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GEOLOGICAL ASSOCIATION OF CANADA
ASSOCIATION GÉOLOGIQUE DU CANADA

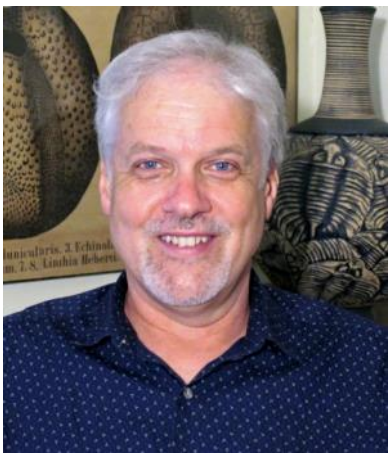
Presidential Preamble

To Start With, Let's Consider the Science

It seems like 2016 has not been an easy year. We have, of course, mourned the passing of heroes who influenced many of us when we were growing up, including some great Canadian geologists. Watching our neighbours south of the border, we have seen a tremendously fractious, divisive, and ill-mannered election campaign, during which tempers were high, arguments were fierce, and facts were either ignored, mis-stated, or the victims of "collateral damage."

Here at home we have observed the continuation of long-term political conversations about many issues. Several of the key issues facing Canada today include significant geological components: the potential development of new petroleum pipelines and tanker traffic, climate change and the regulation of carbon emissions, fracking, building of new hydro dams, installation of tidal power barrages, waste disposal, sea level rise . . . all of these are issues to which geoscientists can bring knowledge and perspective. In these difficult times, it is incumbent on each of us to apply science as we develop our opinions on issues, and this is particularly important when the science that needs to be considered is at some remove from our own area of specialization.

I do often hear geologists speaking knowledgeably and effectively about issues that affect society, the environment, and the economy, but in general those who are sharing the opinions are acknowledged experts on the topic under discussion. The trap we tend to fall into is that, as we move farther from what we really know, we scientists follow our human tendencies: we choose to read the opinions of those with whom we know we agree, and we ignore evidence and opinions that contradict our own preconceptions.



I remember an incident about 15 years ago, during my first term on GAC® Council. There was an intense discussion between a member of GAC® and a member of Council, concerning whether GAC® needed to provide a response to the Government of Canada about steps that were being taken to counteract climate change. It was fascinating to watch, because each individual held a very clear opinion about whether climate change was occurring as a result of human activities, and both of them thought that GAC® should be stating a position on this issue. Indeed, both thought that it was such a clear cut case that the position to be taken didn't even need to be discussed . . . but of course it then turned out that the opinion of one of them was directly opposed to the opinion of the other.

Since we are members of the Geological Association of Canada, and since GAC® is a very broad organization that represents all aspects of Canadian geosciences, it does not have to be like this. One of the greatest benefits of GAC® is that it allows us to share our science with many other Canadian scientists – certainly a lot of those who will attend a particular presentation at GAC-MAC will specialize in work similar to that being presented, but there are often many others who are attending because they are interested, and perhaps because they are trying to find answers to some broad questions.

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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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

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GEOLOG (ISSN 0227-3713; 1712-3747) is the quarterly newsmagazine of the Geological Association of Canada, St. John's, Newfoundland and Labrador. *GEOLOG* is published for the benefit of GAC® members and its content reflects the diversity of the organization. News items and short articles on topics of potential interest to the membership including public geoscience awareness are encouraged. Also encouraged are communications promoting interaction among academic, industry and government sectors. *GEOLOG* accepts and publishes contributions in both of Canada's official languages. Opinions expressed herein are those of the writers and do not necessarily represent the official positions of the GAC®. *GEOLOG* is one of several forums provided by the GAC® for scientists worldwide.

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GEOLOG (ISSN 0227-3713; 1712-3747) est le bulletin trimestriel de l'Association Géologique du Canada, à St. Jean, Terre-Neuve-et-Labrador. *GEOLOG* s'adresse aux members de l'AGC® et son contenu reflète le caractère polyvalent de cette organisation. Nous invitons la soumission de nouvelles et articles courts pouvant intéresser les membres, incluant les thèmes de sensibilisation du public aux sciences de la Terre. Les articles suscitant des échanges d'opinions et d'informations entre les secteurs académique, industriel et ouvernementaux sont également la bienvenue. *GEOLOG* accepte et publie les articles dans les deux langues officielles du Canada. Les idées sont celles des auteurs et ne représentent pas nécessairement la position officielle de l' AGC®. *GEOLOG* n'est qu'un des nombreux forums offerts par l' AGC® aux scientifiques à travers le monde.

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Apologies to any contributors that have been missed. This *GEOLOG* was produced with support from the Royal Alberta Museum. Your contributions for future editions are welcome / Désolé pour ceux qui auraient été involontairement oubliés. Cette copie de *GEOLOG* a été produite grâce à l'assistance du Royal Alberta Museum. Nous sollicitons vos contributions pour les publications à venir.

Contributions for next issue

Please send items for next issue of *GEOLOG* by e-mail to Alwynne.Beaudoin@gov.ab.ca on or before **March 1 2017**.

Lots of geology to explore in Canada's National Parks, including this area around Banff. Take advantages of the Discovery Pass which gives free admission to the National Parks in 2017. Find out more at www.pc.gc.ca/eng/index.aspx

Cont'd from p. 1

I often wonder about the best scientific answers to complex issues during my commute to work, as every day I see the long petroleum trains slowly snaking their way through Winnipeg. What opinions should I be holding with regard to this phenomenon? As a paleontologist, do I express pride that stratigraphic and paleontological science has been applied to the discovery of immense petroleum resources, which are now providing many jobs and enriching our economy? Or as someone who studies ancient and modern environments, do I express concern at the damage to water supplies that might be caused if a substantial quantity of that petroleum manages to leak out during transportation? As a person who is environmentally concerned, do I oppose the development of new pipelines on the grounds that the burning of petroleum is a primary cause of global climate change? Or do I recognize that it is not going to be quick or simple to wean our society from petroleum, and that the building of more pipelines might reduce the number of these petroleum trains, possibly saving us from another Lac Mégantic-scale disaster in the coming years?

To my mind, the best answers to these sorts of questions are not to be found in the opinions of party leaders or newspaper columnists, or even in the bottom line benefit to companies and taxpayers; sound answers will only come from a consideration of the best science that addresses all aspects of each question. It is exactly this sort of science and society approach that is at the heart of the RFG 2018 (Resources for Future Generations) meeting, which will take place in Vancouver in June, 2018. GAC® is a partner in the RFG meeting, which will attract thousands of earth scientists, along with engineers, government representatives, policy makers, and First Nations and Indigenous leaders.

The RFG meeting will be our GAC-MAC 2018, but the broader composition of attendees and topics will allow us to delve to a considerable extent into societal aspects of the extraction and environmental management of energy, minerals, and water, along with our usual intense focus on geological aspects. The conference is intended to look not only at resources and environment in Canada and other developed countries, but perhaps more importantly, it will consider developing countries and disadvantaged people around the world. We can anticipate that many of the presentations could generate intense and honest discussions, at this nexus of geoscience and society. It will be fascinating, stimulating, and probably eye-opening for many of the attendees.

I encourage you to consider proposing a session, short course, or field trip (session proposals are due by March, 2017; see RFG2018.org), and mark it into your calendar now. I look forward to seeing you in Vancouver.

Graham Young
GAC® President

Source: http://www.rfg2018.org/en/RFG/2018/Technical-Program/Technical-program.aspx

Vice-President's Remarks

It is a pleasure to be back on Council and an honour to be the Vice President of the Geological Association of Canada (GAC®). For those that do not know me, my technical background is Quaternary Geology and Sedimentology. During the first 15 years of my career, I was employed with the Federal Government as the Placer Geologist, Chief Geologist and Director of Minerals in Yukon Territory. For the past 20 years, I have been in the private sector as an senior manager in the environmental consulting business and in the analytical geochemistry business.

GAC® is a unique organization with a long and distinguished history as Canada's premier learned geoscience society. On February 14, 1947, a group of geologists met in Toronto with the objective of creating the Geological Institute of Canada. The original goals of the original association were to promote, discuss and disseminate geological knowledge. There was a second meeting on March 11, 1947, which resulted in a Constitution and Bylaws as well as the election of the first Councillors, with a name change to the Geological Association of Canada with 140 charter members (from GAC's website under the Melange tab).

GAC® has continually evolved from an organization that originally had a focus on the minerals industry, to an organization that covers all aspects of Canadian Geoscience, with a stellar reputation of providing leading edge and topical publications as well as conferences on a national scale. The annual conference is an excellent venue for mentoring students and for younger geoscientists that are building their career. GAC® has a tremendous awards program that recognizes career achievements and provides peer recognition on a national scale.

GAC® has been able to adapt with the changing times by creating new Divisions and Sections as well as timely publications largely from a volunteer base. There are three full time employees at the GAC® office at Memorial University who do a great job at keeping the organization operating on a daily basis. We should all be proud of GAC® as Canada's oldest and longest serving geoscience organization that continues to be a strong voice on a national scale that is recognized internationally.

One of the key responsibilities of GAC® Council is to ensure that the organization has a healthy future, which includes the dissemination of scientific knowledge, as well as ensuring there is a long term and stable financial future. Both are challenging but with the significant talent and experience in the GAC® Council, I am sure we are up to the task.

During the next few months, I will be assisting our President with reviewing the current Business Plan and priorities of the Association as well as other key initiatives such as a Revenue Task Force and reaching out to members on our issues and priorities. We need to look at alternatives for new types of revenue generation as well as new ideas for publications and continuing to align with other associations to mutually benefit the geoscience community across the country.

I am excited about contributing to GAC® over the next three years and in particular look forward to attending our annual conferences. Kingston is shaping up to be a great conference and I encourage you to attend this event.

Stephen Morison
Vice President, GAC®

GeoFact: Dec 10 1823: Mary Anning, fossil collector, discovers a complete Plesiosaurus at the Black Ven cliffs of Lyme Regis, Dorset, England.

GeoFact: Dec 16 1811: Earthquake with an estimated magnitude of 7.7 affected New Madrid, Missouri. This was the first in a sequence of seismic events in the region that continued until around 1817.

Reading on the Rocks

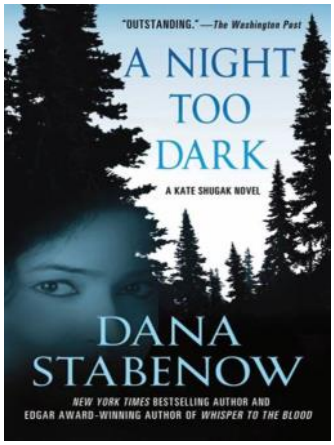
***A Night Too Dark*, by Dana Stabenow. 2010. St Martin's Press, New York. 264 pages.**

Kate Shugak lives on a homestead in a National Park in southeast Alaska. Of Aleut heritage, as are most of her neighbours, Kate is the Chair of the Board of Directors of the Niniltna Native Association, a powerful governing institution in the Park region and beyond. With her background in law enforcement, she occasionally works as an investigator, especially when the workload gets too much for the lone local State Trooper, Sergeant Jim Chopin, who is also her live-in partner.

For years, the regional economy has been stagnant. People make a precarious living from fishing or various forms of tourism, such as guiding visiting trophy hunters or ecotourists. Both occupations are seasonal and highly dependent on the external economy. Many people also hunt, fish, and gather wild foods for subsistence. The region doesn't offer much future for young people, who usually have to leave to seek work in Anchorage or Outside, that is, beyond Alaska.

That's all changed recently. A massive gold deposit has been found on state leases in a wildlife refuge about 50 miles from the main community of Niniltna. With gold almost $950 an ounce on world markets, it's inevitable that the deposit will be mined, especially because it also includes copper and molybdenum, both high demand metals. The discoverer, Global Harvest Resources Inc., is a junior mining company, usually focused on exploration and finding mineable deposits. In this case, the corporation has decided to develop the deposit itself. It's now working to establish the extent of the deposit and embarking on the complex environmental impact assessment process.

Soon the Suulutaq mine site is a bustling place, with bunkhouses, an office trailer, an airstrip, and multiple drill teams working long shifts. By early May, there are more than 100 people on site, including the mine super-intendent, Vernon Truax, and staff geologist, Holly Haynes. Global Harvest is determined to be a good corporate citizen. They've donated computers to Niniltna's school and hired local people, including high school teens as summer roustabouts. But many more roustabouts are from Outside, and bring with them problems and tensions. Young men, bored, with lots of money, foment trouble. Because Niniltna is the nearest community, the crime rate there escalates, as drunkenness, general rowdiness, fights between Outsiders and locals, assaults, and thefts increase.



The locals are divided on the mine. They've seen a mine boom before, with the Kanuyaq copper mine, closed in 1936. Many, like Kate, realize that their way of life will be changed forever, and worry about the influx of Outsiders and the environmental damage likely to be caused by the mine, especially to the valuable salmon runs in the Kanuyaq River. Others see benefit in jobs and steady incomes that can sustain the community and provide needed infrastructure, such as cell service. It's not so simple as for or against.

Local entrepreneurs aren't waiting. George Perry, owner of Chugach Air Taxi Service, has secured a contract to run freight and crew changes for the mine, and is busy upgrading his aircraft fleet. Three of the Aunties, elders and the real powerbrokers in the Park, are exploiting the situation with enthusiasm. From a Riverside Café table, Auntie Balasha is selling kuspuks, colourful hooded overshirts, to Outsiders wanting genuine Native souvenirs. Auntie Edna Aguilar is selling Filipino take-out from her home kitchen. Auntie Vi Moonin sells her boarding house to Global Harvest as digs for mine workers, then cannily negotiates a deal to run and operate it.

All seems to be going well. Then a pick-up is found abandoned on a rough homestead trail in a remote part of the Park. Its driver can't be found. Not unusual; tourists get lost all the time. But evidence in the truck suggests a connection to the mine. After a difficult search through the bush turns up human remains, Kate is tasked with confirming their identity, and figuring out if and why anyone from the mine was in that area.

This is Dana Stabenow's 17th Kate Shugak novel. Her online bio says Stabenow was born in Anchorage, grew up on a fish tender in the Gulf of Alaska, and worked for six years for BP at Prudhoe Bay. Perhaps this is why the locale and characters seem so vibrant and real. You can feel the mist, taste the salmon, hear the cry of gulls, encounter a bear, and smell the tang of spruce. Then enjoy an intelligent police procedural centered on the complexities of modern gold mining.

Alwynne B. Beaudoin
Edmonton, Alberta

Spotlight on Specimens

Peering into Earth's Gem Vault

During the past fifty years the Royal Alberta Museum has built an extensive rock, gems and minerals collection. This collection has grown to tens of thousands of specimens. As it grows, certain specimens have been highlighted as spotlight specimens due to their history, uniqueness or aesthetic appeal. One of these specimens is this unique 11.3 carat rough diamond from the Ekati Mine in the Northwest Territories (Fig. 1). This stunning piece measures over a centimetre across and features inclusions of graphite and triangular pits on its surface.

Diamonds form in high pressure and relatively low temperature zones deep within the Earth. These conditions are typically only found under old thick continental crust that is cooler, such as the Canadian Shield (Janse 1994, Rudnick and Nyblade 1999).

Fig 1: The dark shapes inside the diamond are inclusions of the mineral graphite. Triangular pits point in the opposite direction of the face of the diamond.

Fig. 2 . A collection of small rough diamonds of various shapes and colours.

Normally these diamonds never reach the surface of the Earth. However, magmatic activity deep within the mantle can force magma to the surface in explosive volcanic pipes bringing with them various rocks and minerals including diamonds in a structure called a kimberlite pipe (Creighton *et al*. 2008, Viljoen *et al*. 1994).

The Ekati Diamond Mine opened in 1998 and is the first surface and underground diamond mine in Canada. The mine is located in the Lac de Gras kimberlite field of the Northwest Territories. It has produced over 50 million carats so far throughout its operation. The area was first prospected in 1985 when two geologists discovered and traced a trail of diamond indicator minerals back to the diamond deposit (Zlotnikoc 2008).

This diamond does not sparkle or have flawless faces like a jewelry diamond. Diamonds form in a variety of shapes and colours. Frequently, they have pits and growths on their surfaces and host inclusions of other minerals and fractures inside them. Diamonds can even include other diamonds! When a diamond is processed by a jeweller, its imperfections are removed. The diamond may be ground down, polished, and shaped to the jeweller's desire. These imperfections that are undesirable in jewelry diamonds give natural ones a unique character and can reveal much about their history.

Diamonds form into a range of shapes (Fig. 2). The octahedral shape of this Ekati diamond is typically associated with long steady growth (Tappert and Tappert 2011). This diamond has tiny flecks of graphite held within it (Fig. 1). Like diamonds, graphite is made of pure carbon. However, graphite forms at lower pressures. The presence of graphite may mean that the diamond grew at the edge of favourable conditions for diamond formation (Giardini and Tydings 1962) or incorporated previously existing small graphite crystals as it grew (Glinnemann *et al.* 2003).

A diamond can dissolve and regrow over its lifetime. These periods of change are seen on the surface and in the shape of the diamond and can tell us about its history before it was transported away in a volcanic

Fig. 3: Small shield shaped growth plates are visible on the top left of the lower face. These growth plates are oriented parallel to the crystal face of the diamond, while the triangular pits are pointed the opposite direction.

pipe. On this diamond, triangular pits called trigons are visible (Fig. 1,3) These have been etched or carved out of the diamonds by extremely hot fluids and magmas of the kimberlite pipe interacting with the diamond surface as it was carried to the surface (Evans and Sauter 1961, Omar *et. al*. 1954). The diamond also has small shield-shaped growth laminations oriented in the same direction as the face of the diamond (Fig. 3) that formed as new growth on the surface (Williams, 1932). The curved shape of these shield-shaped plates indicates that growth plates partially dissolved. The edges of this diamond also give evidence of reabsorption, illustrated through rounded or recessive edges and corners on the diamond (Orlov 1977).
Every diamond has a story to tell, and this spectacular piece is no exception. Its unusual size and beautiful faces tell so much about its past. This diamond has great significance as a showpiece and is an excellent spotlight attraction for the Royal Albert Museum. This wonderful piece of Canadian geology will be on display in the World of Gems and Minerals gallery at the new downtown Royal Alberta Museum.

Daniel Francis
Royal Alberta Museum, Edmonton

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Ekati Diamond Mine, Northwest Territories, August 2010
Source: Jason Pineau, Wikipedia, used under Creative Commons license

Events and Happenings

Experimental Education: An Innovative Approach to Teaching in the Field

What happens when you task 25 graduate students with teaching a lesson in a field area they've never been to? A little bit of confusion of course, but it turns out you also get a lot of enthusiasm, creativity and most importantly, learning.

This is exactly what the Multidisciplinary Applied Geochemistry Network (MAGNET; www.magnet.eos.ubc.ca) set out to achieve in summer 2016. MAGNET is an NSERC-funded industrial stream Collaborative Research and Training Experience (CREATE) initiative led by Dominique Weis at UBC. The program connects trainees with leading scientists and state-of-the-art analytical laboratories across Canada to address challenges in analytical, environmental and exploration geochemistry. Our trainees come from diverse backgrounds – geology, oceanography, chemistry, archaeology and environmental science – which gives us a unique opportunity to draw on each other's strengths, create an integrated learning environment, and take a novel approach to geochemistry education and training in Canada.
At least once a year, MAGNET trainees and faculty from across Canada get together for an intensive week of technical training, networking and professional development. Each time, the workshop features a different theme, format and location. This year, we decided to head down to the US to explore three unique field sites in Montana and Wyoming: the Stillwater Complex, the Beartooth Mountains and Yellowstone National Park.

The concept of the workshop drew heavily on UBC's strength in geochemistry and expertise in teaching and learning initiatives, and particularly benefited from the guidance of co-organizer James Scoates. For the lessons, he came up with a somewhat unusual idea: why not have the students teach each other? The benefits of peer learning are well-known and the technique is widely gaining momentum.

Groups of trainees were responsible for designing and delivering half-day teaching modules that included field activities at each of the locations. Planning was carried out using Basecamp, a web-based project management and collaboration tool. Students were free to self-organize into groups of 2-4, with the one rule that each group should include participants from at least two universities. They were also encouraged to choose their own topic as long as it included geochemistry. Within 10 days, all trainees had found groups and defined their topics.

Over the course of two months, the students transformed their ideas into a formal lesson plan, complete with learning goals, a schedule of teaching

Students lead a group discussion on field relationships in the Beartooth Mountains, Montana. *Photo: J. Scoates.*

Co-organizer James Scoates provides an overview of the regional geology of the Stillwater Complex, Montana. *Photo: D. Hanano.*

activities, equipment lists, and plans for safety, environmental mitigation and archiving samples/data. Each group was assigned a mentor (postdoctoral fellow, faculty or staff member) who provided advice, feedback and recommendations throughout the process.

In August, 30 students and mentors flew from all over Canada, from Vancouver to as far east as Chicoutimi, down to the quaint, historic town of Red Lodge, Montana. The first evening we held a kick-off meeting that included pizza and a "snowball fight" – a fun icebreaker and get-to-know-you activity.

Day 1 we headed off to the Stillwater Complex, a large mafic layered intrusion that is actively mined for its extensive reserves of chromium and platinum group elements. After a comprehensive safety discussion (also led by the students), the first group took over. We began by exploring the Peridotite Zone of the Ultramafic Series near the base of the intrusion.

Students practiced identifying minerals, sketching outcrops and using a magnetic susceptibility meter to learn about the formation of chromitite layers. The next day, we completed the Picket Pin traverse, which took us on a transect through the Banded Series in the upper part of the intrusion. Student groups, each armed with a compass, GPS and base map, spent the day locating outcrops, classifying rocks and taking structural measurements. The exercise culminated with each student constructing a cross-section and a discussion of the overall structure and formation of the Stillwater Complex.

We switched gears on Day 3, and drove through the spectacular Beartooth Mountains near the border of Montana and Wyoming. This module was structured as a "jigsaw" activity (a cooperative learning technique) and was very successful, despite the sudden downpour and unexpected lack of outcrop. Each group was assigned a map unit that they had to describe, name

Students instruct their peers on how to make cross-sections at the end of the Picket Pin traverse, Stillwater Complex, Montana . *Photo: J. Scoates*

and match to whole rock major element data. New groups were formed consisting of one expert from each map unit to compile their observations and interpretations for the entire map area. The final discussion synthesized the regional geologic history and major concepts on metamorphism and geochronology.

The second half of the trip took place in the incredible natural laboratory of Yellowstone National Park. Day 4 was spent identifying the different facies of Mammoth Hot Springs on the basis of their physical characteristics, chemistry and microbial communities.

Teams work on a fun activity building the chemical reactions occurring at Mammoth Hot Springs, Yellowstone National Park, Wyoming. *Photo: D. Weis.*

Although we weren't able to directly sample the spring water, the students had fun using infrared thermometers to record temperature variations. At the end, students summarized their facies observations and learned about the biogeochemical processes at play.

The following day, the teaching group provided their peers with an overview of Yellowstone volcanism, including stops to observe the mineralogy and structure of rhyolitic and basaltic outcrops from each of the three volcanic cycles. Students were able to make connections between the different cycles and their geochemistry, and formulate their own interpretations about magma sources, relationships and processes. This module took us on a huge loop of the park, where we often had to stop for bison (and tourists) on the road, making for a long but rewarding day.

On Day 6, we went on a walking tour of the Norris Geyser Basin, an acidic hydrothermal system that provided a useful contrast with the alkaline hot springs we saw at Mammoth. Students completed worksheets consisting of thought-provoking questions and activities at each of the remarkable geothermal features, including geysers, fumaroles and hot springs. On the final day, we investigated the geology, geochemistry and archaeology of Obsidian Cliff. Unfortunately, we couldn't access the area due to construction, but the student leaders did an amazing job improvising. They

PhD student measures water temperature variations at Mammoth Hot Springs, Yellowstone National Park, Wyoming. *Photo: D. Weis.*

used a variety of active learning strategies including polls, think-pair-share, a gallery walk and even a crossword competition and human scatterplot.

We ended the workshop with a wrap-up activity designed to synthesize all of the concepts learned throughout the week. Teams of students drew conceptual maps incorporating all three field sites, and integrating aspects of time, chemistry and processes. The level of participation and the sheer variety and quality of the finished products were both impressive and inspiring.

The workshop was a huge success by several measures. In one week, we were able to explore ancient crustal rocks, mafic layered intrusions, supervolcanoes and modern geothermal systems, spanning four billion years of Earth history. The outdoor classroom and hands-on activities enhanced understanding of concepts introduced earlier in the year and gave students a sense of scale, context and perspective. The trainee-led format facilitated peer-to-peer knowledge transfer and provided professional skills development in project management, teamwork and communication. New friendships were formed during our (rare) free time at stops like Old Faithful and in the evenings over shared meals and campfires. These personal connections and memories will stay with them for years to come.

Time constraints and unforeseen field circumstances were the most difficult aspects the student instructors had to overcome. Keeping learners motivated, especially those with varying knowledge levels, was also a challenge. As one graduate student remarked in their post-trip reflection, “nothing goes according to plan, but it all works out somehow if your students are engaged and interested, regardless of their back-ground.” And at the end of the day, we saw more, did more and learned more than we could have ever imagined. We hope others will be inspired to take more risks in teaching and will use our positive experience with peer learning as a model for future field courses and workshops.

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Students sketch the sediments and basalts of The Narrows (Overhanging Cliff in background), Yellowstone National Park, Wyoming. *Photo: D. Weis.*

AUGC 2016

The 66th annual Atlantic Universities Geoscience Conference (AUGC) was hosted by the Fletcher Geology Club at Acadia University, Wolfville, Nova Scotia, on October 27-29th. Approximately 110 students from Memorial, Dalhousie, St. Francis Xavier, St. Mary's, Acadia, Cape Breton, and the University of New Brunswick attended the conference. Also present were professors from many of the universities and geological professionals from local government organizations and private industry.

The conference kicked off Thursday evening with a 'Jeopardy -style' Challenge Bowl, hosted by the Canadian Society of Exploration Geophysicists. Students from Acadia came out on top and won an all-expenses-paid trip to Calgary in the spring of 2017 for two team members to participate in the national championship.

On Friday the students enjoyed three wet and windy field trips including: (1) a trip to East Kemptville to collect samples from the old tin mine and the spodumene-bearing Brazil Lake pegmatite, led by Dr. Cliff Stanley (Acadia University); (2) a visit to Nova Scotia's South Shore to view the stratigraphy and deformation in the Halifax and Goldenville groups of the Meguma terrane by Dr. Rob Raeside (Acadia University); and (3) a trip led by Drs. Ian Spooner and Sandra Barr across the eastern Annapolis Valley to view glacial deposits and the underlying bedrock. This year a short course on "Using seismic data: from discovery to early field development" was instructed by Dr. Fred Schroeder from Houston, Texas, and sponsored by the American Association of Petroleum Geologists.

Saturday was filled with 16 oral presentations and 6 poster presentations by students at the K.C. Irving Environmental Science Centre on the Acadia University Campus. The quality of all the presentations was excellent and congratulations to all speakers and poster presenters.

The evening awards banquet was held at the nearby Old Orchard Inn, where we were given sage advice about what not to forget in our field kits by Amy Tizzard, winner of the APICS award at the 2002 AUGC, and now a contract geoscientist, based in Oxford, NS, but working in Namibia. Amy regaled us with her adventures, in Yukon, Australia, Kilimanjaro, and Namibia.

Winners of the various awards were:

Science Atlantic Best Paper Award: Sean Murphy, Memorial University, for his paper "Three-dimensional morphological characterization of the trace fossil *Parahaentzschelinia ardelia*, Atoka Formation, Oklahoma." Honourable mentions were made for the presentations by Alexander MacBeath and Nikki Bursey (both also from Memorial University).

Imperial Oil Best Poster Award: Christopher Williams, Memorial University, for his poster "Rifted margin and sedimentary structure of the Porcupine Abyssal Plain, outboard of Goban Spur, southwest Ireland."

Frank Shea Award for best paper in Economic and Applied Geology: Taylor Chew, Acadia University, for his paper, "Geological setting of Au-Cu-Ni-Pb occurrences in the Second Gold Brook area, southwestern Cape Breton Highlands, Nova Scotia."

Rob Raeside regales the students with tales of the South Seas as he describes how the manganiferous kuthohorite-spessartine turbidites were deposited in the Moshers Island Formation of the Goldenville Group at West Dublin, Nova Scotia. *All photos: Anthony Chu.*

CSPG Award for best presentation of a petroleum geology-related paper: Erin Anderson, Dalhousie University, for her paper "Diagenetic effects and fluid flow along erosional boundaries in the Triassic Wolfville Formation at Rainy Cove, Nova Scotia."

CSEG Award for best presentation of a geophysics-related paper: Nicholas Lynch, Memorial University, for his paper, "Geophysical detection of reducing springs: A new approach."

AGS Environmental Geoscience Award: Fiona Henderson, Dalhousie University, for her paper "Predicting zones and potential sampling methods for elevated metal concentrations in urban soils, Halifax, Nova Scotia."

Following the announcement of awards for student presenters, several faculty members were recognized for their long-standing activity with Science Atlantic (and in earlier days APICS): Sandra Barr, David Lentz, Brendan Murphy, and Ian Spooner. Each professor received a Science Atlantic silver pin. Pins will also be awarded to Jarda Dostal, Milton Graves and Patrick Ryall at events in Halifax. Finally, Rob Raeside was inducted into the Science Atlantic Hall of Fame, recognizing his 34 years of activity in APICS and Science Atlantic, on the Earth Science Committee and as member and chair of the Board of Science Atlantic.

The organizing committee (Acadia students Sarah Dunn, Alex Squires, Ashton Baich, Chloe Caldwell, Carol Davis, Brooklyn Herron, Dillon Langelaan, Jackson Malone, Chad Stines, Brendan Vibert, and Alexander Whitney, and faculty advisor Sandra Barr) thank the many volunteers and sponsors, and especially everyone who attended, for helping to make AUGC 2016 such a memorable event.

Rob Raeside (centre) inducted to the Science Atlantic Hall of Fame with Grant Wach (Science Atlantic Earth Science Committee chair) and Lois Whitehead (Science Atlantic Executive Director).

Submitted by Rob Raeside (Acadia University) and Chris E. White (NSDNR) with appropriate nagging by Sandra Barr

Winners of the hardware (from left): Erin Anderson, Dalhousie, CSPG Award; Taylor Chew (Acadia), Frank Shea Award; Christopher Williams, Memorial, Best Poster; Sean Murphy, Memorial, Science Atlantic Best Paper; Fiona Henderson, Dalhousie, AGS Environmental Geoscience award; Nicholas Lynch, Memorial, CSEG Award.

Geological Survey of Canada and its scientists honoured by the Royal Canadian Geographical Society

NRCan's Geological Survey of Canada (GSC) was the centre of attention at the Royal Canadian Geographical Society's College of Fellows Annual Dinner held in Ottawa on November 16, earning four Gold Medals and the Massey Medal.

With 2017 marking the 175th anniversary of the GSC, the RCGS awarded the Gold Medal to the entire GSC to recognize its accomplishments over the years. Also receiving a Gold Medal were the GSC's Dr. Denis St-Onge (retired) and his son Dr. Marc St-Onge along with former GSC scientist Dr. Paul Hoffman. Dr. Steve Blasco (emeritus scientist) from GSC-Atlantic received the Massey Medal.

"It is quite an amazing achievement for the GSC to be recognized as a whole for 175 years of geoscience by such a prestigious external partner as the Royal Canadian Geographical Society and to see four of our own also be celebrated for their achievements," said Louise Laverdure, Director General, GSC-Central and Northern Canada Branch (CNCB).

How does an organization that pre-dates confederation continue to make significant contributions to its field? It comes down to people.

Many GSC employees dedicate their careers to the organization, even contributing when they're retired. The GSC is a tight-knit family in which everyone contributes and helps to shape the organization.

"We have four famous scientists receiving medals this year who have made outstanding career contributions to the understanding of Canada's land mass," said Daniel Lebel, Director General, GSC- Atlantic and Western Canada Branch (AWCB). "As well, the entire GSC is very honoured to receive the Gold Medal as this is a rare privilege that has been granted to very few organizations. To me, it signifies that NRCan and the GSC have made and continue to make great contributions to Canada. All GSC employees should take pride in this recognition."

The Honourable Jim Carr, Minister of Natural Resources, Daniel Lebel, Director General-GSC Atlantic and Western Canada Branch (AWCB), and Paul Ruest, President, RCGS
Images: CRA Events, unless otherwise indicated

The Geological Survey of Canada is Canada's oldest scientific agency and one of its first government organizations. Throughout its history, the GSC has played a leading role in exploring the nation. As Canada's national organization for geoscientific information and research, its world-class expertise focuses on the sustainable development of Canada's mineral, energy and water resources; stewardship of Canada's environment; management of natural geological and related hazards; and technology innovation.

Dr. Denis St-Onge began his geological research studying the geomorphic processes that shaped the high Arctic landscapes, including Ellef Ringnes Island. He developed an original mapping system, which illustrated processes that are active now and were in the past. Later, he applied this method to southwest Saskatchewan and the Swan Hills of central Alberta. Next, he studied the effect of large-scale glaciations in areas such as the Coppermine River–Bluenose Lake regions of Canada. Denis has published numerous maps and scientific papers and his involvement in numerous national and international institutions has led to him receiving many awards, including Officer of the Order of Canada.

Dr. Marc St-Onge, senior research scientist and head of regional geology at the GSC has been described as

one of the world's most prolific and productive geologic mappers. He was recently named by *Canadian Geographic* magazine as of one Canada's greatest modern-day explorers. Marc was interviewed this summer for Japan's public television *Great Nature* documentary series, and in September, the Geological Society of America (GSA) awarded him the 2016 Geologic Mapping Award in Honour of Florence Bascom. Marc's maps are detailed, rigorous, data-intensive, integrated syntheses of geological information and incorporate modern geochronology, geochemistry, petrology and geophysics that have led to a new understanding of the tectonic evolution and natural resources of the Canadian Arctic.

Dr. Steve Blasco, a marine engineering geophysicist based in Dartmouth, Nova Scotia, has spent close to 40 years studying the world's marine environments. His research has taken him to the Canadian Arctic and Great Lakes, Russia, the Caribbean, Bermuda, China, Japan, Norway, France and the North Geographic Pole. Steve has authored and co-authored over 200 reports and publications related to his marine geological research. He has led more than 50 marine scientific field programs on over 20 research vessels, including the international joint U.S.–Russia–Canada investigation of the Titanic wreck site. Steve also led the scientific team on the expedition for the Imax filming of *Titanic*. Since his retirement in 2015, Steve has remained active as an emeritus scientist at the Bedford Institute of Oceanography in Dartmouth. Steve has received many awards throughout his career, including the Order of Canada in 2001.

Dr. Paul Hoffman is now a Sturgis Hooper Professor of Geology, Emeritus, at Harvard University and Adjunct Professor at the University of Victoria. His great contribution while at the GSC was his application of plate tectonic principles to understanding early Earth history. This area of study was of significant interest to the GSC, charged with mapping the large portion of Canada underlain by the Canadian Shield. In 1988, after two decades of collaborative work, Dr. Hoffman published a masterful synthesis on tectonic history of Laurentia, the core of the North American continent.

The Honourable Lois Mitchell, Lieutenant Governor of Alberta, Denis St-Onge, and Gavin Fitch, Vice-President, RCGS.

The Honourable Lois Mitchell, Lieutenant Governor of Alberta, Marc St-Onge, and Gavin Fitch, Vice-President, RCGS.

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The Honourable Lois Mitchell, Lieutenant Governor of Alberta, Paul Hoffman, and Gavin Fitch, Vice-President, RCGS.

Celebrating 175 years of excellence

"We have found many ways to stay relevant for the Government of Canada, for industry and within the science community by having formidable scientists who have made extraordinary contributions to the advancement of science and the knowledge of Canada's natural resources. Our work resonates with Canadians," says Daniel.

"The RCGS awards are an excellent way to kick off the GSC's 175th anniversary celebrations. We may not be as widely known across Canada as we would like to be, but we hope to change that with this medal and our anniversary celebrations," added Louise.

Congratulations to all the individual recipients and to the GSC as a whole!

Brigitte Richard and Allison De Toni
Natural Resources Canada

Editor's Notes

Denis St-Onge received GAC's J. Willis Ambrose Medal in 1991, and a Distinguished Member Award in 2001.

Marc St-Onge was awarded the Howard Street Robinson Medal by the Precambrian Division of the GAC® in 1998.

Paul Hoffman received the Past President's Medal in 1974, the Logan Medal of the GAC® in 1992, and a Distinguished Member Award in 1995.

Each dinner guest was given a Logan keepsake (11.5 cm high)
Image: Jeanne Percival

This article was originally written for The Source*, Natural Resources Canada's staff newsletter. Thanks to Brigitte Richard and Allison De Toni for permission to reprint it in* GEOLOG*. Thanks to Jeanne Percival (EESD Division) for bringing the awards to our attention through the EESD Newsletter.*

Announcements

Hutchison Lecture Tour

Dr. Stephen Piercey, Department of Earth Sciences, Memorial University of Newfoundland, is the 2016-2017 Hutchison lecturer. He will be starting his tour in January 2017 with a sweep through western and northern Ontario. Please check departmental websites for the details of the dates and times of his talks. Dr. Piercey will be offering a choice of three lectures during his tour. These include: "A semi-permeable interface model for the genesis of subseafloor replacement-type volcanogenic massive sulfide (VMS) deposits" and "Zn-rich Volcanogenic Massive Sulphide (VMS) Deposits". The following lecture is new this year:

Evaluating the interplay of magmatism, tectonics, and basin redox in the genesis of the Wolverine volcanogenic massive sulfide (VMS) deposit, Yukon, Canada

The Wolverine volcanogenic massive sulfide (VMS) deposit, Yukon, is a unique natural laboratory to study the interrelationships of magma evolution, tectonics, and basin redox in the genesis of VMS deposits in volcanic- and sediment-rich extensional basins. Pre-VMS (~352 Ma) quartz-feldspar porphyries (QFP) have continental crust-like Nb/Ta ~12, εNd_t = -7.1 to -11.5 (average = -10.6), and εHf_t = -12.2 to -20.8 (average = -16.5). The syn-VMS (~347 Ma) feldspar porphyries have higher high field strength element (HFSE) and rare earth element (REE) concentration, and higher Nb/Ta (~17), εNd_t = -7.8 to -8.1 (average = -8.0), and εHf_t = -13.6 to -18.0 (average = -14.8). Both suites have and Proterozoic (to Archean) depleted mantle model ages (1.59-2.58 Ga). In situ U-Pb on zircons illustrate that while some ages are close to previously reported concordant TIMS ages, most samples have evidence of inheritance with ages ranging from 348-381.7 Ma for the QFP suite and 368.9-370.5 Ma for the FP suite. In situ εHf_t values for the zircons range from -11.5 to -21.0 (average -15.3) and -11.6 to -26.0 (average = -18.7) for the QFP and FP, respectively. The chemical and isotopic shifts from the QFP to younger FP suite reflects the varying contributions from evolved continental crust versus juvenile basaltic melts, and can be accommodated within an evolving continental back-arc basin in which there was a progressive increase in mantle input as a result of upwelling of juvenile basaltic material beneath the back-arc basin as it opened. Notably, the upwelling of mafic magmatism and greater mantle components in the syn-VMS FP suite also coincided with higher temperature felsic magmatism and VMS deposit genesis.

Shales intimately associated with the deposit, and with the porphyritic rhyolites, have redox sensitive trace element signatures (e.g., Mo-U, C_{org}-Ni systematics; Ni-V-Cr-Mn systematics) that indicate deposition under anoxic to sub-oxic conditions that were periodically euxinic with free H_2S in the water column and the unconsolidated sediment pile. In contrast, shales proximal to the mineralized horizon have rare earth element and Y (REY) systematics (Ce/Ce*<<1 and Y/Ho>27) similar to oxygenated seawater. The Ce/Ce* values have a negative correlation with P_2O_5 and suggest a particulate shuttle control by detrital apatite that precipitated in the upper, oxygenated water column where it inherited an oxygenated seawater REE signature, which was then transported to the deeper water and deposited as detrital grains. The Ce/Ce* and Y/Ho values also correlate with CO_2 and carbonate content of the shales. Moreover, the shales with the strongest oxygenated REY signatures and CO_2-enrichment coincide with the strongest euxinic signatures. This paradox can be reconciled by enhanced deposition of apatite coincident with deposit formation, coupled with a late hydrothermal overprint on the shales from low temperature, CO_2-rich (oxygenated?) hydrothermal fluids (i.e., high Y/Ho and Ce/Ce*<<1) in a vent-proximal environment.

The presence of high temperature magmatism, extensional geodynamics, and a H_2S-rich near-vent environment were critical for generating the Wolverine hydrothermal system and the resultant deposition of mineralization. Identification of similar tectonic environments with similar geological and geochemical features is critical for finding new resources along evolving continental margins.

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Green Point, Gros Morne National Park, Newfoundland: Cambrian-Ordovician Global Stratotype
(photo by Andy Kerr, Memorial University - Scientific Editor, Geoscience Canada)

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Geoscience Canada has been the flagship journal of the Geological Association of Canada for more than 40 years, and has evolved over that time in many ways. We are now an independent, untethered Earth Sciences Journal, seeking to publish high-quality research on diverse multidisciplinary topics. Our papers have lasting value on many levels - not only to fellow researchers, but to students and teachers, and also to Society at large. We aim to become well-known and well-read around the globe, and there is no reason we cannot attain such international stature. That is, as long as we have help from Canada's Geoscience Community, which means ***you***.

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Extending our knowledge of forearc magmatism

When the Great Lakes were not quite so great – the impact of climate change

Littoral links between land and sea using LIDAR

Elkanah Billings – the lawyer who extracted testimony from the past

Review: Critical data sources for critical minerals

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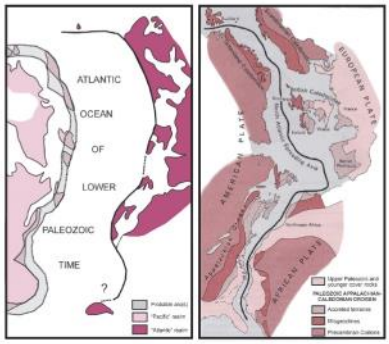

Do simmering hot spots influence entire orogenic zones?

Himalayan basalts – is there a LIP in the air?

The growing state of Winesconsin

The Wilson Cycle turns 50 – thoughts from the delivery room

Review: Gold modelling – questioning the vein gangue

GAC–MAC 2017: Back to where it began – Field trip previews

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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, Chairman, Robinson Fund, c/o Geological Survey of Canada, 490 rue de la Couronne, Québec (Québec) G1K 9A9, Tel: 418-654-3101, E-mail: pmercier@nrcan.gc.ca

The Last Word

Last October I took part in a "Rock and Fossil Walk" through downtown Edmonton, showing people some of the interesting and usually overlooked fossils in stonework on buildings. We pointed out large corals in Tyndall Stone and tiny marine invertebrates in Indiana limestone. It was a great reminder that geology is all around us, if we know how to look. It isn't necessary to travel to remote areas or outside the city. Most of us spend most of our lives in cities. Perhaps highlighting urban geology would help to promote a greater appreciation for our science. If you have an urban geology story to tell, please consider sharing it through the pages of *GEOLOG*. 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

Les contributions d'auteur doivent être soumises par courriel à Alwynne.Beaudoin@gov.ab.ca, en indiquant GEOLOG à la rubrique Objet. Les articles seront acceptés dans l'une des deux langues officielles du Canada. Les fichiers de format MS Word (.doc ou .docx) sont préférables, mais les formats génériques (.rtf ou .txt) sont aussi acceptables. Veillez ne pas soumettre de fichiers au format PDF. Par article, jusqu'à quatre images haute résolution peuvent être soumises; format préféré est .jpg, couleurs RVB, avec un minimum de 300 PPP en taille 5 po x 3 po. Veillez vous assurez que les images sont recadrées et leurs couleurs corrigées, qu'elles sont accompagnées d'une légende ainsi que des informations de référence le cas échéant. Il est de la responsabilité des auteurs d'obtenir la permission de publier toute image de tiers ou de personne reconnaissable. Des diagrammes (graphiques vectoriels) peuvent également être soumis. Le format préféré pour les diagrammes est celui d'Adobe Illustrator (.ai); assurez-vous que le fichier est sauvegardé avec l'option « Sauvegarder le texte comme ligne » activée pour éviter toute substitution de police de caractère. On peut obtenir des informations sur d'autres formats de fichiers en communicant avec l'éditrice. S'il vous plaît ne pas incorporer d'images ou de graphiques dans votre texte; ces images ou graphiques doivent être soumis sous forme de fichiers distincts. Dans votre texte, veillez utiliser des notes numérotées entre parenthèses pour indiquer l'emplacement approximatif de chaque image et graphique. Dans le cas de fichiers dépassant 10 Mo, veuillez contacter l'éditrice pour convenir des modalités de téléchargement. Vos articles seront révisés afin d'en assurer la cohérence orthographique et corriger les fautes de frappe ou erreurs évidentes. Les articles pourront aussi être corrigés pour plus de clarté et éviter des longueurs. Dans les cas où l'éditrice aurait besoin d'informations particulières concernant le texte, elle communiquera avec les auteurs. Les dates limites pour soumettre des articles sont le 1 mars, le 1 juin, le 1 septembre et le 1 décembre.