ASH FALL

Newsletter of the Volcanology and Igneous Petrology Division
Geological Association of Canada

No. 79 January 2, 2017

From the New Chair,

If you are reading this issue of Ashfall, you probably know that the Volcanology and Igneous Petrology (VIP) Division of the Geological Association of Canada is a professional organisation for volcanologists, igneous petrologists, and geologists who work on ancient volcanic and plutonic igneous rocks. Members receive regular newsletters with updates on activities and advances in volcanology and igneous petrology. The association has a membership of about 200 people.

The VIP Division saw changes to the executive in June. Pete Hollings stepped down as Chair and becomes the Past-Chair. John Greenough became Chair. David Lentz stepped up to become the new Vice-Chair. Jamie Braid stays on as Treasurer and Donnelly Archibald continues as Secretary and the editor of Ashfall. Updated contact information is available at http://www.vip-gac.ca/Exec.html. We express our appreciation to Pete Hollings for his work as chair of the VIP Division.

Spearheaded by Pete Hollings, the VIP supported two local field trips this year; the Ottawa-Carleton Universities Student SEG chapter trip to Nova Scotia in August 2015 and the Lakehead University SEG student chapter trip to Iceland. Reports of both trips can be found in Ashfall #78.

Our prestigious VIP Career Achievement Award was received by Joseph Whalen. We express congratulations to students who received the 2016 Gelinas medals. Gold (Ph.D.) went to Jason Coumans (McGill; supervised by John Stix); Silver (M.Sc.) to Michael D'Angelo (Lakehead; Pete Hollings supervisor), and the Bronze medal (B.Sc. Hon. Thesis) was awarded to Samuel Metteer (Lakehead; supervised by Dr. Shannon Zurevinski). Citations for these awards can be found in this issue of Ashfall.

We are thinking about initiatives and activities for continued engagement of the VIP community. One is the Igneous Petrology Series being spearheaded by Jarda Dostal with papers

appearing in Geoscience Canada. Somewhere around 6 papers were published this year and we are hoping to wrap up the series within a year and a half, and approach GAC for publication of a reprint book containing the papers. We are also shaking the bushes for fieldtrip ideas and anticipate trips associated with upcoming GAC-MAC conferences. A more ambitious suggestion is organization of a trip to perhaps Hawaii, Greece or Italy. If you have some ideas, we would love to hear from you. Keep reading Ashfall for news about these and other VIP Division activities.

John Greenough - Chair, VIP Division

About the New Chair,

John Greenough received his Ph.D. from Memorial University. His thesis used geochemistry to examine the tectonic origin of Cambrian volcanic/basaltic rocks in Eastern N. America, Europe, and N. Africa. Since then he has published ~100 reviewed papers that span the fields of agrifoods (wine and maple syrup geochemistry), geoarchaeology, metamorphism, and, of course, igneous petrology. He was a Canadian Journal of Earth Sciences Associate Editor from 2000-2008, and became "Editor-In-Chief" from 2008-2013 and he is an Associate Editor with Geoscience Canada since 2005.

About the New Student Councillor

I am currently a PhD student at the University of Ottawa and visiting researcher at GEOMAR Helmholtz Center for Ocean Research in Kiel, Germany. My research focus is on the relationships between tectonics, volcanism, and hydrothermalism in modern back-arcs of the western Pacific. This work includes: field studies of active vent sites and submarine volcanoes, seafloor geological mapping and structural lineament analyses, and studies of ore mineralizing processes, hydrothermal alteration, and stable isotope systematics. I have been fortunate to participate in three sea-going research expeditions during my studies. In addition to modern volcanic settings, I have a background in igneous petrology related to magmatic ore deposits, and have spent numerous summers working in northern Canada.

Melissa Anderson - Student Councillor

Field Trip Reports

Department of Earth Sciences, University of New Brunswick, SEG Student Chapter: Nova Scotia Field Trip Report

(June 17th – 19th, 2016)

The Society of Economic Geology student chapter at the University of New Brunswick conducted a three-day field trip to Nova Scotia, Canada in June 2016. The rationale of choosing Nova Scotia is the fact that its geology records a history of over a billion years that includes the formation of the Appalachian Mountains and the opening of the Atlantic Ocean. As a result, it hosts numerous intrusion-related and vein style mineral deposits. The main goal of this field trip was to visit some of these deposits along with other areas of metamorphic, igneous, structural and sedimentary geology interests. Below is a brief summary of the sites only associated with igneous settings we visited on this trip.

1. LCT Pegmatite Deposit (Brazil Lake Area)

The Brazil Lake pegmatite deposit carries the major economic geology part of our field trip to Nova Scotia. These rare-element pegmatites are important resources for economic concentrations of rare elements (e.g. Sn, Li, Ta, Rb, Cs, etc.), presence of high-quality industrial minerals (e.g. muscovite, spodumene, feldspar, Fig 1a), and occurrence of gem minerals (e.g. tourmaline, beryl Fig. 1b) and they are often related petrogenetically to fertile, progenitor granites. This is an active exploration site that with plans for another drilling phase of about 1660 meters on the property (personal communication with John Wightman, the exploration geologist during site visit). Metallurgical work conducted on a 272 kg sample of spodumene-rich (34.4% modally) pegmatite indicated 0.18-0.3 wt. % Fe_2O_3 in the spodumene. Shell Canada Ltd. evaluated the site with mapping, geophysics and geochemical sampling, and found variable, but elevated levels of Li (<275 ppm), Rb (<190 ppm), Cs (<100 ppm), Sn (<177 ppm) and Ta (<95 ppm). A more extensive program of drilling and stripping in 2002 by Champlain Resources Inc. exposed a large area of previously unknown pegmatite. Work to date indicates that this pegmatite has the potential to produce high-quality feldspar, quartz, mica and spodumene with appreciable grades of tantalum.

2. White Rock Mine (quartz and kaolin deposits)

Black Bull Resources Inc. owns this mine. The company reports that it has defined a high-quality quartz (silica) deposit with total measured plus indicated quartz resources of 12.2 million tonnes, grading 97.4% SiO_2, with an additional inferred quartz resource of 7.3 million tonnes. This is one of the largest white quartz deposits in eastern North America (Fig. 2). Black Bull has also reported that the quartz ore can be upgraded to 99.5% SiO_2 with flotation processing, which could allow for additional value-added applications of the material. Unlike many quartz deposits, which consist of quartz-rich sedimentary sand (silica sand), the White Rock Mine is a primary hydrothermal bedrock deposit. The deposit lies within the Tobeatic Fault Zone along the southern margin of the

South Mountain Batholith, a large granite body. The ore zone consists of a massive quartz breccia core, generally 50-100 m wide, flanked by quartz-kaolin-mica breccia zones ranging in width from 10 to 60 m. This massive, high-purity quartz core will allow Black Bull Resources to provide its customers with a wide range of particle sizes, from very fine grains up to approximately 15 cm in diameter. To date the deposit has been traced along strike for 2 km and is open to the southwest, with excellent potential for additional resources.

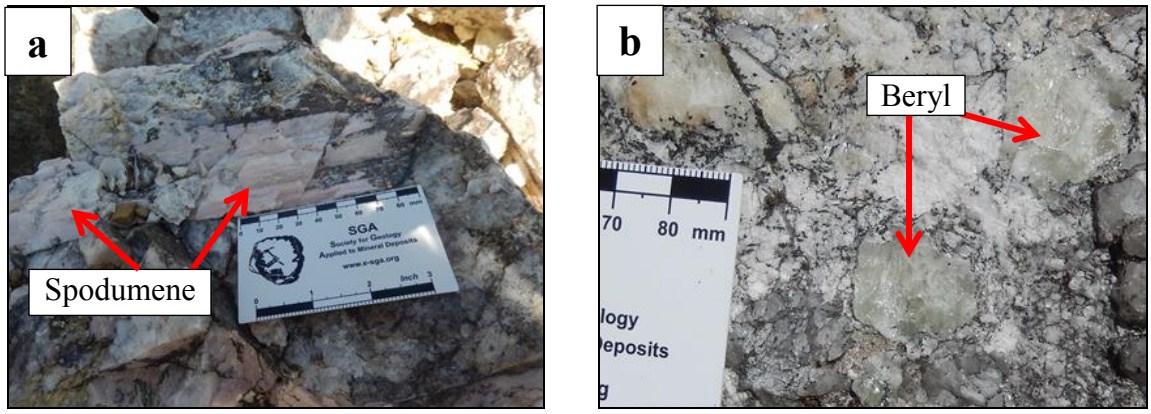


Figure 1: *Spodumene-rich boulder (**a**) from Kspar-muscovite-quartz-spodumene dyke, (**b**) beryl crystals cropping out of the quartz-Kspar- pegmatite dyke at the Brazil Lake area, and (**c**) Dr. Geoff from Nova Scotia Department of Natural Resources explaining the regional geology to the SEG student's members of the group.*

Figure 2: *A group photo standing on one of the white rock (kaolinite and quartz) pile (**a**); and a close-up photo of the quartz crystals with interstitial kaolinite (**b**).*

Peggy's Cove Area

The last stop of our field trip visited the Peggy's Cove area of southern Nova Scotia which contains abundant, flat-lying, zoned, tourmaline-bearing aplite–pegmatite sheets cutting leucomonzogranite of the peraluminous, 372 Ma South Mountain Batholith (Fig. 3a). This holocrystalline, coarse-grained granite is dominated by potassium feldspar typically appearing as large, rectangular crystals in a fine-grained matrix, plagioclase, quartz, and biotite (up to 10%) with rapakivi texture in some places (Fig. 3b). Cutting across some outcrops are narrow tourmaline-bearing aplite–pegmatite sheets (Fig. 1a). They contain minerals similar to those in the granite. Aplite has a fine-grained, sugary texture and lacks biotite (Fig 3f); while in pegmatite, the crystals are unusually large (Fig 3e). Tourmaline occurs within the aplite–pegmatite sheets as coarse rosettes of euhedral crystals within aplite (Fig. 3f), and segregations or pods of tourmaline within zoned pegmatite (Fig. 3e); these pods, with maximum dimensions of 10–30 cm, contain the largest concentration of tourmaline. In some locations, there are fragments of dark grey rock surrounded by granite. These are bits of the rock into which the granite intruded i.e., Meguma's metamorphosed sedimentary rocks (Fig. 3c; Barr and Hild, 2015).

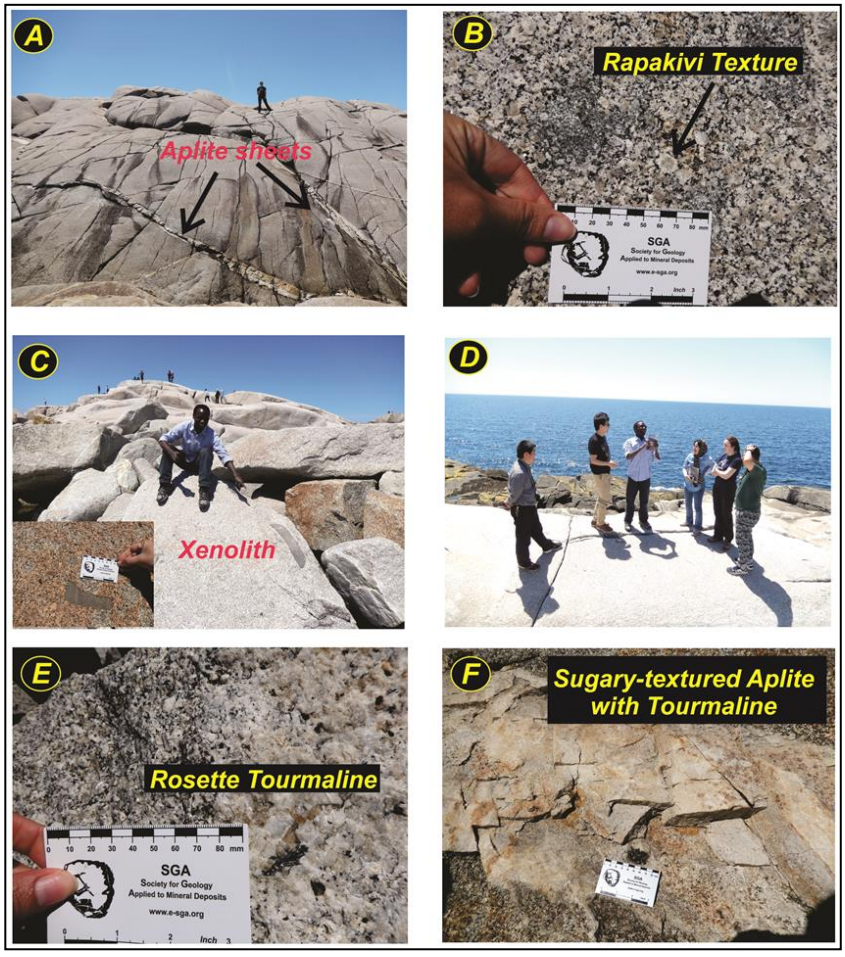


Figure 3: *Field photo of Peggy's Cove Granite in Nova Scotia:* ***(a)*** *Extensive outcrop of Peggy's Cove granite with aplitic sheets.* ***(b)*** *Rapakivi texture in coarse- grained Peggy's Cove granite.* ***(c)*** *Dark grey xenoliths in different sizes in the granite (Meguma's metamorphosed sedimentary rocks).* ***(d)*** *Ronald explaining the difference between xenolith and an enclave for the group.* ***(e)*** *Rosette tourmaline in very coarse-grained pegmatite.* ***(f)*** *Rosset tourmaline in fine-grained, sugary textured aplite.*

Contribution from Nadieh Mohammadi (University of New Brunswick)

Adventures at Sea: Exploring the Mariana Back-Arc

By: Melissa O. Anderson,
University of Ottawa & GEOMAR Helmholtz Centre for Ocean Research Kiel

Focusing on the Back-Arc

The Mariana region is famous for its trench, home to the deepest location on Earth (the Challenger Deep), visited by filmmaker James Cameron in 2012. Perhaps overshadowed in the media, the shallow volcanic arc contains 20 hydrothermally active seamounts, where over 20 new species were discovered. In contrast, the back-arc remained almost entirely unexplored for volcanic or hydrothermal activity, with only a few serendipitous discoveries of hydrothermal venting at ~13°N and 18°N (Fig. 1). In November, a team of scientists from the University of Washington, Oregon State University, and NOAA/PMEL, launched an expedition on the R/V *Falkor* (Fig. 2) to systematically survey over 600 km of the back-arc to find new vent sites, and to better understand the physical, chemical, and geological forces that shape biodiversity in this region. I was selected to join the cruise through the Schmidt Ocean Institute's "Student Opportunities Program," aimed at sending students to sea to gain research experience: https://schmidtocean.org/apply/student-opportunities/. This is my account of the 27-day expedition, in which I hope to convey the reality of doing research at sea, and highlight some of our fantastic discoveries.

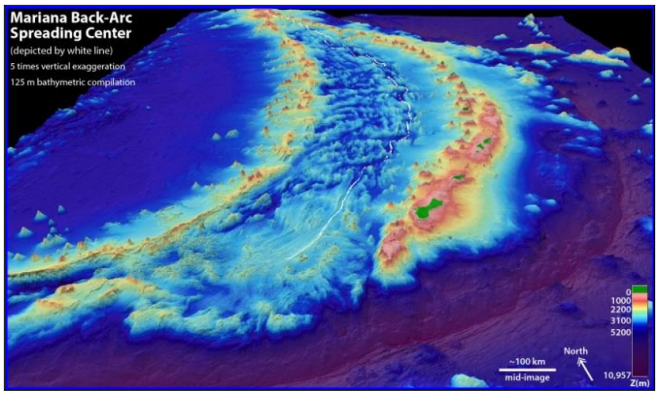


Figure 1: *Bathymetry of the Mariana arc- back-arc region. Image credit: Susan Merle (NOAA).*

Data presented here are from the "Hydrothermal Hunt in the Marianas" FK151121 cruise (doi: 10.7284/906519), and represents the combined efforts of the shipboard scientific party.

Figure 2: *The Schmidt Ocean Institute's R/V Falkor.*

T-minus 1 Day until Departure

Figure 3: *Eruption of the West Mata volcano, discovered by scientists at NOAA's Pacific Marine Environmental Laboratory (May 2009). Photo credit: NOAA and NSF.*

I received an urgent email with bad news: a typhoon would be making landfall in Guam in two days, so our research cruise to the Mariana back-arc departed a day early. Already the heavy rain started, pounding on my hotel room window as I lie there, jetlagged, wondering if my luggage will make it in time after somehow ending up in Japan. If not, the next four weeks would be an adventure in laundry. This was my second seagoing research expedition, and I was filled with a nervous excitement: Will I get seasick? What will my role on board be? What will the team be like? The legendary NOAA researchers (including Joe Resing, Bill Chadwick, Susan Merle, Ed Baker, Sharon Walker, Dave Butterfield, and Tamara Baumberger) who were responsible for the first remarkable observations of a deep-sea volcanic eruption at a nearby arc volcano just a few years prior (Fig. 3) led the cruise. Luckily (for me), I was about to be isolated on a ship with them for a month, and there will be plenty of opportunities to badger them with questions. With no luggage to pack or prepare, I spent the rest of the evening catching up on emails—although Google founded the Schmidt Ocean Institute's Eric and Wendy Schmidt—expecting problems that unavoidably arise during isolated research. (The internet access turned out to be excellent, allowing us to live-stream to classrooms during the cruise!).

Adaptation

Figure 4: *The CTD (Conductivity-Temperature-Depth) device.*

I made my way up the narrow gangway up the ship, hefting my oversized backpack that had miraculously arrived on the last flight in at 2 am. After a flurry of introductions, a ship tour, and a safety briefing, we were off! The plan was to transit quickly northwards to avoid the worst of the storm. We pull out of the calm harbour into the angry seas, and before long, I was feeling nauseous, despite my precautionary administration of seasickness medication. When the time came for our abandon-ship drill that afternoon, I was relieved to see that I was not the only green-faced person in the crowd. The first few days at sea proved challenging, my body was slow to adapt. Even walking was difficult, banging from one side of the narrow corridor to the other as I tightly gripped the handrails.

Finally, the weather calmed a bit, and it is time to set up and check equipment. Our tools include the ship-based multi-beam echo sounder, used to generate bathymetric maps of the seafloor at a 40-m resolution, the *Sentry* Autonomous Underwater Vehicle (AUV), used to map and photograph the seafloor at a 1-m resolution, as well as Conductivity-Temperature-Depth (CTD; Fig. 4) and Mini-Autonomous Plume Recorder (MAPR) devices to locate hydrothermal plumes by measuring chemical and physical changes in the water column. After several days of testing and troubleshooting, we were finally prepared to do some science!

Plume Hunting

Up and down, up and down; the CTD was towed behind the ship, moving through the water column in a yo-yo pattern, sniffing for plumes (known as a 'tow-yo'). In the control room, my job was watching wavy lines on the screens for indications of a change in redox, temperature, or turbidity (suspended particles in the water column), ready to trigger a sampling container. We had a lot of ground to cover, so we did marathon 24-hour tow-yos. We divided our time into 12-hour shifts, and I was on the night watch. After a few quiet days, we were elated when we finally make our first discovery on day 8 at ~14.5°N. And so it continued day after day, with long tedious stretches punctuated by excitement whenever we encounter a plume signal (Fig. 5). In total, four new vent sites were discovered, more than doubling the amount of known sites in the back-arc from three to seven (Fig. 6). This included one of the deepest vent sites ever found at 4230 mbsl (meters below sea level); of the ~700 vents around the world, only three are deeper!

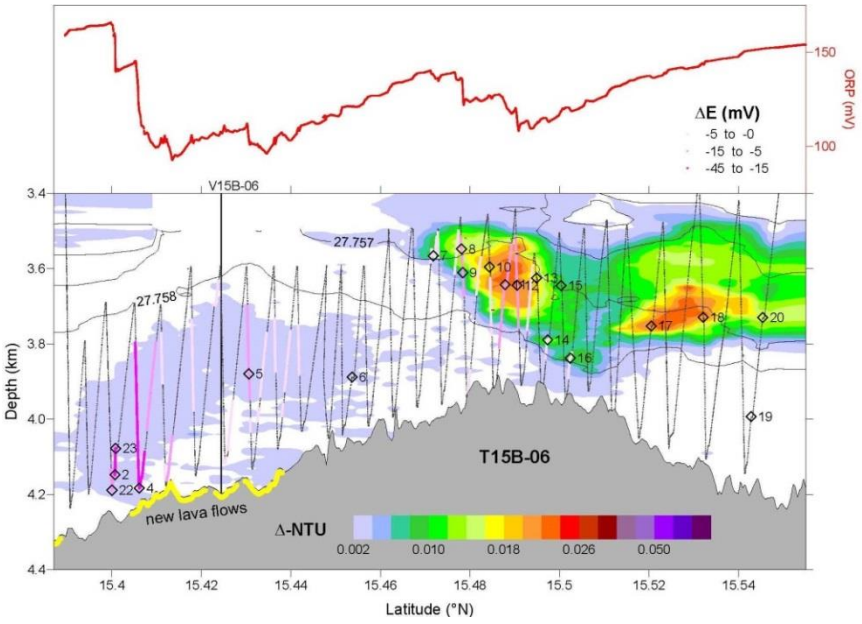


Figure 5: *Hydrothermal plume signature measured by CTD. Color contours map the particle plume (ΔNTU) distribution above the Mariana back-arc segment centered at 15.5°N. Black dots show the tow track line, open diamonds are bottle sample locations. Red line above the color contours is oxidation-reduction-potential (ORP) voltage. Image credit: Sharon Walker (NOAA).*

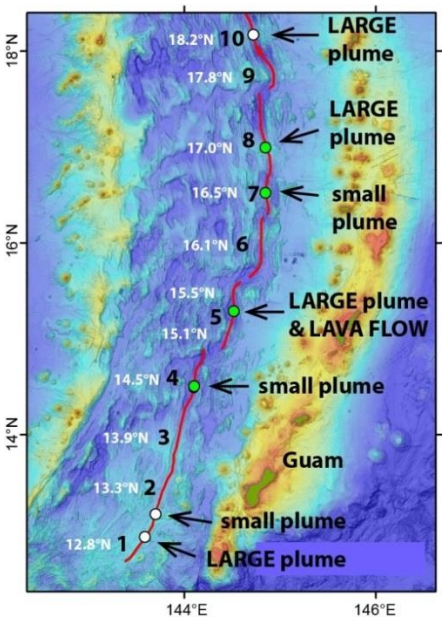


Figure 6: *Hydrothermal vent sites in the Mariana back-arc, with previously-known sites are in white and new discoveries during this cruise in green. Image credit: Susan Merle (NOAA).*

AUV Deployments

The AUV *Sentry* was deployed at each new vent site to collect 1-m resolution bathymetric maps (Figs. 7, 8). These high-resolution maps also helped to guide remotely-operated vehicle (ROV) dives during Leg 2 of the cruise the following year. In addition, *Sentry* performed photo surveys, and was equipped with sensors to detect plumes in the deepest parts of the back-arc where the CTD device cannot go.

Figure 7: *Deploying the AUV Sentry (WHOI).*

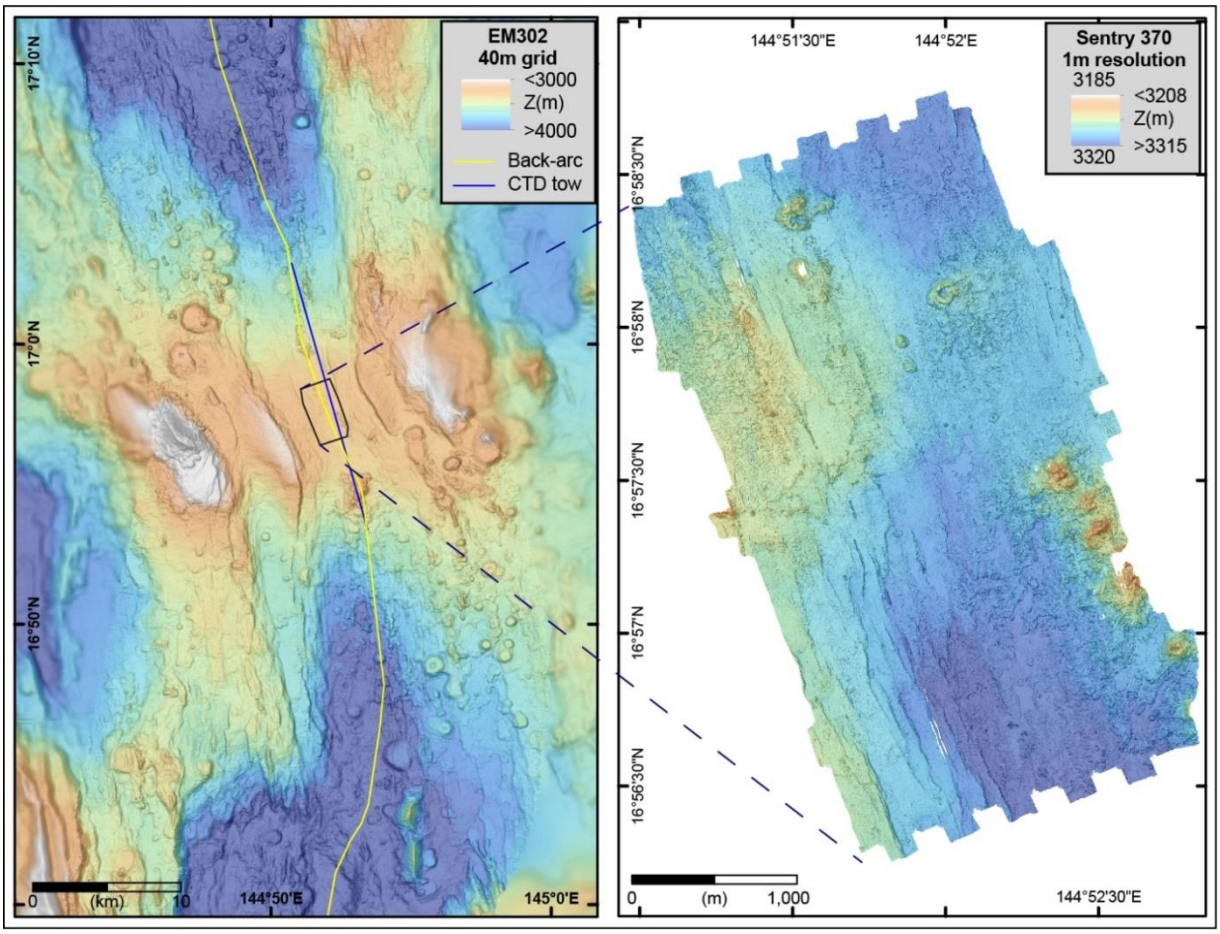


Figure 8: *Ship-based multi-beam bathymetry (left) of a large axial volcano, and high-resolution AUV bathymetry (right) revealing flat-lying sheeted volcanic flows and collapse structures. Image credit: Susan Merle (NOAA).*

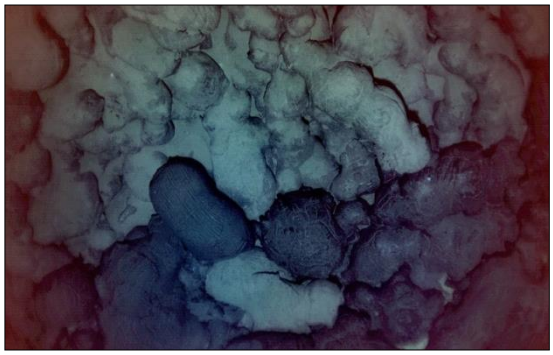


Figure 9: *The contact between an older, sediment pillow flow (above) and young, glassy pillow flow (below). Photograph by AUV Sentry.*

One AUV photo survey revealed an exciting discovery: a very recent (< 3 year old), still-cooling lava flow along a hummocky volcanic ridge (Fig. 9). This was a remarkable observation, as eruptions along slow-spreading ridges are thought to only occur once every hundred years! The thickness of the erupted material was calculated by comparing the bathymetry collected during this cruise to data collected during the R/V *Melville* cruise in 2013, with a maximum thickness of ~127 m.

Return to the Deep

The second leg of the "Hydrothermal Hunt" on R/V *Falkor* (December 2016), returned to the newly-discovered vent sites with ROV *SuBastian* to collect geological, fluid, and biological samples. This work tested the hypothesis that vent sites in the arc and back-arc have distinct ecosystems, controlled by the geology and fluid chemistry at each site. The ROV dives were live-streamed on YouTube by SchmidtOcean. Already, spectacular vigorously-venting black smoker chimneys up to 30-m tall were discovered and sampled (Fig. 10). Cruise updates, including blogs and videos, are available online at: https://schmidtocean.org/cruise/searching-life-mariana-back-arc/.

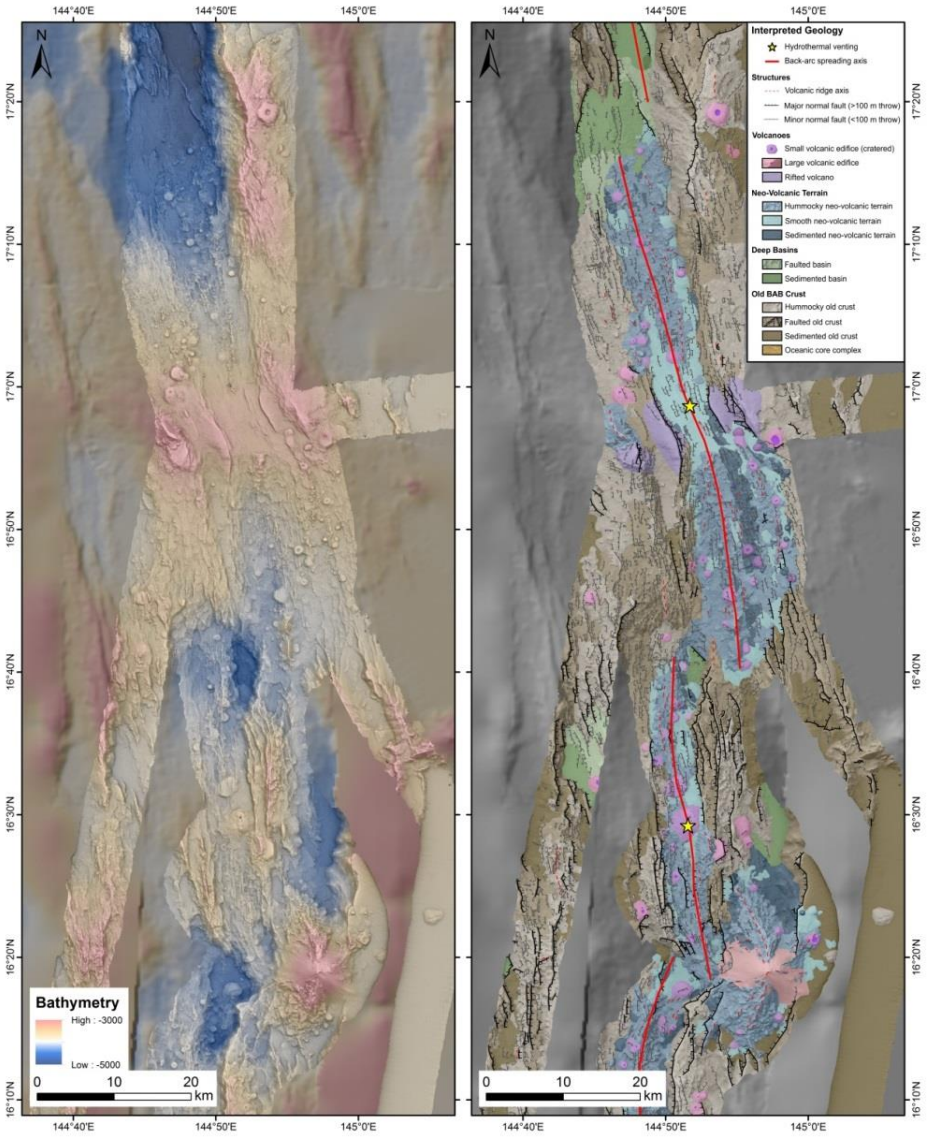
Figure 10: *The top of 16-m tall black smoker hydrothermal chimney, screen-capture from high-definition video by ROV SuBastian (SOI).*

Ongoing Work

While the majority of Earth's volcanism occurs in submarine environments, these settings are under-explored due to their inaccessibility. As a result, many primary volcanic features, including eruption style, frequency, and volume are unknown in most locations. Importantly, the 'big picture' relationships between tectonic processes, magmatism, and hydrothermal venting are poorly understood in back-arc settings.

In order to address some of these questions, geological maps of the seafloor were generated over the southern and central back-arc (Fig. 11), through quantitative assessment of volcanic geomorphology using multi-beam bathymetry, acoustic backscatter (i.e., the intensity of the signal returned to the ship, which is attenuated by increased sedimentation), and limited seafloor observations that provide ground-truthing. Targeted investigations seek to address the following: (1) What are the controls on magma supply (reflected in the segment morphologies)? (2) What is the role of cross-arc

volcanism? (3) What are the controls on ridge segmentation? (4) How do the segment-scale structures relate to the geodynamic setting? and (5) What are the primary tectonic/magmatic controls on hydrothermal venting at the seafloor, and can we predict where other large and inactive vent sites can be found? We hope to publish the results of this study soon—Stay tuned!



Acknowledgements

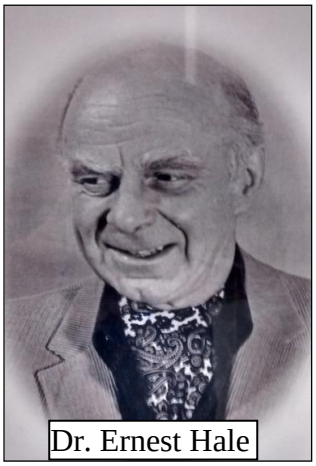
I would like to thank Captain Heiko Votz and the crew of the R/V *Falkor*, as well as the AUV *Sentry* team. The work presented here is the combined efforts of the "Hydrothermal Hunt" shipboard scientific party, led by Joseph Resing and William W. Chadwick Jr. Funding for this project was provided by NOAA Ocean Exploration Research Program (NOAA-OER-2016-003) and the Schmidt Ocean Institute (SOI-FK151121).

Contributed by Melissa Anderson

UNB student Chapter

Iceland Field Trip (May 5-17th, 2016)

Last spring, a group of UNB Geology and Geological Engineering students were fortunate enough to travel to Iceland as another chapter in the biennial Hale memorial field trips. Dr. W. Ernest Hale (1927-1986) was a successful economic geologist who worked all over the world before returning home to teach, where he became Chair of Geology at UNB. He left behind the Hale Fund to help undergraduates go on geologic field trips they would otherwise not experience. Past trips include active eruptions in Italy, geological tours of Scotland & Ireland, the Eifel volcanic field in Germany, the Grand Canyon region and the Basin and Range provinces of the American Southwest.


Dr. Ernest Hale

Upon our arrival in Iceland our first few days consisted of exploring the Reykjanes Peninsula. Our first stop was to the "Bridge Between Continents" where students could literally stand between the European and North American Continental plates, along the mid-Atlantic Ridge. Each year this area becomes slowly larger due to the divergent plate margins. We then travelled to one of Iceland's renewable energy plants, where they harvest their energy geothermally through close proximity to Gunnuhver. After inhaling the foul odor of the sulfurous fumes, we travelled to the actual steam vents themselves to get a closer look. Upon arrival we were immediately able to see the steam and hear the vigorous noises associated with the release of pressure from the ground.

Another day was spent exploring the geology of Reykjavik and surrounding area by first examining marine Pleistocene shelled fossils in the sediments around Reyjkavik's harbour, and then travelling to a small but magnificently exposed volcanic vent nearby. A great variety of smaller scale igneous textures and structures were observed and discussed, such as lava tubes, ropy textures for flow direction, dripping textures and the transition between a'a and pahoehoe flows further from the vent.

Next, we travelled to Þingvellir National Park (located about 50km east of Reykjavik). This is one of Iceland's most popular tourist attractions due to the location's geologically significance, as well as being a preserved historical site. Throughout the day, we explored Þingvellir by walking in the rift valley (graben structure) located in the boundary between the North American and Eurasian tectonic plates. We visited and read about the cultural sites, and learned about the Alþing (national parliament of Iceland) which was established in 930, and held sessions until 1798. Throughout our day, we

visited many of the sites, including an old church which was preserved from the Alþing and faulting sequences which can form during the multiple earthquakes occurring in this region. This region is also accompanied (on the horizon) by a large shield volcano forming about 9000 years ago, which is a consequence of the geological activity produced on the rift.

Other stops throughout Reyjkanes Peninsula included spectacular volcanic outcrops at Grindavik, Kleifarvatn, and Keillir. This outcrop shows basaltic injection through hyaloclastite, with Dr. Shaw for scale. Adam, J.

One day we visited two of Iceland's most popular geological attractions, Gullfoss and Geysir. Gullfoss is a tiered, cataract waterfall located in Southern Iceland, is part of the Hvítá river network. During the early portions of the 20th century, businesses tried to use Gullfoss to generate energy unsuccessfully. Presently the waterfall is owned by Iceland and the government has no plans to generate energy but to rather preserve the natural environment. Later on in the day, at a stop at Geysir we observed the eruptions. Many of the geysers that exist in Iceland are in Haukadalur but are known to exist in several other localities. The largest and most famous at this site is called Strokkur and erupts about every 7 minutes to a height of around 30 meters. Though some of the geysers were inactive, they could be awakened anytime due to shallow tectonic activity.

A perfectly-timed photo of Strokkur shows the expanding steam eruption that occurs regularly. The geyser vents a solution from a hot spot located kilometres below; these brines deposit sulfur-rich, siliceous minerals around the edges of the hydrothermal system. Kynock, R.

We organized the trip to have an independent day in the middle, where students could take in Reykjavik's culture or explore a different area of the Reykjavik of their choosing. Some students spent the day discovering the largest church in Iceland, Hallgrímskirkja, or the various art galleries and museums, while others spent the day hiking an area in eastern Iceland. An incredible waterfall was visited while biking, shown below. Hraunfossar is glacial-fed, with groundwater permeating through the porous rock originating from under the Hallmundarhraun lava field. This lava field formed after an eruption in the year 930 and is 8-9 cubic kilometres in size.

We then travelled to a cabin on the Sandur plains, a glacial outwash plain in the south of Iceland comprised of a sedimentary package formerly underwater, now exposed by eustatic fall and sediment buildup. Our cabin was situated below the old shoreline's paleo-sea cliffs, which were towering walls of basalt and gabbro up to 800 feet tall. During the cross-country drive we stopped to observe numerous waterfalls along the paleo-sea cliffs, as well as the site of the famous 2010 Eyjafjallajökull eruption that disrupted transatlantic air travel for weeks.

Glacial flour suspended in the Hraunfossar water makes it a brilliant turquoise colour. Adam, J.

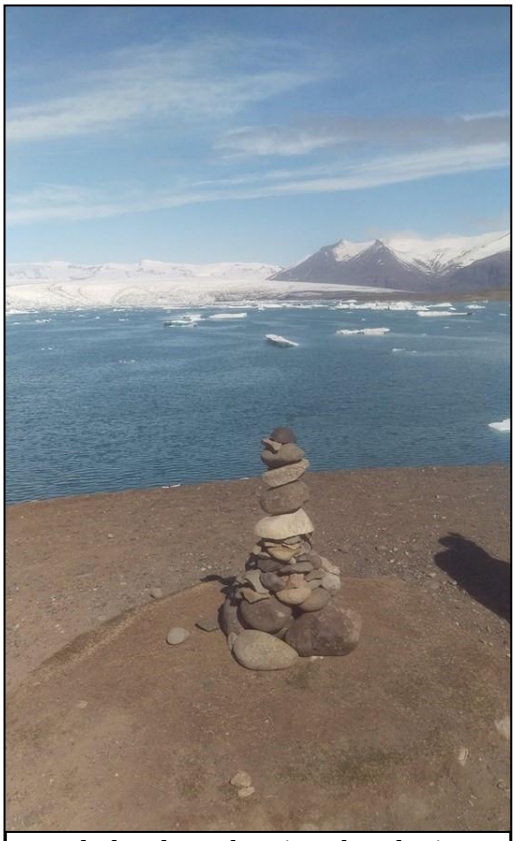
Skogafoss, one of the many waterfalls along the paleo-sea cliffs defining the northern boundary of the Sandur plains. Wilson, B.

The next day, we visited riverside sedimentary outcrops, showing up to 6000 years of sedimentary accumulation, including tephra layers used to date eruptions at sites across Iceland and the world. We also toured part of the Eldja volcanic field, a mafic extrusive fissure famous for its sheer volume of basaltic lava produced. A single eruption in 934 covered 800 square kilometres with 18 cubic kilometres of lava and cooled slowly. The degassing of the basaltic lava left thousands of cinder cones dotting the top of the

volcanic field. We also hiked the rim of an erosive canyon called Fjaðrárgljúfur, where a stream cut through 200 vertical feet of solid basalt and gabbro.

Students had the fortune of visiting a recently erupted volcano, Eldfell (Icelandic for "*Mountain of Fire"*) on the island fishing community of Heimaey in the Westman Islands. Eldell erupted unexpectedly from an island cross-cutting fissure on the eastern coast late in the night of January 23rd, 1973 which eventually concentrated to a single vent. 5,300 residents evacuated quickly within hours of the initial eruption by boat and by plane before tephra covered the islands only airstrip. Heimaey would become known as a triumph in geological engineering by the efficient cease of massive a'a lava flow from destroying the harbour by pumping sea water onto the leading edge. The physical geology of the island drastically changed by the 2.5 square kilometer addition of new land east of the vent and extremely thick cooled lava on the mainland above destroyed houses. The volcano today is shortening due to wind blasted erosion, but still has a visible crater and a narrow walkable path to the highest point of the outside walls. Geothermal heat, which now powers the island, can be felt directly from fumaroles beneath the wall forming rock, which we students found made a good relief from the cold Atlantic winds, with just a small addition of chocolate candies into the fumaroles to cover up the sulfuric odour!

The view from the vent of the most recent volcanic eruption overlooking the town. Parts of the town in the bottom right of the photo were covered by the advancing lava before geoengineers redirected the flow into the harbour. Kynock, R.



Jokulsarlon, showing the glacier terminus and calving. Manley, S.

We visited Jokulsarlon, a river flowing into the north Atlantic where a glacier terminates underwater. We observed the glacier calving, and the constant turbulence caused by the 'calves' overturning as the floated slowly away. The largest pieces of ice will raft glacial sediments from this lagoon throughout the North Atlantic.

We then took a guided hike of the edge of Vatnajokull, in Skaftafell National Park. The entire glacier is an ice cap covering more than 8000 square kilometres of southwestern Iceland. We hiked through the moraine and a few hundred metres into the ablation zone of an outlet glacier leading up a U-shaped valley to the main ice cap.

We revisited Skaftafell National Park the very next day to hike the basaltic hills around Vatnajokull, and look down onto the outlet glacier we had already hiked. Geological highlights of the park include top-to-bottom views of an entire outlet glacier, its outwash moraine and deltaic structures, as well as 'bent' columnar basalt formations which formed near-surface while the angle of heat loss (paleo-up) gradually changed.

Bent columnar basalts in Skaftafell National Park. Manley, S.

Approaching the end of what was an incredible journey, we visited the world-famous Reynisfjara shore, near the village of Vik in Myrdalur on Iceland's South Coast. The impressive black pebble beach featured breathtaking cliffs and inspiring basalt columns known as Gardar. Out in the sea are imposing basalt sea stacks, which according to folklore, two trolls attempted to drag a three-masted ship to land but were turned to stone as daylight broke.

Basalti Sea Stack, Reynisfjara shore, near the village of Vik in Myrdalur on Iceland's South Coast. Richardson, M.

The students of UNB who attended the trip would like to thank those who made this trip possible. Dr. Hale's generosity gave us this unique opportunity, and his donation is in the true spirit of geologic education. Dr. Cliff Shaw of UNB Geology put in countless hours making sure we saw the maximum amount of geology on our trip, and that we completed the trip safely. Many other UNB students, staff and university groups contributed time or money to our trip. Many thanks to everyone involved for an unforgettable experience.

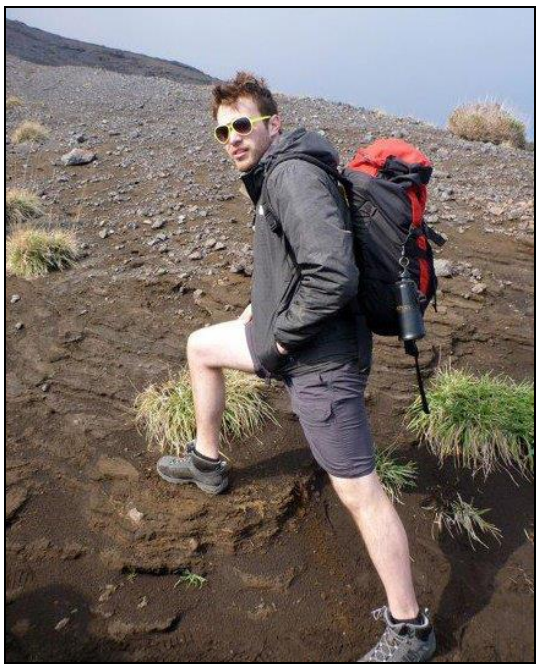
Field trip summary courtesy of UNB Geology and Geological Engineering undergraduates Sander Manley, Jennifer Adam, Regan Worden, Rilea Kynock and Mark Richardson. *sanda.manley@unb.ca*

2016 Awards

GÉLINAS MEDALS

Every year the Volcanology and Igneous Petrology Division of the Geological Association of Canada presents three medals for the most outstanding theses, written by Canadians or submitted to Canadian universities, which comprise material at least 50% related to volcanology and igneous petrology. A gold medal is awarded for the best Ph.D. thesis, a silver medal for the best M.Sc. thesis and an antique copper medal for the best B.Sc. thesis. Nominated theses are evaluated on the basis of originality, validity of concepts, organization and presentation of data, understanding of volcanology and petrology, and depth of research.

Gold Medal – Dr. Jason Coumans



The Volcanology and Igneous Petrology (VIP) Gold Medal for best PhD goes to Jason Coumans. Jason completed his thesis at McGill under the supervision of John Stix on "Magmatic and volcanic processes at near-ridge seamounts". The thesis focused on the Taney Seamounts in the Pacific and has led to a paper accepted in the Journal of Petrology with two other papers under review. The thesis was an impressive combination of igneous petrology and analogue modeling to investigate the origin of the seamounts and the nature of caldera collapse.

Citation by Peter Hollings

Jason's Response

I am extremely grateful and honored to receive the 2016 Léopold Gélinas gold medal. First I would like to thank the Geological Association of Canada, specifically the Volcanology and Igneous Petrology Division (VIP), for selecting me. It means a great deal to me to be named among a number of excellent researchers who are doing amazing things in Volcanology / Igneous Petrology. I was very fortunate to have been supervised by Dr. John Stix and I am eternally thankful for his mentoring, support, advice and thoughtful critiques over the years. I would like to thank Dr. William Minarik, Dr. David Clague, and Dr. Don Baker who have shared their seemingly infinite knowledge of igneous processes with me while putting up with my seemingly endless door knocking. I would like to extend a special thank you to Dr. James Brenan who sparked my interest in Igneous Petrology / Volcanology and pushed me to apply to graduate school. It is the extraordinary efforts of scientists like John, Bill, Dave, Don, James and many members of the GAC-VIP who foster curiosity in young minds, and for that I am thankful. Finally, I would like to thank the McGill Earth and Planetary Sciences department and the Volcanology Research group for accepting me into their community. I have had a wonderful time during my Ph.D. and discussions with many McGill EPS members have taught me a great many things.

Thank you very much for this award,

Jason P Coumans

Silver Medal – Mike D'Angelo

This year's Volcanology and Igneous Petrology (VIP) Silver Medal goes to Mike D'Angelo from Lakehead University supervised by Peter Hollings for his MSc thesis entitled "Geochemistry, petrography and mineral chemistry of the Guichon Creek and Nicola batholiths, south central British Columbia". Michael characterized the Guichon Creek Composite Batholith as part of a larger study of the Highland Valley Copper porphyry system. Using petrography, whole-rock geochemistry, mineral chemistry, and radiogenic isotopes, he developed a petrogenetic model for its emplacement history. Emplacement occurred in at least two pulses, with an early magmatic pulse crystallizing to form the gabbro, diorites and granodiorite. The primary magmas fractionated at depth and experienced little crustal contamination. The petrogenetic model was then correlated with nearby porphyry deposits and it was determined they came from the same source. This was a well-written thesis involving a lot of analytical techniques and data that is deserving of the Gélinas Silver Medal.

Citation by Donnelly Archibald

Mike's Response

I would like to thank the Volcanology and Igneous Petrology Division of the Geological Association of Canada for awarding me the Silver Leopold Gelinas Medal. I am honoured to receive this award in recognition of my Masters research.

I would also like to thank everyone who provided me with support over the course of my graduate studies, including all members and sponsors of the CMIC-NSERC Alteration "Footprints" project. Special thanks goes out to the Teck Resources Limited staff at the Highland Valley site, particularly Miguel Alfaro, Suzanne Byron, and Semyon Martynenko for allowing me access to my field site and aiding in sample collection. I would also like to acknowledge financial support from the Society of Economic Geologists Foundation (SEGF) Graduate Student Fellowship supported by Anglo American.

Finally, I would like to extend my greatest thanks to my thesis supervisors Dr. Steve Piercey and Dr. Peter Hollings. I am especially grateful to Pete for all of his guidance, encouragement and patience over the course of the three and a half years he has supervised my undergraduate as well as my graduate studies. Most of all, I would like to thank him for all of the opportunities he has opened up for me to become a better geologist and scientist by providing me with the opportunity to travel across North America to meet new people and see spectacular geology as well as always pushing me to present my research.

Mike D'Angelo

Bronze Medal – Samuel Metteer

This year's Volcanology and Igneous Petrology (VIP) Bronze Medal goes to Samuel Metteer from Lakehead University for his B.Sc. honours thesis titled "Mineralogy and Petrology of the Rabbit Foot Dyke, White River ON" supervised by Dr. Shannon Zurevinski. The thesis is based on detailed petrographic descriptions of rocks that are inherently challenging to describe, and observations are supplemented by ~100 quality mineral analyses. The student distinguishes himself by systematically comparing the petrography and mineralogy of this new diamond prospect with the complicated, state-of-the-art classification schemes for volatile-rich alkaline rocks. He concludes that the Rabbit Foot rocks are diatreme-facies kimberlites with melnoitic affinities. By reviewing the characteristics of related rocks of the Superior Province, he points out atypical aspects of all these Type 1 kimberlites and is able to augment the criteria for identifying diamond prospects in Ontario

and Quebec. In addition to excellent science, the thesis is well-written and organized. The Volcanology and Igneous Petrology Division of GAC acknowledges this commendable work and congratulates Mr. Metteer on winning the VIP Bronze Medal for 2016.

Citation by John Greenough

Samuel's Response

It is an honour to be awarded this 2016 Leopold Gélinas Bronze medal of the Volcanology and Igneous Petrology Division of the Geological Association of Canada. Thank you to the GAC for selecting my thesis. I am glad that somebody enjoyed reading my work; I certainly enjoyed the research, the writing, and the process. Tremendous thanks to my thesis advisor Dr. Shannon Zurevinski for her tireless and enduring mentoring and support. Thanks to Dr. Roger Mitchell who has seen more of these unusual volatile-rich alkaline rocks than anybody has, and whose passion for the science do few rival. Our discussion on the contentious nature of these rock types was greatly beneficial to the project. Thanks to Curtis Brett of Rio Tinto Canada Diamonds Exploration Inc. for making this project possible, and for the fine introduction to the field area. I would also like to thank the small but strong faculty of the department of Geology at Lakehead University. It is amazing what the six of you pull off each year, and I am proud to be a Lakehead U. Geology grad.

Thanks again to the GAC. It is an honour to be recognized by the VIP Division.

Sam Metteer

CAREER ACHEIVEMENT AWARD – JOE WHALEN

The Volcanology and Igneous Petrology Division of the Geological Association of Canada in recognition of career achievements in the field of volcanology and/or igneous petrology present the Career Achievement Award. Candidates are judged on their lifetime scientific contribution.

Nomination Letter
(By *Robert S. Hildebrand)*

I am pleased to nominate Joseph B. Whalen for the Career Achievement Award of the Volcanology and Igneous Petrology section.

I have known Joe since the early 1980's when we were both research scientists at the Geological Survey, working on somewhat similar rocks. Over his career, he published 47 papers in referred journals, 56 government

reports, and was lead or co-author on 27 geological maps. Joe started his career studying the Ackley City batholith of southern Newfoundland as part of his Master's thesis under Dave Strong at Memorial University. In that study he combined field mapping and geochemistry to elucidate processes active in the development of a cupola or top of a major mineralized batholith and was an early advocate of thermogravitational diffusion as a fractionation process. He then undertook his doctoral studies with Bruce Chappell at ANU, where he worked on the geochemistry of arc rocks in Papua, New Guinea and honed his geochemical chops in Chappell's lab. Joe returned to Canada and joined the GSC, first as a postdoc, then as a research scientist, a position he retained until his retirement.

Over his ~30 years at the GSC Joe was incredibly productive and worked in granitic terranes over the breadth of Canada: Appalachians, Cordillera, and Shield. His early work involved detailed mapping, petrological, and geochemical studies in the Appalachian orogen of Newfoundland, Quebec and New Brunswick. His papers on A-type granites and the Topsails intrusive suite are modern classics, while his overview paper on A-type granites, in which he developed a popular discrimination scheme, has now been cited nearly 2500 times. His work in the Canadian Shield led to several detailed papers on the origin of intrusive rocks and their possible tectonic setting. These include Archean and Paleoproterozoic magmatic rocks of the Flin Flon Belt, the Wabigoon subprovince, the Piling Group, the Kisseynew Domain of Manitoba, and the voluminous Cumberland batholith of the Trans-Hudson orogen. At Sturgeon Lake, Whalen showed that the Sturgeon plutonic suite was emplaced contemporaneously with caldera collapse and massive sulfide deposits and Cu-Mo porphyry-type mineralization. Joe's study of the huge Cumberland batholith of Baffin Island included a 900 km isotopic transect melded with U-Pb zircon ages and geochemistry to suggest that the batholith is dominated by magmas ultimately derived from delamination of the lower plate during collision – a novel, but likely correct, interpretation for rocks of the Canadian Shield. His Cordilleran work was mainly on the Triassic to Eocene Endako batholith and its associated Jurassic Mo deposits. There he linked several mineralizing events with repeated plutonic emplacement.

Joe's more recent collaborations with Cees van Staal and others in Newfoundland led to landmark papers on the Appalachians and proved how talented a petrographer Joe really is as he picked apart the strongly deformed Taconic Notre Dame arc and younger, less deformed, slab failure rocks, and the Silurian plutonic suites in Newfoundland, which again showed a rapid transition from arc to slab failure, or break-off, magmas. Even more recently, Whalen studied granitic clasts in the volcanogenic massive sulfide deposit at Buchans Newfoundland to help constrain the origin of the transported ore.

His masterful understanding of granitic suites allowed him to develop several magmatic trends on the Q-ANOR plot, which allows direct

comparison of granitic geochemistry with modal analyses.

My recent collaborations with Joe on the Cordillera of North and South America started because we both had realized the importance of slab failure magmatism and so decided to merge our expertise. The collaboration has been extremely fruitful and with Joe's insightful ideas about geochemistry changed the way future petrologists will look at Cordilleran-type batholiths.

Throughout his career, Joe used mapping, petrography, geochemistry, geochronology, and an arsenal of isotopic tracers, such as Nd, Pb, Sr and O, to arrive at thoughtfully deduced and innovative conclusions. Tectonocists and geochronologists alike have found Joe, with his unassuming, low-key character, to be a superb collaborator. He is thoughtful, precise and knowledgeable.

He is superbly organized and so all his geochemical and isotopic databases are available on the Internet for others to utilize.

Today, Joseph B. Whalen is the pre-eminent granite petrologist in Canada and with over 30 years of top-quality petrographic studies under his belt is more than deserving of the Career Achievement Award.

Robert S. Hildebrand,

Department of Earth & Planetary Sciences, University of California, Davis

Joe's Response

I was overwhelmed and humbled when informed that I was to receive the Career Achievement Award of the Volcanology and Igneous Petrology Division. First, I want to say that I am sorry for not being able to be here in person to convey my appreciation for this award. Second, I would like to thank my nominators: Robert Hildebrand, George Jenner, Cees van Staal and Brendan Murphy. Third, I owe much to the Geological Survey of Canada, my employer of 32 years, for support that enabled me to pursue my research interests in igneous petrology and geochemistry. When you receive recognition in the twilight of your career one cannot help but reflect on accomplishments and challenges.

My research interest in granitoid rocks was initiated by Dave Strong at Memorial University and greatly expanded by Bruce Chappell and John McDonald at Australian National University. My subsequent achievements, which are based on field projects in nine provinces and territories, owe a great deal to many fine research collaborators at the GSC, several universities, and provincial surveys. Of particular note is Ken Currie who, on my arrival at the GSC in 1981, mentored me in not only Appalachian geology, but also GSC field logistics and office politics. Since retirement, GSC emeritus status has provided me the opportunity to expand my research beyond Canada. Current work on Cordilleran batholiths and their origin by slab failure, with Bob Hildebrand is some of my most fulfilling yet. Stay tuned as there is more to come. Thank you very much.

Joe Whalen

2015 Volcanology and Igneous Petrology Division Financial Summary

Balance January 1, 2015	**5576.50**	
	Credits	**Debits**
Dues		
Publication sales		
Support for students (SEG-OCUSC and Lakehead)		1000.00
Annual Business Meeting , lunch		
Newsletter		
Postage, Copying, Miscellaneous Office		
Web page charges		16.75
VIP Award Medal Engraving & new medals		1463.35
Profit from short course		
Bank Charges		12.70
Bank interest		
Totals	**0.00**	**2492.80**
Balance December 31, 2015	**3083.70**	

Jamie Braid (Treasurer) Peter Hollings (President)

Meeting Announcements

GAC-MAC May 14-18, 2017
Kingston, Ontario

"BACK TO WHERE IT ALL BEGAN"

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 & 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.

http://www.kingstongacmac.ca/en/

The VIP Division will be sponsoring a session entitled "Magmatic and Metallogenic Processes Associated with Large Igneous Provinces". Marie-Claude Williamson and Christopher Lawley will convene the session with support from colleagues Danielle Giovenazzo, Richard Ernst, Sverre Planke and Steven Bergman.

Please navigate to this link for a full description of the session:

http://www.kingstongacmac.ca/technical-program/technical-sessions/

AGS 2017 February 10-11, 2017
Fredericton, New Brunswick

The 2017 AGS Colloquium and Annual General Meeting will be held at the Fredericton Inn, Fredericton, New Brunswick February 10-11, 2017.

http://ags.earthsciences.dal.ca/ags.php

A theme session will be held at the 2017 AGS Colloquium, entitled "Magmas and metals" The session will be convened by James Brenan. Following is a description of the session:

"Many of Earth's metallic deposits are linked to magmatic activity, with the processes by which the elements are concentrated related to a variety of compositional, physio-chemical and tectonic factors, come of which are as yet poorly understood. This session will bring together researchers applying field observations, chemical and isotopic analysis, experiments and numerical simulations to gain a better understanding of the role of magmas in concentrating metals, with a goal to developing advanced ore formation models". – *James Brenan*

VIP Reminders

The Career Achievement Award - the deadline is **31 January 2017.** Please send nomination letters to John (john.greenough@ubc.ca)

The Gold Gélinas medal for an outstanding PhD thesis in the fields of volcanology and igneous petrology - the deadline is **28 February 2017.** Please send nominations to John (john.greenough@ubc.ca).

The Silver Gélinas medal for an outstanding MSc thesis in the fields of volcanology and igneous petrology - the deadline is **28 February 2017.** Please send nominations to Donnelly (darchiba@stfx.ca).

The Bronze Gelinas medal for an outstanding Honours thesis in the fields of volcanology and igneous petrology - the deadline is **15 April 2017.** Please send nominations to David (dlentz@unb.ca).

GAC-VIP Executive

Chair:	John Greenough	john.greenough@ubc.ca
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For more information, visit the GAC-VIP Division Website:

http://www.vip-gac.ca/About.html