writing.

It could be a scene from a movie; sometimes it even happens in real life – a great idea hastily scribbled down on a napkin goes on to change the world of science, economics or entertainment. But what if those napkins of legend were something more than an ephemeral record of a flash of genius? Could the spontaneous act of writing be an indispensable step in turning a creative spark into a fully formed idea?

A learning community takes shape

A group of McGill scholars has been diving into questions like these in an effort to enhance undergraduate science education with targeted writing exercises aimed at building students' ability to develop their ideas and convey them to others.

“Oftentimes in academia, we ask students to write as a way for them to report on what they’ve learned, but we don’t ask them to write to develop their thinking,” says Marcy Slapcoff, a teaching and learning professional who was instrumental in establishing the Earth and Planetary Sciences (EPS) learning community.

Formed in 2018, the learning community brought together four faculty members and a master’s student from McGill’s Department of **Earth and Planetary Sciences** along with staff from the McGill Writing Centre, the McGill Library, and Teaching and Learning Services. At regular meetings, members have exchanged ideas and developed new ways to integrate writing into undergraduate science courses.

Writing with a purpose

From one of these meetings, EPS professor **Natalya Gomez** took the idea of using spontaneous writing as a teaching tool and tried it out on her class, Geodynamics (EPSC 510), the very next day. In her version of the so-called ‘ink shedding’ exercise, Gomez asked her students to write down, unrehearsed, a few quick ideas in response to the question, ‘What makes a good scientific presentation?’ After swapping notes and discussing what they had jotted down, the students came up with a collective set of responses that Gomez says was “better than anything I could have come up with myself.”

When it comes to writing tasks that are more formal in nature, Gomez says the learning community experience has led her to think more carefully about her students’ perspective when she is setting assignments: “We say, ‘Write a literature review’, but we could be much more specific. What is a literature review? Who’s going to read it? What’s the scope? What’s the point of it?” she says.

Slapcoff sums up this deliberate approach to writing by saying: “The best writing has an audience and a purpose. We want students to identify that in what they’re reading and then to try and start writing things that have an audience and a purpose.”

Science is still science

At the same time, Slapcoff is quick to emphasize that, for the EPS learning community, building better writing skills is not an end in itself. The skills and knowledge students are expected to master in the courses taught by learning community members remain wholly within the earth and planetary sciences domain.

“The most important thing is figuring out what the faculty want the students to learn during the class,” Slapcoff says.

“Then we look at those learning outcomes and figure out how writing can support them. If professors want their students to develop their quantitative skills; if they want them to develop a view of how the different earth systems interact; if they want them to understand taxonomies – whatever it is, the question we ask is: ‘How can writing support that?’”

Mastering new tools

Anna Hayden, who was an EPS master's student when she joined the learning community, says she appreciated the opportunity to learn more about different approaches to writing. The APOS framework, a structured approach to writing taught at the McGill Writing Centre, is one example of a strategy Hayden took away from the learning community and something she did not know about when she was an undergraduate majoring in earth and planetary sciences at McGill.

"Often it seems as if writing is the end result and you don't really get to practise that skill throughout classes that are primarily focused on numerical experiments, or simulations, or looking at rocks," Hayden says.

Communicating science to the wider world

While scientific fundamentals remain essential to undergraduate science education, Slapcoff notes that the ability to communicate science to a non-specialist audience is emerging as a learning outcome in itself.

"It's becoming clear that this is more of an urgent need," she says. "The public needs to better understand science."

Aiming to develop her students' ability to communicate earth and planetary sciences to an audience from outside the discipline, Gomez has been working with Diane Dechief from the McGill Writing Centre to create a blog-writing assignment for her upper-year earth system science course, Earth System Applications (ESYS 500). Collaborating on the same, semester-long research project, Gomez's students will give frequent updates as they investigate seasonality and climate change in the Saint Lawrence River Basin, with blog posts that describe both the process of conducting the research and their research findings in jargon-free language.

Meanwhile, Gomez's colleague **Peter Douglas** has his class, Isotopes in Earth and Environmental Science (EPSC 519), trying their hand at another form of science communication with an assignment modelled on the News & Views articles published in the journal, Nature. Gomez herself has had good results with a similar assignment in the past, having adapted the idea from an assignment created by McGill pharmacology professors Bastien Castagner and Jean-François Trempe.

Drawing on expertise from across the campus

This kind of exchange of ideas and teaching strategies across departmental boundaries is at the heart of the Office of Science Education's mission. Established in 2018 with Slapcoff as its director, the OSE takes an inquiry-guided approach in bringing together diverse expertise from across the McGill campus to tackle specific pedagogical questions.

"It really does start with interesting questions that come from the departments and from the faculty members themselves," Slapcoff explains.

“From there, we think about who we can bring together to start answering those questions. I don’t have all the answers but I know that if we bring the right people together – in this case, someone from Teaching and Learning Services, someone from our office, the Writing Centre, the Library, and EPS faculty members and students – and work together over time, we can start addressing these questions.”

Coordinated access to resources like the Writing Centre and the Library was something Anna Hayden particularly appreciated about the EPS learning community. Hayden, who is now working towards a Ph.D. at the University of Waterloo, thinks greater awareness of those resources would be of direct benefit to undergraduate students.

“I think McGill has all of the resources that a student really needs to be able to improve their writing, but it’s just the visibility of those resources that needs to be improved,” she says.

Taking the long view

Gomez says working with three of her fellow professors in the learning community – all at different stages of their career – has been an opportunity to take a long-range view of how students’ writing skills develop as they move through an undergraduate program.

“We each teach our courses and while we might know that this person is going to cover geochemistry and I’m going to cover earthquakes, I think we learned a lot about how writing is actually taught in the curriculum, which was not really formally known before,” she says.

“I think we still have a lot to learn from the rest of the department about how these skills develop over the course of the four years that our students are here.”

Fergus Grieve
Communications Officer
Faculty of Science

McGill Reporter
25 November 2019

Melting ice sheets may cause ‘climate chaos’

Current international climate policies do not take into account full effects on global climate

The weather these days is wild and will be wilder still within a century. In part, because the water from melting ice sheets off Greenland and in the Antarctic will cause extreme weather and unpredictable temperatures around the globe. A study – **Global Environmental consequences of twenty-first-century ice-sheet melt** *Nicolas R. Gollege, Elizabeth D. Keller, Natalya Gomez, Kaitlin A. Naughten, Jorge Bernales, Luke D. Trusel & Tamsin L. Edwards,* Nature 566, 65-72 (2019) - published recently in Nature (https://www.nature.com/articles/s41586-019-0889-9) is the first to simulate the effects, under current climate policies, that the two melting ice sheets will have on ocean temperatures and circulation patterns as well as on air temperatures by the year 2100.

Consequences for ocean circulation and water and air temperatures

“Under current global government policies, we are heading towards 3 or 4 degrees of warming above pre-industrial levels, causing a significant amount of melt water from the Greenland and Antarctic Ice Sheets to enter Earth’s oceans. According to our models, this melt water will cause significant disruptions to ocean currents and change levels of warming around the world,” says Associate Professor Nick

Golledge from Victoria University of Wellington's Antarctic Research Centre in New Zealand. He led the international research team made up of scientists from Canada, New Zealand, the UK, Germany and the USA.

The research team combined highly detailed simulations of the complex climate effects of the melting with satellite observations of recent changes to the ice sheets. As a result, the researchers have been able to create more reliable and accurate predictions of what will occur under current climate policies.

Warming in Eastern Canada and cooling in Northwestern Europe

Professor **Natalya Gomez**, from the Department of Earth and Planetary Sciences at McGill contributed to the study by modelling projected changes to water levels around the globe as ice melts into the ocean. The ice sheet simulations suggest that the fastest increase in the rise of sea levels is likely to occur between 2065 and 2075. Melting ice sheets will affect water temperatures and circulation patterns in the world's oceans, which will in turn affect air temperatures – in a complex ice-ocean-atmosphere feedback loop.

"Water levels would not simply rise like a bathtub," says Gomez. *"Some areas in the world, such as the island nations in the Pacific, would experience a large rise in sea level, while close to the ice sheets the sea level would actually fall."*

However, the effects of ice sheet melt are far more widespread than simply leading to changes in sea levels. As warmer melt water enters the oceans, for example in the North Atlantic Ocean, major ocean currents such as the Gulf Stream will be significantly weakened. This will lead to warmer air temperatures in the high Arctic, Eastern Canada and Central America, and cooler temperatures over northwestern Europe on the other side of the Atlantic.

New information to help shape future climate policies

According to the researchers, current global climate policies set in place under the Paris Agreement do not take into account the full effects of ice sheet melt likely to be seen in future.

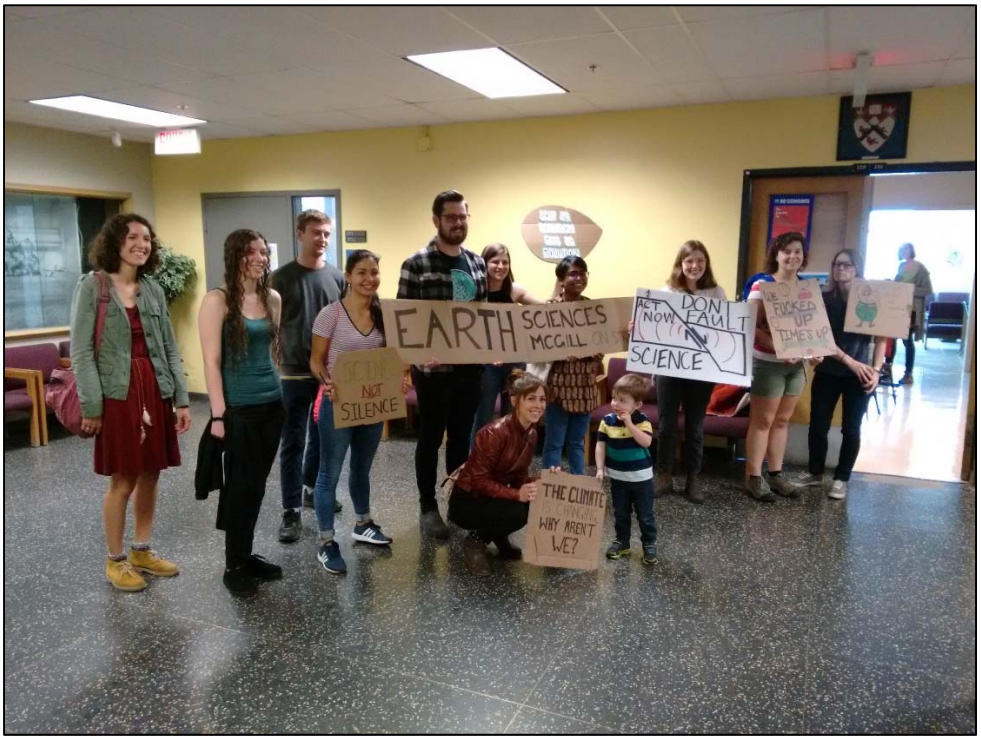
"Sea level rise from ice sheet melt is already happening and has been accelerating in recent years. Our new experiments show that this will continue to some extent even if Earth's climate is stabilized. But they also show that if we drastically reduce emissions, we can limit future impacts," says Golledge.

what'snew@mcgill
07 February 2019

Climate Change Protest

Downtown Montreal

27 September 2019



Mathilde Jutras

Prix Acfas Resources Naturelles 2019

Le 75e Gala de l'Acfas a eu lieu le 14 novembre 2019 à l'Édifice Jacques-Pariseau de la Caisse de dépôt et placement du Québec. À cette occasion, neuf prix Acfas ont été remis à des chercheur-se-s parmi les plus influent-e-s au Canada. Les cinq lauréat-e-s 2019 du concours La preuve par l'image ont également été récompensé-e-s.

Le prix Acfas Ressources naturelles 2019 a été remis à Mathilde Justras, doctorante à l'Université McGill.Au cours des dernières décennies, on a observé une diminution dramatique du contenu en oxygène des océans et des environnements côtiers. L'estuaire et le golfe du Saint-Laurent ne font pas exception avec une réduction de moitié dans leurs eaux profondes. Il en résulte un stress important sur la vie marine, car les espèces dépendent de l'oxygène pour respirer. Certaines, nombreuses, ne peuvent tout simplement pas survivre dans de telles eaux. C'est un enjeu critique dans cette région où la pêche se trouve ainsi gravement menacée. Les travaux de la lauréate contribueront à une meilleure compréhension des processus causant la désoxygénation, puis à la conception de stratégies d'adaptation.

L'estuaire est un environnement côtier, alimenté d'abord par le fleuve, puis par des rivières et par l'eau de l'Atlantique Nord. L'augmentation de la population humaine autour du Saint-Laurent accroît l'apport de nutriments en provenance des eaux usées et de l'agriculture. D'où un foisonnement d'algues et de micro-organismes en surface, qui, à la fin de leur vie, se déposent dans les fonds marins, où ils sont décomposés par des bactéries aérobiques. L'eutrophisation a alors lieu : les bactéries consomment l'oxygène disponible dans les eaux profondes. Ces eaux sont alimentées par le courant du Labrador (riche en oxygène) et le courant du Gulf Stream (pauvre en oxygène). Avec les changements climatiques, on s'attend à un déplacement de ce dernier vers le Nord, ce qui réduira d'autant le contenu en oxygène des

eaux entrant dans le golfe. Ce dernier processus externe expliquerait environ les deux tiers de la désoxygénation observée dans l'estuaire du Saint-Laurent.

Par ailleurs, avec le déplacement du Gulf Stream, on s'attend à voir plus de tourbillons se détacher de ce courant et rejoindre le Saint-Laurent. La chercheuse étudiera cet effet et suivra les tourbillons lors de leur transit du golfe à la tête de l'estuaire à Tadoussac. Pour ce faire, elle utilisera des séries de données recueillies par le groupe d'Alfonso Mucci de l'Université McGill, de même que la base de données publique BioChem de Pêches et Océans Canada, qui cumule 40 ans d'information. Son analyse permettra de déterminer avec précision le temps de transit. À partir des données de concentration d'oxygène au début et à la fin de ce passage, il sera possible d'établir un taux précis de consommation d'oxygène.

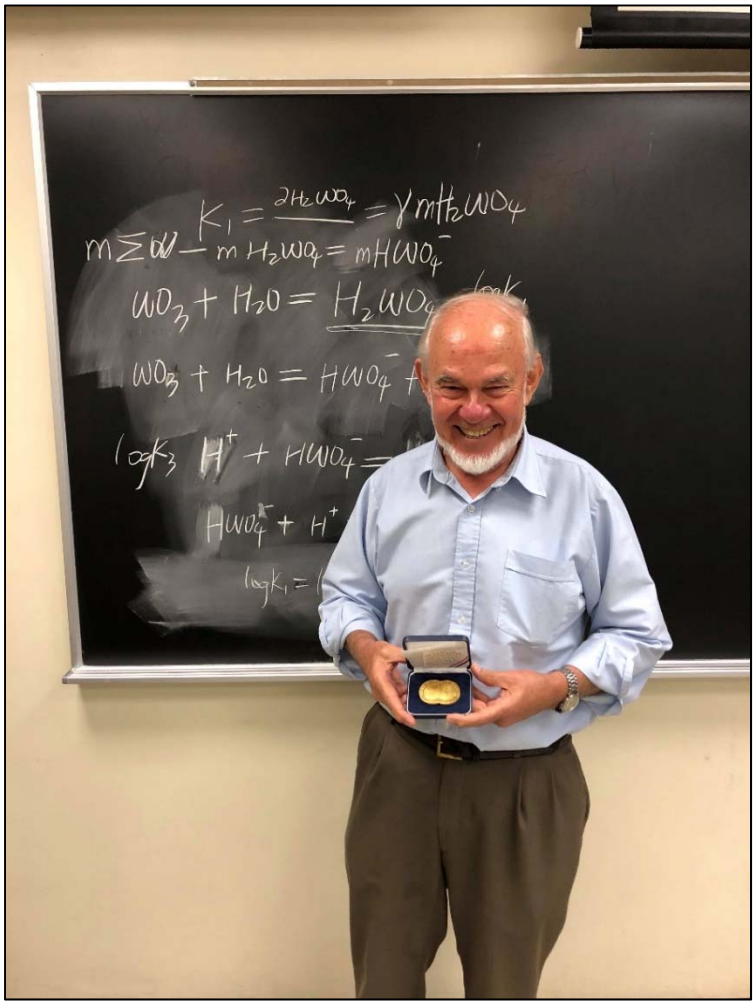
La lauréate utilisera aussi des modèles de circulation globaux pour étudier les processus climatiques et océaniques qui actionnent ces changements. Pour ce faire, elle corrélera les concentrations d'oxygène dans l'Atlantique avec divers patrons climatiques connus. De telles prédictions sont essentielles pour estimer les conséquences sur l'écosystème et sur les ressources halieutiques. De plus, de par sa connexion avec l'Atlantique Nord, le Saint-Laurent est un détecteur (« le canari dans la mine ») des changements de circulation et de propriétés de l'eau dans l'océan Atlantique. L'opportunité pour les chercheurs québécois d'avoir accès à ce laboratoire unique se doit d'être saisie.

Puisque les travaux de Mathilde Jutras combinent le taux de consommation dans l'estuaire et les changements de propriétés de l'eau entrant dans le golfe, il sera possible d'évaluer l'effet sur l'état final d'oxygénation dans l'estuaire, et donc de prédire l'impact des changements climatiques sur le taux d'oxygène dans le Saint-Laurent.

AE (Willy) Williams-Jones

Penrose Gold Medal

Society of Economic Geologists



The **R.A.F. Penrose Gold Medal** was established in 1923 to be awarded primarily in recognition of a full career in the performance of "unusually original work in the earth sciences," which shall be broadly interpreted to encompass major contributions to (a) the science through research, (b) the profession through teaching, program administration, and development of exploration technology, and (c) the development of mineral resources through mine geology, exploration, and discovery. The Council of the Society of Economic Geologists selected Willy Williams-Jones as the 2018 recipient of the Society's **Penrose Gold Medal**. Willy received the award on October 8th, 2019 at this year's 89th annual meeting in San Antonio, TX.

The Society of Economic Geologists Awards for 2018*
R. A. F. Penrose Gold Medal for 2018
Citation of Anthony E. Williams-Jones

Christoph A. Heinrich

Economic Geology, v. 115, no. 1, pp. 223–229

President Doug Kirwin, dear Councilors and members of SEG, dear colleagues and friends: I am standing in for a big bunch of admirers from different fields of economic geology, who all think it is high time for Anthony Williams-Jones to receive the Penrose Gold Medal. Your fans, Willy, include leading exploration consultants like Dick Sillitoe, senior academics like Steve Scott, Jim Franklin, Steve Kesler, Bob Bodnar, Kurt Kyser, and Jeremy Richards, as well as former collaborators and ex-graduate students—many of whom are now leading their field, including Scott Wood, Iain Samson, Bob Linnen, Frances Wall, Werner Halter, Bill Mercer, Don Bubar, Zoltán Zajacz, and Alex Gysi. They all wrote exceptionally strong letters of support for this nomination. I will cite a few passages, just to give you the flavor of diversity of everybody's enthusiasm for Willy's work and for Willy as a person. The common theme of all of them is the exceptional breadth of Willy's engagement and impact. This breadth starts with global geography: Willy was born in England, raised in South Africa, where he studied at University of Natal, then moved quite precipitously to Canada, where he completed his Ph.D. at Queen's University. He then worked for the minerals industry in Brazil and elsewhere before joining McGill University in Montreal as a professor. There he stayed except for various academic visits to research organizations in Australia and New Zealand, where I first met Willy, as well as universities in Europe and Asia in more recent times. In terms of scientific breadth, the same four keywords come up in many letters and with everybody who knows Willy: an outstanding experimentalist in terms of novel laboratory approaches; the geoscientist who investigated the greatest number of elements; the strong link between rigorous geochemical quantification and field study; and the inspiring mentor for younger colleagues. (1) Experimentation: Willy is, in my opinion, the most significant experimentalist in economic geology since they heydays of Paul Barton, Hans Eugster, Wayne Burnham, Hugh

Barnes, Greg Anderson, and Terry Seward, who had laid the foundations of our chemical understanding of the main ore elements in hydrothermal fluids. Willy's most important contribution is to extend experimentation from hot aqueous liquids to vapor-like fluids. The method he and his research associate, Artasches Migdisov, used and the message they obtained are both as elegant as they are simple: Metal transport is not only temperature-dependent, but equally a function of fluid density: the more hydrated any metal complex, the more soluble in gas-like fluids it becomes. This is the key to understanding magmatic-hydrothermal systems, where fluids start off vapor-like at low to intermediate density and can then take different pressure-temperature paths toward becoming either denser and liquid-like or expand to fumarolic gases. This is a fundamental concept that links volcanism with plutonism and ore formation. (2) The periodic table: "No one else, now or in the past, has carried out so many important studies of such a wide range of economically interesting and important elements and processes," writes Steve Kesler in his support letter. Rare earth elements, Zr, Nb, Ta, Li, most recently Sc and Co—especially the lithophile

elements that had been neglected in the "sulfideheydays." Every one of these experimental and thermodynamic papers is well cited, as everybody investigating deposits of these rare metals cites Willy as quintessential literature. (3) Field application: While Willy's impressive citation numbers are mainly due to his pioneering experimental papers, he never stopped in the laboratory, but went out to apply his knowledge by close field-based interaction with innovative mining companies. Dick Sillitoe writes: "Although the details of this work are not readily accessible to the average explorationist, the resulting conclusions have wide applicability to ore deposit modeling." Field projects are commonly driven by Willy's conviction that younger scientists need to obtain the freedom to define their career between the diverse work environments one can develop as an economic geologist, ranging from academic and theoretical to field-based and applicationoriented. This reflects on: (4) Willy as a mentor: Let me cite Zoltán Zajacz, who is an outstanding young experimentalist, perhaps the rising star in that field. He comments on Willy's influence on his work, but equally admires him as a person, just like me and all other colleagues: "Willy's enthusiasm for science and economic geology is simply contagious. I think anyone would leave feeling energized and ready to tackle any scientific problem after talking to him. Beyond any doubt, his exceptional character and enthusiasm must be one of the keys to his incredible productivity." In addition to his receiving many important research awards that reach well beyond economic geology,

Willy's dedication to teaching earned him most recently the Mentorship Medal of the Canadian Confederation of Earth Sciences. Anthony Willams-Jones, dear Willy: You are a giant as a teacher and as a researcher alike, and you are a wonderful and inspiring friend. I wish to congratulate you on your R. A. F. Penrose Gold Medal, joined by many colleagues and former students from all over the world, and by all of us here!

Acceptance of the R. A. F. Penrose Gold Medal for 2018
Anthony Williams-Jones

President Kirwin, SEG Fellows and members: I am very grateful to SEG and extremely honored to receive the prestigious R.A.F. Penrose Gold Medal, which I am delighted to accept on behalf of the many students, postdoctoral fellows, and research associates who have shared their research with me. Some of them are with us this evening. This award is as much theirs as it is mine. We would not be receiving it, however, if were it not for the hard work of all the people who were involved in nominating me, particularly Chris Heinrich and Steve Kesler, who spearheaded the nomination. Thank you so much. Many people have had an impact on my career, and I would like to briefly single out a few of them for special mention. Dugald Carmichael, my Ph.D. supervisor in metamorphic petrology at Queen's University in Canada, was the one who really introduced me to the world of science. He saw me crawl, take my first tentative steps, and then develop the confidence to start to ask some relevant questions and even try to answer them. His initial diet for me was Korzhinski's book, The Physicochemical Basis of the Metamorphic Facies Concept. It was hardly pablum for a recently arrived young immigrant from South Africa, but it certainly provided a great

dose of intellectual nourishment. Dugald showed me the importance of combining careful field and petrographic observation with rigorous thermodynamic analysis. My subsequent four years in Inco's international exploration division were pivotal in my decision to reinvent myself as an economic geologist. The intellectual challenge of trying to predict where to find economic mineralization was intoxicating and the sense of accomplishment after an exciting discovery was extraordinary. I consider myself extremely lucky to have been hired by McGill University with no previous academic experience beyond my Ph.D. and nothing to show by way of publication. I doubt there are many universities that would take this risk today. I am very grateful to my colleagues there for providing me with a very supportive and collegial environment in which to build my career. One of these colleagues was Scott Wood, who introduced me to the exciting world of experimental hydrothermal geochemistry. Thanks to him and a subsequent sabbatical with Terry Seward, I plunged into this world and made experimental geochemistry one of the key axes of my research group. This, however, would not have been possible without Artasches Migdisov, who ran my experimental laboratory for 17 years and shared some amazing science with me. Any success that I have had as an academic, I owe mainly to my students, postdoctoral fellows, and research associates with whom I share this award. Hardly a day goes by without one of them giving me cause to think. I have a lot of fun doing science with them and with no one more so than Olga Vasyukova who has made Strange Lake our critical metals laboratory and who shares her science with me on an almost daily basis. In closing, I would like to thank the many others who have supported me during my career, particularly Jim Clark, a master of critical thinking, who keeps my science nicely grounded and is an important mentor to many of my students. Finally, I would like to thank my wife, Colleen, my sons, Bryn and Glyn, and my daughter, Leigh-Ann, for their patience and understanding, without which I would not be here today.

Stearns A. “Tony” Morse
Mineralogical Association of Canada
Peacock Medal

Stearns A. “Tony” Morse *(M.Sc. ’58, Ph.D. ’62),* professor emeritus of geosciences, has received the Mineralogical Association of Canada’s Peacock Medal, its highest award, for “outstanding contributions to the mineral sciences of Canada.” The award was presented at a lunch June 19 during the association’s annual meeting in Vancouver, British Columbia.

The 1.5-inch diameter gold medal is intended to recognize the breadth and universality of the awardee’s contributions in mineralogy, applied mineralogy, petrology, crystallography, geochemistry or the study of mineral deposits, rather than in a narrow area of expertise, the association states. The Peacock Medal, formerly the Past-Presidents’ Medal, is not restricted to Canadian researchers.

Morse says he was “quite thunderstruck” to receive the letter informing him of the honor, and “if not for some of the fine details I might have supposed it a hoax.” He adds, “What a wonderful thing to be so honored. And especially pleased to have such a recognition from Canada, where all my realities in our splendid science have germinated.”

Morse still has an active research office in geosciences, says department head Julie Brigham-Grette, who adds, “We are very excited for the recognition of Tony Morse with the Peacock Medal for his wonderful and ongoing career in geology. Even I used one of his textbooks to learn phase diagrams when I was an undergraduate student. This award sheds a strong light on his contributions and legacy in the field.”

Morse earned his undergraduate degree in geology at Dartmouth College, where his father was an English professor. From 1949-52, Morse was a field assistant in archaeology and then oceanography on the 100-foot schooner *Blue Dolphin*, studying Labrador fjords. After serving in the U.S. Army, he returned for further study in Labrador fjords in 1954.

He went on to earn an M.S. and Ph.D. from McGill University and to be hired by British Newfoundland Exploration Ltd., to study the Kiglapait Layered Intrusion in Labrador. He also studied ice as a mineralogist at the U.S. Army’s Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire. Morse was a member of the geology faculty at Franklin and Marshall College in Lancaster, Pennsylvania, for nine years before coming to UMass Amherst in 1971.

From 1971-81, he and colleagues from Cornell and Syracuse universities led a large research group studying the Nain Anorthosite from the research vessel *Pitsiulak*, supported by the National Science Foundation. Anorthosites, an enigmatic intrusive igneous rock also associated with many layered intrusions, occur only in special places and within a special time interval in the geologic record; in North America chiefly in a belt from Labrador to the Adirondacks. How they form is still not well understood.

Morse’s other research work included experiments at the Carnegie Institution of Washington and at Smith College, and studies related to the earliest crust on the Earth and Moon, the nature of the Earth’s core-mantle boundary, and

the thermodynamics of rocks and melts. His other honors include life membership in Clare Hall, University of Cambridge, and election as a fellow of the American Geophysical Union.

At the awards lunch, Morse gave a 10-minute talk and later, a half-hour presentation about his scientific and personal history, in particular about his wife Dorothy's role in his career and research. She and their three daughters served as research assistants in Labrador for many years in the field and aboard ship.

University of Massachusetts Amherst
News & Media Relations - 20 February 2019

PEACOCK MEDAL

The Peacock Medal formerly the Past-Presidents' Medal is awarded to a scientist who has made outstanding contributions to the mineral sciences in Canada. There is no restriction regarding nationality or residency. The medal is intended to recognize the breadth and universality of these contributions in mineralogy, applied mineralogy, petrology, crystallography, geochemistry or the study of mineral deposits rather than in a narrow area of expertise. A committee of three Past Presidents, chaired by the immediate Past Presidents, considers all nominations received. Previous departmental recipients include: **Don Baker** (2014), **Don Francis** (2009), **Anthony E. Williams-Jones** (2005), and **Gabrielle Donnay** (1983).

Stearns A. (Tony) Morse's research covers many aspects of melting and crystallization in the Earth and planets, but most recently is concentrated on mafic magmas at crustal pressures. A particular target has been the Kiglapait layered intrusion in Labrador and the Skaergaard intrusion in Greenland. New studies of cumulates by Marian Holness at Cambridge have opened up a whole new avenue of research illuminating the process by which igneous cumulates form and solidify into rocks (e. g., Holness et al. 2007 J. Petrology 48, 2359-2377). We find that this study of dihedral angles in thin section leads us back to the latent heat released when new crystal phases arrive at the liquidus. The crystal mush overlying the solidification front tends to impede the sensible heat transfer out of the solidified rock and gives it a longer history at high temperature than before, allowing better cumulate maturation.New plagioclase composition data for the Skaergaard intrusion, combined with our earlier experimental determination of the equilibrium among plagioclase, olivine, augite, and melt at 5 kbar has permitted a new estimate of crystallization temperatures in the Skaergaard intrusion (Morse, 2008 Am. Min. 248-251). What makes this result particularly interesting is that it matches very closely a thoughtful experimental determination by Alex McBirney and Dick Naslund in 1990.The range of plagioclase compositions at both Kiglapait and Skaergaard receives new attention as an indicator of adcumulus growth, by which an initial porosity tends to be eliminated by an isothermal exchange process. New data show that residual porosity in both intrusions decreases to zero at intermediate stratigraphic levels and then rises to the end of crystallization, recording an increased tendency to equilibrium crystallization in the late-stage rocks. More surprisingly, the treatment of old and new data suggests that a considerable degree (4-6 mole percent) of scatter in mineral compositions within a given hand specimen is original with the accumulating crystals. This discovery suggests that even the olivine compositions may have not equilibrated with each other over the scale of centimeters during very slow cooling from the solidus temperature. In the meantime, theoretical and applied research on multiphase Rayleigh fractionation in magmas has yielded a quantitative test for the probability that large magma chambers may harbor an internal reservoir that replenishes the melt in a crystallization zone, allowing a much slower variation of mineral compositions than predicted by binary solutions crystallizing alone. The implications of this study ramify throughout the local and regional mineral variation in layered igneous rocks.Recent experimental work by grad student Deb Banks McIntosh defines the phase equilibria of a model Kiglapait magma composition at pressures up to 15 kb, with coexisting spinel, garnet, and aluminous pyroxenes that break the olivine-plagioclase tie line.A new "Kiglapait Project" is being inaugurated to make available and curate electronically maps, sections, sample catalogs, chemical and mineralogical data, photomicrographs, field photos, and publications to accompany the Kiglapait sample collection at its eventual resting place at the American Museum of Natural History in New York. Much work needs to be done.

Philip Greene

AGU Outstanding Student Presentation Award – Tectonophysics Section

Philip Greene (B.Sc. '12) on top of Tasu mountain - nearly the highest peak on Haida Gwaii (at ~900 m) and only a few kms from the epicenter of the 2012 earthquake. Photo: Sean Lahusen

The Outstanding Student Presentation Awards (OSPAs) are awarded to promote, recognize and reward undergraduate, Master's and PhD students for quality research in the geophysical sciences. Each year, Sections recruit judges to assess and score student oral and poster presentations at meetings. Typically the top 2-5% of presenters in each Section are awarded an OSPA. Of the 167 award winners at the Fall 2018 AGU Meeting, Philip Greene (B.Sc. '12) was one of ten winners in the Tectonophysics Section. The title of Philip's presentation was *An Examination of Upper-Plate Uplift Driven by Subduction Initiation in Haida Gwaii, Canada*.

Vanier Scholarship
Fiona d'Arcy

In May 2019, the new Vanier Canada Graduate Scholarships were announced by the Honourable Kirsty Duncan, Minister of Science and Sport. The Vanier Scholarship is one of Canada's most prestigious awards for doctoral students. Fiona is one of 16 McGill students to receive this award. "The Vanier awards help Canada attract and retain some of the brightest doctoral students to build up our world-class research talent," said Duncan. "Since taking office, our government has been working hard to return science and research to their rightful place and today's investments are helping us do just that." Launched in 2008, the Vanier Scholarship program recognizes students who demonstrate excellent leadership skills and a high standard of scholarly achievement in the social sciences and humanities, natural sciences and engineering, or health-related fields.

<u>New techniques for measuring temporal and spatial variation of carbon dioxide emissions in volcanic plumes to improve eruption forecasting</u>

Fiona's research focuses on how we can interpret changes in volcanic gas chemistry to understand volcanic systems. I am particularly interested in carbon dioxide, as this is one of the most common yet sensitive components of volcanic gas. However, it can be challenging to collect volcanic gas samples. In my PhD, I will measure changes in carbon dioxide composition in detail in order to forecast magmatic changes at highly dynamic volcanoes. To do this, I am developing a remote-controlled sampling assembly to safely capture a gas sample from within a volcanic plume using a drone. I will examine the unique chemical signature (isotopic composition) of the carbon dioxide in these gas samples and compare this with other records of volcanic carbon dioxide fluxes, such as those measured by satellite and indirect proxies such as tree rings. The overall aim of this work is to develop techniques to improve eruption forecasting for local observatories.

Photo courtesy of: Robert Bogue

Donald (Don) Bubar
2019 Distinguished Service Award
Prospectors & Developers Association of Canada

Recipients are celebrated at an Awards Gala & After Party at the Fairmont Royal York Hotel, during the annual PDAC Convention in Toronto.

The PDAC Board of Directors selects recipients based on recommendations of the Awards Committee.

The Distinguished Service Award recognizes an individual who has achieved one or more of the following: made a substantial contribution to mineral exploration and mining development over a number of years; given considerable time and effort to PDAC; made outstanding contributions to the mineral industry in the field of finance, geology, geophysics, geochemistry research, or a related activity.

In recognition of his contribution to building awareness of Indigenous issues among PDAC members, his support of geoscience education in Canada, and his exploration successchai was the 2019 recipient.

During Don Bubar's 40-year career as a geoscientist he has contributed to successful exploration in Canada, and been a leading advocate for geoscience education. But his most enduring legacy may be his role in forging a better, more productive relationship between Indigenous groups and the minerals industry. As founder and head of the PDAC's Aboriginal Affairs committee, Don recognized the urgent need to bring the two groups together in dialogue about how exploration and mine development could support local communities through training, jobs, and business development.

Don graduated from McGill University with a B.Sc. in geology in 1977 and completed his M.Sc. at Queen's University in 1981. He worked as an exploration manager for Aur Resources from 1984 to 1994 where, as Vice-President of Exploration, he helped guide the discovery of the Louvicourt copper-zinc mine near Val d'Or, Québec. He has been President and CEO of Avalon Advanced Materials since 1995, working to develop three advanced stage projects across Canada with the potential to provide critical metals and minerals for new technology applications.

Don was chair and co-chair of PDAC's Aboriginal Affairs committee from its creation in 2004 until his retirement from the PDAC Board of Directors in 2013. During his tenure, the number of Indigenous

participants at the organization's annual convention grew exponentially and, in 2009, PDAC signed a ground-breaking agreement with the Assembly of First Nations to promote participation of Indigenous people in the minerals industry. Through Don's work, there is increased understanding by PDAC members about the importance of community engagement from the earliest stages of mineral exploration.

Don serves on the Advisory Board to the Faculty of Science at his alma mater McGill, and is a Director of the Northwest Territories and Nunavut Chamber of Mines. He has personally endowed three separate scholarships supporting at least six students annually at McGill and at Dalhousie University in Halifax.

In 2016 Don joined the Board of Mining Matters, a charitable organization with the mission to support geoscience education in the Canadian school system and increase awareness about the relevance of minerals and metals in modern society. In his latest role, he will advocate for Indigenous youth camps where the next generation of northerners will have the opportunity to explore career opportunities within the industry.

PDAC Awards – March 5, 2019
https://www.pdac.ca/about-pdac/awards/2019-award-recipients

Awards Gala – March 5, 2019 - Fairmont Royal York Concert Hall

PDAC Alumni Reception

Monday, March 4, 2019

InterContinental Toronto Centre



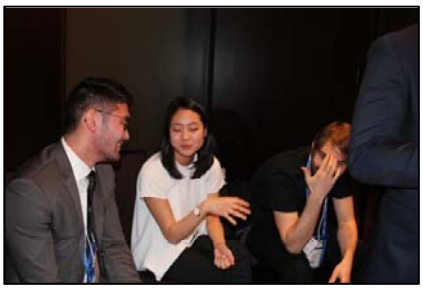




















Nicolas Cowan

2019 Harvey B. Richer Prize

Canadian Astronomical Society

Harvey B. Richer Gold Medal for Early Career Research in Astronomy was established in 2016 thanks to a generous gift from Harvey B. Richer, a former Director of CASCA and Professor at the University of British Columbia. The Richer Medal is awarded every second year, in odd-numbered years, in recognition of significant and sustained early career research in astronomy. To be eligible, the nominee must be a member of CASCA in good standing, and a Canadian astronomer or an astronomer working in Canada. The nominee will normally have received his or her PhD degree within the previous 10 years.

CASCA is pleased to announce that Dr. Nicolas Cowan is the recipient of the 2019 Harvey B. Richer Gold Medal in recognition of significant and sustained early career research in astronomy. Dr. Cowan is an established leader in the field of exoplanets through his work on high precision infrared photometry, determining the energy balance in exoplanet atmospheres, and using exoplanets as `laboratories' for planetary science. Dr. Cowan has 80 papers with a citation count of over 4700. In addition to this high level of scholarship, Dr. Cowan has an impressive record of supervision and training, having worked with two postdoctoral research scientists, nine graduate students, and thirty-six undergraduate students.

CASCA is delighted to recognize Dr. Cowan's scholarship with this award.

Vincent van Hinsberg

2019 Young Scientist Award

Mineralogical Association of Canada

This award is given to a young scientist who has made a significant international research contribution in a promising start to a scientific career. The areas of research include mineralogy, crystallography, petrology, geochemistry, mineral deposits, and related fields of study. The award was presented at the May Annual Meeting of the Mineralogical Association of Canada.

Benjamin Keenan

2019 Green Talents Cohort

Recently, Benjamin Keenan, a PhD candidate in the Department of Earth and Planetary Sciences, was selected for the Green Talents program. Hosted by the German Federal Ministry of Education and Research to promote the international exchange of innovative green ideas, the program brings together up-and-coming researchers from around the world.

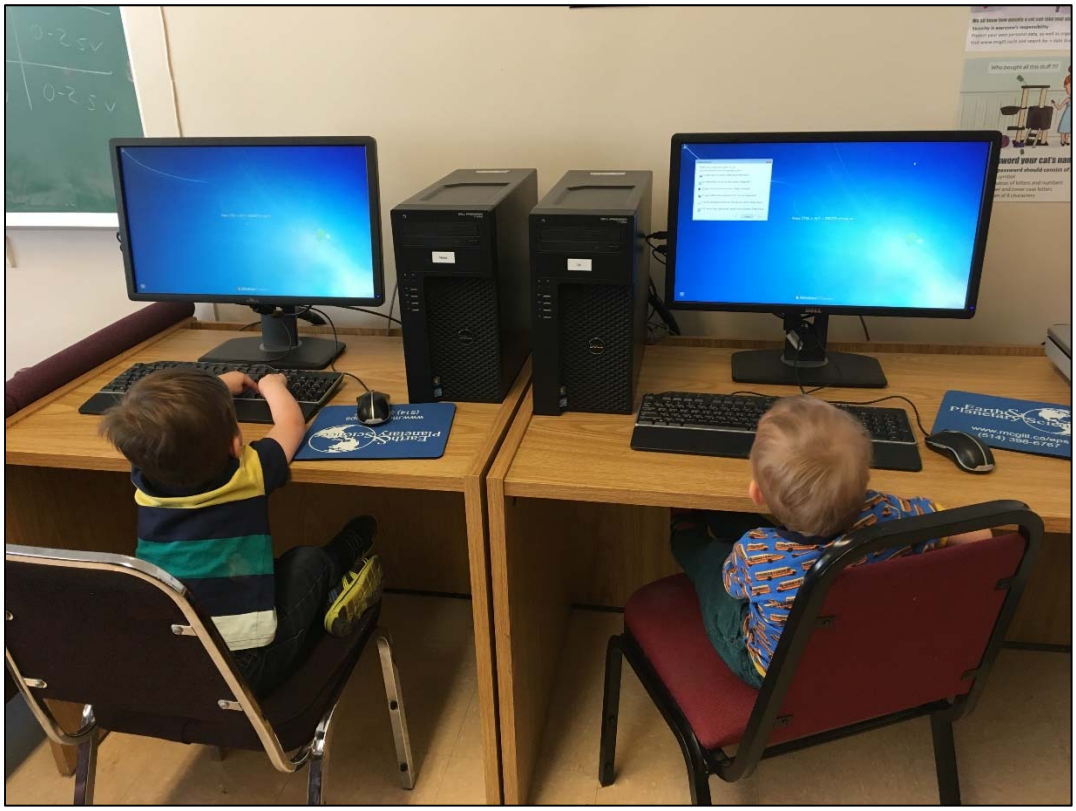
"As a result of the increasing global resource consumption and the resulting damage to our ecosystem in the form of extreme weather events and global conflicts, we need sustainable, transboundary solutions more urgently than ever. Climate impacts and protection do not stop at borders, but can only be addressed globally in research and development," said Professor Christa Liedtke, Director of the Division Sustainable Production and Consumption at Wuppertal Institute, and a member of the Green Talents jury. "It is the future of this planet that is at stake – that is why young interdisciplinary and highly motivated young scientists are of great importance for overcoming global challenges. Their generation is the future."

Keenan, a member of Peter Douglas' research group in the Department of Earth & Planetary Sciences, was one of 25 researchers from a variety of fields selected from 837 applicants worldwide. Keenan is using a combination of organic and inorganic geochemical tools to test the hypothesis that some societies declined because of a changing climate. He sees the history of the Maya as a relevant narrative for recent discussions about climate change.

Selected by a jury of German scientists, the award winners were granted unique access to the country's research community. The 2019 awardees just finished a two-week tour from October 14–26, which brought them to hotspots of sustainability science in Germany. The tour ended at a major networking conference in Berlin, where the Green Talents were presented with their awards.

What's New Communications – McGill University – October 2019

New Staff …



New staff arrived to help us out for Homecoming Wine & Cheese – 27 September 2019 …

Lucas (Thornton) Filion and Jeff McKenzie

Sam Rowe-Kirkpatrick

Keeping Us Safe …

Don Baker and **Alfonso Mucci** keeping us safe – October 2019 Fire Drill Exercise

Open House
22 October 2019

From the Geology Scrapbook – McGill in the 1860s

ALL OUR YESTERDAYS
BY EDGAR ANDREW COLLARD

A Number Of Things

"DROVES of milch cows were driven morning and night through the streets to the fields, and back for milking." This was one of the memories that came most vividly to mind in the 1890s, when Joseph Charles, living in retirement in Manitoba, recalled the days of his childhood in Montreal half a century earlier. The sight of the cows in the streets had been part of Montreal's daily scene.

Mrs. John Lovell, recalling her memories of Montreal about 1837, could write: "Most people had their cows at that time. Our yard extended from St. Joseph (now Notre Dame Street, west of McGill) to Bonaventure Street. I was often amused to see the boy go by with his horn to call them to pasture, and again in the evening bring them home. They would wait patiently until the gate was opened."

The pasturelands were nearby. One was in the fields above Sherbrooke Street, in the area where the Sheraton Mount Royal Hotel now stands. Farther east, cows were pastured in part of the area that is now Place Viger.

They were pastured, too, on the unfenced campus of McGill University. In the 1840s a number of professors had their living-quarters in the East Wing of the Arts Building, and were supplementing their meagre salaries by growing vegetables and pasturing cows in the university grounds. Later the campus, in its neglected state, came to be regarded as a sort of common, where anybody might pasture a cow.

Sir William Dawson in his old age remembered the forlorn appearance of the campus when he arrived to be principal of McGill in October, 1855: "The grounds were unfenced and pastured at will by herds of cattle, which not only cropped the grass, but browsed on the shrubs, leaving unhurt only one great elm, which still stands as the 'founder's tree', and a few old oaks and butternuts, most of which have had to give place to our new buildings." Cows were still being pastured on the campus in the 1860's.

The practice of keeping cows did not die out after the city had grown and the old, convenient pasturelands were no longer available. Many Montrealers still kept cows in their backyards, maintaining them on purchased feed.

Mr. George McNamee, the secretary-manager of the Royal Automobile Club who died three years ago, used to recall that his old family home on what was then called Palace Street, near the Windsor Station, had milk from their own cow, kept in the yard behind the house.

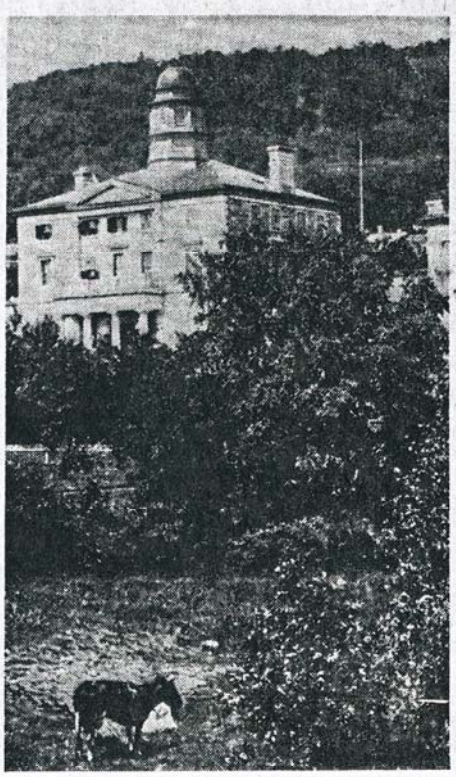
Chaperone

Diaries are often the best sources for history. They belong to the day, and have the freshness of the moment. They also provide the personal experience of history, soon lost in impersonal generalizations.

Miss Ethel Chadwick of Ottawa has just published selections from the diary she kept as a girl in Montreal in the period round the turn of the century. (It is entitled "Social Memories of Montreal," and is in the bookstores at $1.75). It gives sprightly glimpses into the social life of Montreal, and of the manners and etiquette of the time.

Take such a diary-entry as this, dated December 31, 1901: "Last day of the old year, and my Grandmother's eighty-first birthday. Wore pale blue tonight and a wreath of forget-me-nots in my hair, to the Charity Ball in the Medical Arts building in McGill University. Madame Louis Masson chaperoned me, she had also Blanche Pillette and Annette Duchesnay. Such a jam, it was really fearfully hard to even make one's way to the ballroom. It was a programme dance but I unfortunately soon lost mine after it was filled up and besides it was so crowded that one had to dance with whom one came across as waiting for one's partner would have meant losing most of a dance. I had dances with Hugh MacKay, Mr. Coghlin, Percy Butler, Mr. Jack Hood, Simms, Ouimet, MacCallum, Huntly Gordon, Donald Hingston, Ernest Shepherd, Gordon Glass, Leon Garneau. I had supper with Hugh MacKay. We got a table with his sister Anna, Mr. Glass, and others I knew not. During supper, 'Auld Lang Syne', and we all stood up, took hands and made a ring round the table and said the old year out and in the new. Then all the mem shook hands with us and we wished each other a happy New Year. It was sad, yet thrilling. Perhaps the principal event of this last year was the death of Queen Victoria in January and the accession of the Prince of Wales as Edward VII.

"Soon after I got back to the ballroom, I found that my chaperone had been waiting for me and wanted to go; was I sorry with a whole lot more men with whom I wanted to dance. One man asked me to stay on and that he would drive me home, but I told him I was not allowed to drive home with men alone. He suggested getting another couple to come with us but I thought I better go and tore myself away to my intense sorrow in the midst of having the best time I ever had at a dance, and so got home quite early — only about two."



The McGill campus in the early 1860s, showing a cow in the foreground.

Water-Carts

It is less than 100 years since many people in Montreal had no running water in their houses, but bought their water from the water-carts — the casks on wheels — that distributed water taken from the river. These water-carts used to be filled by being driven into the river, until the water was almost level with the axles. The casks could then be filled without being removed from the carts.

Clean water was supposed to be had between the foot of St. Sulpice Street and Jacques Cartier Square. One Montrealer, George Horne, frequently counted 50 or more water-carts in the river at this point. But only a little distance away, at Custom House Square (now Place Royale) a dirty creek, which flowed through the city, emptied into the river

manner of filth.

Yet the water-carts w
about the city, making th
deliveries, and though
epidemics were many,
everybody died.

As late as the 1860's wa
was still being sold from
water-carts. Of this period
W. Hughes, the Montr
plumbing contractor, wro
"The masses of people in
early days in Montreal w
not troubled with plumbe
bills, because they had
plumbing in their hous
While there was a wat
works, and certain stre
were provided with mains,
introduction of water into
houses was by no mea
universal, and there w
large districts where th
were no mains. The wa
was distributed from barr
drawn from a two-whee
cart, carried into the house
tin pails of a regulation si
the price being three pails
a penny."

The shortage of water, i
its cost, led many household
ers to have the family wa
ing taken to the riverfront.
be done there for nothing.
women washing their cloth
beating them on the stones,
dancing on them were one
the familiar sights of
waterfront. Many of th
gathered in the area just
of the Bonsecours Church.

John Stafford, the merch
tailor, remembered seei
them there in the 184
"Scores of washing-wor
frequented the beach . . .
with skirts tucked up, sta
ed with bare feet upon clot
in tubs or in the water of
river without tubs . . .
talk of the women and th
shouts of laughter, with
rush of the waters and
gracefulness of their action
they wrung their clothes
get the water out of th
made a picture that was
of action and that would h
commanded attention a
where if properly painted."

Montreal Star - 1967

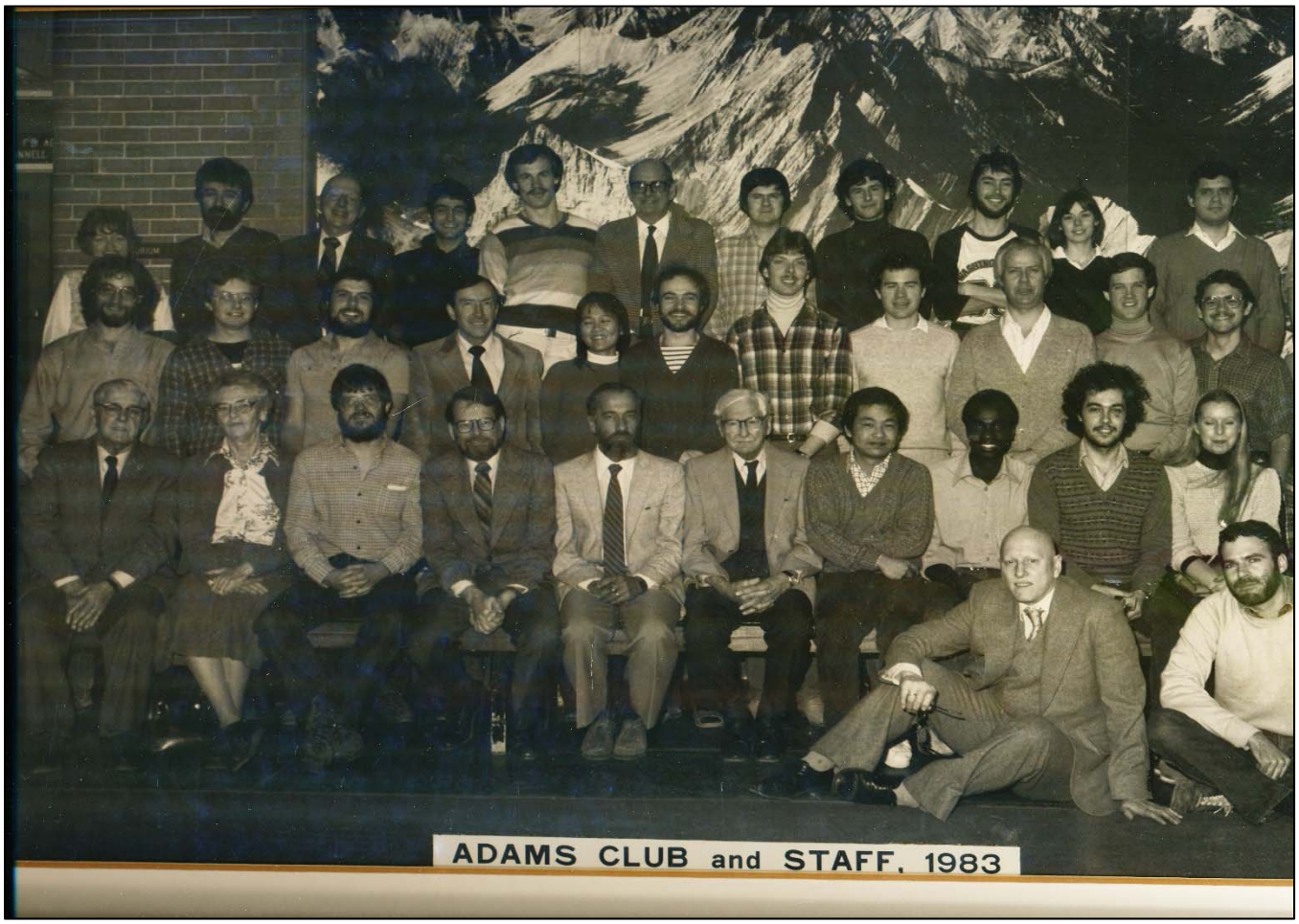
1967-1968 Monteregian Geology Club

1967- MONTEREGIAN GEOLOGY CLUB -1968

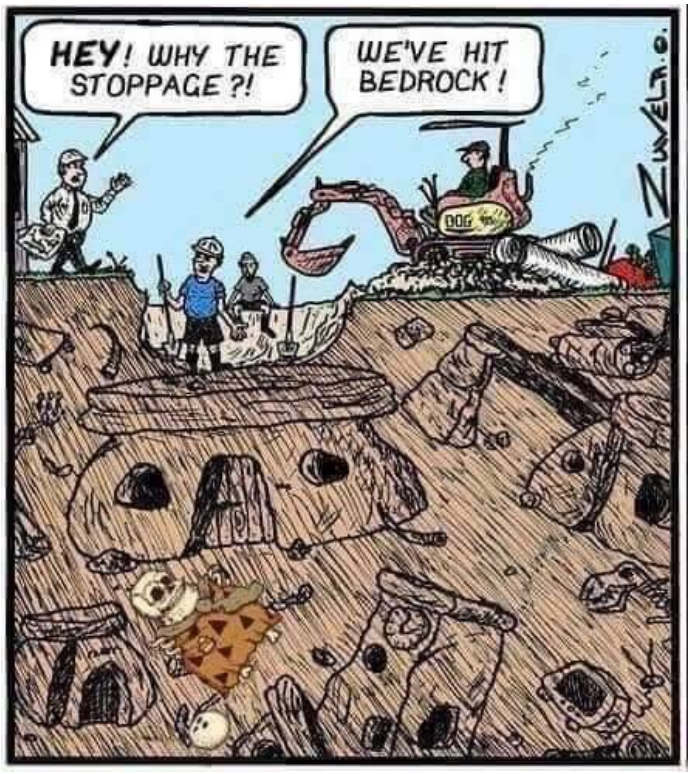
standing: Medford,Achtman,Douglas,Achtman,Smith,Schultheis,Dixon,Allebone, Watson,Duke,Webb,Putter,Cant,Hoffman,Kensett,Fleming,Schwartzman, Beavan,Schlien.

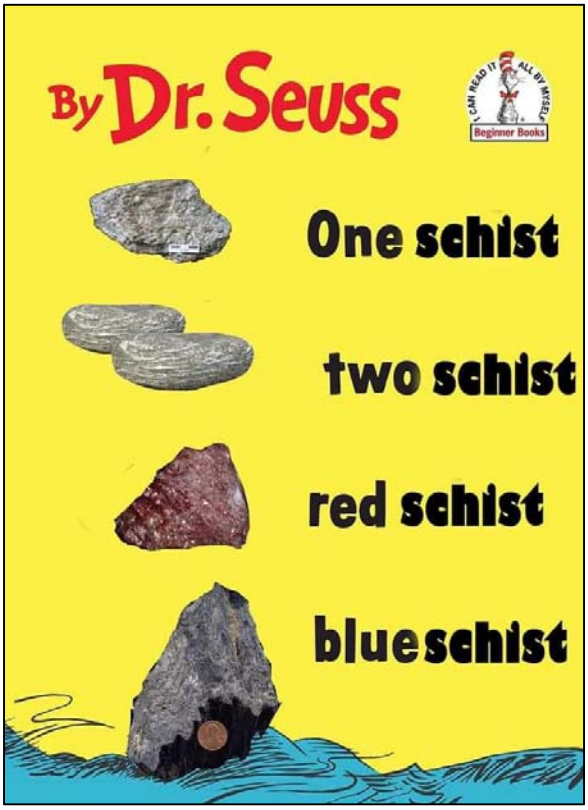
Kneeling: Fox,Brisebois,Cunningham,Siemiatkowska,Dean,Stanisavljevic, Frohlinger,Doak.

1983 Adams Club & Staff



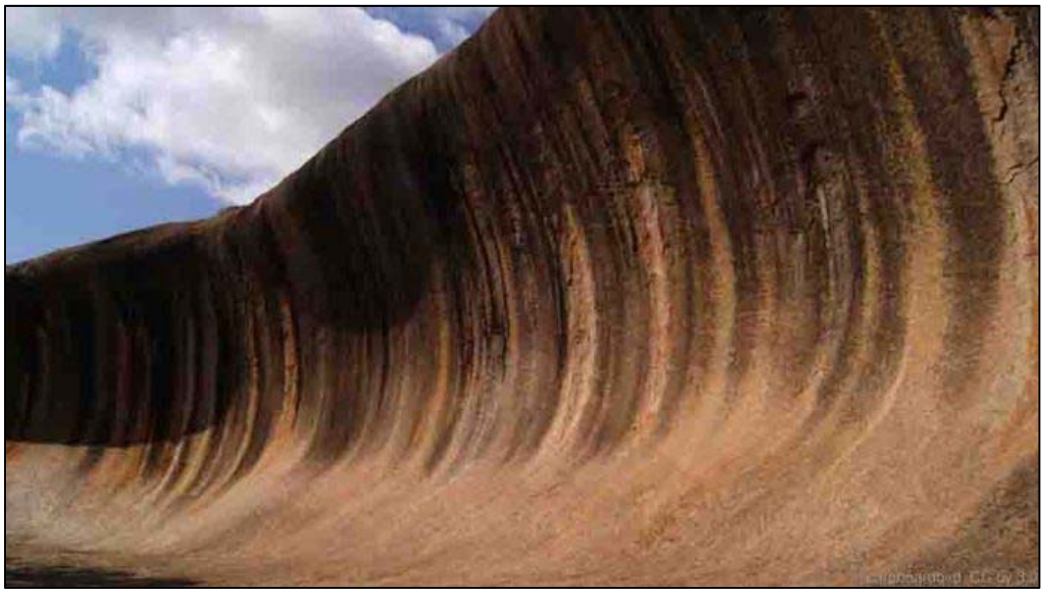
Funnies …


HEY! WHY THE STOPPAGE?!
WE'VE HIT BEDROCK!
DOG
ZUVELA.O.

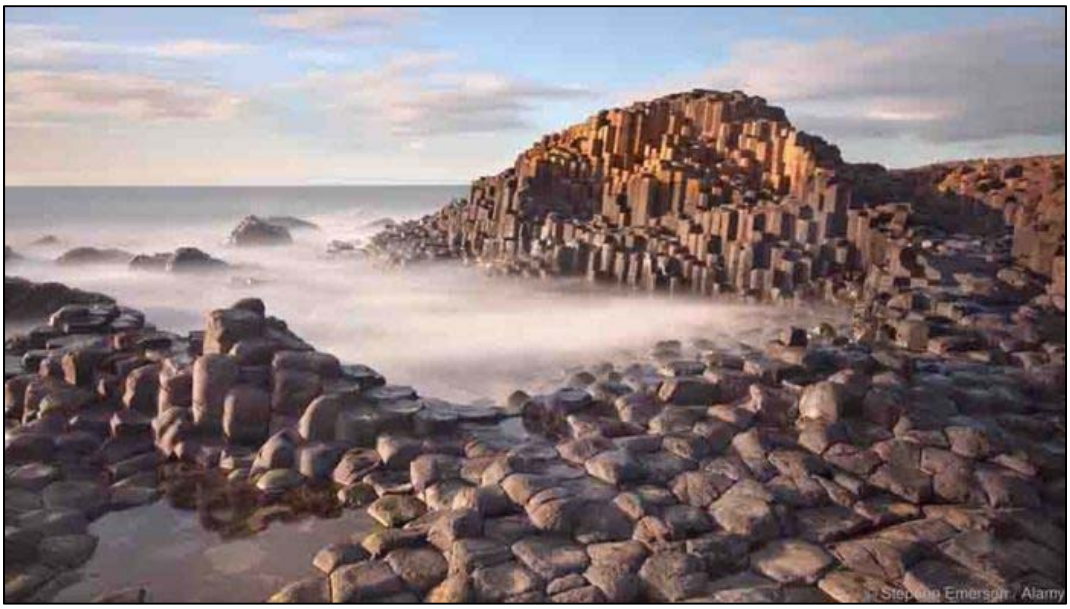

By Dr. Seuss
I CAN READ IT ALL BY MYSELF
Beginner Books
One schist
two schist
red schist
blue schist

Amazing & Strange Rock Formations

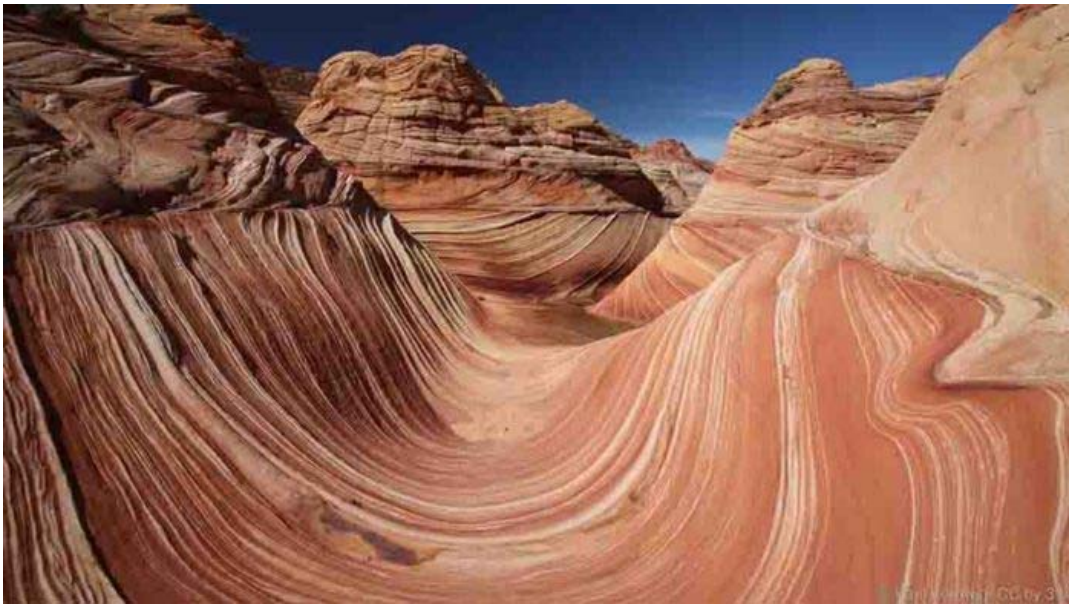
Zhangye Danxia, China – these rainbow mountains look like something out of a painting. The Danxia landforms, found in China's Gansu Province, are made of strip of red sandstone that were deposited over millions of years, like slices of a layered cake.



Wave Rock, Australia – This concave rock is 14m hight and 11m long. It is part of the norther side of Hyden Rock, a giant granite outcrop over 2.7 billion years old, located in Hyden Wildlife Park in Western Australia. The wave is believe to have formed by the action of running water on granite. The colourful streaks on its face are made of minerals left behind by rainwater run-off.



Giant's Causeway, Northern Ireland - These massive hexagonal black basalt columns rise like steps and interlock neatly. There are over 40,000. They probably formed after volcanic activity 50-60 million years ago. The sizes of the columns were most likely determined by the speed at which the erupted lava cooled.



Vermillion Cliffs National Mounument, Arizona - Popular among hikers, Vermillion Cliffs is a treasure trove of deep canyons and steep cliffs. It is also home to "The Wave" (pictured), which is made up of undulating sandstone. The Monument is located on the Colorado Plateau, and gets its rich reddish hues from the sandstone that formed the landscape. The colours of the site change as the day progresses.

Cave of the Crystals, Naica, Mexico - This cave contains gigantic, sword-like gypsum crystals. It is 300m underground in the Naica Mine in the Mexican state of Chihuahua. It was discovered by two brothers drilling for lead and silver. The enormous crystals are believed to have formed when gypsum-saturated groundwater flowed through the caves, and was heated and cooled by hot magma below. Some of the largest crystals may be over 500,000 years old.

Travertine Hot Springs at Parmukkale, Turkey - Pamukkale, meaning "cotton castle" in Turkish, is a natural site in Denizli Province in southwestern Turkey. The city contains hot springs and travertines, terraces of carbonate minerals left by the flowing water. It is located in Turkey's Inner Aegean region, in the River Menderes valley, which has a temperate climate for most of the year.

The Great Blue Hole, Belize – This underwater sinkhole is 320m wide and 125m deep, and a major scuba diving attraction. It is part of the Belize Barrier Reef, which is in turn part of the Mesoamerican Reef. This hole is believed to have formed during the recent ice ages, when a submerged limestone cave system collapsed due to changes in the sea level. Huge stalactites and stalagmites are found in the hole, which contain records of past climates.

Marble Caves, Chile - The Marble Caves is geological formation of unusual beauty. These caves have formed in a pure marble and are bathed in the deep blue water of General Carrera Lake

The Realmonte Salt Mine in Siciliy, Italy - There are currently three salt mines Realmonte in the province of Agrigento and Racalmuto and Petralia, in the province of Palermo, managed by the company Italkali . The Realmonte field, overlooking the southern coast of Sicily, about four kilometers from Agrigento and a kilometer from Porto Empedocle.

Valley of the Moon, Argentina - Arid and rugged, this barren landscape looks like – you guessed it – the surface of the Moon. But it is actually a fossil graveyard. The site contains undisturbed deposits from 250-200 million years ago. Fossils of some of the oldest dinosaurs, fish, amphibians, reptiles and over 100 species of plants have been found. There are also huge petrified tree trunks.

Chocolate Hills, the Philippines - The Chocolate Hills (Cebuano: Mga Bungtod sa Tsokolate; Filipino: Mga Tsokolateng Burol) are a geological formation in the Bohol province of the Philippines. There are at least 1,260 hills but there may be as many as 1,776 hills spread over an area of more than 50 square kilometres (20 sq mi). They are covered in green grass that turns brown (like chocolate) during the dry season, hence the name.

Richat Structure "Eye of the Sahara", Mauritania - Formally known as the Richat Structure, the Eye of the Sahara looks like a bullseye from above. Located in the Sahara desert, it is a dome-shaped rock structure about 50 km across. Once thought to have been caused by a meteorite impact, it is now believed to have formed from uplifted rock that was later eroded.

Skaftafell, Iceland - Skaftafell is a preservation area in Öræfi, southeast Iceland. It used to be a manor farm and a national park, but has been a part of Vatnajökull National Park since its establishment in 2008. Skaftafell National Park was a national park, situated between Kirkjubæjarklaustur, typically referred to as Klaustur, and Höfn in the south of Iceland. On 7 June 2008, it became a part of the larger Vatnajökull National Park. It was founded on September 15, 1967, and enlarged twice afterwards. Before its inclusion into Vatnajökull National Park, it measured about 4807 km2 (2884 mi2), making it Iceland's second largest national park. It contains the valley Morsárdalur, the mountain Kristínartindar and the glacier Skaftafellsjökull (a spur of the Vatnajökull ice cap).

North Island, New Zealand - Champagne Pool is a prominent geothermal feature within the Waiotapu geothermal area in the North Island of New Zealand. The terrestrial hot spring is located about 30 km (20 mi) southeast of Rotorua and about 50 km (30 mi) northeast of Taupo. The name Champagne Pool is derived from the abundant efflux of carbon dioxide (CO2), similar to a glass of bubbling champagne. The hot spring was formed 900 years ago by a hydrothermal eruption, which makes it in geological terms a relatively young system. Its crater is around 65 m (213 ft) in diameter with a maximum depth of approximately 62 m (203 ft) and is filled with an estimated volume of 50,000 m3 (1,800,000 cu ft) of geothermal fluid.

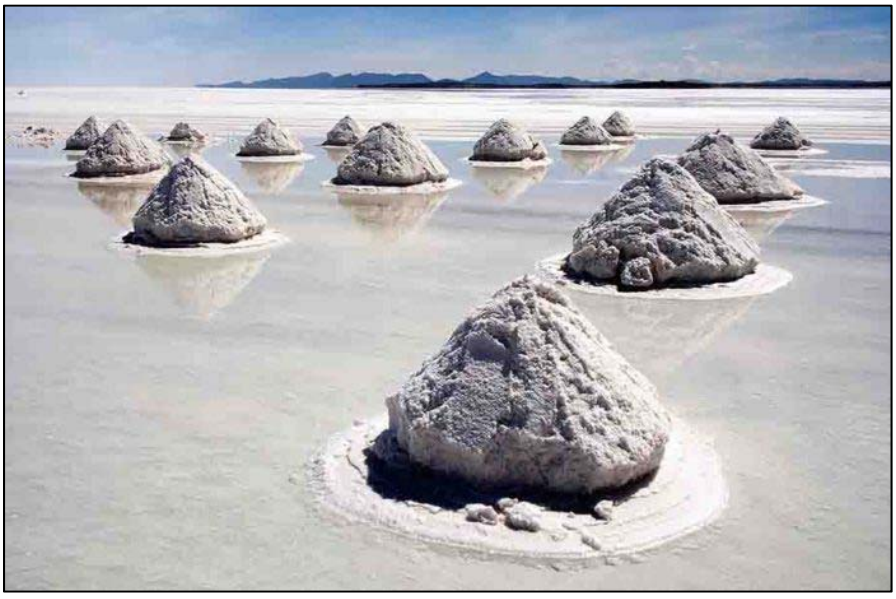
Cerro de los Siete Colores "The Hill of Seven Colors", Argentina - Cerro de los Siete Colores (The Hill of Seven Colors) is one of the hills bordering the Quebrada de Purmamarca which is in turn is a western branch of the Quebrada de Humahuaca up to Cuesta del Lipán, in Jujuy Province, Argentina.

Blue Lake Cave, Brazil - Blue Lake Cave is a cave located in Bonito, Mato Grosso do Sul, Brazil. The cave has been listed as a protected area by IPHAN since 1978. Gruta Do Lago Azul, or the Blue Lake Grotto, the large cave is filled with a pool of astonishingly clear blue water. Thought to be over 200 feet deep, the water turns a particularly beautiful blue when sunlight shines through a hole in the ceiling of the cave, and makes the water shimmer in the light.

Fingal's Cave, Scotland - Fingal's Cave is a sea cave on the uninhabited island of Staffa, in the Inner Hebrides of Scotland, known for its natural acoustics. The National Trust for Scotland owns the cave as part of a National Nature Reserve. It became known as Fingal's Cave after the eponymous hero of an epic poem by 18th-century Scots poet-historian James Macpherson.

Door to Hell "Gate to Hell", Turkmenistan - The "Door to Hell" is a natural gas field in Derweze, Turkmenistan, that collapsed into an underground cavern in 1971, becoming a natural gas crater. Geologists set it on fire to prevent the spread of methane gas, and it has been burning continuously since then. The diameter of the crater is 69 metres (226 ft), and its depth is 30 metres (98 ft).

Eisriesenwelt "World of Ice Giants", Austria - The Eisriesenwelt (German for "World of the Ice Giants") is a natural limestone and ice cave located in Werfen, Austria, about 40 km south of Salzburg. The cave is inside the Hochkogel mountain in the Tennengebirge section of the Alps. It is the largest ice cave in the world, extending more than 42 km and visited by about 200,000 tourists every year. The Tennengebirge mountains were formed during the late Tertiary period, during the Würm glaciation period of the Pleistocene. The mountain range, one of the massifs in the Austrian Alps, is the largest karst plateau in the Salzburger Alps, and the Eisriesenwelt is located at the rim of this plateau. Although the cave has a length of 42 km, only the first kilometer, the area that tourists are allowed to visit, is covered in ice. The rest of the cave is formed of limestone. Eisriesenwelt was formed by the Salzach river, which eroded passageways into the mountain. The ice formations in the cave were formed by thawing snow which drained into the cave and froze during winter. Since the entrance to the caves is open year-round, chilly winter winds blow into the cave and freeze the snow inside. In summer, a cold wind from inside the cave blows toward the entrance and prevents the formations from melting.



Salar de Uyuni, Bolivia - Salar de Uyuni (or Salar de Tunupa) is the world's largest salt flat at 10 582 square kilometers (4 086 sq mi). It is in the Daniel Campos Province in Potosí in southwest Bolivia, near the crest of the Andes and is at an elevation of 3 656 meters (11 995 ft) above sea level. The Salar was formed as a result of transformations between several prehistoric lakes. It is covered by a few meters of salt crust, which has an extraordinary flatness with the average elevation variations within one meter over the entire area of the Salar. The crust serves as a source of salt and covers a pool of brine, which is exceptionally rich in lithium. It contains 50 % to 70 % of the world's known lithium reserves, which is in the process of being extracted. The large area, clear skies, and exceptional flatness of the surface make the Salar an ideal object for calibrating the altimeters of Earth observation satellites.

Annual Gifts Support Earth & Planetary Activities

Annual gifts from alumni like you have helped enhance the educational experience of Earth & Planetary Science undergraduate and graduate students. Annual giving has an immediate and meaningful impact on students –with your help, we will be able to continue to enrich our student field trips and field courses, speakers series, scholarships, programs, laboratory facilities, and be able to respond to our most pressing needs and emerging opportunities. *If you would like to donate, the easiest way it to do so is:* www.mcgill.ca/give, *select 'Faculty of Science' on the 1st drop down menu and then select 'Other' in the 2nd drop down menu – type in 'Earth & Planetary Sciences' in the text box that appears.*

Anne Kosowski
Administrative Officer
Earth & Planetary Sciences
3450 University Street,
Montreal, QC H3A 0E8
(514) 398-3490
anne.kosowski@mcgill.ca

Left Photo: Late Holocene moraine-dammed lakes in the Cordillera Huayhuash, Peru
Right Photo: Purgatoria Fault scarp in southern Peru

Don Francis, Jonathan O'Neill *(Ph.D.'09),* and Shake

Jennifer Abbott or Robert Davis, University Advancement, Faculty of Science, (514) 398-4787, jennifer.abbott@mcgill.ca or rob.davis@mcgill.ca

KEEP IN TOUCH

What's new with you?

Are you in contact with your classmates?

Please let us know … anne.kosowski@mcgill.ca

Name:
McGill EPS Degree:
Graduation Year:
Mailing Address:

Telephone:
Fax:
Email:

What's New:

http://www.mcgill.ca/eps

Don Francis and Logan