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GEOLOGICAL ASSOCIATION OF CANADA
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President's Preamble

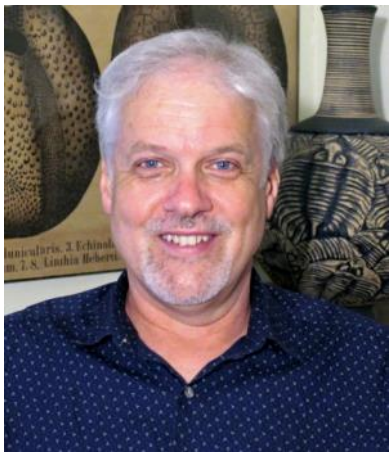
What Geologists Share: Fieldwork and the Four Dimensions

A few weeks back, during the golden days of early autumn, I did some collaborative field research in southwest Manitoba with colleagues from the Manitoba Museum. Spending field time with people from other disciplines, I began to consider our different thought patterns, patterns that have developed as a result of our experience and training.

The zoologist was driving our van, but he was constantly scanning around for creatures as he drove. He could recognize the species and gender of a bird in flight before I could even see the bird, and he counted dozens of red-tailed hawks during a morning where I noticed maybe four of them. He detoured around snakes on the road and then stopped to ascertain their species, age, and sex.

At a prehistoric bison kill site, the archaeologists could talk about the season of a hunt hundreds of years ago. They could envision the behaviour of people who drove the bison over a ridge and into a kill zone in the low wet rushes. We could see bits of bone everywhere, but they could find tools, know how the tools were made, and understand how the people were living and what resources they used. To me, it seemed like each of these non-geologist experts had their own "super power," a quality that was beyond the ability of mere mortals. As time progressed, I realized that we geologists also have our own super power.

As we looked at older geological sites, it was striking that those of us doing geology could see things that our colleagues could not. Our background allowed us to readily place a series of long-past events in chronological order, and to "see" those events in the context of other things happening around them. We could see how the small modern Souris River sits in a valley that was eroded by much larger floods from the outflow of ice-dammed post-glacial lakes; high in the valley wall, those flows had cut through sediment deposited previously by a glacier, which had itself transported materials from the Cretaceous shales that sit lower in the valley. We could recognize this sequence, and we could keep the events and their locations in order in our heads; from their comments, our non-geologist colleagues clearly had a difficult time with this.



During many summers I have done fieldwork in the Churchill area of the Hudson Bay Lowland, and in 2014 and 2015 I worked there with groups of geologists that included people far outside my area of expertise. I am an invertebrate paleontologist, but these field parties included regional stratigraphers, sedimentologists, a petroleum geologist, and a Quaternary geologist. We certainly did not understand the details and technical terminology associated with one another's specialties, but we all seemed to readily follow the other people's thinking and arguments.

I have taken part in many other geological field trips, and geologists never really seem to have trouble crossing boundaries between one specialty and another. It seems that, at some point, most geologists have learned to apply similar logical thinking to a variety of geological settings and subjects (and this even holds true for those of us who started off in disciplines other

Cont'd on p. 4

GEOLOGICAL ASSOCIATION OF CANADA

The MISSION of the Geological Association of Canada is to facilitate the scientific well-being and professional development of its members, the learned discussion of geoscience in Canada, and the advancement, dissemination and wise use of geoscience in public, professional and academic life. The VISION of the GAC® is to be a multidisciplinary scientific society supportive of the entire scope of the geosciences in Canada. The GAC® aims to be a geoscience community that is knowledgeable, professionally competent and respected, whose input and advice is relevant, widely sought and utilized, and whose vital contribution to the economic prosperity and social well-being of the nation is widely acknowledged.

La MISSION de l'Association géologique du Canada est d'aider au développement scientifique et professionnel de ses membres, de favoriser les échanges géoscientifiques au Canada ainsi que de promouvoir et de diffuser l'utilisation éclairée des géosciences dans un contexte public, professionnel et académique. La VISION de l'AGC® est de faire connaître une communauté géoscientifique de grand savoir, dont les compétences professionnelles sont respectées, dont les suggestions et les avis sont pertinents, recherchés et utiles, et dont la contribution largement reconnue est considérée comme vitale pour la prospérité économique et le bien-être de la nation.

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A curious visitor at the Denver Convention Center. Perhaps he's wondering what all those geologists are doing there? Attending the Geological Society of America meeting, of course! GAC® was there too.
The 40-foot-high Big Blue Bear was created by artist Lawrence Argent and installed in 2005. The sculpture is called 'I see what you mean'. *Photo: Karen Dawe*

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Contributions for next issue

Please send items for next issue of *GEOLOG* by e-mail to Alwynne.Beaudoin@gov.ab.ca before **December 15 2016.**

The Big Blue Bear checking out the fine array of geoscience books on display at the GAC® booth at the GSA meeting in Denver.
Photo: Karen Dawe

than geology). The fact is that we all share a set of general principles: the geological time scale, uniformitarianism, the rock cycle, erosion, weathering, the law of superposition, the law of original horizontality, and the application of Occam's Razor to our field observations. Walking around in the world, we all carry this basic information as a toolkit, and as a result we can see what other geologists are talking about, whether they are structural geologists, paleontologists, or geophysicists.

Field experience is absolutely critical to this understanding. At some stage we have all had to consider the world as a four-dimensional place; we look at the three physical dimensions of each geological site, considering what we can see on the surface and interpreting how it is likely to extend below that surface, but we are also constantly interpreting the changes through deep time that have produced what we see today. We visualize how overlying or crosscutting features can be teased apart to find the likeliest story. Basic geological field research, considering a variety of rocks and settings, gives all of us at least a modest understanding of the breadth of geology. It emphasizes to us that basic principles are important, and it encourages our interest to such an extent that many of those principles become fixed in our brains.

I am, however, concerned that geology is in some danger of losing that breadth. We hear so often now that we need to be teaching students to do very specific tasks, so that they will be trained for particular technical jobs – they need to know how to use very complicated and specialized equipment, how to log core in certain standard ways, how to carry out standardized studies that lead to particular defined research goals. This is important – there is no question that people need to make money and have careers, that our economy requires skilled and talented scientists, and that we constantly have a need for particular resources or that certain sorts of environmental problems must be solved.

The danger in becoming an entirely "job-trained" modern discipline, though, is that we could also lose that vision that might allow us to solve future problems that we don't yet even recognize. And the pursuit of very applied and directed work is likely to mean that scientists ignore anything they observe that was not included in the original workplan or grant proposal.

Lately, I have been reading some of the Geological Survey of Canada Reports of Progress that documented 19th century scientific exploration of Canada (I could say geological exploration, but many of them are so much more than that). Almost every field scientist employed by the GSC seems to have been a talented polymath, and as they carried out fieldwork in previously unexplored territory, they didn't just look at geology. They observed and tried to understand

David Rudkin (L) of the Royal Ontario Museum acts as polar bear guard for a group of geologists collecting at Bird Cove, Churchill, Manitoba, in August of 2015. *Photo: Graham Young*)

everything, making incisive and generally accurate interpretations on the fly while canoeing many miles a day through often-hostile wilderness, collecting samples, mapping, and sometimes producing landscape paintings or photographs before sleeping under canvas. And then they did it all again the next day, and the day after, through the entire summer, perhaps making it back to "civilization" after the first snows of autumn.

Those GSC scientists were, of course, given the task of locating and documenting deposits that might have economic importance. In the report for 1869, for instance, Robert Bell assessed silver resources along Lake Superior and Lake Nipigon, Ontario (Bell 1870), and Charles Robb noted molybdenum deposits in central New Brunswick, an area where mine projects are still being developed today (Robb 1870). While they were doing this, they also considered other questions they had been assigned, such as Bell's discussion of where the transcontinental railway might be located in the area around Nipigon.

At the same time, the GSC field geologists documented many phenomena that had no obvious economic significance, simply because they were there and might become important in the future. The remarkable reports of J. B. Tyrrell hold many examples of this, such as his description of the Cedar Lake amber locality in Manitoba (Tyrrell 1892). Bell (1880) and Tyrrell (1897) both considered glacial geology as they spent time in the area around Churchill, Manitoba; this topic was far from most of their other geological work, but both made significant contributions to the development of ideas on postglacial rebound.

These 19th century GSC geologists showed such remarkable drive, ability, stamina, and creativity, that most of us in the modern world are really just faint shadows by comparison. We may not be able to duplicate their energy, and the administrative and bureaucratic demands of the modern scientific world mean that we will never be permitted to have their focus, but we can still emulate their broad curiosity about all of geology and related disciplines.

As a museum curator, I feel very fortunate that many geologists do maintain this broad view of the world, since so much material in museum collections has come from such scientists. For example, a mining company geologist working with a drill crew in the Grand Rapids Upland was looking for an ore body, but was also interested in regional geology. I cannot speculate on what they found in terms of nickel and other metals, but he made an important paleontological find: he generously passed along to my colleague at the Manitoba Geological Survey that there were eurypterids (sea scorpions) in the Ordovician rocks in this area, and she in turn passed that along to

Graham Young (L) and Debbie Thompson of the Manitoba Museum collecting Ordovician fossils at Airport Cove, Churchill, Manitoba, in August of 2016. *Photo: Michael Cuggy*

me. As a result, we were able to go and scout in that same area, finding the site that hosts the strange and significant William Lake biota (Young *et al.* 2012).

As we travel around our country and the world, it is incumbent on us as geologists to always be using those tools that our training has given us. If it is my job to search for fossils, that doesn't mean that I should be ignoring folds or minerals, just as a mining company geologist should not ignore the landforms beneath which an ore body might lurk. There are never enough of us in any one discipline in this huge land, and we all benefit if we are each considering the entire science as we travel around, not just our own little piece of it.

As a science, we always need to collaborate, to think of our colleagues, make use of our networks, and pass along any information that could be useful to someone else. This is, of course, a major reason why the GAC® exists, and why our annual GAC-MAC meetings are so critical to the continued health of our science in this immense country. The geological integration of time and space is our super power. Let us use it wisely!

Graham Young
GAC® President

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Nancy Chow (L, University of Manitoba), Brian Pratt (University of Saskatchewan), and Derek Armstrong (Ontario Geological Survey) discussing and photographing an Ordovician cephalopod at a site along the Churchill River, Manitoba, in August of 2015.
Photo: Graham Young

Milestones, Memories, and Tributes

Charlie Roots
1956-2016

Charlie Roots, a research scientist with the Geological Survey of Canada (GSC), passed away on June 28, 2016, five years after being diagnosed with amyotrophic lateral sclerosis (ALS).

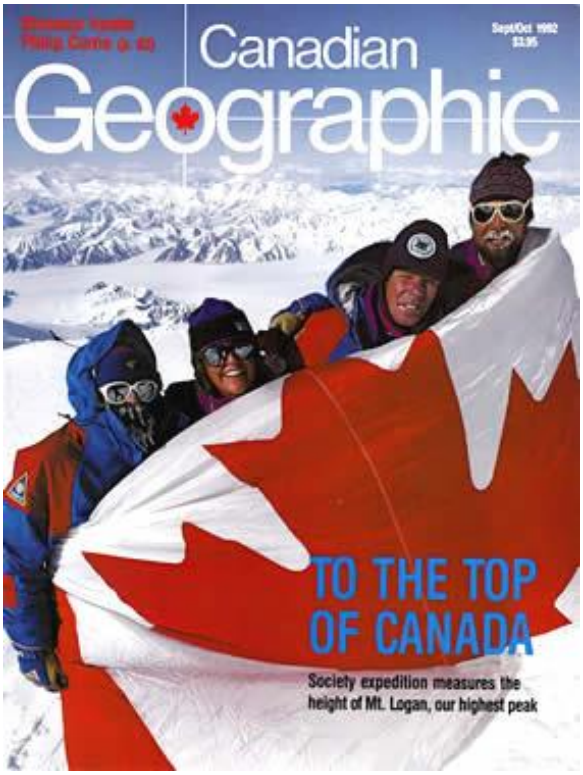
Charlie's interest in and love of the natural world was kindled at a young age by his father, the late Fred Roots (who recently passed away in October 2016), and godfather, the late John Wheeler (1924-2015) –– both legendary scientists with the GSC. Charlie first studied geology at Dartmouth College for his B.Sc., and then at Carleton University for his M.Sc. and Ph.D. After completing his Ph.D. in the Ogilvie Mountains of Yukon, he joined the GSC in 1988 and started what would be a distinguished research career, mapping Yukon's geology and seeking to understand the tectonic history recorded in the rocks.

He moved to Whitehorse in the spring of 1992 to join the team that ascended Mount Logan under the auspices of the Royal Canadian Geographical Society. This expedition had both historic and scientific significance: it celebrated three anniversaries of national importance to our country – Canada's 125th anniversary, the Geological Survey of Canada's 150th anniversary, and the 50th anniversary of the Alaska Highway – and it marked the first use of GPS instruments to measure the height of Mount Logan. Charlie was a key member of the team, and is remembered by his fellow climbers as a tireless worker and reliable friend.

Upon completion of the Logan Expedition, Charlie joined the newly-formed mapping team established in Whitehorse under the Canada-Yukon Mineral Development Agreement. This group was the nucleus for what was to become the Yukon Geological Survey, and although Charlie was employed by the federal survey, he was considered by YGS, and many in Yukon Government, as "one of us".

Charlie dedicated his career to mapping and understanding the geology of Northern Canada, focusing primarily on Yukon but extending his work to other parts of the North. Over his career he authored or co-authored over 70 publications, including geologic maps, reports and scientific papers. The fundamental knowledge that he generated has contributed to our understanding of Cordilleran geology and its resource endowment; his work has also served as a foundation for new research into the breakup of Rodinia, global glaciation, and the evolution of northwestern Laurentia.

Charlie was passionate and knowledgeable about many aspects of Earth science and was enthusiastic about sharing his knowledge with Yukoners. He gave many public lectures, led geological walking tours, and collaborated on a number of publications that describe Yukon's dynamic and evolving landscapes (including the



GSC's GeoScape series of posters and the book *Ecoregions of the Yukon Territory*). He also mentored many student assistants and younger colleagues who joined the survey after him, sharing his knowledge and indulging their ideas and enthusiasm. Over the length of his career he collaborated with numerous university researchers and their graduate students, modestly deferring credit for new ideas to his younger protégés. Charlie's interests and enthusiasm resonated with several Yukon artists, leading to collaborative activities in places such as Tombstone Park.

Throughout his career, his wife Mary Ann, a well-loved Montessori school teacher and dance instructor, was a cherished partner and avid participant in some of Charlie's professional projects. She was working as a GSC camp cook when they met in their early years in Yukon; she participated in the Dome Road race with the geologists; and she is referenced numerous times in his field notes from the Logan Expedition. Charlie, Mary Ann and their children Galena and Logan hosted many visiting scientists in their home over the years and were actively engaged in the community in sports, arts and education.

Notwithstanding his scientific contributions, what Charlie is most likely to be remembered for is his character, which embodied enthusiasm, unbiased curiosity, modesty, and a contagious sense of fun. Those who worked in the field with Charlie will remember his capacity and enthusiasm for epic traverses and hard work. As a party chief, he would regularly be the first up to get ready for the day and the last to bed as he spent the late evening on his diary. He cheerfully took on the least desirable jobs around camp and an unkind or discouraging word was almost unknown.

Over the last five years, in the face of his increasingly debilitating illness, Charlie came to terms with his fate to become a beacon of courage and strength. He maintained his positive attitude to the end as he purposefully wrapped up his projects by publishing several maps and papers using a voice-controlled computer. His colleagues and friends were fortunate to have been able to celebrate his life and say goodbye at the gatherings that he held for them, and at those that were held for him. He will be missed by everyone who knew him.

This tribute from his colleagues at the YGS was compiled by Carolyn Relf, Maurice Colpron, Grant Abbott and Don Murphy

The tribute will also appear in the Yukon *Exploration and Geology Overview 2016*, to be published in January 2017 by the Yukon Geological Survey, Whitehorse

Fred Roots
1923-2016

Fred Roots was modest, brilliant and a legend of polar exploration

He conducted extensive field research and helped shape global climate change policy

Modest, brilliant and plainspoken, Fred Roots was a much-honoured explorer with a mountain range named after him in Antarctica (the Roots Range), a scientist whose unstinting, often dangerous field research on polar ice caps inspired climate change policy around the world, an impassioned mentor who inspired bureaucrats, scientists and students right up to the end.

Yet, he was largely unknown outside the scientific community.

"Much of his work in building Canada's reputation was gritty and thankless," said his friend, Dr. Henri Rothschild, the president of the Canada-Israel Industrial Research and Development Foundation. "Science, geography, geology, exploration are either below the radar screen of popular culture or mythologized in our psyche – heroes, adventurers like Indiana Jones. And Fred would have recoiled at the notion of being called a hero."

Once, when he gave a lecture on plate tectonics at Princeton University in the late 1940s, Albert Einstein was among his audience of rapt listeners. And during a trip last August with Students on Ice, a program he'd been involved with since it began in the late 1990s, there he was at the age of 93, firmly stepping from a ship into a Zodiac bobbing on choppy seas, hiking through the tundra of Greenland and sharing stories of rock formations, wolves and dandelions with teens from around the world. He relished the chance to pass on his knowledge to a new generation, to impress upon them the importance of the polar regions to the health of the planet and show them that nothing was impossible if you put your mind to it.

"Last August, we had a wonderful student from Nunavut who had cerebral palsy, and Fred extended his hand to escort her up a steppe in Greenland," said Geoff Green, the founder of Students on Ice, who first met Dr. Roots when he pitched the idea to a federal committee. "They slowly appeared over the ridge holding each other up and we all gave them a standing ovation.

"It was pure Fred," Mr. Green continued. "He was chiseled from a lifetime of being an explorer, a dog musher, a man consumed with learning about the land and humanity's relationship to it. In the last year or two, if you tried to help him, he'd refuse. He still had the firmest handshake of anyone you'd ever meet. We thought he'd never stop."

On Oct. 18, after a beautiful day spent in his garden, Dr. Roots died in his sleep at his home in East Sooke on Vancouver Island. He was 93. It was exactly how he would have wanted to go, said Dr. Rothschild: quiet and efficient.

"Fred hated causing a fuss," he continued. "He was the only person I knew who understood profoundly what it meant to be a Canadian; that we live in a magnificent piece of geography that includes one of the two poles and we have a duty to understand and take care of it on behalf of the planet."

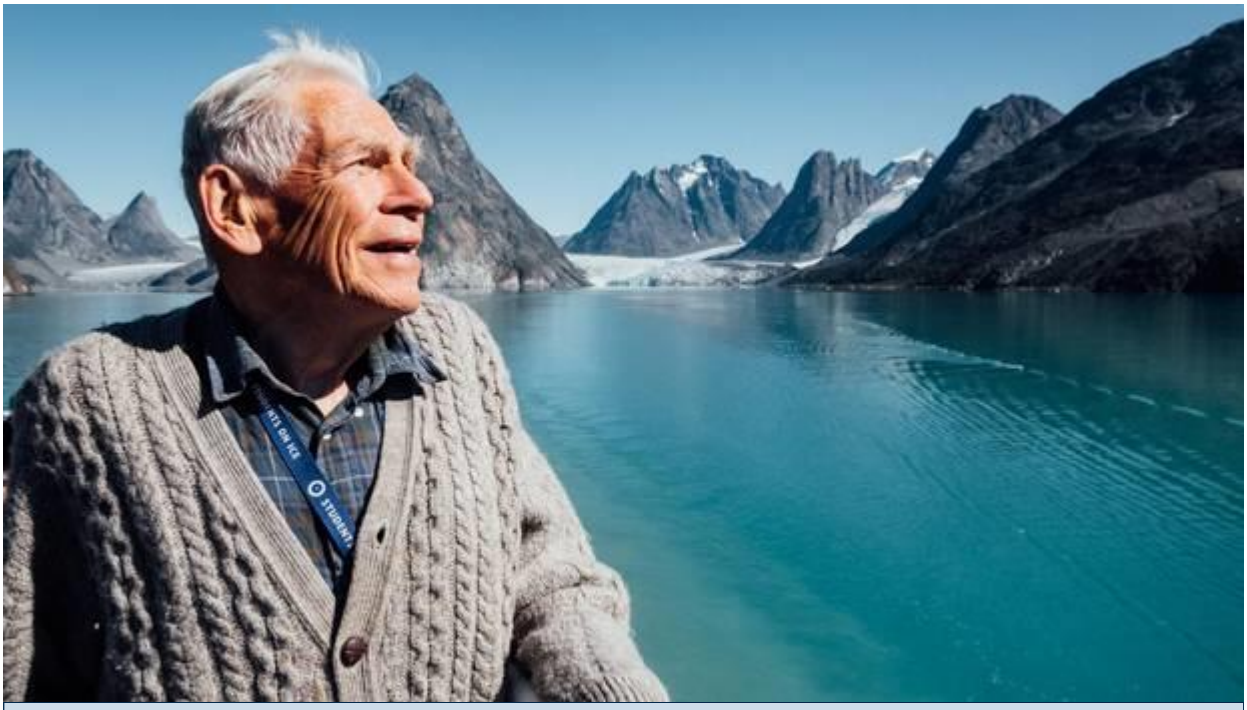
His daughter, Jane Roots, noted that throughout his life, her father was wont to say: "It's not who did it. It's what got done."

Ernest Frederick Roots was born in Salmon Arm, B.C., on July 5, 1923, the second of Ernest and Margaret Roots's three children. The family lived there until young Fred, as he was known, was a toddler, when his father, who worked for the Canadian Pacific Railway, was appointed chief engineer of the Banff Springs Hotel.

The family loved living in the Rockies, spending time skiing, hiking and rock climbing. But tragedy struck when the little boy was eight, for his father contracted typhoid and died, leaving his mother to raise the children on her own. Fiercely independent and a woman ahead of her time, she instilled in them the kind of strength that made them practical and fearless. Once they all left home, she got a job with Procter and Gamble, travelling throughout Southeast Asia to promote the benefits of contraception.

In high school, Fred got a job as an assistant meteorological observer for Banff National Park. No matter the season, he would climb to a remote station at the summit of one of the park's mountains to change the charts and measure the flow of water.

The experience helped form his passion for the land and its history, and was good training for what was to come.



Polar explorer/scientist Fred Roots
Image © Martin Lipman / Students on Ice. Used with permission

He completed his final years of high school at what was then called Vancouver Technical College. He went on to do both his undergraduate and master's degrees in science at the University of British Columbia.

From UBC, he moved on to Princeton University, where he completed a PhD in geology; part of his fieldwork was surveying more than 18,000 square kilometres of previously unmapped terrain in northern B.C. for the Geological Survey of Canada. While doing this, he uncovered fossils that helped explain the geologic structure of the mountain ranges in the area; one of the fossils, which dates back about 575 million years, now carries his name, *Protophoreta rootsi*.

In 1949, Dr. Roots was asked to be the lead geologist of the Norwegian-British-Swedish Antarctic Expedition. It marked the first time that an expedition was organized around an international team of scientists, which was tasked with finding out if climatic fluctuations previously observed in the Arctic were also occurring there.

The men were dropped off and for three years were left to their own devices. They measured and mapped, took photos and samples and wrote constantly in notebooks.

When one of the team members developed an infection after getting a rock chip in his eye, they followed instructions sent via Morse code to remove the eyeball, fashioning tools out of tin cans and anesthetizing the patient with copious amounts of whisky. Then, they all kept going.

"Fred was so matter of fact," said Mr. Green of Students on Ice. "About the eyeball, he said it was a lot bigger than he thought it would be."

During the expedition, Dr. Roots set out alone on a six-month dogsled journey – a record that still stands as the longest solo such journey in the world.

To his dying day, he wore a scuffed brown leather belt that had been fashioned from the harness of Rachel, the husky that had been his lead dog on the journey.

After the Antarctic expedition, his long and illustrious curriculum vitae includes participating in the first comprehensive geological study of the Queen Elizabeth Islands in the Canadian Arctic and leading Operation Stikine, a geological investigation of the northern Cordillera mountains.

In the late 1950s, he proposed and then organized the Polar Continental Shelf Program, serving first as its coordinator and then as director until 1971. Under his watch, it became the major Canadian comprehensive scientific program in the Arctic, connecting and cooperating with other circumpolar countries.

Dr. Fred Roots and students examining an ice core in Antarctica
Image © Alex Taylor / Students on Ice

And as science adviser to the environment department in the 1970s and 80s, Dr. Roots used his talent for straight talk steeped in science to help transform it from a little-respected entity that had little influence on big political decisions into the powerhouse it is today as Environment and Climate Change Canada. Few others, if any at all, could have done the same, Dr. Rothschild said.

"Governments are like a human immunology system where you have to go through lots of barriers to change things, and to achieve what he did was remarkable," he continued. "Fred had the same beautiful articulation whether he was talking to a kid he just met or to a cabinet committee."

Although he "retired" in 1989, Dr. Roots would remain as special adviser emeritus to the department until 2003. It was during a research fellowship at the Scott Polar Research Institute at Cambridge University in England that Dr. Roots met the woman he would marry and with whom he would have five children.

June Blomfield had a master's in geography and a passion for sailing, had worked during the Second World War as a nurse and had landed at the institute as a librarian. In 1955, they married and moved to Ottawa, where Dr. Roots was employed at what was then called the Department of Mines and Technical Surveys.

He was absent much of the time for his work, including summers, doing what he needed to do to understand the world. June Roots, matter-of-fact and discreet, remained behind to care for the kids.

"My mother was incredible – and incredibly strong," Jane Roots said. "In the summers, she used to drive us all by herself – five kids – from our home in the Gatineau out to wherever my father was working. We'd camp."

Along the way, Dr. Roots collected a slew of awards and honours, including the Massey Medal from the Royal Geographical Society of Canada in 1979, the Order of Canada in 1987, Polar Medals from a number of countries and, in a ceremony this past March in New York, the Explorer's Club medal – the highest honour the organization bestows. Past recipients include the mountaineer Sir Edmund Hillary, the primatologist and activist Dame Jane Goodall, and Neil Armstrong, the first man on the moon.

In the video that was played to introduce him at the gala, Dr. Roots was shown speaking to young people on a ship during a Students on Ice expedition.

"We all live on a planet where nature has designed the playing field and nature sets the rules of the game, no matter what we think," he said. "Don't be afraid to fail. Don't be afraid to try something out of the ordinary. Don't be afraid to take a chance but at times your verve and your nerve must serve in a game where you take your chance."

When he stepped onto the stage, he was given a standing ovation.

Dr. Roots leaves his wife, June; his daughters, Jane, Frances, Hannah and Robin; five grandchildren; and his younger brother, Walter. His son, geologist Charlie Roots, died last summer from amyotrophic lateral sclerosis, also known as Lou Gehrig's disease.

Lisa Fitterman
The Globe and Mail
November 4, 2016

Reading on the Rocks

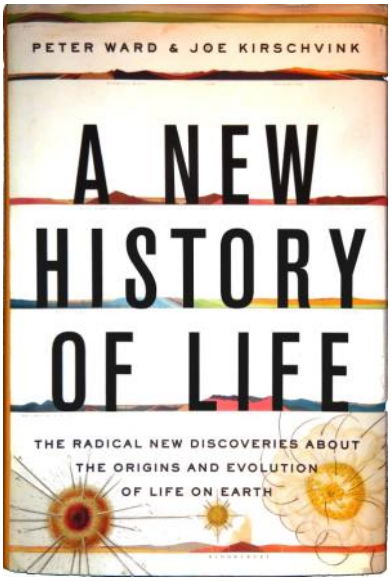
A NEW HISTORY OF LIFE: The Radical New Discoveries about the Origins and Evolution of Life on Earth, by Peter Ward and Joe Kirschvink. 2015. Bloomsbury Press, New York. 391 pages. ISBN 978-1-60819-907-5. $35.00 (Can.)

Doing paleontology and reading general paleontology are two very different activities. With apologies to Lewis Carroll, one activity leads you down a rabbit hole where you go mad examining details in obscured fossils. In the other activity, and this time on the other side of a book cover, you find yourself trapped in an imaginary world complete with an evil Red Queen and figuratively conversing with two gurus, singing in unison, and offering to guide you through their arguments about "how" and "what if" this is that in their version of the big picture. Welcome to *A NEW HISTORY OF LIFE,* and, to use the authors' own words, "a seamless duet".

Before ever opening *A NEW HISTORY OF LIFE* and by simply reading the dust jacket text proclaiming this "the first major synthesis for general readers in two decades", I will now say this is no more than promotional material. On this matter of "first", I also note that nowhere in this book is there any reference to any of the clear, eloquent writing on the history of life and of evolutionary processes by the well-known British evolutionary biologist Richard Dawkins. How very odd - and this is only the start.

Ward and Kirschvink have built their duet around three well known themes: (1) Catastrophism, (2) the role of oxygen, carbon dioxide and hydrogen sulfide in shaping the "nature and history of life", and (3) the evolution of ecosystems. A fourth unstated theme, an undercurrent spread throughout the text, posits *humans bad*, particularly all of us billions with a penchant for burning things.

As for mechanisms controlling the machinery of macroscopic life, evolution and ecosystems, the authors invoke a model for True Polar Wandering as a phenomenon apparently tied to growth of large mantle plumes, and ultimately leading to the release of significant quantities of carbon dioxide into the atmosphere (hot and cold climate cycles). So, as a Spoiler Alert for those that want the short answer, this is not a book about "radical new discoveries", nor is it, in big bold type, *A NEW HISTORY OF LIFE*. Our understanding of this particular flavour of planetary science is achieved in increments and certainly with a long history of generating multiple working hypotheses. Focussing, as they do, upon their favourite model for earth history may one day prove to be prophetic, or may simply be seen as yet another ill-fitting piece of this complex puzzle.



Past the dust jacket, the book opens innocently enough with some introductory remarks about the differences between history and life history, liberally sprinkled with quotes from other American writers. All, as likely as not, are paraphrasing the Irish statesman and writer Edmund Burke - "People will not look forward to posterity, who never look backward to their ancestors". Soon, however, other general and questionable remarks start to creep into their narrative. One in particular, "many of the great events of evolution cannot be repeated", is simply not true. Rare, yes. Impossible, no.

A pattern of odd, seemingly offhand and general remarks set the stage for many of the chapters. For Chapter 1, "Telling Time", the literary distraction is a short critical editorial on our "arcane time scale" and describing it as a "rickety old contraption held together by nineteenth century rules and current European Formality". Near as I can tell, this exaggeration is meant to get general readers questioning some of the basic fundamental tenets of our science. Many earth scientists, likely the majority, rely upon the Geological

Time Scale to effectively communicate practical and legal matters of professional applied geology and resource studies to one another and to securities commissions. The Geologic Time Scale will always be a work in progress and does not represent any failing on the greater part of the earth sciences community. In contrast, in this chapter, Ward and Kirschvink's description of the Phanerozoic as the "time of *invisible* life" (emphasis added) is but one of many real editorial and proofing failures sprinkled through the text.

Chapters 2 through 7 offers a lengthy epistle on the origins for Earth, the earliest history of the planet and on the origins of life through natural processes. While not opposed to the fundamentals of their story - it has been around for many decades - I do question their certainty on the age and intensity for specific life altering events (e.g., >20% atmospheric oxygen in the early Proterozoic). Likewise, when it comes to identifying the earliest life on the planet, I am comfortable knowing that this too remains a moving target. New research published just this summer apparently moves the physical evidence for life deeper into the Archean and into a time that doesn't quite fit into the authors' particular schedule of events.

With life firmly established in the Proterozoic and surviving and prospering through the massive and lengthy Cryogenian glacial epochs, Chapters 8 through 12 track the emergence, and evolution of invertebrates, vertebrates and land plants through the Paleozoic. A chapter titled "The Cambrian Explosion: 600-500 Ma" explores the lengthy history of accumulated Proterozoic endosymbiotic genetic change leading to the emergence of hard physical evidence for fossils. Later, during their review of this important episode in the history of life, Kirschvink dons his geophysicist hat and examines the role and mechanics of the "True Polar Wandering" hypothesis. Anomalous plate motions, pole motions, and velocities (if real) are seen as a part of a mechanism that may determine extreme climate cycles and therein drive evolution and extinction of many forms of plant and animal life. These changes include the emergence of land plants and amphibians in the Devonian and the rise of reptiles and mammal-like reptiles in the Carboniferous and Permian. Apparently, none of this animal evolution would happen without the rapid rise of atmospheric oxygen from terrestrial plant growth and the accompanying deposition of carbon from plant burial. This is the time when the global carbon cycle assumes a modern appearance. Overall and throughout this *NEW HISTORY*, their treatment of plant evolution is a somewhat simplistic and one sided discussion, missing any mention of significant changes to reproductive strategies.

Permian extinction and Mesozoic recovery leading to the rise of dinosaurs and their kin (chapters 12 to 16) is linked to significant changes in microbial floras and in the flux of the important atmospheric gasses, carbon dioxide, hydrogen sulfide, oxygen/ozone, and methane. The colourful language describing this "horrific" time of "planetary killing" as a result of "great bubbles of highly poisonous H_2S gas rising into the atmosphere", also includes other related events leaving "a planet choked in rotting plants but nearly without animals". Literary imagery is followed with the certainty that "This is exactly what happened at the end of the Permian - in the oceans, anyway." "On land, it would have been very much like some combination of World War I and II combined". Wow! This is the stuff of disaster movies or earth history with a Hollywood flourish.

The evolution and extinction of dinosaurs and their other reptilian cousins, as covered in chapters 13 through 16, follows a well-known line of changes in the function of limbs, lungs, metabolism and size, but now by admission wrapped into their "revisionist history that is the goal of this book". Their story continues to focus upon physical planetary processes that this time generate global climate changes showing the early Mesozoic as a time of anomalously high temperatures and low oxygen values. Aside from some apparently very old artwork from Alice Woodward (*ca*. 1895) and other similarly unreferenced figures of uncertain origins, there are no graphical references to qualify and to quantify changes or to show a timeline and history for any of these significant evolution and environment shifts.

End Cretaceous extinctions (Chapter 16) follow a now well established model for bolide induced catastrophic collapse of Mesozoic ecosystems that may have been connected in some way with a uniformist planetary evolution model of mantle plume continental basalt magmatism. In the grand scheme of things, some details, such as error bars on timelines, and opinions on the intensity of two events remain to be discovered. I will venture to say that most of us are comfortable knowing the world's best known extinction still holds some secrets. None of this is addressed in their new history.

Inasmuch as it matters little to me whether the end Cretaceous was a very fast (hours) or a relatively slower (centuries) extinction, the Cenozoic recovery, presented in chapters 17 and 18 focuses upon the well-trodden path and title "The Age of Mammals", with a nod to the birds. Both classes of animals expanded to fill the ecologic void generated from dinosaur extinction and with many mammals and birds expanding into other (new?) ecological settings. It is also a time when the planet started a slide into a colder Icehouse world. We are all the products of this colder planet.

Chapter 19, "Humanity and the Tenth Extinction", is reserved for us. However one chooses to measure, we are either a cause for extinction or an ultra-adaptive lifeform that can rapidly accommodate many environment changes. Nevertheless, there are limits to what one may consider acceptable natural changes and adaptations; Ward and Kirschvink put us squarely on the cause side of the extinction debate.

"The Knowable Future for Earth Life", Chapter 20, offers multiple short and long term solutions to our current role as guardian of this dominion. Change is inevitable and in the expanse of geologic time the planet will become uninhabitable. For the authors, what we do with our present and future condition remains unclear. "Life is about change" and "Nothing lasts".

On technical and production matters, diagrams and photos in *A NEW HISTORY OF LIFE* are not particularly sharp, sometimes old, with little obvious relevance to the accompanying text, and with captions that can be vague. At another very basic level, and throughout the book, there is a discomforting disconnect over the use of metric and imperial measurements, with some paragraphs and sentences jumping from one system to the other.

Throughout the book and by their own admission the "revisionist" text is presented in an absolute matter of fact manner with little or no space reserved for other competing ideas and models. Readers are obliged to either choose to accept or reject their stories or to sift through pages of end notes and references to determine how they assembled their opinions.

Ward and Kirschvink have succeeded in their stated aim for an agenda-driven thesis, connecting nearly all major events in Earth's biologic history. Without counter-points, competing hypotheses and other data to carefully assess, their story may make sense to some. For now, I am not among the convinced.

Given this book to read in February and finally completing it in September, I have to say this has been a frustrating challenge. For me, a sometimes paleontologist, it was something like reading a page of dogma, stewing over some infuriating remarks or disconnected comments and putting aside the book until I calmed down. Stories of their university "friends" and "colleagues", "junior", "great" or otherwise, and references to mostly American movies and sit-com television may appeal to a popular readership but seem out of place in a book that wants to be taken seriously.

Inasmuch as time will tell whether this becomes a California cult classic or a prophetic discourse, I will suggest that at this point you save your money and take a pass on *A NEW HISTORY OF LIFE*.

Elliott Burden
St. John's, Newfoundland

During the GAC Council meeting in October, several members of Council visited Kingston to meet with the local organizing committee for the GAC-MAC 2017 conference (see more details about the conference on p . 20). Here, Dène Tarkyth, Graham Young, James Conliffe and Steve Morison, pose in front of one of the many imposing buildings on campus.
Photo: Karen Johnston-Fowler.

GeoFact: Nov 30 1778: Joseph Banks elected President of the Royal Society, a position he held for the next 41 years.

Events and Happenings

Howard Street Robinson Lecture Tour

As announced in the last issue of *GEOLOG*, Dr. Rebecca Jamieson of Dalhousie University's Department of Earth Sciences is the recipient of the 2016 Howard Street Robinson Medal, representing the Precambrian Division. She started her lecture tour with visits to several venues in Ontario in September 2016, and continued with a sweep through western Canada in November. Please check departmental websites for details of the dates and times of her talks. Dr. Jamieson is offering the following lecture during this tour.

How do large hot orogens work? Lessons from the middle crust

Large hot orogens are characterized by their broad areal extent, crustal thicknesses exceeding ca 60 km, central plateaux bounded by external thrust wedges, and internal temperatures high enough to promote widespread partial melting in the middle and lower crust. In these systems, melt-weakened middle crust can flow in response to a pressure gradient and/or underthrusting by a strong indentor, leading to lateral transport of ductile middle crust (infrastructure) relative to both cooler upper crust (superstructure) and stronger lower crust and upper mantle. The resulting dynamic behaviour and geological characteristics of large hot orogens are therefore fundamentally different from those of typical fold-and-thrust belts. The Mesoproterozoic Grenville Orogen of Ontario presents a superb opportunity to investigate the mid-crustal level of a large, hot, convergent orogenic system. Over the past 30 years, field, structural, petrological, and geochronological studies along the well-exposed Georgian Bay transect have illuminated the fundamental tectonic characteristics of the western end of the orogen. It was assembled by northwest-directed ductile thrusting towards the Archean foreland between ca 1100-1040 Ma, and reworked by ductile extension and flattening between 1040-1000 Ma. Widespread upper amphibolite- to granulite-facies assemblages record P-T conditions of 10-14 kb at 700-900°C. Protoliths were largely pre-1200 Ma Laurentian crust with some peri-Laurentian accreted terranes. We have also used 2D thermal-mechanical numerical models to investigate the geodynamic behaviour of the system. The results suggest that lateral flow of migmatite in the orogenic core was triggered by transport of strong lower crust beneath melt-weakened middle crust. Post-convergent flow was accompanied by ductile thinning and extension in the orogenic core and coeval thrusting on its flanks. While there is good first-order agreement between model predictions and observations, further testing against geological data is required. Comparison of model results with observations from the Grenville Orogen and similar systems suggests that significant volumes of Proterozoic orogenic crust may have been reworked by ductile lateral flow of middle crust.

Selected references:

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Jamieson, R. A., M. J. Unsworth, N. G. W. Harris, C. Rosenberg and K. Schulmann (2011) Crustal melting and the flow of mountains. In: *When the Continental Crust Melts,* edited by M. Brown, E. Sawyer and B. Cesare. *Elements* 7: 253-260. doi: 10.2113/gselements.7.4.251.

Jamieson, R. A., C. Beaumont, C. J. Warren and M. H. Nguyen (2010) The Grenville Orogen explained? Applications and limitations of integrating numerical models with geological and geophysical data. In: *Lithoprobe – parameters, processes and the evolution of a continent* (Lithoprobe Synthesis Volume II, edited by R. M. Clowes and T. Skulski). *Canadian Journal of Earth Sciences* 47: 517-539.

Jamieson, R. A., C. Beaumont, M. H. Nguyen and N. G. Culshaw (2007) Synconvergent ductile flow in variable-strength continental crust: Numerical models with application to the western Grenville orogen, *Tectonics* 26, TC5005, doi:10.1029/2006TC002036.

CPC at CBU

The Canadian Paleontology Conference was held at Cape Breton University in Sydney, Nova Scotia, from August 26-28, with a pre-conference field trip around the Highlands National Park (and beyond) from August 24-25. The conference was small but mighty - and diverse, with 35 participants (volunteers, students, professionals and community members) from all over North America with backgrounds in fine arts, chemistry, geophysics, economic geology, science communication, and, of course, paleontology. The 2015 Billings Award Winner, Dr. Paul Smith, opened the conference with a talk addressing the future of paleontology and how to avoid our own extinction! In true Cape Breton style, we had a ceilidh, a few samples of the local fare, and a kitchen party wrapping up the conference on Sunday night with more live music. A free public showing of *Jurassic Park* (in 3D) and talk, with question and answer period, by Dr. Michael Ryan was sponsored by the Atlantic Geoscience Society and was a huge success, with over 150 attendees. Later that same day the CPC hosted a special session on geoheritage/geotourism/ museums. The official sessions ended with awarding the Bolton Prize for best student presentation to Greer Stothers, a fine arts student at Sheridan College who uses the most up-to-date information and research to recreate images of ancient life.

Our hope is that there is a renewed interested in the CPC as we see this an important conference to share ideas and network within Canada, and beyond!

CPC 2017 will be hosted by the Calgary office of the Geological Survey of Canada, coinciding with the GSC's 175th anniversary. The meeting will be held next fall; watch for a formal announcement in the coming weeks.

Melissa Grey and Jason Loxton

CPC participants on a tour of Louisbourg

A Trip Through the Bathurst Mining Camp

On September 30th, 2016, Dave Lentz and his Economic Geology class, at the University of New Brunswick, headed north to the Bathurst Mining Camp for a two-day field trip.

The first stop on our trip was the remains and tailings of the lead, zinc, and copper VMS deposit, Brunswick Number 12. This enormous pile of tailings was constructed to contain the sulphuric water inside.

The second stop was the Flat Landing Brook formation, down on the brook bank. This formation consists of aphyric rhyolitic flows interbedded with pyroclastic rocks. Minor thrust faulting and deformation had occurred forming folds in the rocks at our feet.

A secondary stop later down the road showed the same rhyolitic rock but with less deformation and higher contents of magnetite and zinc.

Dave Lentz showing students local folds in the Austin Brook formation.

Next, we visited the Austin Brook iron-bearing district. Heavy dark magnetite and pyrite grains are mineralized within this iron-rich deposit. This mine has not been touched in decades since they had mined it out for its iron. This is related to Nepisiguit Falls formation in a later stop.

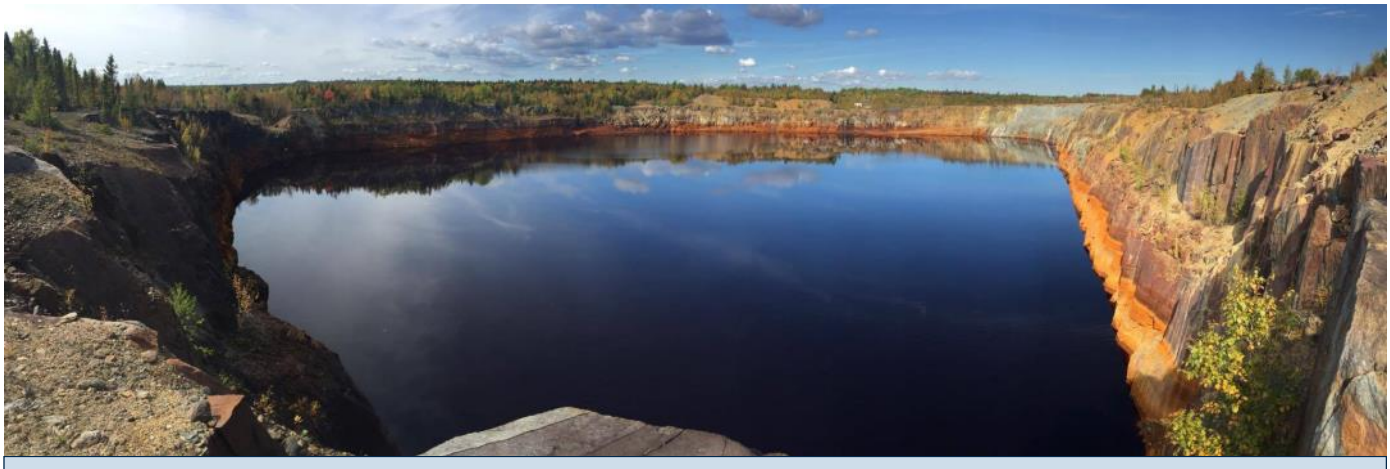
The next stop on our trip was the copper-lead-zinc Brunswick Number 6 deposit. Here, the blood red water with assumable low pH had stained the inside walls of the flooded open pit. We walked on the outskirts and found small folds and striations in the surrounding host rock indicating the unique deformation that it had undergone as well as glaciation.

Pabineau Falls was our following stop. The massive pink, coarsed-grained, equigranular biotite granite pluton contains alkali feldspars up to 2 cm in length. Pegmatite dykes and quartz veins locally cut the granite. Heavy rapids and small waterfalls cut through the granite body, giving way to the tourist attraction.

Dave Lentz and UNB students.
All photos by Adam Clark

Next, our class stopped at a large outcrop of pillow basalts located near the Caribou and Restigouche mine

Restigouche Open Pit



Brunswick Number 6

sites. And we made a quick stop to view the Caribou mine, which is still in operations.

Our final stop of the trip was the former Restigouche open-pit lead-zinc mine. Here, we examined the high grades of iron, zinc and sulphides in the host rock by the amount of pyrite, chalcopyrite, and sphalerite mineralized in the tailings. Some boulders contained tectonic textures indicating how the mineralization was deformed. The water in the open-pit is pumped with lime to maintain the pH levels.

Adam Clark
University of New Brunswick

Another stop on the Bathurst district field trip

Students visit Pabineau Falls

Announcements

A Blast from the Past–President: Get involved, Give us a nomination, GAC® Council needs you!

As I now transition to a lesser role with GAC® Council, I have one significant responsibility left – nominations to Council. I chair GAC®'s Nominating Committee along with the preceding three past-presidents and we are tasked with identifying new Councillors, including your next GAC Vice-President. We need you!

We look for interested GAC® members who are willing to help steer GAC® and are focussed on strengthening our organization. We try to nominate new Councillors from government, industry, and academia, from multiple discipline backgrounds and from all regions of Canada. The only formal requirement to serve on Council is GAC® Membership AND it is membership renewal season. Renew your membership now for the tremendous early bird rate of $85 CDN! The only other preferred requirements are enthusiasm and energy.

We are looking for people to fill a variety of Council positions including:

- Councillor for Publications – helping guide our books, flagship journal Geoscience Canada, and all our various publications
- Councillor for Lecture Tours – helping to coordinate the Hutchison and Howard Street Robinson speaking tours annually
- Councillor for Science Program – helping to shape upcoming GAC-MAC conferences like Resources for Future Generations 2018 in Vancouver; Quebec City 2019; GeoCanada 2020 in Calgary; and beyond
- Vice-President – the first step toward the President's seat – the business and planning role on Council (some previous familiarity with the operation of Council is desirable).

And a new Council role:

- Councillor for Media Management – we are looking for a dynamic young Councillor to help with our brand management and communications through all social media avenues including Facebook, Twitter, Tumblr, Instagram, etc.

We are looking for nominations before year-end (December 31, 2016) to assume a Council role at GAC-MAC in Kingston, May 2017. Please send your suggestions – yes, self-nominations (aka volunteering) is permitted – by email to gac@mun.ca , a subject line of "Council Nomination" would be welcome. I personally look forward to hearing from you and helping continue to build GAC for the future.

All the best from rainy Vancouver
Vicki Yehl
GAC® Past President

Connect with the *Canadian Journal of Earth Sciences*

Published since 1964, the *Canadian Journal of Earth Sciences* (*CJES*) reports current research in all aspects of earth science, including geomatics, geophysics, and geology. Geological Association of Canada members are invited to submit to CJES. To learn more about CJES, and its publisher Canadian Science Publishing, download the *Top 10 Reasons to Publish in CJES*. (www.cdnsciencepub.com/files/pdf/tenreasonstopublishwithcjes.pdf)

We're on social media! Connect with *CJES* on Twitter (@CanJEarthSci) and Facebook (www.facebook.com/CanJEarthSci/). We're posting about newly published articles, new issues and more. We're looking forward to connecting.

Helen Belyea remembered?

I am working on a biographical article dealing with the life and career of Helen Belyea. It focusses especially on her influence as a role model for successive generations of women in geology, and also how her work helped form the foundation for Alberta's modern petroleum industry. I am looking for former colleagues or friends of Helen Belyea who personally knew her and would be willing to talk to me about her impact and about her as a person. If you can help, please contact me, Mark Campbell (mark@wordsworthinc.com)

RFG2018

Letter of Invitation from the Chair, RFG2018 Steering Committee

I invite you to Vancouver, Canada, in June 2018, to attend the first international conference focused on the resources that will be required for future generations. The conference, Resources for Future Generations, will be held under the auspices of International Union of Geological Sciences (IUGS) in collaboration with local Canadian partners – the Canadian Federation of Earth Sciences (CFES), the Canadian Institute of Mining, Metallurgy and Petroleum (CIM), the Geological Association of Canada (GAC) and the Mineralogical Association of Canada (MAC). These organizations will be joined by other national and international associations in the delivery of an excellent program relevant to all interested in resources and related earth and environmental science.

RFG2018 is the first IUGS conference to be held between Quadrennial IUGS International Geological Congresses and the first to be focused on a specific topic, Resources for Future Generations. Under this topic, there will be three major themes – Energy, Minerals and Water, with an additional theme broadly related to the Earth and the knowledge that underpins the future availability and responsible use of resources.

We expect to attract 4000-5000 attendees including earth scientists and engineers involved in research and resource development, members of government and civil society focused on resource management, and First Nations and indigenous people interested in resources. We are especially keen to attract young professionals, researchers and students who represent the future generation – the topic of the conference. In addition to a full technical program with plenary, oral and poster sessions, there will be pre- and post-conference short courses, workshops and field trips.
The conference will be held on 16-21 June 2018 in Vancouver in the Province of British Columbia on Canada's west coast. Vancouver is a magnificent city located in a beautiful setting surrounded by mountains and the Pacific Ocean, Canada's gateway to Asia and other Pacific nations. Vancouver is renowned for being a friendly, cosmopolitan and entertaining city. It is also an appropriate location for RFG2018, since the extraction and environmental management of energy, minerals and water are integral to the success of British Columbia.

On behalf of the RFG2018 Steering Committee and all of our partners, I look forward to welcoming you to Vancouver in June 2018.

John F. H. Thompson
Chair, RFG2018 Steering Committee

Website: rfg2018.org

Important dates (provisional)

- February 2017: Call for abstracts, workshops and short courses opens
- June 2017: Early-bird registration and housing central opens
- October 2017: Call for abstracts, workshops and short courses closes
- January 2018: Notification to authors of accepted abstracts, workshops and short courses
- March 2018: Presenters registration deadline, End of Early-bird registration

Image source: http://rfg2018.org/en/RFG/2018/Rfg-Highlights/Why-RFG.aspx

Themes and Sub-themes for RFG1018

The Earth
Evolution of the planet led to the concentration of minerals and metals, recognition by early humans, and exploitation and use by the human race. Understanding the earth and earth processes has implications for the location of resources, efficient and clean extraction, and stewardship of our planet.

Energy
Availability of energy has supported the development of the human race. Increasing population and basic human needs will require vast increases in energy supply.

Minerals
Minerals service every aspect of modern life. Although influenced by cycles and volatility, human needs, energy demands, and new technology will maintain demand for many commodities.

Water
Clean water is a fundamental human right. Availability of water requires understanding surface and subsurface sources. Water is critically linked to energy and minerals, in addition to agriculture.

ENERGY	MINERALS	WATER	THE EARTH	RESOURCES AND SOCIETY
Conventional	Major minerals	Sub-surface water	Earth Evolution	Resources and indigenous people
Unconventional	Minor - critical minerals	Surface water	Earth Processes	Role of Geological Surveys
Sedimentary Basins	Technology and metals	Water - Minerals	Earth Systems	Resource frontiers - Arctic, Oceans
Geothermal - renewable	New Sources	Water - Energy	GAC-MAC	Knowledge and education
				Geoethics
				Young leaders

The 2017 Annual meeting of the GAC/MAC in Kingston will coincide with the 175th anniversary of the founding of the GSC in Kingston. The Geological Survey of Canada, Canada's oldest scientific agency, was established by the legislature of the Province of Canada in 1842, in Kingston, Canada West.

The Department of Geological Sciences and Geological Engineering at Queen's and the GSC will be hosting this celebratory event at Queen's University.

Please join us at the conference May 14-18, 2017. For more details see: www.kingstongacmac.ca

Howard Street Robinson Fund

The Robinson Fund was established in 1977 by the Geological Association of Canada, using a bequest from the estate of Howard Street Robinson. The fund is dedicated to the furtherance of scientific study of Precambrian Geology and Metal Mining by:

- sponsoring an annual Distinguished Lecturer Tour whose focus alternates between Precambrian research and economic geology (lecturer alternately chosen by the GAC®'s Precambrian and Mineral Deposits divisions)
- supporting Special Projects including publications, symposia and conferences.

Proposals for special projects on Precambrian Geology or Metal Mining should be submitted to the Robinson Fund Committee. Projects should be sponsored or organized through the GAC® or one of its Divisions or Sections. Proposals that have a wide appeal or degree of accessibility to the GAC® membership are preferred.

For further information and proposal submissions, please contact: Patrick Mercier-Langevin, Chair, Robinson Fund, c/o Geological Survey of Canada, 490 rue de la Couronne, Québec G1K 9A9, Tel: 418-654-3101, E-mail: pmercier@nrcan.gc.ca

The Last Word

Graham Young's thoughtful essay on the perspectives different professionals bring to fieldwork echoes my own field experience. People with different expertise can all *look* at the same section but each *see* something quite different. I have also spent time in the field with archaeologists and marvelled at their ability to spot fire-broken rock, lithic debitage, and butchered bison bone. In the same section, I see a volcanic ash layer, several palaeosols and the sedimentary record of a debris flow. The more eyes look at the landscape, the richer and more complex our understanding becomes. The interchange of ideas and perspectives is rewarding and productive. And it's fun! Alwynne B. Beaudoin, *GEOLOG* Editor

Information for Contributors

Contributions should be submitted by e-mail to Alwynne.Beaudoin@gov.ab.ca, with GEOLOG in the subject line. Contributions are welcome in either of Canada's two official languages. MS Word (.doc or .docx) is the preferred format for contribution but generic word processing (.rtf or .txt) files are also fine. Please do not submit PDF files. Up to four hi-res images may be submitted per contribution: preferred format is .jpg, RGB colour, with a minimum 300 dpi resolution at 5" x 3" size. Please ensure that images are cropped and colour-corrected, and provide a caption for each image, and an image credit line if needed. Contributors are responsible for securing permission to publish for any third-party images or images of living recognizable people. Diagrams (vector graphics) may also be submitted. Preferred format for graphics is Adobe Illustrator (.ai); make sure that the file is saved with "save text as lines" option enabled to ensure no font substitutions. Additional information on other file formats can be obtained from the Editor. Please do not embed images or graphics in your text document; images or graphics should be submitted as separate files. In your text, use a call-out in parentheses to indicate the approximate placement of each image and graphic. If files are larger than 10 mb, please contact the Editor for alternate delivery arrangements. Your contribution will be copy-edited to ensure consistent spelling and orthography and to correct any obvious typos or errors. Contributions may also be edited for clarity and length. If the Editor has questions about specific information in the text, she will contact contributors for clarification. Contribution deadlines are March 1, June 1, September 1 and December 1.

Consignes aux auteurs

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