

Photo by Tim Patterson

## **EARTH SCIENCES DEPARTMENTAL UPDATE APRIL 2024**

# **Celebrating 70 Years of Discovery, Innovation and Community**

In 2023 we celebrated the 70th anniversary of Carleton University's Department of Earth Sciences. We marked the occasion with a fabulous rafting field trip in the Grand Canyon in May and a Celebration Weekend with field trips and a gala reception in September. We also note that in

2023 our popular BScH program with a concentration in Vertebrate Paleontology turned 20!

We welcome recently hired faculty Drs. Lyle Nelson and Peter Crockford (replacing retired Professors Emeriti Claudia Schröder-Adams and George Dix) and are

excited that Dr. Elliot Skierszkan joined us in January 2024 (in a newly created cross-appointed position in Earth Sciences and Environmental Science). Despite a decline in enrolment during the

*continued on next page*

## **A SPECIAL THANKS TO OUR DONORS**

Our partnerships provide students with a great education and real-world experience. Our endowments, the Collins, Cox, K. Sethu Raman and Jeletzky funds, steadfastly support

student participation in field schools and summer internships for students. We thank our donors who are creating new endowments, scholarships, and bursaries, helping grow

the Charlie Roots Honours Project Fund in Earth Sciences, topping up existing scholarships and bursaries and supporting the Geological Time Trail Project.

Covid-19 pandemic years we are bouncing back with 128 undergraduate and 40 graduate students, 50 minors and ~2048 students per year registered in general interest courses such as Climate Change, Dinosaurs, Natural Disasters, Oceanography, On the Origin of Planets, and Planet Hollywood. Students are choosing our programs because of their diversity and high quality, wealth of field opportunities, outstanding opportunities for original student research, and our reputation as a friendly, active department with a strong community spirit.

We are proud of our new teaching and research laboratories, the result of a multi-year expansion and renovation of department space. Jim Mungall acquired a new SEM, and in the summer we'll be moving back into the

completely overhauled clean lab complex of the Isotope Geochemistry and Geochronology Research Centre (IGGRC) which is currently under renovation.

Bet McLarty Halfkenny, her colleagues, and volunteers continue to be successful in leading local and national outreach initiatives. Beth McLarty Halfkenny, Geoff Pignotta, and others have planned out an ambitious project, collaborating with Indigenous partners and Carleton University, to create a 4.5 km long Geologic Time Trail on Carleton's campus, showcasing the 4.5 Ga years of Earth history.

Read on in the newsletter for comments from the current chairman of the department, Tim Patterson, and a variety of articles and pictures showcasing many recent activities.



# 70<sup>TH</sup> ANNIVERSARY

## Grand Canyon Rafting Field Trip

As a kick-off to our 70th-anniversary festivities, 29 students, alumni, staff, faculty, retirees, and friends of the department went on a week-long, 'extreme geology' white water rafting and camping excursion on the Colorado River to study the 2 billion years of Grand Canyon geology exposed there. Professor Lyle Nelson was our primary geological expert, working with students who were on the trip as part of our Earth Sciences capstone field course. The river guides, rafting and camping gear, food, and logistics were provided by Hatch River Expeditions. The raft trip began at mile 0 at Lees Ferry and ended at mile 188 (~303 kilometers) at Whitmore Wash. The students created a field guide and made presentations en route explaining key geologic relationships visible from

the river or encountered on hikes. Navigating the river within the confines of the canyon unveiled the immense scale, intricate complexity, formidable ruggedness, and endless allure of this extensive network of canyons. The expertise, resourcefulness and knowledge of the guides added immeasurably to the expedition experience, not to mention their culinary skills. At the end of the trip, participants got fabulous views of the canyon and surrounding canyonlands as they were ferried out of the canyon by helicopter and then flown in a small aircraft back to Las Vegas. Participants were blessed with sunny skies and some starry or moonlit nights. All agreed that the Grand Canyon expedition was a truly outstanding wilderness experience and geological field trip.



Day 3, Carbon Canyon/Lava Canyon Chuar Hike (starting at Mile 63). Lyle Nelson discusses late Neoproterozoic Chuar Group geology with Audrey Scanlon and Nicole Kiluk, as well as to alumnus and Adjunct Professor Maurice Lamontagne, who is partially obscured from view.

MAY 2023





Day 4, Mile 115. As was customary each evening, trip participants have gathered at the end of the day to unwind and engage in conversations about the exciting experiences that unfolded during yet another fantastic day on the river.



On the first day out, at one of the first sets of rapids encountered on the Colorado River, Alumnus Larry Spence, and students Audrey Scanlon and Nicole Kiluk are reminded of how frigid the waters really are, despite the 33°C sunshine.





The raft proved to be the ultimate classroom setting, with trip leader Lyle Nelson imparting in-depth information to the students about the awe-inspiring geology they encountered while the raft serenely descended through the geological succession of the canyon. Directly behind the students are excellent exposures of the Cambrian Tapeats Sandstone. From the front to the rear, the group consisted of Audrey Scanlon, Alex Ovas, Connor McTaggart, Nicole Kiluk, and Lyle Nelson.







## Celebrating the Department's **ANNIVERSARY**

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September 22-24, 2023

Alumni and retirees travelled from far and wide to attend weekend celebration events (featured in the following section of the newsletter); the Ottawa region and Carleton Campus were at their best with sunny days, summer temperatures and fall colours. On Friday evening there were informal gatherings of a few groups including some participants of the first international field trips to Spain in 1972 & 1973 (i.e., Clint Tippett, Peter Meehan, Randell Stephenson, and Franz Nentwich to name a few), alumni from the late 1970s (organized by Warren McBride & Mary Louise Hill) and past and present students and researchers of Tim Patterson's lab.

The celebration weekend coincided with the 15th annual Geoheritage Day in the Ottawa - Gatineau region (described later in the newsletter). Brian Cousens led a field trip for alumni, retirees, and friends of the department to take in some of the Geoheritage Sites and back on campus, Tim Patterson gave an afternoon department tour.

On Saturday evening over a hundred guests gathered for a reception and dinner in Richcraft Hall on

campus. Staff member Michelle Co has created a short reel of the evening which is linked <https://bit.ly/47ZSLyb>. The farthest travelled participants were Randell Stephen from the UK and John Moore from Salt Spring Island. Professor Emeritus Ray Yole joined us by zoom from Vancouver Island - people lined up to have a chat with him. The most senior alum was K. Sethu Raman who attended with his wife Sabita, and the most senior Professor Emeritus was Al Donaldson. Alumni, students, and department members were pleased to see Dean of Science Maria de Rosa, Professors Emeriti Richard Brown and George Dix, Distinguished Research Professor Georgio Rinalli, Scientist in Residence Richard Ernst, and retired staff members Brian McKinstry, Dan Marshall, Ron Conlon, Peter Jones, and Tim Mount in attendance. Regretfully retirees Gail Atkinson, Keith Bell, John Blenkinsop, Claudia Schröder-Adams, Richard Taylor and Bill Tupper were unable to attend, as

was former staff member Elsie Lambton. We had a great turnout of Adjunct Professors including Don Cummings, Jordan Mallon, Geoff Pignotta (also a staff member), Rob Rainbird, Natalia Rybczynski, Shuangquan Zhang (also a staff member) and former Adjuncts Simon Hanmer and Charlie Jefferson. Participants enjoyed catching up with friends, reconnecting and finding out about what's new in the department and at Carleton.

On Sunday morning, alumnus Dr. Quentin Gall guided a group of alumni and friends of the department, including, retirees John Moore, Ron Conlon, and Peter Jones, on a Geoheritage walking tour in the historic heart of downtown Ottawa. Participants were regaled with vignettes about local history and architecture as well as the geology of the dimension (building) stones in buildings, monuments, pavements, and interior stone finishings.

**There was an enthusiastic call to hold a 75th reunion in 5 years' time - a testament to the success of the weekend events!**





Group photo of 70th Anniversary Field Trip participants - Hog's Back Falls Geoheritage site.

September 23, 2023

## **Alumni Geoheritage Day Field Trip**

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As part of the 70th Reunion and Geoheritage Day, Brian Cousens (with plenty of help) led twenty-one alumni and friends of the Department of Earth Sciences (formerly Geology) on a four-stop field trip around the Ottawa area. Remarkably, most of the participants had not been to most of the stops. Grenville basement rocks were visited at the W. Erskine Johnson schoolyard in Kanata, stromatolites at the north end of the Champlain Bridge, folded and faulted Paleozoic sedimentary rocks at Hog's Back Falls, and Holocene Champlain Sea sand dunes at Pinhey's Sand dunes. The participants had a lot of catching up to do, and the stops and the bus ride were perfect places to do it. Thanks to Wasuu Raji for assistance, Geoheritage Day volunteers at the stops, and Beth Halfkenny and Sheila Thayer for arranging for lunch from Di Rienzo Deli.





Seated participants on the downtown Ottawa Geoheritage walking tour are looking at the National War Memorial while Dr. Quentin Gall (red jacket) explains the history and meaning of the cenotaph, as well as the geology of the monument and surrounding paving stones. The view is looking northward towards the East Block of Parliament.



Group photo of Geoheritage walking tour participants in front of the Ottawa-Carleton Centre Heritage Building, now part of City Hall just before they scattered to look for sedimentary structures and fossils in the Gloucester Limestone of the building.





Celebrants at the evening reception and dinner in Richcraft Hall comprise undergraduate and graduate students, alumni from the 1970s to 2023, current and former faculty, staff and adjuncts and their friends and families.



Professor Emeritus Ray Yole “zoomed in” to the anniversary party to chat with former colleagues and students.

## Department History Project

Please help us portray our Department's 70 years of history and adventures. Do you have photos or tales from your time at Carleton? Please send your stories, memories and photographs to Tim Patterson ([TimPatterson@cunet.carleton.ca](mailto:TimPatterson@cunet.carleton.ca)). We are going to try to make a poster for each of the seven decades - we've made a start on the 70s and 80s, but there is much to do, and we welcome your participation.

## Please visit our Flickr site

<https://www.flickr.com/photos/199527834@N02/albums> where we have archival photos, video and even music spanning from the 1950s to present. Please visit!



# LETTER FROM TIM PATTERSON

## Chairman of the Department of Earth Sciences



Seventy years ago, in 1953, the Department of Geology was founded at what was then Carleton College, although the first Geology courses were offered as early as 1942. A group of forward-thinking educators, led by Professor Patrick Arthur Hill, who served as the chairman and the only faculty member, along with four part time lecturers, all employees of the Geological Survey of Canada, taught a small group of students. They laid the foundation for what has grown into a department that has not only survived the test of time but thrived in it. This marked the beginning of an exciting journey of exploration, learning, and discovery. The department has undergone many changes through the intervening years, but it remains a bastion of excellence, and it's a privilege for me to be a part of this 70 year long legacy.

As we celebrate the 70th Anniversary of the Department of Earth Sciences we are proud of the contributions of our many alumni to science, industry, and academia, and their dedication to the betterment of our planet. We are grateful for the continued engagement of alumni, adjuncts, research associates and retirees with the department and we celebrate your achievements. The unwavering commitment of faculty and staff, past and present, to the pursuit of knowledge, has been the bedrock of our success. The countless hours spent teaching, mentoring, and researching has inspired generations of students and has advanced the frontiers of earth sciences. This



dedication is the heart of the department and is a reminder that the bonds forged within these walls endure, and that this collective wisdom will continue to guide us. Our students represent the promise of the future. To the students... as you navigate your academic journey in the Department of Earth Sciences, remember that you are part of a tradition of excellence. The challenges you face today will be the stepping stones to your future accomplishments. Our hope is that you will carry the torch of earth sciences forward, making discoveries that will shape our world for the better.

During this celebratory year we also reflect on the profound changes that the field of earth sciences has witnessed. Our world faces critical environmental challenges, from climate change to a shortage of the critical mineral resources required for the green transition. It is in our hands, as earth scientists, to seek solutions and drive positive change. We must remember that the earth is not just our field of study, it is our home. Our work is not merely scientific research, it is the pursuit of a sustainable, thriving planet for all. It is a testament to our duty to protect and preserve the beauty and wonder of the natural world.

There are some key features of the earth sciences training received at Carleton that sets us apart from other earth sciences programs in North America. Top of the list is our emphasis on experiential learning including hands-on data collection in the laboratory and field, original student research, field mapping courses and field trips. During our 70th anniversary celebration weekend in September 2023 I had an opportunity to speak with alumni from the "1972 and 1973 expeditions to Spain". Those back-to-back trips were very important as they set the stage for a progressively increased emphasis on experiential learning in the department that continues to this day. In the years since our students have gone all around the world as participants in our capstone

field trips. As we all know there is no substitute for comprehensive field training for students to develop the independent problem-solving skills and self-confidence required to become a successful geoscientist. To that end we supplement the day trips that are part of many conventional courses with mapping, economic geology, vertebrate paleontology, environmental geoscience, and sedimentology field schools at every level from 2nd to 4th year. In addition, each year we offer a 4th year-graduate level capstone course that, in the tradition of the 1972 and 1973 Spain field courses, may travel to destinations anywhere in the world. This past spring, we put on a special 70th Anniversary faculty-staff-alumni-student trip,

under the leadership of Lyle Nelson, that examined the geology of the Grand Canyon from whitewater rafts. In the spring of 2024, Brian Cousens will introduce students to the volcanic terrain of Hawaii. In 2025 Fred Gaidies will lead students on a traverse through the Alps. We had a gap in field trip offerings due to the COVID-19 pandemic, but in 2019 I taught a field course on Mallorca in the Mediterranean. Other trips in recent years went to locales as far as far afield as Antarctica, Chile, Europe, Iceland, and New Zealand as well as North American destinations.

Critically important to the success of these field courses is the ability of students to be able to afford to take them. We are enormously privileged to have two field course endowments that have been established in the department, which partially offset the costs of these important field experiences; the W. H. Collins Memorial Scholarship established in 1994, and the K. Sethu Raman Endowment for Field Education in Earth Sciences, established in 2018. We are extremely grateful to those donors who have made it possible for all our students, many of them with limited means, to be able to participate in at least one of our upper division field courses.

The Department of Earth Sciences has always adapted with the times. In 1987 we rebranded from being the

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***“The countless hours spent teaching, mentoring, and researching has inspired generations of students and has advanced the frontiers of earth sciences.”***

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Department of Geology to the Department of Earth Sciences, in recognition that our teaching and research cover the entire earth system. As we all know there is an increased awareness of environmental issues, and earth scientists have the background that permits them to significantly contribute to nearly every area of environmental concern. For that reason, we are introducing a B.Sc.H. program with a concentration in Environmental Geoscience that meets requirements for professional accreditation. Armed with this degree our students will have the tools that they need to succeed in the job market of the early 21st century, with its focus on resource exploration (particularly critical minerals), water resources, sustainable hydrocarbon exploration, environmental mitigation and remediation, hazard mitigation, conservation sustainability and many other subdisciplines. We envision that this new area of focus will have a strong uptake from amongst our undergraduate population and will attract students to study at Carleton University.

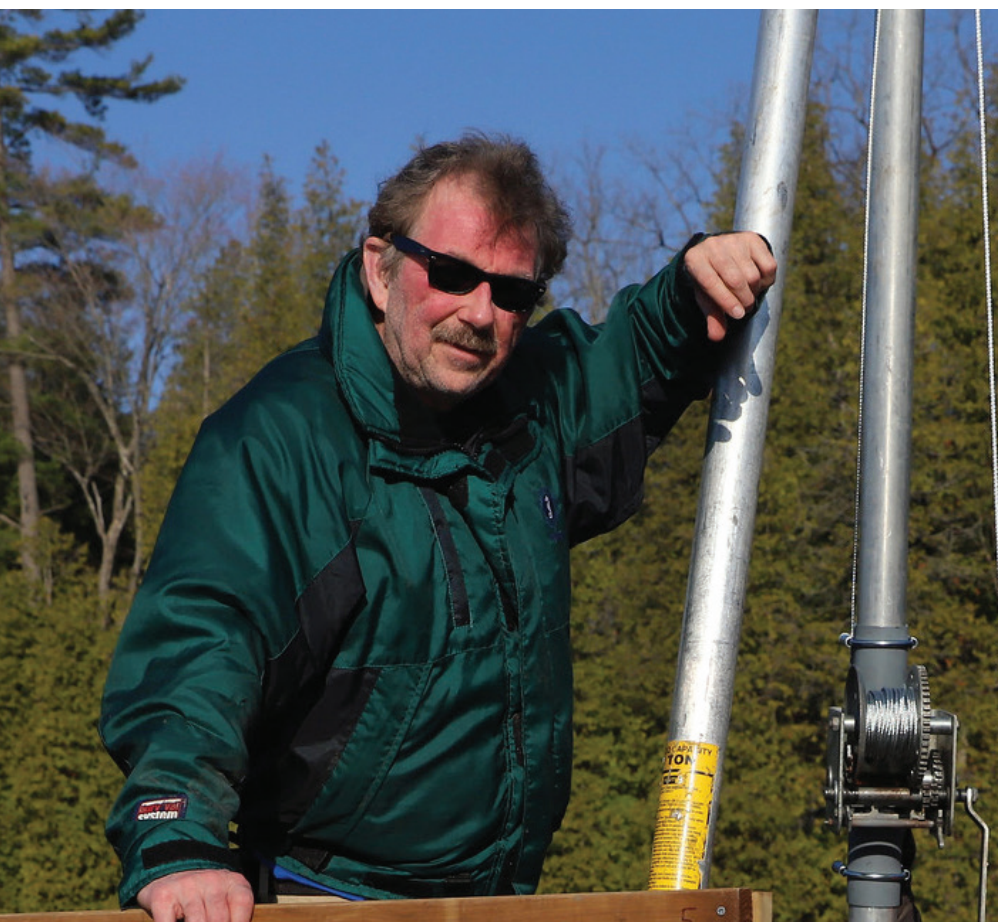
In addition to our focus on teaching, research is a very important departmental activity, and for decades we have had a reputation as an important research nexus. We are undergoing a rapid generation shift at present,

and we have tasked ourselves to up the ante, with our current goal to become the top ranked mid-sized earth sciences department, not just in Canada, but in North America. With the hiring of top-drawer faculty through recent years, such as Hillary Maddin (vertebrate paleontology and evolutionary development), Hanika Rizo Garza (isotope geochemistry applied to early earth history), Lyle Nelson (paleoenvironmental sedimentology focusing on climate, biogeochemical cycles, and the evolution of complex life in the Proterozoic and early Phanerozoic), Peter Crockford (isotope geochemistry and sedimentary geology applied to evolution of biosphere and earth's surface through time), and Elliott Skierszkan (environmental geochemistry and hydrology specializing in contaminants in water and northern permafrost regions) we have the capacity to reach that goal.

I can't feature the research activities of our newest faculty members without mention of the activities of our longest serving member, Giorgio Ranalli who joined the department in 1970. Upon his retirement in 2006 he was appointed as a Distinguished Research Professor in recognition of his continued high level of scholarly activity. Giorgio has maintained a continuous record of service to

the department for a remarkable 53 years – so far... he has just been appointed to another term!

In closing, let us use this 70th anniversary milestone as an opportunity to renew our commitment to the Department of Earth Sciences at Carleton University. We've come a long way, but the path ahead is rich with challenges and opportunities. Let us continue to push the boundaries of our understanding and use our knowledge to serve the Earth and its inhabitants. Thank you for being a part of this remarkable journey. Happy 70th anniversary!







**Peter Crockford**

## Welcome **New** Faculty Members

We have recently hired three new Assistant Professors. **Peter Crockford** and his team use isotope geochemistry and sedimentary geology to constrain how the biosphere and Earth's surface have evolved throughout Earth history. **Lyle Nelson** is a paleoenvironmental sedimentologist. He studies sedimentary strata of the Proterozoic and early Phanerozoic with the goal of understanding feedback among changes in climate,

biogeochemical cycles, and the evolution of complex life. **Elliott Skierszkan** has a cross-appointment with both Earth Sciences and Environmental Science. Elliott is an environmental geochemist with research projects investigating chemical and hydrological interactions that control the fate of contaminants in water, with a special focus on northern permafrost regions.





Elliott in the field in northern Yukon sampling an acidic and metal-rich natural spring as part of an investigation on impacts of thawing permafrost on water chemistry and quality.

**Elliott Skierszkan**



Lyle hiking in the midst of exhumed 538 million-year-old stromatolite reefs in South Africa that preserve a record of late Precambrian biodiversity.

**Lyle Nelson**





# Update on

# Professor Emeritus Sharon Carr

Sharon, who joined the department in 1990, retired at the end of 2023. Her expertise is in structural geology and tectonics, field geology, and geochronology. Sharon specializes in unravelling the operative processes, geologic history, and structural evolution of deformed and metamorphosed rocks from the core zones of orogenic belts. She collaborates with colleagues and members of the LITHOPROBE community to synthesize data at the larger scale to constrain models for the geometry and tectonic evolution of orogenic systems through time. Sharon's graduate students have been successful by any measure with careers in academia, government surveys, consulting, and industry. In addition to her primarily Cordilleran and Grenville Province research with graduate students and colleagues, Sharon has supervised or co-supervised, trained, and mentored ~30 B.Sc.H. students as they studied the geology and/or geochronology of field-based projects from all over Canada. She has steadfastly mentored students, student clubs, early career scientists and alumni. Throughout her time at Carleton, Sharon was key in managing, staffing, and acquiring essential instruments and high-tech laboratories for the Isotope Geochemistry and Geochronology Research Centre – an essential facility supporting a large community of researchers and students conducting innovative research on all aspects

of planet earth through time, and providing in-depth, hands-on training of 'highly qualified personnel.' As Department Chair from 2013 to 2016, Sharon shepherded the department through a period of active faculty and staff rejuvenation, and the major expansion, redesign and renovation of existing and new teaching space, specialized research laboratories, offices, and common departmental space. She has been active in liaising with Advancement, Alumni, and other department supporters to create scholarships and endowments that directly benefit students and their opportunities to participate in field trips, B.Sc.H. thesis research (e.g. Charlie Roots Project Fund in Earth Sciences) and other academic and professional activities (e.g. Sharon D. Carr Student Activity Fund). Sharon looks forward to having more time for indulging her curiosity and interests in such areas as landscape design, Indigenous issues, small watercraft, live music, art & architecture, country living, quadrupeds – especially equines, and classical guitar, as well as continued adventures near and afar with her favorite bipeds, exploring the landscape, waterways and history of the Frontenac Arch near her Wolfe Lake home, and staying engaged with her community, geoscience, geoheritage and geological consulting.



# *In Memorium*

By Tim Patterson

We are saddened to report the passing of several faculty and staff in recent years — the reality of a department that is now 70 years old. These former colleagues were pivotal in shaping the future of countless students, many of whom have since achieved remarkable success in their post Carleton careers.

**Professor Emeritus George Skippen**, metamorphic petrologist, left us in November 2019. He joined the department in 1967 and retired in 2002 after distinguished 35-year career. During that time, he served as departmental chairman from 1978-81, followed immediately by a stint as Dean of Science until 1983. Dr. Skippen won many awards for his research (e.g. the 1992 MAC Hawley Medal), and the mineral Skippenite was named in his honor. George leaves behind a legacy of research on carbonate petrology and crustal fluids that is still widely cited, and his many successful students who have gone on to careers in academia, industry, and government.

The irrepressible and legendary, we'll leave it at that, **Jack Hogg**, passed away in February 2021. Jack had a 30-year career as a technical staff member in the department from 1965 to 1995. He had many duties but was instrumental in running departmental field courses, a task that he relished.

In July 2021, we bid farewell to **Dr. Ken Hooper**, a veteran of the Bomber Command during World War II, who passed away at the age of 98. After an early career that took him around the world, Ken joined the department in 1958, which was then only five years old, as a micropaleontologist. He served in this position for three decades until his retirement in 1988.

By any account **Professor Emeritus George Chao**, who passed away in May 2022, at the age of 91, had an outstanding 35-year career (1960-1995) as a mineralogist. He not only made significant contributions to science through the discovery of many minerals, including Carletonite, but he lived a truly remarkable journey that began in Harbin, Manchuria on the eve of the Japanese invasion in 1931, through a convoluted “against-all-odds” pathway that eventually led to a stellar career in academia.

In September 2023, **Professor Emeritus Dave Watkinson**, economic geologist, passed away at the age of 85. Throughout his remarkable 35-year tenure in the department from 1970 to 2005 Dave was a prolific scientist and served as departmental chairman twice, from 1982-83 and again from 1993-1996. He is also fondly remembered as a mainstay at departmental social events, particularly Christmas parties. Dave was an accomplished pianist who could play a large repertoire of music by ear. His annual Christmas carol marathon, which commenced at noon and featured a rotating ensemble of faculty, staff, and student carolers, became a much-anticipated tradition. This musical interlude often extended well into the afternoon and beyond, leaving a lasting imprint on any and all who were part of it.



# General Interest Geoscience Courses

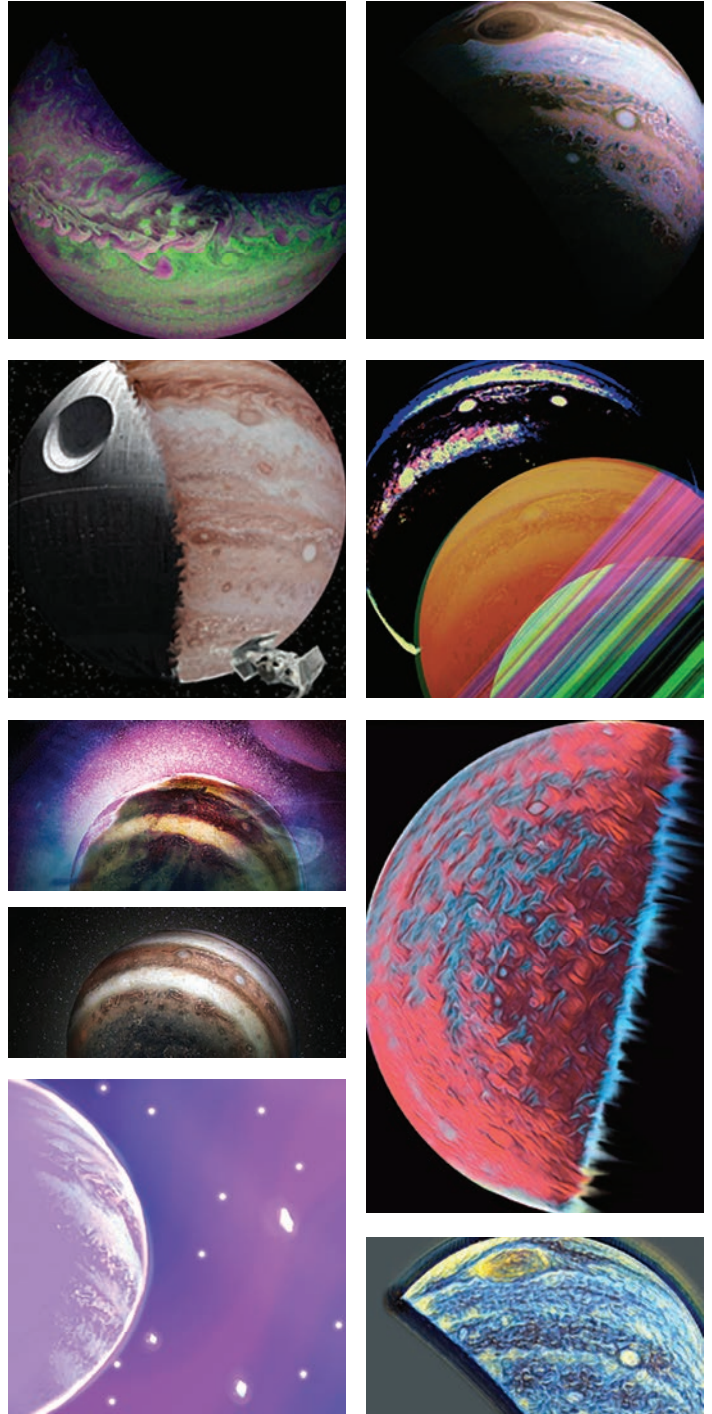
are taught by the Department of Earth Sciences as well as core courses in the Earth Sciences programs. In addition to our popular and well subscribed courses on Dinosaurs, Climate Change, Oceanography, and Natural Disasters, we recently started offering Planet Hollywood and On the Origin of Planets. We have also proposed two exciting new courses, UNESCO World Geoparks and Geoheritage and A Geologic Tour of the National Parks of North America – if approved, they will make their debuts in the fall and winter terms of the 2025-26 academic year.

Dr. Geoff Pignotta teaches EARTH 2012, *Planet Hollywood* which examines how public perception of Earth Science is influenced by non-documentary Hollywood films and other mainstream media. Earth Science concepts and content portrayed in Hollywood films are sometimes accurate but more frequently misrepresented in the search for the next box office hit. Popular Hollywood films from the last several decades are used to critically evaluate the Earth Science concepts and content that they present and directly compare them to the actual science.

In EARTH 2419, *On the Origin of Planets*, Professor Hanika Rizo leads students on an exhilarating journey through intriguing subjects, including meteorites, comets, asteroids, terrestrial planets, ocean worlds, and the quest for exoplanets and extraterrestrial life.

Images from spacecraft orbiting Jupiter formed the basis of a student organized image contest in Hanika's 2022 winter term EARTH 2419 course. Students downloaded raw JunoCam images of Jupiter acquired by NASA from spacecraft currently orbiting the planet. They manipulated the data with software, enhancing Jupiter's features in order to study them.

Here are samples of student creations.







# Loxiwe Technology Research Project

## Indigenous & Western Science

By Gavin Woodburn

Aerial view of an 800 m<sup>2</sup> Loxiwe (clam garden) surrounded by forest at low tide in Phillips Arm, British Columbia. Notice the curved rock wall at the water's edge – it was constructed by the people of this area (likely over 4000 years ago) by rolling large rocks down the beach. This flattens and extends the beach by catching gravel sized sediment at the ideal tidal zone for clam habitat (0.7-1.5 m above sea level). The dark green on the beach is seaweed which grows due to the lack of management – historically the seaweed would have been removed to keep the clams more accessible.



In the Kwak'wala language, the word Loxiwe means "place of rolling rocks," but it is also the word we use to describe unique intertidal beach features created by humans thousands of years ago that are referred to as clam gardens. The Loxiwe technology research project aims to weave together Indigenous Science with Western Science taking an ethical research approach and using 3-eyed seeing (i.e., 3-eyed seeing, a framework created by Dr. Myrle Ballard, considers the perspectives of western science, Indigenous science, and the environment). This includes making knowledge accessible through multimedia such as academic writing, videos, and graphic recordings.

The Loxiwe project includes multiple forms of Indigenous and Western scientific methods to create a more (w)holistic understanding through interviews with Elders and Knowledge Keepers, mapping the clam beds using drone and other surveying methods, conducting clam population surveys, and exploring the broader area to see other connections between environmental systems and Indigenous presence on the land and in the water. While there are many different ways of knowing in Indigenous Science, the Loxiwe Project is an excellent example of the power of 3-eyed seeing in conducting science research.



Photo of Loxiwe at low tide showing the flat beach surface composed of the gravel to boulder sized substrate which clams like to bury deep in. Water on the surface represents the Loxiwe's ability to retain water as tide goes out, which is a powerful feature in moderating temperature within the habitat.



Aerial view of a 2200 m<sup>2</sup> Loxiwe at low tide in Phillips Arm, British Columbia. The outer perimeter of this Loxiwe is a rock wall, at the water's edge, constructed thousands of years ago by the people of this area. The rock wall serves to flatten and extend the beach by catching sediment at the ideal tidal zone for clam habitat (i.e., 0.7-1.5 m above sea level).



Gavin Woodburn digging up butter clams on a Loxiwe (Clam Garden) in Phillips Arm, BC at low tide. Gavin is a Kwiakah First Nation member and fourth year B.Sc.H. Earth Sciences student taking a concentration in Geophysics and a minor in Indigenous Studies. He also works for the Indigenous Science Division at Environment and Climate Change Canada and is leading a project about Loxiwe technology.



# Learning bundles at Carleton for Science students

By Gavin Woodburn & Sharon Carr

Indigenous learning bundles are teachings produced and delivered by Indigenous experts as classroom resources for instructors and learning tools for students. They provide the factual and theoretical basis for understanding Indigenous history and politics in Canada, and prompt students to consider how this knowledge might be applied in their area of study. Bundles tailored for science students encourage students to begin to understand Indigenous ways of knowing. Students start questioning the knowledge they are learning and begin thinking about science through a different lens.

For example, Professor Jim Mungall incorporates a learning bundle called “Indigenous-Canada Relations” as part of his EARTH 4303 course entitled, “Resources of a Finite Earth.” Jim explains,

“When I talk about land tenure and property rights in Canada, as part of my lecture about how mineral exploration is conducted on public and private lands, I bring this Indigenous perspective in. We explore how the Crown and Indigenous nations have or have not codified the ownership and stewardship of land in Canada through Canadian history (including prior to contact with Europeans) and talk about the different meanings of land ownership in different cultures.”

The incorporation of learning bundles in education serves to encourage students to engage in many perspectives, develop critical thinking skills and approach science in an ethical way.



**Would you like to replace your Carleton Earth Sciences graduation ring?** Email your request

to [earth.sciences@carleton.ca](mailto:earth.sciences@carleton.ca) and we will provide you with contact information for the jeweler who makes the rings and a letter confirming your graduation. The jeweler will handle your order and payment upon receipt of the graduation confirmation letter.





# Scanning Electron Microscopy Lab

Professor Jim Mungall's Mineral Deposit lab hosts a new state-of-the-art JEOL JSM-IT500 scanning electron microscope (SEM) with Oxford ULTIM MAX solid state energy-dispersive X-ray detector that is operated by Dr Maryam Shahabi Far. This instrument is in use around the clock generating high resolution images of the compositions and mineralogy of rock samples. For example, Rafael Bacha used it extensively in his PhD research where he documented basin-scale chemical

alteration of mafic sills during the Lufilian orogeny in the Central African Copper Belt – this alteration led to the release of cobalt into migrating fluids that ultimately generated the world's principle resource of this vital battery metal. The X-ray maps and automated phase analysis were critically important to the success of his research. Since the installation of the SEM in mid-2020, the instrument has supported in-house and industry research and over 20 student research projects.





# MAPPING FIELD SCHOOL

## Grenville Province - May 2023

Under the leadership of Dr. Geoff Pignotta, ERTH 2802 field school students learned how to describe, map, and interpret structurally complex metamorphic rocks, culminating in an independent mapping exercise on the Ore Chimney Mine property. The course was a success, thanks to the support of wonderful and hard-working TA's. The enthusiastic and positive group of students accomplished all of the goals for the course, despite rain and overflowing beaver ponds. We are ever grateful to the Lancaster family for hosting the group and to Garry Smith for generously permitting access to private land for geologic mapping.





# Graduate Student Field Course

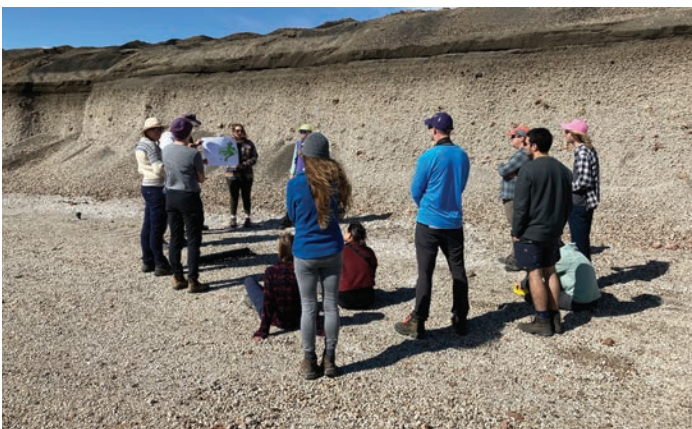
## August 2023

Professor Brian Cousens and Dr. Erin Bethell (Carleton Alum and U of Ottawa Research Associate) led thirteen graduate students (from Carleton U, Memorial U, U of O, and U of T) on a field course in Iceland – part of an NSERC iMAGE-CREATE graduate student training workshop. Iceland is geologically unique: magmatic and tectonic interactions between the underlying hotspot and the spreading centre of the mid-Atlantic rift produce volcanoes that are commonly modified by interaction with glacier ice and water. Starting in Reykjavik with a Golden Circle tour, the group visited the

Gulfoss waterfalls, Kerid Crater, Geysir geothermal field and Thingvellir Park, home to the first democratic parliament and situated in a rift valley – the on-land extension of the mid-Atlantic Ridge. Field site-visits in southern Iceland included the Skogafoss waterfall, “rootless” volcanic cones, sites of subglacial eruptions, and a pumice quarry on the flank of Hekla volcano. Driving to the Snaefellsnes Peninsula, the group investigated columnar-jointed lava flows, spatter vents, cinder cones and glacial structures around the spectacular Snaefellsjokull volcano. The field trip concluded in northeastern Iceland, a geologists paradise with geothermal fields, volcanic maars, massive young lava fields, and spectacular pyroclastic deposits. The costs of the trip were largely supported by the NSERC iMAGE-CREATE grant.



2023 graduate student field course at Thingvellir Park, in the Mid-Atlantic Ridge rift zone, led by Brian Cousens (kneeling on the left side) and Erin Bethell (standing on the right side).



2023 Iceland graduate student field course. Student presentation on the geology of Hekla volcano, as participants stand in a quarry of ca. 1000-year old pumice from a Hekla eruption.



2023 Iceland graduate student field course. Investigations of young lava flow morphologies at Krafla volcano where lavas, from 1975, are still hot at depth and produce steam when it rains!





Beth McLarty Halfkenny and her Geoscience outreach collaborator Lesley Hymers at Cliffs of Fundy, Geopark Field Trip, GAC-MAC Halifax, May 2022.

## Beth McLarty Halfkenny and Geoscience Outreach Activities

Beth's creativity, leadership, and impact in the realms of in-house, local, national, and international Geoscience education and outreach projects is ever expanding and increasingly important in improving the perception of geoscience for the public good, essential for building a sustainable future. Beth rallies volunteers and organizes the autumn Geoheritage Day events in the Ottawa-Gatineau region, supports teachers and students in the K-12

system with class visits and workshops on campus, runs professional development workshops and field schools for teachers, and coordinates our extremely popular Earth Sciences Summer camps.

Beth's activities extend far beyond her role as Department Curator and Outreach Coordinator. She has regularly helped organize and co-chair Geoscience Education Sessions at annual GAC/MAC conferences and collaborates with colleagues at

other institutions and educational agencies to support teacher training nationally, through the Canadian Geoscience Education Network. Beth, her long-time colleague Lesley Hymers, and others have championed the creation of a new Division of the Geological Association of Canada, the "Geoscience Education and Communication Division." In collaboration with Geoff Pignotta, Indigenous Elders and Carleton University, Beth has proposed the



Geological Time Trail project – a 4.6 km trail on Carleton Campus serving to represent 4.6 billion years of Earth history through time. She is also part of an initiative with George Dix, Geoff Pignotta and Quentin Gall to showcase Geoscience on the Rideau Trail – which is being developed as a “New Geotrail” pilot project in the APGO Education Foundation, “Geotrails Program.”

In 2022-23 Beth, served as President of the Canadian Federation of Earth Sciences (CFES) and is currently Past President. The CFES is an umbrella organization that represents a federation of Earth Sciences societies and associations across Canada. Established in 2006, CFES brings together approximately 15,000 individual Earth Scientists in industry, government, and academia. The organization advocates on behalf of the Canadian Earth Science community with government and the public and supports K-12 students and teachers via the Canadian Geoscience Education Network. The CFES cooperates with observer organizations and other Canadian non-member organizations on issues of public education and professional registration, and represents its members internationally, as a member of the International Union of Geosciences (IUGS) and UNESCO.

During her tenure with CFES, Beth was able to advance the Geologists in National Parks program, in partnership with Parks Canada and the APGOEF, piloting two-week volunteer Geologist in Residence positions at Pukaskwa National Park, Ontario in the summers of 2022 and 2023. Both volunteer geoscientists and Parks staff were so pleased that Pukaskwa will make this a permanent program going forward and will encourage other National Parks to use this template to get on board with the program. At present, Beth is rebuilding the CFES Earth Science Careers Website, to help youth learn about the breadth of exciting careers in Earth Sciences, with hopes to launch in the new year.

## PARTNERS AND SPONSORS





# UNESCO Geodiversity Day

October 6, 2022

Beth was also instrumental in organizing an event entitled, “Celebrating Geodiversity; the critical foundation for diverse ecosystems on a changing planet” for the first annual UNESCO Geodiversity Day, co-hosted by Carleton’s Department of Earth Sciences, the Faculty of Science and the Canada Science and Technology Museum’s Curiosity on Stage. The event featured a keynote address by Dr. Claudia Schröder-Adams, entitled “Remarkable Earth and Ecosystem Changes in the Canadian Arctic Through Deep Time” and a Q & A discussion with expert panelists, followed by a reception. The event was well attended by “in person” and “video-

conference” attendees – for recordings in English and French see the link: <https://science.carleton.ca/geodiversity-symposium/>.

The panelists, with diverse expertise in biodiversity, local ecosystems and water and mineral resources helped focus the discussion on connections between Canada’s remarkable and varied landscapes, ecosystems, and human societies. The participants and audience all agreed that the messages from Arctic research and the interdisciplinary discussion helped to underline the importance of connecting Earth and Ecosystems as we talk about biodiversity and sustainability.



UNESCO Geodiversity Day keynote speaker Claudia Schröder-Adams (Professor Emeritus, Earth Sciences, Carleton University [CU]) presented a lecture entitled, “Remarkable Earth and Ecosystem Changes in the Canadian Arctic Through Deep Time.”










UNESCO Geodiversity Day 2022 participants are (left to right) Beth McLarty Halfkenny (co-organizer, Earth Sciences, CU), Claudia Schröder-Adams (keynote speaker, Professor Emeritus, Earth Sciences, CU), and panelists Jan Peter (Research Scientist, Economic Geology, Geological Survey of Canada), Peter Dang (Entomologist, Biodiversity Conservancy International, Project Director of Restoration at Pinhey Sand Dunes, Nepean), Tessa Dilorio (Hydrogeologist, Risk Management, City of Ottawa), Steven Cook (Canada Research Professor, Director Environmental and Interdisciplinary Science, CU) and Maria DeRosa (Dean of Science, CU).





# Geologic Time Trail and the Alice Wilson Geoheritage Park

## Map Green Ribbon & Geological Time Trail

-  Property Line
-  Green Ribbon Trail
-  Geological Time Trail
-  Potential Bioswale
-  Potential Indigenous Cultural Marker or Artwork
-  Existing Building
-  Planned Building
-  Potential Building
-  Work under development prior to the CMPU

The Green Ribbon trail system will reinforce and rejuvenate the existing green frame around the campus while also increasing opportunities for recreational activities, added connections to the regional ecological patch matrix and provide enhancements to the riparian corridor.



Map of Carleton Campus showing the location of the proposed Geologic Time Trail.





These large rocks in the Alice Wilson Geoheritage Park are representative examples of local geological units and features. They will be moved into new locations and incorporated into the Geologic Time Trail.

A 4.6 kilometer long, accessible walking trail - The Geologic Time Trail - has been featured in the Carleton Campus Master Plan! This installation will help students and the public grasp the expanse of geologic time on planet Earth and will illustrate some key moments in Earth history that helped to shape the local geology and campus landscape. The trail will begin at the Indigenous Waypoint Marker at the new campus O-train Station and will wind its way through the Carleton campus, providing us with an opportunity to connect more deeply with our teaching, learning, community, and working spaces. With rock outcrops and landscaped vegetation, markers for major geologic time transitions and notable events, and interpretive signage, the trail will be an outdoor

classroom and learning tool relevant to many disciplines and issues including those in the Geosciences.

As a first step to establishing the trail footprint, our exhibit of rock samples in the Alice Wilson Geoheritage Park, representing examples of local geological units and features, is on the move! This collection of large boulders near the Steacie Building front entrance will be relocated to the Rideau River waterfront near the new pedestrian footbridge and Richcraft Building. The exhibit is expected to be relocated in the spring and summer of 2024. To learn more about the 2023 Campus Master Plan, visit <https://carleton.ca/finance-admin/campus-master-plan-2023/>.



# Geoheritage Day 2023

Geoheritage Day is our annual invitation to the public to meet us at some of the exceptional rock outcrops in the region to learn about the geological processes that have shaped our landscape. This year the event took place on Saturday September 23, to coincide with the Department of Earth Sciences 70th Anniversary celebrations, allowing Alumni and Retirees to join us at the hosted sites. Five sites welcomed approximately 200 visitors including some talented folks from Ottawa's Urban Sketchers. We'd like to express our thanks to all the volunteers for generously sharing their time and enthusiasm! For further information about Geoheritage - visit the site linked here: <https://geoheritageday.carleton.ca/>



Simon Hanmer, John Moore, and Charlie Jefferson (left to right), examining relationships in Precambrian Grenville rocks at W. Erskine Johnston/George Vanier schoolyard on Geoheritage Day (participating via the 70th Anniversary Field Trip lead by Brian Cousens).



Geoheritage Day volunteers Ian Bietz and Nikole Kiluk at their display at the Hog's Back Park Geoheritage site near Carleton campus. The display depicts information about the local rocks and how they fit into the Geoheritage story of the region. Ian and Nikole showed visitors examples of fossil specimens, to help them in their search for fossils and sedimentary structures in the rocks, and explained how to decipher the significance of their observations with respect to the ancient sedimentary environments of deposition.

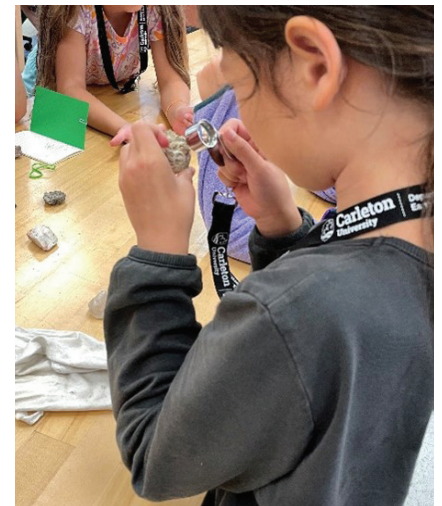


Examples of art created by the Urban Sketchers on Geoheritage Day at Hog's Back Park Geoheritage site.



Ottawa Urban Sketchers, who are perched atop tilted sandstone beds of the Ordovician Rockcliffe Formation at the Hog's Back Park Geoheritage site, are creating art inspired by the geological and natural environment.





# Earth Science Summer Camp 2023

During three weeks in July and August, we welcomed 150 campers, aged 8-12, all eager to explore the Earth Sciences. We used our labs and classrooms, nearby outdoor spaces, and Hog's Back Park to investigate volcanoes, earthquakes, fossils, rocks, minerals and related Earth processes in a fun and hands-on way. Campers received a hand lens, notebook and pencil, and a rock,

mineral, and fossil starter collection, and made a fossil mold and cast model to take home. Our summer camps routinely sell out within hours of registration opening so we must be doing something right! Thanks to our fabulous camp staff, Andrew Traynor, Trystan Warnock-Juteau and Sara Ellacott.



## Featured Research

# Study of ancient sedimentary rocks reveals origins of modern animal biodiversity

Lyle Nelson and his colleagues have been studying stratigraphic records preserved in mountain ranges of the Mojave Desert in North America and the Namib Desert in Southern Africa to better understand the tempo and drivers of the 'Cambrian Explosion,' the interval of Earth history when >80% of modern animal phyla first appear as fossilized organisms. In recent publications, Nelson et al. (2022, 2023) present high-resolution age-calibrated biostratigraphic and chemostratigraphic records for the Ediacaran-Cambrian boundary that suggest the base of the Cambrian Period is more than six million years younger than currently recognized, consistent with relatively rapid diversification of major groups of animals.

Nelson, L.L., Crowley, J.L., Smith, E.F., Schwartz, D.M., Hodgkin, E.B. and Schmitz, M.D., 2023. Cambrian explosion condensed: High-precision geochronology of the lower Wood Canyon Formation, Nevada. *Proceedings of the National Academy of Sciences*, 120(30), p.e2301478120.

Nelson, L.L., Ramezani, J., Almond, J.E., Darroch, S.A., Taylor, W.L., Brenner, D.C., Furey, R.P., Turner, M. and Smith, E.F., 2022. Pushing the boundary: a calibrated Ediacaran-Cambrian stratigraphic record from the Nama Group in northwestern Republic of South Africa. *Earth and Planetary Science Letters*, 580, p.117396.



Lyle Nelson measuring a section of 540-million-year-old strata in South Africa that preserve records of late Precambrian biodiversity and geochemical change.



Peter Crockford performs some not so simple accounting. An exquisitely preserved sandstone cast of *Ernietta*, a soft-bodied animal that lived in shallow marine environments during the latest Precambrian.

## Peter Crockford performs some not so simple accounting

How much life has ever been on Earth and how much life will ever be on Earth? Peter and colleagues from the Weizmann Institute of Science in Israel and Smith College in Massachusetts have recently published a paper in *Current Biology* which estimates the total amount of carbon ever fixed by the biosphere, the total number of cells to have ever existed on Earth and identify the most common 'Earthling' to have ever existed. In his work, Peter and colleagues estimate that the biosphere has cycled an amount of carbon equivalent to Earth's entire

carbon stock  $\approx 100$  times, that  $\approx 10^{39}$ - $10^{40}$  cells have existed on Earth, and that Cyanobacteria are the most common form of life to have ever existed. The paper notes that this is a step forward in the ongoing effort to set Earth as a benchmark when comparing it to other potentially habitable worlds.

Peter W. Crockford, Yinon M. Bar On, Luce M. Ward, Ron Milo, Itay Halevy, The geologic history of primary productivity, *Current Biology*, 2023, ISSN 0960-9822



# Crawford Lake declared the “Golden Spike” for the Anthropocene



Dr. Carling Walsh, Ph.D. student Zack Milani and Professor Tim Patterson prepare to pull a freeze core from the bottom of Crawford Lake while Dr. Maxim Falchenko waits to rush the core to shore during coring in April 2023. The coring raft upon which they stand is a mainstay of the Patterson lab - built by Tim's father in the mid 1990s it has been used to collect cores from all over North America.

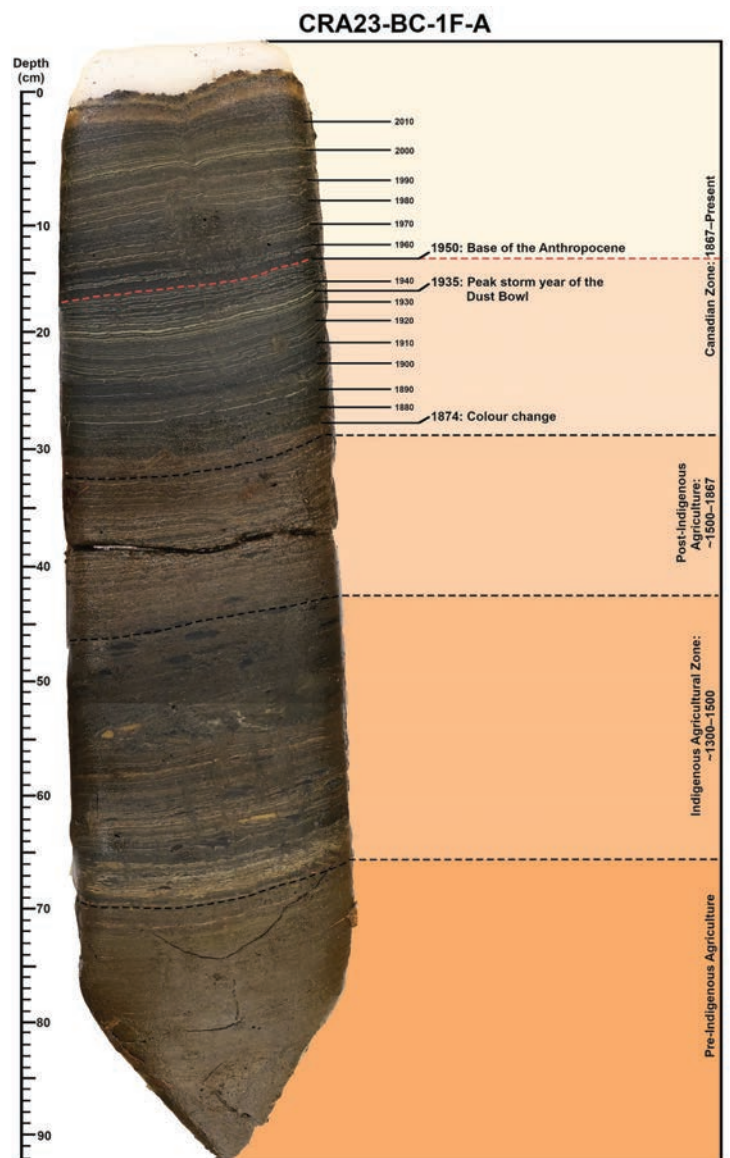


Research at Crawford Lake, near Milton Ontario, carried out by Tim Patterson's Lab has attracted significant international media and scholarly coverage. The work captured the public's imagination, in progress becoming the biggest geology news story of the last year. Professors and co-investigators Tim Patterson, Francine McCarthy (Brock University) and Martin Head (Brock University) lead 'Team Crawford,' a consortium of >60 researchers from institutions in Canada and around the world. The Anthropocene Working Group of the Subcommission on Quaternary Stratigraphy chose Crawford Lake as the Global Boundary Stratotype Section and Point (GSSP), or "Golden Spike," for a proposed Anthropocene epoch, with a start date of 1952 to coincide with the detonation of the 10.4 megaton Ivey Mike thermonuclear test, the record of which is well preserved in the sediments of Crawford Lake. The exemplary geologic record preserved in Crawford Lake beat out 11 other candidate GSSP sites spanning five continents including Antarctic ice, tropical corals, and mountain peat bogs.

Tim and his students produced a precisely dated multi-proxy geological record of the annually deposited laminated sediments in the lake with unparalleled sub-annual detail. Crawford Lake's finely laminated sediments contain a nearly thousand-year record of human influenced environmental history. This includes a complete record of atmospheric nuclear weapons testing beginning with the Trinity nuclear test in 1945, as well as atmospheric fallout of fly ash derived from high temperature fossil fuel combustion in the nearby steel mills in Hamilton. Together with other evidence in the lake record of the "Great Acceleration," the period after WWII when human activities began to leave an indelible imprint on Earth's geologic record, Crawford Lake is a poster child for how humans have brought about more changes in a few decades than have occurred through the entire Holocene. Thus, the proposition that we have left the Holocene Epoch and are 70 years into a new epoch, the Anthropocene.

In late March 2024, the International Union of Geological Sciences, the overseers of the geological time

scale, unfortunately rejected the proposal. Tim and his collaborators are currently revising their proposal to designate the post-1952 record as the "Crawfordian" Stage/Age within the Holocene, following the Maghalayan. Brad Rosenheim, chair of the GSA Geochronology Division, summed it up best in the wake of the IUGS decision, when he stated in a letter to GSA members, that the decision was a sign that the current system "is not equipped to deal with looking at the present, nor with the rate of change currently occurring on our planet."

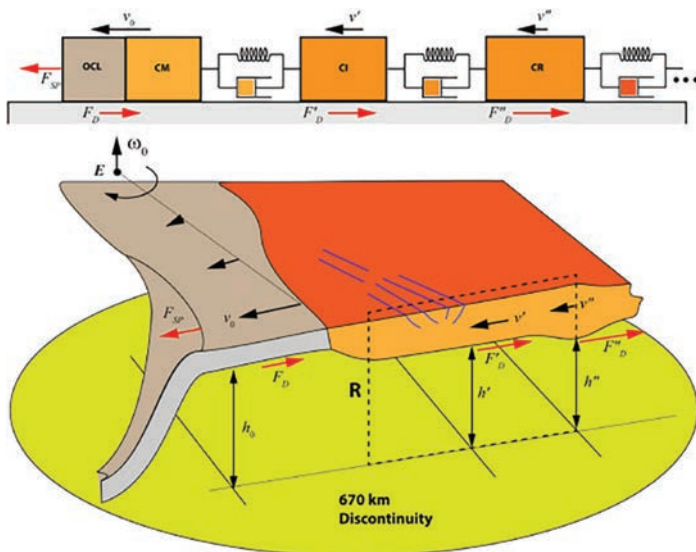


The varved sedimentary record of Crawford Lake comprises alternating layers of calcite deposited in the lake during the warm summer months and organic rich layers deposited when phytoplankton begin to die off in the fall. The superb annual record of deposition at Crawford Lake preserves a record of human influence on the lake that spans back nearly 1000 years.

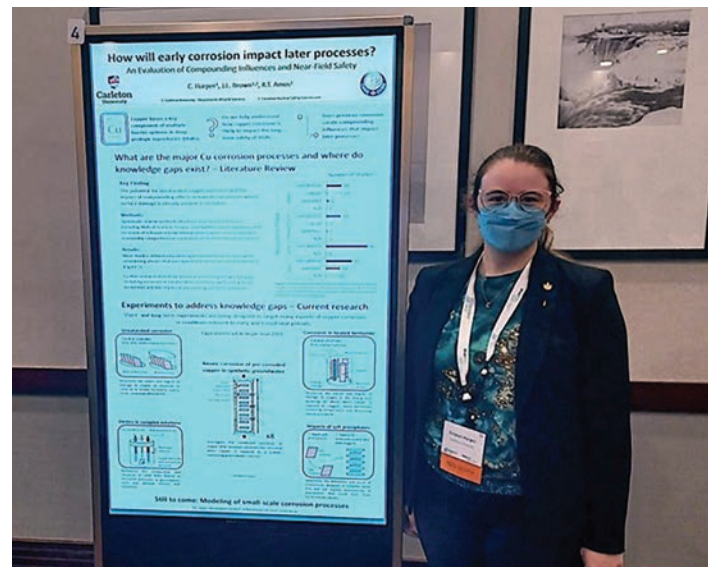


# Selected Research Achievements

We feature the research activities of our community on the Department of Earth Sciences webpage [earthsci.carleton.ca](http://earthsci.carleton.ca). Please check it out – and click on the link for each article to get an in-depth summary, pictures, and links to published papers, interviews, or conferences, etc. Here are a few examples from 2023 to whet your appetite.

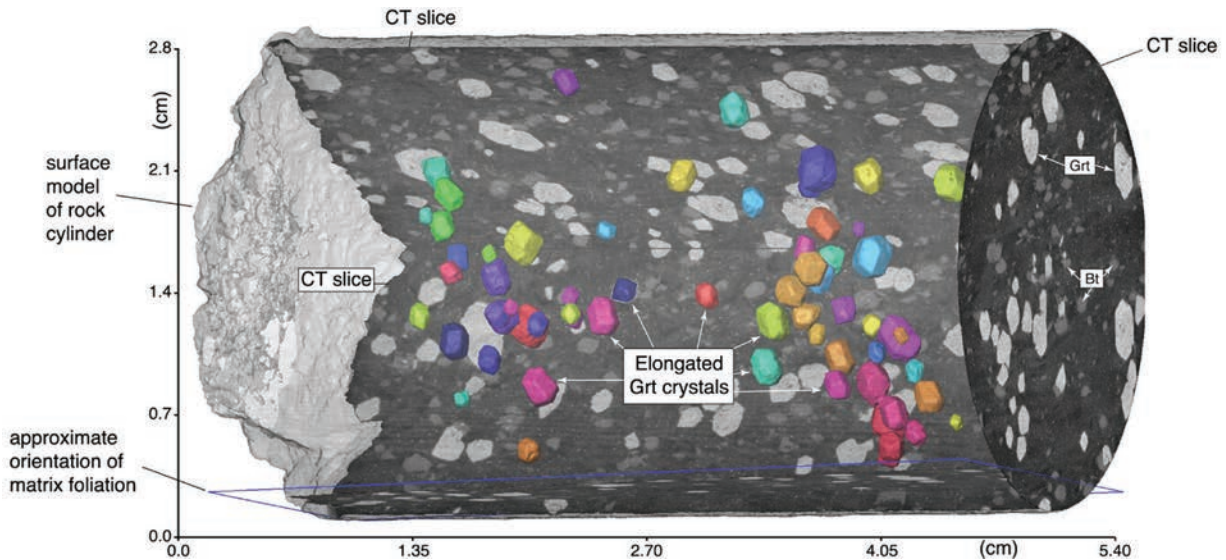


**Distinguished Research Professor Giorgio Ranalli** and Professor Antonio Schettino from the University of Camerino, Italy, have published a paper in *Evolving Earth* entitled, “Ultra-slow transverse waves during continental breakup.” They present a model of the continental extension- sea floor spreading transition using, for the first time, a lithosphere rheology including long-term anelasticity, combined with a non-linear viscous asthenospheric mantle. The results of the numerical model show that continental breakup does not necessarily require the presence of pre-existing weak zones, and that ultra-slow transverse waves (wavelengths ~ thousands kms, period ~tens kyrs) are formed during the extension. These waves induce oscillating topography that could be responsible for eustatic cycles in both axial rift and off-rift lacustrine systems.



**PhD student Colleen Harper** studies copper corrosion in the context of long-term storage of used nuclear fuel in deep geological repositories. She was awarded first place in a poster competition on her research results entitled, “How will early corrosion impact later processes? An evaluation of compounding influences and near field safety” at the 2023, 5th annual Canadian Conference on Waste Management, Decommissioning and Environmental Restoration (NWMDER). Her research looks at the corrosion of copper that will be used as an oxidation barrier on used nuclear fuel containers and focuses on the rate and extent of the corrosion under the evolving environmental conditions expected within the deep geologic reservoirs over the expected million-year lifetime of the facility. Her work is supported by the Canadian Nuclear Safety Commission (CNSC) and will help them make upcoming regulatory decisions on high level nuclear waste storage.

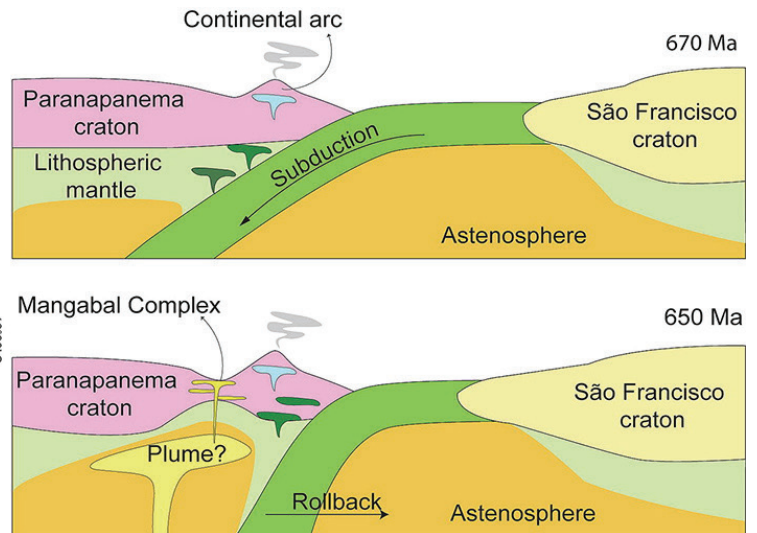
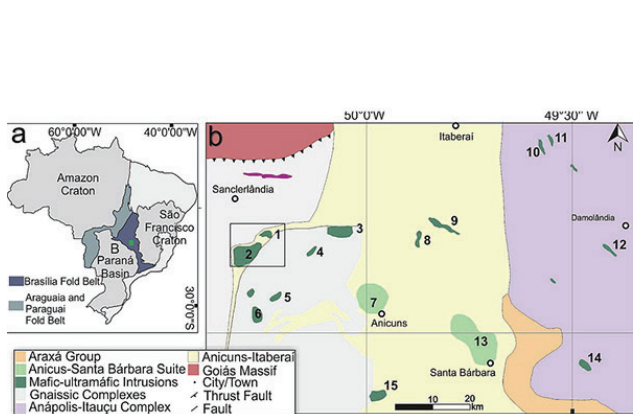




**Professor Fred Gaidies** et al. unlock the fascinating history of metamorphic rocks from the Grenville Province of SE Ontario. Using a variety of techniques, including high-resolution XR- $\mu$ CT, LA-ICP-MS, and in-situ Lu-Hf geochronology, Gaidies et al. provide evidence for repeated metamorphic events during the Grenvillian Orogeny. Garnet crystals, which formed during these events, developed spectacular compositional and

microstructural properties, and, once again, acted as geological time capsules needed to gain insight into our planet's past.

Gaidies F, McCarron T, Simpson A, Easton RM, Glorie S, Putlitz B, Trebus K (2023) Polymetamorphism during the Grenvillian Orogeny in SE Ontario: Results from trace element mapping, in-situ geochronology, and diffusion geospeedometry. *Journal of Metamorphic Geology*, DOI:10.1111/jmg.12745



**PDF Claudia Augustin** came to Carleton from Brazil on an international Cotutelle program to conduct PhD research with Professor **Jim Mungall** and Scientist in Residence Dr. **Richard Ernst**. She and her coauthors have recently published a paper stemming from her PhD en-

titled, "U-Pb in-situ SIMA baddeleyite and zircon dates and thermodynamic modeling of the Mangabal Complex: Indications of asthenospheric mantle influence in the formation of layered intrusions of the Brasilia orogen" in the journal, "Gondwana Research."





**PhD student Alexandre Rouleau**, from **Professor Hanika Rizo's** research group, has been honoured with a MITACS Globalink Research Award, enabling him to conduct research at a renowned German laboratory for several months. This prestigious award will facilitate his investigation of rocks from the Saglek-Hebron Gneiss complex, located in northern Labrador, Canada, where some of the oldest rocks on Earth are found. During his internship at the University of Cologne, Alex will analyze the rocks he has collected from the area whose ages range from 2.7 to 3.9 billion years. This study promises to yield invaluable insights into the evolution of the Earth's ancient crust and early mantle.

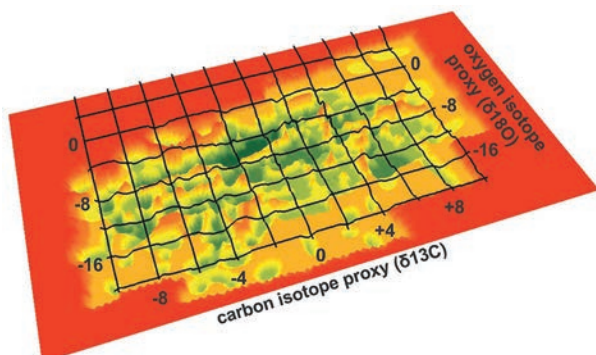


**Adjunct Research Professor Rob Rainbird** is asking "What did Earth look like between one billion and two-and-a-half billion years ago? When did our atmosphere and oceans become oxygen-rich? Did oxygenation occur rapidly or during slow oscillations over hundreds of millions of years? Rob's publication entitled, "Searching for Primary Evidence of Early Earth's Atmospheric Evolution" in "Scientia" stems from his NSERC Discovery Grant-funded support of Ph.D. student **Nabil Shawwa** and M.Sc. student **Thomas McLoughlin-Coleman**, co-supervised by Professor **Jim Mungall**. The photo shows an outcrop of lithified glacial till (called diamictite) of the Gowganda Formation, near Elliot Lake, Ontario.



**PhD student, Nabil Shawwa** had his photo selected as the cover for the April 2023 issue of "Geology". Dean's Blue Hole, a 202 m deep, water-filled sinkhole near Clarence Town on Long Island, Bahamas is the deepest known cave in the Bahamas, and the second deepest in the world. Although the processes linked with its formation are still unclear, its considerable depth may indicate a fracture of the bank margin.

Vimpere et al. 2023. Carbon isotope and biostratigraphic evidence for an expanded Paleocene-Eocene Thermal Maximum sedimentary record in the deep Gulf of Mexico, *Geology*, p. 334-339.



**Adjunct Research Professor Hafida El Bilali** and coauthors published a paper in "International Reviews," entitled, "A novel big-data perspective on earth system evolution." They produced a stability of 'landscape' of Earth system evolution, drivers and tipping points through time using an extensive set of published carbon ( $\delta^{13}\text{C}$ ) and oxygen ( $\delta^{18}\text{O}$ ) isotope data from sedimentary carbonates spanning the last 2.5 billion years.

Hafida EL Bilali, Richard E. Ernst, Timothy W. Lyons & Andrey Bekker (2023): A novel big-data perspective on earth system evolution, *International Geology Review*, DOI: 10.1080/00206814.2023.21884055



# ERTH 4908 BScH

## THESIS PRESENTATION DAY 2023 WAS A SUCCESS!

The Earth Sciences community, including students, thesis supervisors, adjuncts, faculty, staff and family came to support our Honours Thesis students from the Class of 2023 and help celebrate their achievements. They presented their research in a conference format with each student presenting a talk and a poster session, followed by an awards ceremony. Below are the recipients for this year's awards.

**B.Sc.H. student Trystan Warnock-Juteau** carried out research entitled, "Redescription of a Juvenile Hadrosaurid Skull from the Upper Cretaceous of Alberta using Computed Tomography," supervised by **Jordan Mallon** and **Tim Patterson**. Trystan is the winner of the **F.K. North Award**, which is awarded annually, on the basis of outstanding academic performance by a student in their final year of the Honours Earth Sciences programs at Carleton University. Friends and colleagues of the late Professor Ken North endowed this award, in recognition of his 19 years of service as a renowned teacher of Geology at Carleton University.

**B.Sc.H. student Mark Flesch** carried out research entitled, "Determining the dissolution rates of scheelite in tungsten-rich mine tailings through column experiments" supervised by Drs. **Rich Amos** and **Hanika Rizo**. He is the winner of the **Simon Guest Memorial Prize**, which is awarded annually in memory of Simon Guest—a former student within the Geology Department. This prize is given to a fourth year Honours student in Earth Sciences for an outstanding thesis presentation (as reviewed and judged by Earth Science peers within the Department).

Mark was also awarded the **GAC-PDAC Logan Prize** for Carleton University 2023. The purpose of the Logan Student Trust Fund of GAC, with contributions from



Trystan Warnock-Juteau with ERTH 4908 coordinator, Dr. Geoff Pignotta



Mark Flesch with ERTH 4908 coordinator, Dr. Geoff Pignotta

PDAC, is to "...support the career and academic advancement of geoscience students." In addition to academic excellence, the candidate exhibits leadership skills that pertain to organizing events, field trips and participating in Geology student clubs - Mark was co-president of the GeoSoc club this year - the student Geology Society.



# 20<sup>TH</sup> ANNIVERSARY

## The B.Sc.H. Earth Sciences concentration in Vertebrate Paleontology and Paleoecology has turned 20

This unique program, founded by **Professor Emeritus Claudia Schröder-Adams**, is thriving under the leadership of **Professor Hillary Maddin**. To date, thirty-three students have graduated from the undergraduate program, and there are currently twenty-eight students registered. In collaboration with a team of Adjunct Research Professors, the world class collections housed at the Canadian Museum of Nature form the bases of many grad-

uate and undergraduate research projects. Annual field expeditions to places including Alberta, Saskatchewan, and the Maritimes, provide our students with opportunities to gain hands-on field experience and discover fossils for themselves!

The vibrant paleontology research community attracts graduate students as well as undergraduate students.

We owe a great debt of gratitude to the Adjunct Research Professors

and their collaborators, Contract Instructors, and Graduate Student Teaching Assistants who help make this program such a success... especially the Adjunct Research Professors who teach courses, take students to the field, supervise projects and provide research opportunities, training and mentorship to undergraduate and graduate students. Thank you.

Carleton paleo contingent at the annual Society of Vertebrate Paleontology conference, held in Cincinnati Ohio, October 2023.





The program arose, starting in 2003, from the synergy between **Professor Claudia Schröder-Adams** and scientists at the Canadian Museum of Nature (CMN). Claudia's shared project with **Dr. Steve Cumbaa** investigating Cretaceous bonebeds in Manitoba, rich in vertebrate material and revealing a unique depositional history, led to a closer collaboration between our two institutions. Claudia's long-standing work in the Western Canada Sedimentary Basin, rich in vertebrate fossils, with the extraordinary Dinosaur Provincial Park and the extensive

vertebrate fossil collections of the CMN offered a variety of thesis projects for undergraduate and graduate students alike. Claudia's interest in polar paleoenvironmental change was closely aligned with research of **Dr. Natalia Rybczynski** (CMN) who works on the evolution of mammals found at High Arctic fossil localities. These collaborations provided incredible field opportunities for students. Their collaboration also resulted in an exciting expedition with 'Students on Ice' to Antarctica in which students from the vertebrate program participated.



Rongé Island, Antarctica. Claudia (sitting) and Natalia (wearing red, center of image) are discussing the geological and paleoecological history of the Antarctic Peninsula with participants of the 2011 Students on Ice expedition.

The program expanded with inclusion of scientists from the museum (CMN), plus their associates, to accommodate the ever-increasing interest from students and the need for student research projects and specialized courses. Experts such as **Drs. Natalia Rybczynski** (Arctic mammals), **Robert Holmes** (dinosaurs), **Xiao Chun Wu** (dinosaurs), **Michael Ryan** (dinosaurs), and **Sanja Hinic Frlog** (fossil birds), all generously gave of their time and expertise to provide a diverse subject offering to

Carleton's students and foster the program. In 2013, **Dr. Jordan Mallon** (Carleton U, B.Sc.H. 2005) was hired as a dinosaur expert at the CMN; Jordan was one of the first undergraduate students in our program. His current contribution as an Adjunct Professor and supporter of the program closed a wonderful circle showcasing the program's accomplishments.

The established success and growing enrolment of the Vertebrate Paleontology Program required a more solid



foundation. In 2011, Claudia successfully lobbied Carleton's administration for an NSERC Banting Fellowship and creation of a full-time faculty position in Vertebrate Paleontology to follow. **Dr. Hillary Maddin** was successful in winning this highly competitive scholarship and was appointed on faculty in 2015. Hillary has vitally transformed the program with a state-of-the-art laboratory and specialized course offerings while continuing to foster collaborations with CMN and other collaborators, including in-house faculty members.

Two additional recent hires at the CMN include mammal paleoecologist **Dr. Danielle Fraser** and early vertebrate paleontologist **Dr. Tetsuto Miyashita**, who as

Adjunct Research Professors complete the current group of experts contributing to Carleton's vibrant Vertebrate Paleontology Program. Together this group has received several large grants to support interdisciplinary paleontological research and foster field programs in new areas within Canada. Our in-house faculty members and CMN Adjunct Research Professors provide even more diverse and cutting-edge experiences to students in the now massive Vertebrate Paleontology & Paleoecology Concentration at Carleton (26 current undergraduates, and 24 graduate students and 8 postdoctoral fellows, past and present).

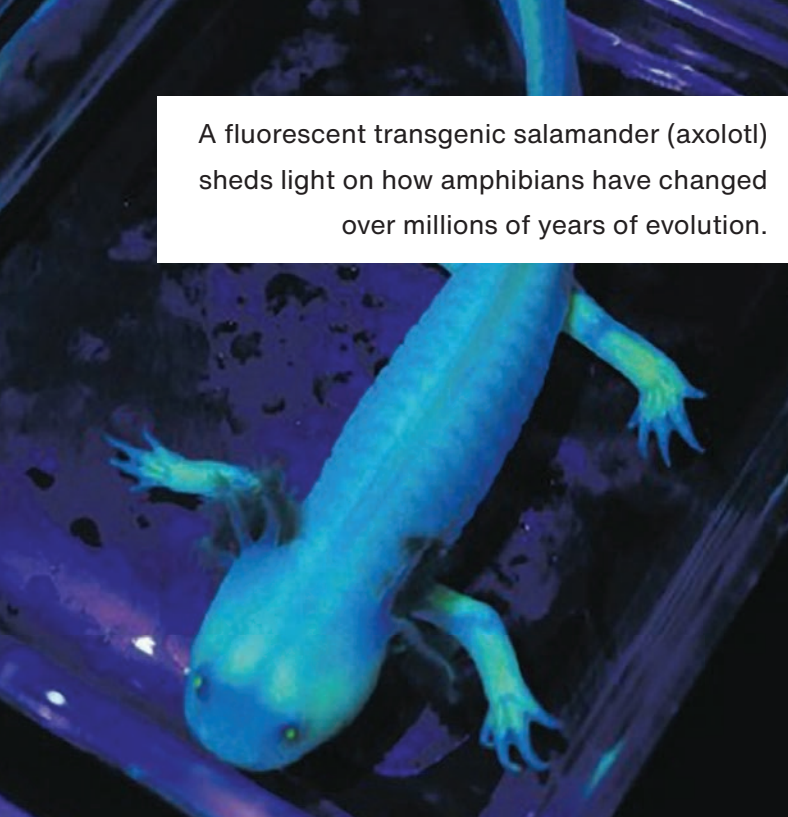
# Who are we?

## Faculty Members



**Professor Hillary Maddin** and her students conduct research on the origin and evolution of early land animals (amphibians and reptiles). The Vertebrate Paleontology Research Lab at Carleton supports the field research as well as studies in real-time of developmental evolution using transgenic model species.





A fluorescent transgenic salamander (axolotl) sheds light on how amphibians have changed over millions of years of evolution.



Graduate students **Gabrielle Adams** and **Dana Korneisel** excavate a 315 million year old fossil tree at Joggins NS.

## Adjunct Research Professors



**Dr. Steve Cumbaa** is a Researcher Emeritus and Research Associate in Palaeobiology CMN. Steve's research focuses on fossil fishes and other marine vertebrates and their palaeoenvironments. Currently he is working on fossils recovered from Lower Devonian marine deposits in the Northwest Territories with **Dr. Tetsuto Miyashita** (CMN; Carleton) and his students, and on faunas from Late Cretaceous marine environments in Nunavut, Saskatchewan and Manitoba. Steve was an Adjunct Research Professor in Earth Sciences at Carleton from 1998-2019, working on collaborative research with **Professor Claudia Schröder-Adams**, as co-supervisor to several of her graduate students and teaching courses. As head of Paleobiology at CMN at the time, Steve worked with professors **Claudia Schröder-Adams** and **George Dix** at Carleton, and with **Rob Holmes** and other colleagues from the museum to develop courses and establish the Vertebrate Palaeontology Program. Steve says he is very proud of being a part of what has become a real success story as well as a wonderful opportunity for students to participate fully in fieldwork, fossil preparation and collections study.





**Dr. Jordan Mallon**, conducting field work in the badlands of the South Saskatchewan River, near Hilda, Alberta is a Research Scientist in Palaeobiology at the Canadian Museum of Nature. He specializes in matters of dinosaur palaeoecology and systematics. He regularly conducts fieldwork in Alberta and Saskatchewan, and has ongoing international research collaborations in

China, Spain, the US, and UK. Jordan was among the first graduates of the vertebrate palaeontology program at Carleton and is thrilled to be able to contribute to its ongoing success teaching courses, providing lectures, and supervising student projects and thesis as well as supervising graduate students.

**Dr. Tetsuto Miyashita**, collecting a Devonian fossil fish in the Canadian Arctic in the summer 2023, is a Research Scientist in Palaeobiology at the Canadian Museum of Nature. He is a broadly trained paleontologist interested in the evolution of vertebrate body plans - his taxonomic expertise is Palaeozoic fishes, with some additional projects on dinosaurs and other Mesozoic reptiles. He runs genetic experiments on zebrafish and collects hemichordate worms to understand how developmental processes facilitate major evolutionary shifts. Tetsuto's recent fieldwork with students has been conducted in the Atlantic provinces, Canadian Arctic, southern Alberta, Mongolia, and South Africa.







**Dr. Thomas Cullen** in Northern Ontario studying the palaeoenvironments and palaeontology of Cretaceous sedimentary deposits (photo by T. Dudgeon).

Thomas graduated from Carleton's B.Sc.H. vertebrate palaeontology program in 2010, and then completed a PhD at the University of Toronto/Royal Ontario Museum. After postdoctoral positions at Chicago's Field Museum, the North Carolina Museum of Natural Sciences, and Carleton University (NSERC PDF) he was appointed as an Assistant Professor of Paleobiology at Auburn University in the US. Thomas's research focuses on

understanding ecosystems and palaeoenvironments in ancient greenhouse climate systems, such as the Cretaceous, using a variety of geological and biological methods. His fieldwork takes him to the badlands of Alberta, the mountains of Northern BC, the Hudson Bay Lowlands of Northern Ontario, and to sites across the southeastern and western US. In his role as an Adjunct Research Professor at Carleton, Thomas collaborates on research projects and co-supervises Honours and Graduate Students.



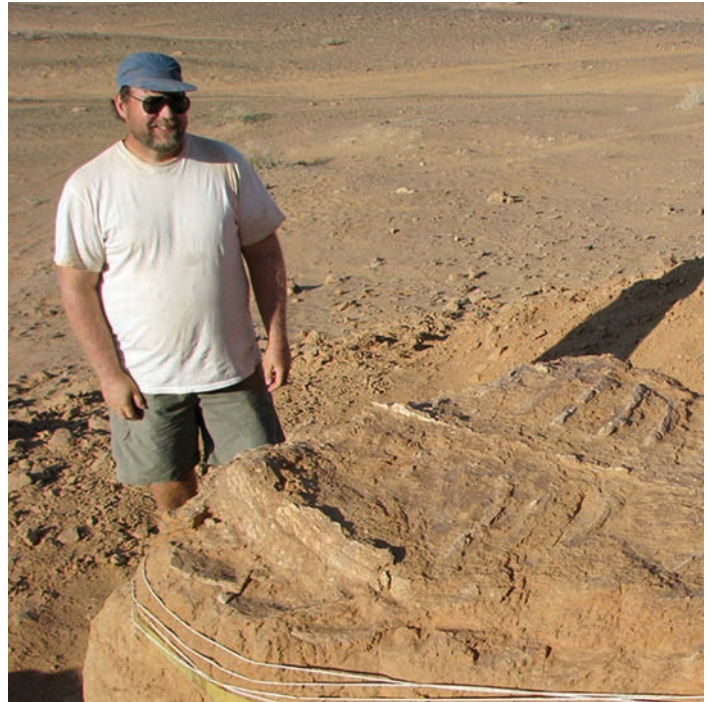
**Dr. Natalia Rybczynski** is taking a close look at a layer of sub-fossil (mummified) leaves in a Pliocene deposit on Ellesmere Island, 2008 (Photo credit Martin Lipman/CMN). She is a Research Associate with the Canadian Museum of Nature and has contributed greatly to our students as a long-serving Adjunct Professor (since 2004). Her research interests include the evolutionary history and functional morphology of feeding systems, as well as the ancient mammals and paleoenvironments of the Neogene High Arctic. In 2015, Natalia was named in **Canadian Geographic's "Top 100 Modern-Day Explorers."** In addition to supervising graduate and undergraduate theses, she has brought students with her to the field and in 2011 she co-led the "Students On Ice" field trip to Antarctica with Claudia.





**Dr. Danielle Fraser**, Research Scientist and Head of Palaeobiology at the Canadian Museum of Nature, examines horse fossils in the museum collections.

Danielle studies mammal evolution and palaeoecology - she is particularly interested in the eco-evolutionary conditions that led to the origin and formation of modern mammal faunas. She has recently been collecting Miocene-age mammal fossils belonging to animals such as horses, rhinocerotids, and pronghorn relatives in Grasslands National Park, Saskatchewan. In addition to field work, her research incorporates stable isotope analysis, palaeodietary analysis, phylogenetics, and computational palaeobiology. For example, undergraduate students apply stable isotope analyses and radiocarbon dating to fossils to contribute to overarching project research goals. Current graduate student projects include study of taxa across a range of spatiotemporal scales such as small rodents and large horses, caribou, bison, and elephant relatives as well as topics such as *inter alia* variation in stable isotopes in caribou antlers and their relation to their modern and palaeodiets, and spatial patterns of morphological variation in rodents, taxonomy and ecology of extinct Pleistocene horses from Beringia.



## Dr. Michael J. Ryan,

excavating an ankylosaur skeleton at Hermin Tsav, Mongolia, has made tremendous contributions to our program as an Adjunct Professor since 2007 - supervising undergraduate and graduate students and teaching, especially in the paleontology field course. He has previously held positions as Head of Education at the Royal Tyrrell Museum of Palaeontology (Alberta), and Coordinator of Research and Head of Vertebrate Paleontology at the Cleveland Museum of Natural History. Michael is an internationally respected paleontologist whose research involves the systematics, taphonomy and palaeoecology of Late Cretaceous dinosaur faunas and specializing in horned dinosaurs - he has described more than a dozen new dinosaur species in the past decade. He has led or co-led expeditions in Canada, the United States, Mongolia, Greenland, South America and Africa. Michael has also worked for Lucasfilm as a Location Consultant, relocating the filming sites in Tunisia from the original *Star Wars: A New Hope*. Ryan co-produced the successful Kickstarter documentary of the adventure, *Journey to Tatooine*, released in 2018.



# SELECTED RESEARCH ACHIEVEMENTS

## Thais Condez, PDF in the Maddin Lab,

co-authored the article by Lueditke et al., “Ongoing declines for the world’s amphibians in the face of emerging threats” – featured on the front page of the October 2023 issue of the prestigious publication “Nature.”



Thais has been working with a team of more than a hundred specialists in a comprehensive re-evaluation of the conservation status of amphibians worldwide. After assessing the extinction risk for all 8,011 known amphibian species, they have found that amphibians are still in trouble, being the most threatened group of vertebrates in the world. Two out of every five amphibians are threatened with extinction, and the primary drivers for this are climate change and habitat loss. The paper shows that salamanders are the most threatened amphibians

globally, which is especially concerning because of the emergence of a pathogenic fungus in Europe that can be lethal to these organisms. It is important to prevent the spread of this pathogen across the Americas, which is home to the most biodiverse community of salamanders in the world. Conservationists will use the information from this study to inform actions at the local level and identify opportunities for broader collaborations focused on recovering amphibians and communicating their ecological importance.





Reconstruction of the synapsid parent and offspring represented by the new fossil (art by Henry Sharpe).

In 2019, **Hillary Maddin**, graduate student **Arjan Mann**, and local field expert Brian Hebert discovered the remains of the earliest evidence of parental care in a land vertebrate. The skeletons of a parent encircling a juvenile individual were found in the lithified infill of a hollowed out lycopsid 'tree' on Cape Breton, NS. The new species of early synapsid (member of the mammal line) was called *Dendromaia* meaning "tree good mother" with the species name (*unimakiensis*) acknowledging the Mi'kmaq name for its location of discovery.



Part and counter-part fossil specimens of the newly discovered synapsid species *Dendromaia unimakiensis*.



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**Michael J. Ryan** and his student **Logan Micucci** have described the new small horned-dinosaur, *Gremlin slobodorum*, from the upper Cretaceous (Campanian) Oldman Formation of southern Alberta (~78 million years ago).

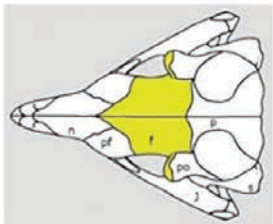
The 2 m (6.6 ft) long *Gremlin slobodorum* was a four-footed plant-eater that used its beak-like snout to browse low-growing vegetation. A member of the Lepto-

ceratopsidae, it differed from its ceratopsid cousins, such as famous Triceratops, in lacking horns on its face and only having a small frill extending from behind its head.

The name *Gremlin* refers to the mythical mischievous creatures said to cause mechanical problems for allied planes in WWII. Like those small creatures, *Gremlin* is annoyingly only known from a single bone (frontal) that with its counterpart forms

the top of the skull between the nose and the eyes. The unique ornamentation on the surface of the bone allows *Gremlin* to be distinguished from all other leptoceratopsids.

The specific epithet, 'slobodorum' honors the fossil hunter, Wendy Sloboda, who found the specimen in 2011 and her father Ed, who have both participated in and supported dinosaur research in southern Alberta for many years



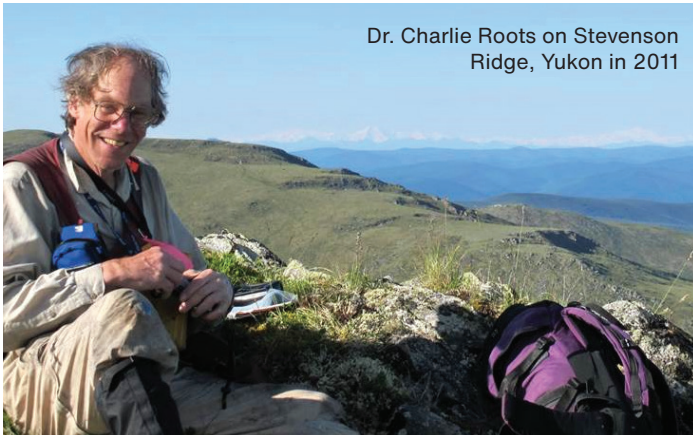
Skeleton of leptoceratopsid. Inset dorsal view of skull showing the position of the paired frontals.





## Current Fund Raising Priorities in the Department of Earth Sciences at Carleton University

We currently have two active projects – please consider donating through the Carleton Future Funder webpage.



Dr. Charlie Roots on Stevenson Ridge, Yukon in 2011



### Charlie Roots Honours Project Fund in Earth Sciences:

Thanks to the support received from generous donors, Charlie's legacy of encouraging students to find and pursue their purpose can exist in perpetuity at Carleton. We want to continue to grow the principal of this ~ \$570,000 endowment. Every year, in perpetuity, the not inconsiderable annual interest is awarded to support the direct costs of research of B.Sc. Honours student thesis projects (i.e. in the current year we have made research awards totalling \$20,675). For further information about the endowment, Charlie Roots, and a report on projects supported since the fund was endowed in 2019, see the link <https://earthsci.carleton.ca/charlie-roots-honours-project-fund-2023> on the department webpage. Your donation extends beyond a financial contribution and enables student recipients to explore their ideas, passions, and academic goals.

DONATE via the Future Funder website at <https://future-funder.carleton.ca/campaigns/charlie-roots-honours-project-fund-in-earth-sciences-6/>. For further information contact Sharon Carr at [Sharon.Carr@carleton.ca](mailto:Sharon.Carr@carleton.ca).

### Earth Sciences Geoheritage Park & Geological Time

**Trail Project – Carleton Campus:** The Geoheritage Park and Geological Time Trail initiative will provide a space to learn about the local geological history and build a deeper understanding of the vast expanse of geological time. In collaboration with Carleton University and Indigenous Elders, we will relocate and enhance an existing display of boulders and build a 4.6 kilometer accessible trail on the Carleton Campus - representing the 4.6 Ga years of geological history on earth. This interactive space will provide awareness for Carleton students and campus visitors to make connections between the places they walk each day and the Earth processes that have created the present-day landscape and the surrounding environment. We are excited about this initiative to increase Earth Science literacy.

DONATE via the Future Funder website <https://futurefunder.carleton.ca/campaigns/geoheritage-park-and-geological-time-trail/>. For further information see the article in the Outreach section of this newsletter or contact Beth McLarty Halfkenny at [BethMcLartyHalfkenny@cunet.carleton.ca](mailto:BethMcLartyHalfkenny@cunet.carleton.ca)



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