ASH FALL

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

No. 62 October 4, 2006

A word from the Editor

Hi folks, welcome to the first Ashfall since I have taken over as Editor. I'll be working hard to maintain the same high standards set by Brian. In this issue Brian Cousens and Glyn Williams-Jones have written of their activites around the world this summer, while Renée-Luce Simard provides an update on activities in the Flin Flon area. Finally Wulf Mueller has contributed an article discussing recent advances in the Abitibi.

I was fortunate enough to visit Yellowstone this summer as part of a trip to attend a Penrose conference in Lander, Wyoming. The conference brought together a small group of geologists from a range of disciplines to discuss the onset of plate tectonics. With the majority of Archean cratons represented and plenty of time for discussion both with and without beer, it proved to be an interesting meeting. The majority of the presentations can be found on the meeting website. By the end of the meeting the majority view was that plate tectonics started between 3 and 4 Ga, considerably older than the consensus five days earlier.

After the meeting I spent a few days visiting the Yellowstone caldera. If you could see past the crowds at the major tourist spots the geology was impressive, and best of all hiking more than a few minutes from the road left the crowds far behind.

It has been a relatively quiet summer in terms of active volcanos. Tungarahua volcano in central Ecuador erupted on August 16, 2006, spewing lava, ash, and gravel over the surrounding area and causing substantial damage according to the VolcanoWorld web site. Despite scientist's predictions that Mayon volcano in the Philippines could erupt as a result of the full moon in August, things seemed to have quietened down. There have also been significant eruptions at Mt Merapi in Indonesia with eruption plumes reaching altitudes of ~6.1 km on the 2 and 3 August. Glyn's article includes his visit to Merapi this summer.

President's Message

This is my first report as the new Chair of the Volcanology and Igneous Petrology Division and I would like to begin by thanking the Past Chair, Wulf Mueller for the excellent job he has done over the past two years. I only hope that I will be able to follow in his footsteps. I would also like to thank Brian Cousens who has stepped down as Secretary-Treasurer. For the last several years Brian was the heart of the Division, pumping life into all of our activities. The rest of the new executive is Vice-Chair Glyn Williams-Jones from Simon Fraser University and Secretary-Treasurer, Pete Hollings, from Lakehead University. I look forward to a very successful year.

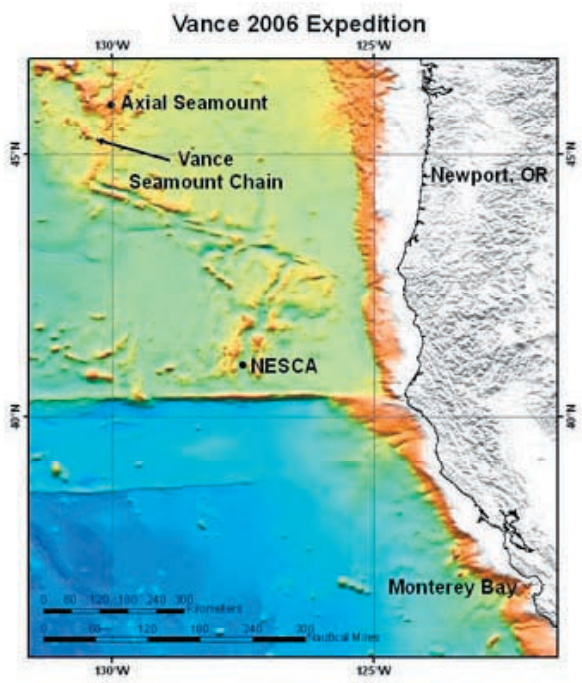
There are some interesting events being planned. At GAC/MAC Yellowknife 2007, the Division will sponsor a special session on Submarine Volcanism and Associated Mineralization: Modern vs. Ancient and a short course on Oceanic Volcanism and Mineralization. We will also be sponsoring an Archean symposium next summer at the University of Western Ontario. As in the past, we will be soliciting nominations for the Leopold Gelinas awards for the best PhD, MSc and BSc honours theses in volcanology and/or igneous petrology. Another initiative planned for the year is the remodelling of our website. We would also like to make the Ashfall more informative. In this regard, we are soliciting contributions about current research/activities in volcanology and/or igneous petrology such as the contribution of Wulf Mueller in this issue or reports on interesting meetings etc. Currently, the Division is in the process of publishing a series of papers in Geoscience Canada reviewing different types of igneous rocks. Georgia Pe-Piper from Saint Mary's University is the editor of the series. If anyone has some good ideas for additional activities we will welcome suggestions.

Canadians Invade US Research Vessel!

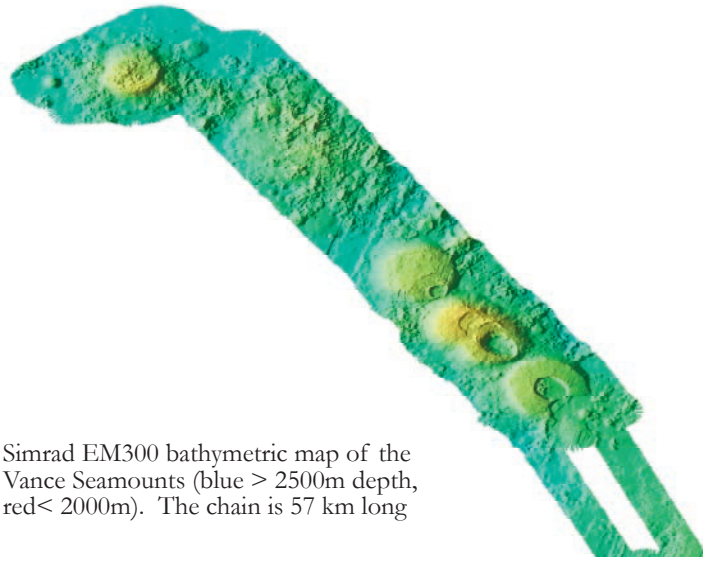
Brian Cousens, Carleton University & John Stix and Christopher Helo, McGill University

Between July 23rd and August 6th, 2006, scientists aboard the research vessel RV Western Flyer of the Monterey Bay Aquarium Research Institute (MBARI) investigated the geology of the Vance seamounts and Axial seamount adjacent to the southern Juan de Fuca Ridge. Along with four geologists and biologists from MBARI and two geologists from the University of Florida were five Canadian scientists: Brian Cousens and Liz Cornejo from Carleton University, John Stix and Christoph Helo from McGill University, and Kristen Choquette from the University of Ottawa. Our focus was on the Vance seamounts, a chain of volcanic seamounts that has formed adjacent to the west side of the Juan de Fuca Ridge over the past 2.5 Ma. As each volcanic edifice formed, it was carried off to the northwest as the underlying plate grew, forming a chain. Most of the seamounts are circular and flat-topped, and most have one or more deep calderas. The calderas resulted from the collapse of large magma chambers beneath the seamounts. Several of the calderas are nested, indicating that several individual eruption and collapse events occurred. Thus these seamounts offer the opportunity to better understand caldera formation on submarine volcanoes and to track off-ridge deep magma inputs and shallow-level magma evolution within the volcanic edifice.

We had a rough start, fighting 35 knot winds and rough seas for the first three days on our way to the Juan de Fuca from Monterey. On day two we managed only 55 nautical miles in 24 hours! Even the seasoned seafarers spent much of day two in a bunk. Those who check out the weblog for the cruise (www.mbari.org/expeditions/vance/index.html) will notice the lack of photos for the first two days and lots of mention of Bonine... We actually skipped over our planned dive at the Gorda Ridge (NESCA) because of bad weather conditions, and crawled on towards the Vance seamounts.



Map of the Juan de Fuca Ridge area with cruise destinations.



Simrad EM300 bathymetric map of the Vance Seamounts (blue > 2500m depth, red< 2000m). The chain is 57 km long

After six days, and under vastly improved weather conditions, we arrived at the first of our Vance dive sites. Time to dive! The remotely operated vehicle, Tiburon, was designed and built at MBARI and is a wonderful tool for seafloor exploration. While the scientists and pilots sit in luxury in the control room on board the Western Flyer, Tiburon descends to the seafloor through a moonpool in the centre of the ship, connected to the ship by tether. We control where the ROV goes, and all of the scientists in the control room have input into where to stop and take a closer look. Tiburon sports a brand-new HDTV camera, digital camera, a glass and sediment suction sampler, and a sample drawer for rock and animal samples. After a 12-hour dive, we routinely collect thirty rock samples and a dozen biological samples.

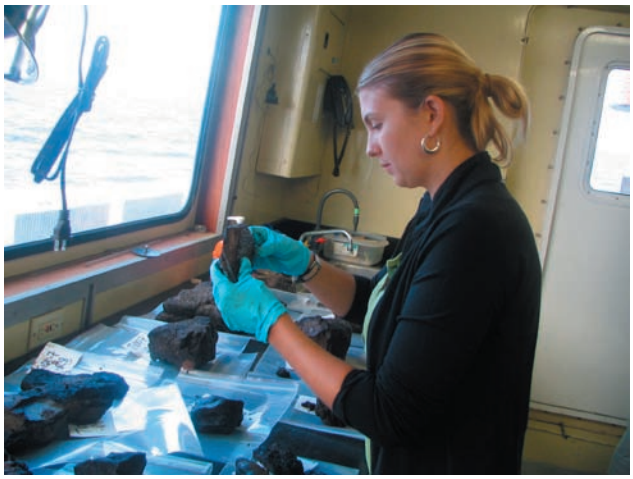
ROV dives were designed to investigate the caldera walls, where we expected to see exposed sections of the lava flow and pyroclastic history of the seamount, as well as the summit plateaus. The caldera walls typically ex-

RV Western Flyer and ROV Tiburon on the moonpool floor.

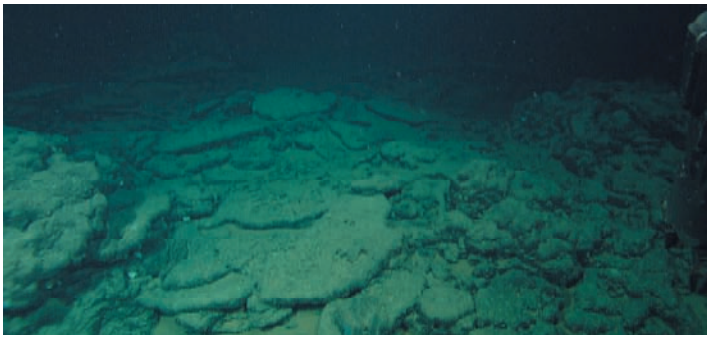
posed thick (up to 30m!) massive flows, rarely showing columnar jointing, as well as abundant pillow flows. Pillow flows rarely were interlayered with thin sheet flows. All of the lava flows were truncated as a result of caldera collapse, such that they now form vertical cliffs several hundred

Chris Helo and John Stix.

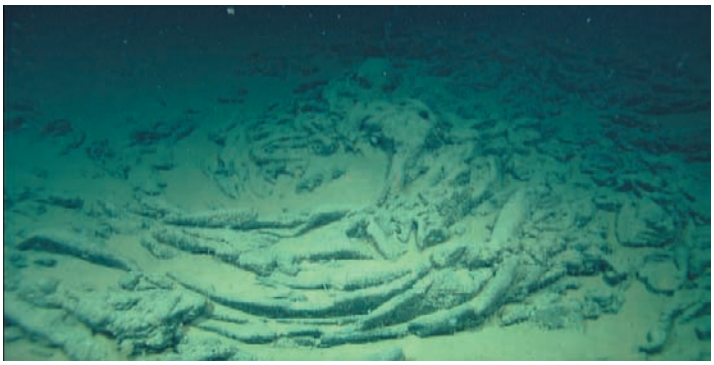
The Control Room during a dive. John Stix is seated on the floor, Cristoph Helo is sitting to his right. Brian Cousens is at the Science Camera station in front of Cristoph.



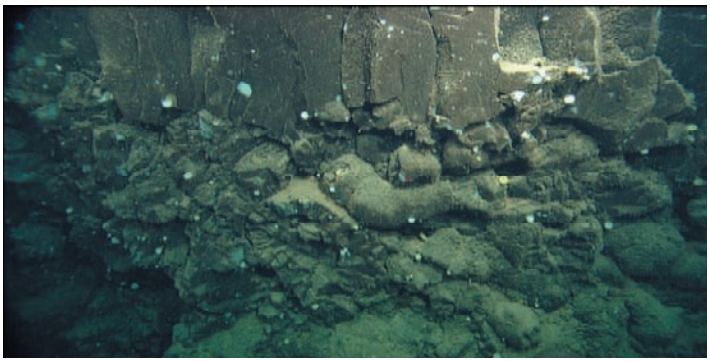
After a dive, Kristen Choquette picking brittle stars from one of the rock samples recovered by the Tiburon.



Slabby hyaloclastite layers at the top of a caldera rim



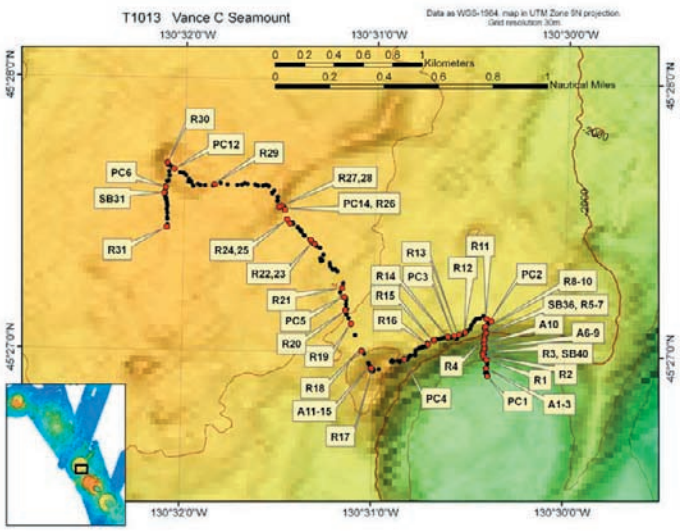
Sheet flows on caldera floor.



Pillow lavas overlain by massive, columnar jointed flow.

metres tall. At the base of the steep slopes are huge talus piles composed of irregular lava fragments from upslope. At the top of the caldera walls were thin beds of volcaniclastic material that overlay the lava flow units. The volcaniclastite was deposited by an explosive eruption, perhaps as a result of caldera collapse. Some of the Vance seamounts also have post-caldera flows overlying the volcaniclastite, indicating that magmatic activity did not stop after caldera collapse.

Throughout our dives on the Vance seamounts, Fe-Mn oxide encrustations on the lavas were a thorn in our sides. In some cases, the > 1 cm-thick encrustations disguised the underlying lava, so we often did not know if we were on pillow lavas, talus, sheet flows or hyaloclastite. We often were not sure if we had collected just crust with the ROV manipulator arm or if we had also sampled some of the underlying lava flow. Even lavas forming the youngest of the Vance chain, closest to the Juan de Fuca Ridge, were heavily encrusted in oxides and covered by hyaloclastite. A previous dredge haul across one of the Vance seamounts



Typical dive map, showing dive track and sample location sites.

recovered sulphide chimneys, massive Fe-oxide deposits and thick Fe-Mn-encrusted hydrothermal chimney samples, so hydrothermal vents once existed on at least one of the Vance seamounts. Unfortunately, other than the thick Fe-Mn oxide crusts on EVERYTHING, we saw no evidence of an old hydrothermal vent site on any of the seamounts.

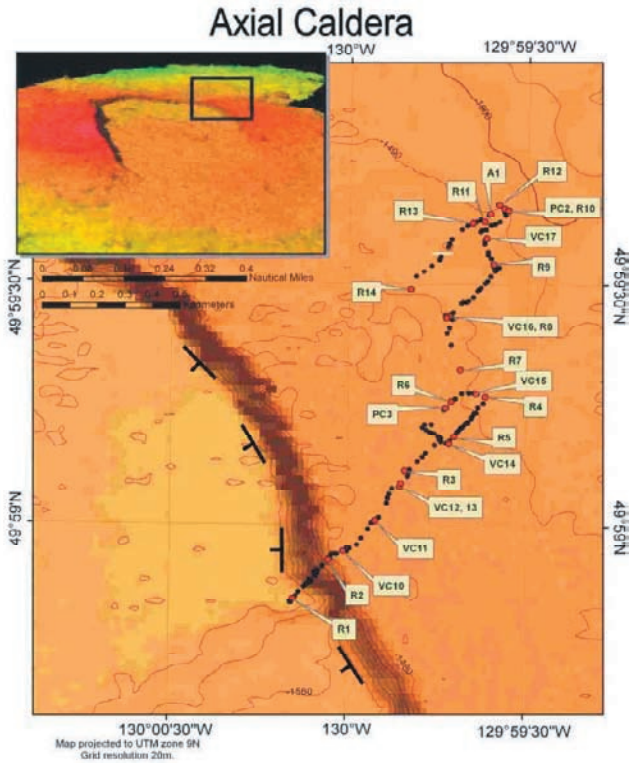
In addition to our study of the Vance seamounts, we also

Brian Cousens picking mud out of a lava fragment.

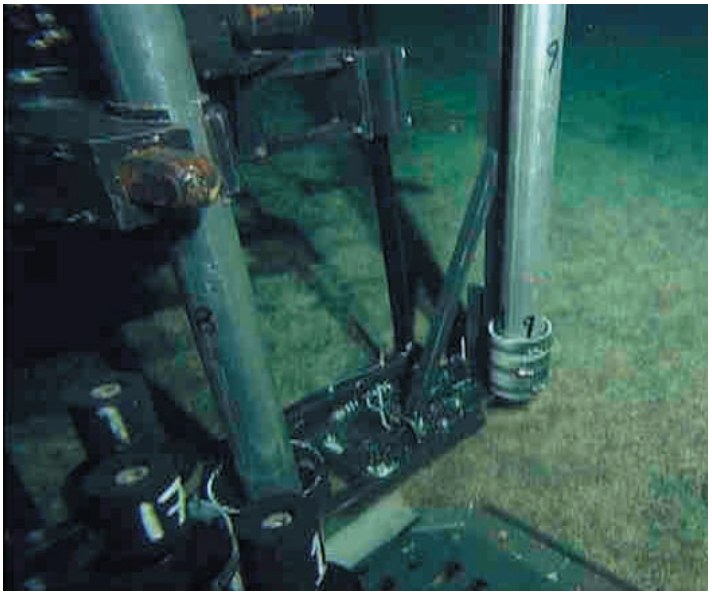
Liz Cornejo showing off our colourfully-inked Styrofoam cups, sent down attached to Tiburon and shrunk by water pressure.

The Science Party dressed to kill in high-fashion survival suits during a boat and fire drill!

visited Axial Seamount, a hotspot-type volcano situated on the Juan de Fuca Ridge. Axial Seamount includes a large summit caldera, about 3 x 8 km, within which an eruption last took place in 1998. Two dives were slated to investigate sedimentation on the flanks of the summit, moving away from the caldera wall. For these two dives we had to slightly modify the Tiburon to carry a vibracoring system, equipped with 2 m long aluminum core tubes. The sediment usually consists of calcareous ooze with interbedded layers of hyaloclastite. Although the thickness of the sediment overlying the lava flows did vary in a manner slightly different from what we had expected, our recoveries at the end of the end of the day were still pretty neat. The high-



Map showing the diving track and sample locations of the dive on the eastern flank of Axial. The inlay on the top left shows a perspective bathymetric map of the entire caldera.



The ROV is taking a core sample, by pushing the left tube into the sediment.

light of our retrievals: “limu o pele”, tiny thin glass bubble-wall shards, some welded, others containing bubbles, or little crystals. These limu provide evidence of explosive activity and records information about the eruptions that have taken place.

The cruise started slow, but it seemed like no time at all until we had to return to port. The photo below shows the science party as we arrived at Newport , Oregon, enjoying the sunshine in the harbour area. The cruise was a huge success, and now it is up the the students and their supervisors to make sure that we get lots of high-quality petrological and geochemical data to go along with the superb video record of the geology of the seamounts. Our success was, as usual, thanks to the crew and ROV pilots of the Western Flyer. Many thanks to Chief Scientist Dave Clague for inviting us to participate, to Joe Jones for keeping track of the biologists, and to Jenny Paduan for her phenomenal organizational skills on land and at sea. I can hardly wait for next summer’s cruise!

Back onshore, laboratory analyses of the cores and lava samples will hopefully provide answers to some of the following questions. What is the frequency of these hyaloclastite producing eruptions? What is the trigger for these submarine caldera collapses? What is the mechanism driving these explosive eruptions in a water depth of about 2000m? What is the exact process forming the limu? How exactly does degassing of the lava take place? Some may be answered by simply analyzing the profiles of the sediment cores and evaluating the abundance of hyaloclastite layers, which will be done at MBARI. Others require some detailed studies of the glass composition or even analogue modeling in the labs at Carleton and McGill. Hopefully we can solve some of these mysteries of deep-sea eruptions!

The Science party arriving in Newport

Volcanoes in the Sun: Stomping around Ecuadorian & Indonesia Volcanoes

Glyn Williams-Jones, Department of Earth Sciences, Simon Fraser University

Well, as the newly "elected" vice-chair (thanks Wulf!) of the VIP, I thought I should tell you all a little about what I got up to during my summer "vacation". Perhaps by the end of this, I'll have convinced some of you to join me on future trips!

Eruption column from Sierra Negra volcano, Galapagos, October 22, 2006. The column reached approximate 15 km altitude. Photo courtesy of Karen Harpp, Department of Geology, Colgate University.

I am fortunate to be involved in a National Science Foundation grant to continue work on a rather mysterious volcano, Sierra Negra, in the Galapagos. Now I say mysterious because this basaltic shield volcano (with large summit caldera – 7 x 10.5 km) underwent incredible inflation of more than 2 m between April 2003 and October 2005 (~5 m total uplift since 1992!) with elastic doming of the floor of the caldera and what is thought to be at least 2 episodes of ~1 m trapdoor faulting! This inflation culminated in a spectacular fissure eruption on October 22, 2005 with an eruption cloud reaching at least 15 km, lava fountaining and extensive Aa & pahoehoe flow emplacement (see BGVN report 30:9-10 for more details).

Lava fountaining, October 29, 2006. Dennis Geist and Terry Naumann in the foreground. Photo courtesy of Karen Harpp, Department of Geology, Colgate University.

Willy attempting to compete with local sulphur miners. Each basket ways approximately 30-40 kg. Ijen crater floor.

All this action was caught by survey and continuous GPS as well as survey gravity measurements for the five years leading up to it. My new PhD student, Nathalie Vigouroux and I headed down for two weeks in June to help with a follow up micro-gravity, GPS and gas flux survey in order to "bracket" the eruption. After a rather painful trip down (3 days of missed flight connections – thanks Continental! and some thumb twiddling, turtle watching and watching World Cup soccer in Sierra Cruz) we made it to the volcano. While not the "drive in" volcanoes I had become accustomed to in Central America, it was spectacular nonetheless. We camped on the caldera rim and made runs onto the caldera floor to attempt SO_2 gas flux measurements (no luck this time because of frenzied wind directions) and dynamic micro-gravity surveys (one successful line of only 4 stations plus fresh Aa-destroyed boots!). As a first reconnoitre down there, it was a good run and we will be heading back down again in early December for another survey (and hopefully every 6 months or so for the next couple of years) to investigate the mass and/or density changes and try to understand the mechanics behind this rapid inflation.

If that wasn't enough for me, I also headed down to Indonesia for three weeks with my other Ph.D. student, Guillaume Mauri, to start working on Kawah Ijen volcano in eastern Java. The idea here was to use self-potential and micro-gravity surveys in conjunction with digital photogrammetry (for a precise DEM) to image the hydrothermal

Ceramic pipes used to condense sulphur into liquid which pools at bottom and is cooled by water. Temperature at mouth of pipe ~240°C.

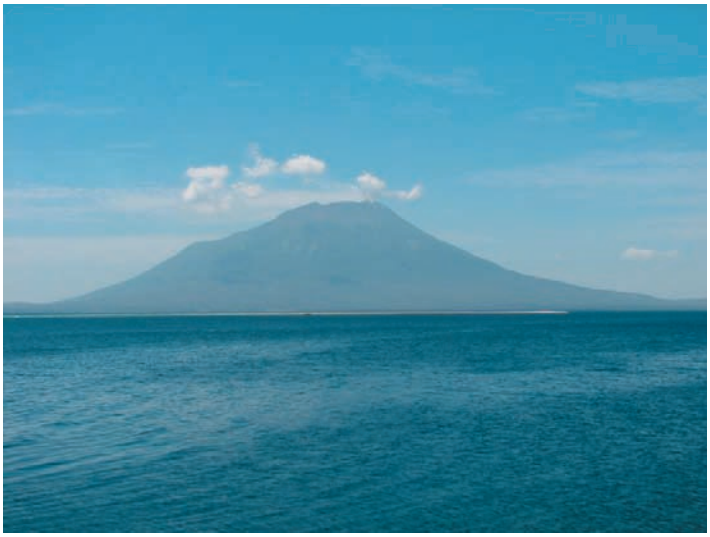
system around this spectacular 1 km-diameter acid crater lake (pH ~0.5). While Guillaume and a field assistant got on with that work, my partner in crime, Willy Williams-Jones (yup...father and son!), ran off to Merapi (Indonesia's most active volcano and recently so – see BGVN report 31:05) to continue with an ongoing studying investigating the transport of metals in the vapour phase. While we were not able to make the summit this year because of politics and time constraints, Willy's Ph.D. student, Olivier Nadeau, and another field assistant did make it up and got some very good gas and condensate samples to go with their grab samples (for melt inclusion work) from the recent pyroclastic deposits.

We then headed off to the Flores Islands (home of the recently discovered Flores Man, aka Hobbit! – a potentially new hominid species - http://www.nature.com/news/specials/flores/index.html) to do the ground work scouting for a Volcano/Landslide/Tsunami project that we are planning with John Stix and colleagues from SFU. Again, logistical and political difficulties (Indonesia is a big complex country!) made things a bit tricky but we were able to get out and look at a number of volcanoes (Ili Lewotolo, Ili Werung, and Ili Leowotobi amongst others) that may be good candidates.

Following our trip out east, we headed back to Kawah Ijen to do a bit of "student supervision" and also to try and get a handle on the gas chemistry of the system. One of the amazing things about Ijen is that the locals actually mine the sulphur. Large ceramic pipes are inserted into the fumaroles, allowing native sulphur to condense into a liquid and pool at the bottom of these pipes. For a mere 6 cents per kilogram, miners carry out 60-80 kg of sulphur, twice a day, without any protection from the gases – this leads to a life expectancy of only 35-40 years! We were more fortunate with our equipment and were able to make SO_2 gas flux measurements on the rim and condensate samples from the fumaroles. We will be back next year with more gear, especially a multi-gas sniffer (to go after H_2O, CO_2, SO_2 and maybe H_2S), to try and better characterise the total gas flux of the system and investigate the buffering effect of the acid lake. We have a feeling that we might be seeing the formation of a high-sulphidation epithermal gold deposit, so stay tuned!

Indonesia is truly a volcanologists paradise, with 80 Class A volcanoes (volcanic activity since 1600 AD). What is really impressive is that each of these volcanoes has at least one observatory, staffed by local residents and generally with at least one seismometer. More than can be said for most "first world" countries!

Anyway, I'll be heading back to my old stomping grounds in Central America (Masaya, Nicaragua and Poas, Costa Rica) this spring so if you are up for playing on some nice and easy "drive in" volcanoes, just let me know!



Ili Lewotolo volcano, Flores, Indonesia. Notable degassing from pervasive summit and crater fumaroles.

Kawah Ijen volcano. Crater diameter is ~1 km and pH of lake "water" is 0.5.

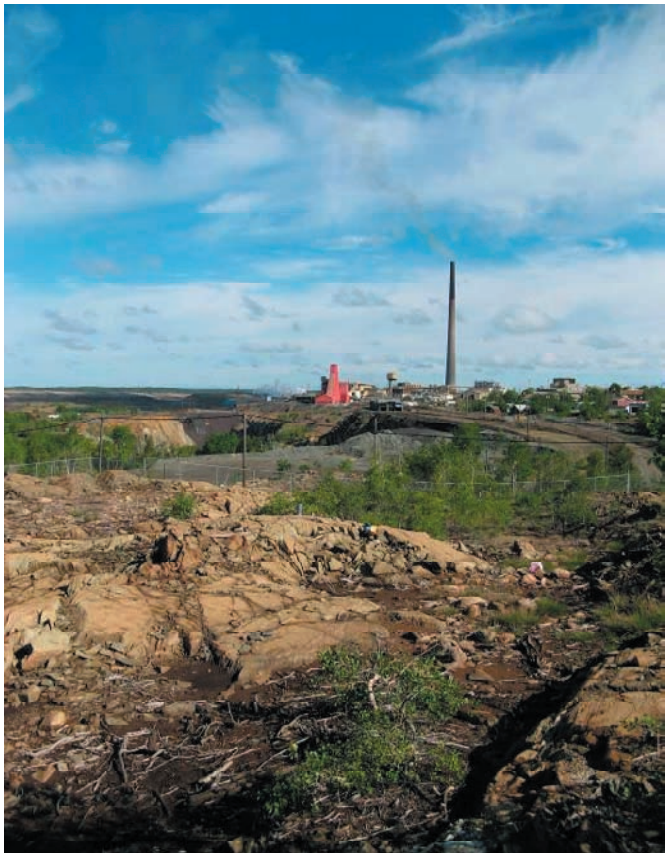
Wonderful Flin Flon!!!

Renée-Luce Simard, Manitoba Geological Survey

If you ever have a spare week-end next summer, you should strongly consider visiting Flin Flon, Manitoba. Not only is Flin Flon the host town of some of the most important volcanogenic massive sulphide (VMS) deposits in Canada, but also one of the best exposed VMS camp in Canada, thanks to the Hudson Bay Smelter! The volcanology up there is fantastic!

Located some 750km north of Winnipeg, the Flin Flon area of the Paleoproterozoic Flin Flon belt is well known for its VMS deposits. Six current (Callinan, Triple 7 and Trout Lake) and past (Flin Flon, Mandy, and Schist Lake) producing VMS mines occur in the immediate vicinity of the town of Flin Flon, which makes this area one of the most productive base metal region in Canada. However, despite its productive past, reserves at Flin Flon are being rapidly depleted, with the prospect that new reserves/deposits are needed to maintain the economic viability of the Hudson Bay Smelter at Flin Flon.

With the intent of stimulating private-sector resource exploration in areas of high base metal potential in established mining communities, the Government of Canada launched a new five year Targeted Geoscience Initiative (TGI3) in 2005. As part of this initiative, the Manitoba Geological Survey, in collaboration with the Saskatchewan Geological Survey, the Geological Survey of Canada, and researchers



View of the Hudson Bay Smelter, Flin Flon, Manitoba

Traversing around Burley Lake, 4km south of Flin Flon, Manitoba

from Laurentian University, is participating in production of a new 1:10000 scale "cross-border" geological map of the Flin Flon area. I was the lucky one picked to remap the Manitoba side, whereas Dr. Kate MacLachlan of the Saskatchewan Geological Survey led remapping in Saskatchewan. Both crews shared a camp at the Centennial Mine site along with Dr. Harold Gibson, Dr. Bruno LaFrance, Michelle DeWolfe (Ph.D. candidate), Dave Lewis (Master's student), and Eilidth Cole (Master's student) from Laurentian University. Other researchers from the Geological Survey of Canada and the Manitoba Geological Survey joined the crew at some point or another during the summer. With incredible support from all agencies and Hudson Bay, Mining and Exploration, the season was a great success!

Today I just want to give you an idea of how fantastic the rocks around Flin Flon are. The VMS deposits of Flin Flon are part of the Flin Flon formation, a complex volcanic succession that is the product of primary pyroclastic eruptions, redeposition of pyroclastic and autoclastic deposits, and effusive eruption of basaltic-andesitic flows, and rhyolitic domes (Devine, 2003; Master's thesis, Laurentian University). These rocks, along with the associated

Felsic breccia, Flin Flon formation

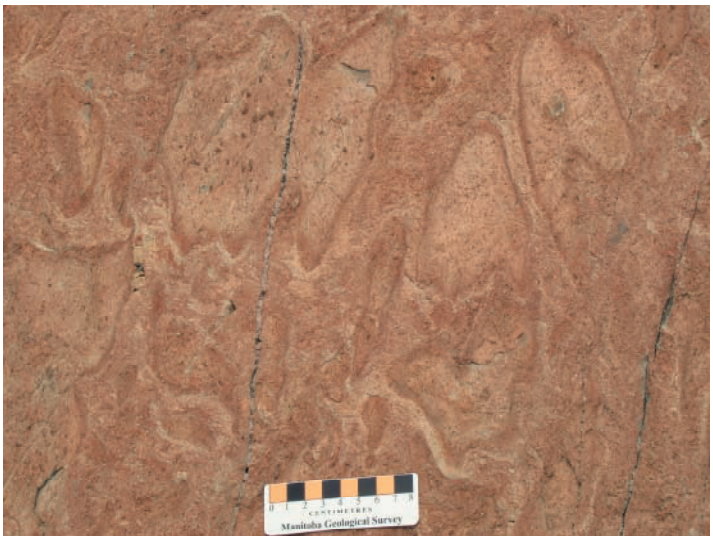
Pillowed flow showing shattered interpillow sediments (peperite), Flin Flon formation

Pillowed flow showing concentric contraction cracks, Hidden formation, south of Flin Flon

VMS deposits, are interpreted to have formed within a large, subaqueous subsidence structure (calderas; Devine, 2003). The VMS deposits are associated with rhyolitic flow or dome complexes toward the top of the Flin Flon formation, and are interpreted to have formed during a period of quiescence, at the end stages of caldera collapse in the area (Devine, 2003).

Renewed voluminous basaltic-andesitic volcanism of the overlaying Hidden and Louis formations form the hangingwall of the Flin Flon VMS. These formations are composed mainly of basaltic flows and sills, with subordinate rhyolitic flows and volcaniclastic rocks. They are interpreted as products of voluminous volcanism forming a shield volcano to have erupted during a period of resurgent basalt volcanism and subsidence that immediately followed a hiatus in volcanism marked by VMS ore deposition (DeWolfe, pers. comm. 2006; PhD thesis in progress, Laurentian University). Recent detailed mapping and volcanic facies analysis south of Flin Flon by R.-L. Simard (Manitoba Geological Survey) and M. DeWolfe (Laurentian University) recognized more subsidence structures associated with felsic volcanism within these hangingwall rocks.

Exposure in most of the Flin Flon area is exceptional with commonly 30-70% of unlichened outcrops (>90% directly around the smelter). Regional metamorphism is lower greenschist facies with excellent preservation of primary textures. The amount and quality of exposures in the area allow for detailed volcanic lithofacies mapping and stratigraphic analysis. Hope to see you out there in the coming years!



Amoeboid pillow breccia, Hidden formation, south of Flin Flon

A new interpretation of the Blake River Group, Abitibi greenstone belt: the importance of volcanological facies mapping and the discovery of a megacaldera

Wulf Mueller, Université du Québec à Chicoutimi

The 2707-2696 Ma Archean Blake River Group of the Abitibi greenstone belt has been the centre of attention in the last few years because of a new provocative and ingenious idea by Pearson (2005), Daigneault and Pearson (2006), and Pearson and Daigneault (2006, to be submitted to Geology). The Blake River Group has been re-interpreted as a caldera cluster or nested caldera system, or as the principal researchers call it, a Megacaldera Complex. With this new interpretation by Vital Pearson and CONSOREM (Consortium de recherche en exploration minérale), of an 'old déjà vu mining camp' that many had thought had passed its prime, a new wave of exploration ensued. Curiously, it is another case of how new ideas based on detailed volcanic facies mapping (field work) and careful re-interpretation of existing data sets can lead to new exciting results.

I guess, what I am trying to say is: With the advent of modern volcano-sedimentary lithofacies mapping techniques, applying sequence stratigraphic notions to ancient rocks, and incorporating new analytical methods, new exciting interpretations are possible, and hence the field geologist is not yet an obsolete article. You still need the dinosaur out there!! All technical results are based on field observations. To make a point: many of us who work on Archean or ancient systems use U-Pb age determinations to get an idea of age relationships between volcanic (rock) formations, intrusive phases, stages of deformation, or relative timing of sedimentary basins. The obtained age is only really valid if the right question is asked, as survey or facies mapping programmes should precede sampling. If the question we ask is not correct (i.e. doesn't make sense), then the question is erroneous, not the age (see Mueller and Mortensen, 2002 on ages and evaluation of intrusive and extrusive rocks). Ask the right question and the age will make sense. The Blake River Group or Blake River Megacaldera Complex is being mapped with the new vision of CONSOREM, and UQAC (Université du Québec à Chicoutimi), UQAM (Université du Québec à Montréal), Ministère des ressources naturelles et de la faune du Québec (MRNFQ), Ontario Geological Survey and the Geological Survey of Canada (GSC) are combining their efforts. Let's rumble in the jungle.....!

Brief Review

Calderas are collapse structures between 2-100 km in diameter derived from (1) violent explosions, (2) continual effusive evacuation of high-level magma chambers, and/or (3) lateral migration of magma (Tilling and Dvorak, 1993; Lipman, 2000). The pre-caldera structure is either a stratovolcano, a composite volcano, or a shield volcano. The different types of caldera are a function of the collapse

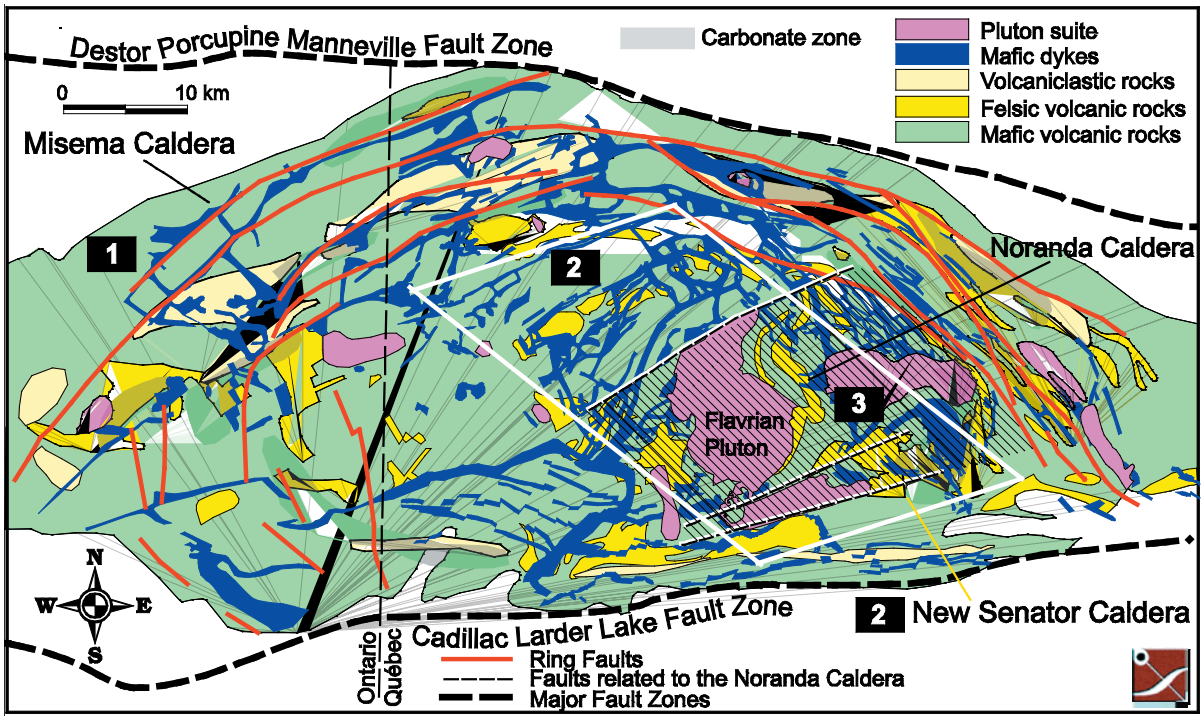


Figure 1: General geology of the Blake River megacaldera complex (BRMC) with annular mafic dyke swarms and ring faults that outline the Misema Caldera (1) of the early caldera event. The New Senator (2) and Noranda (3) calderas are part of the second and third caldera-forming events, respectively (Pearson, 2005).

mechanism with piston, trapdoor, piecemeal, down sag, and funnel calderas being identified (Walker, 1984; Roche et al., 2000). These subsidence mechanisms control the eruptions and topography of the caldera moat, and with it, intra-caldera depositional sites for subsequent small-scale volcanism such as flows or fountaining eruptions, but also, the locus of synvolcanic faults systems and hence volcanogenic massive sulfide deposits. The latter is only valid in a submarine environment. Ohmoto (1978) reconized early on that silicic submarine calderas were key sites for volcanogenic massive sulfides (VMS) and Mueller et al. (2004) substantiated this assessment, showing that the Archean calderas from the Rouyn-Noranda (de Rosen-Spence, 1976), Hunter Mine (Mueller and Mortensen, 2002), Normetal (Lafrance et al., 2000), and Sturgeon Lake areas (Hudak et al., 2003) were first order hydrothermal VMS loci.

The 3000 km^2 subaqueous Blake River megacaldera complex (Figure 1) is a world class metallotect with respect to both hydrothermal Cu-Zn massive sulfides and gold-rich massive sulfides. Based on the innovative work by Pearson (2005), this caldera complex is series of both overlapping (e.g. Las Cañadas caldera) and nested calderas (e.g. Campi Flegrei field, Naples). The Blake River megacaldera complex defines the Blake River Group and is subdivided into the Misema and Noranda subgroups (Goodwin, 1977). The former is composed of calc-alkaline mafic volcanic rocks and the latter contains both tholeiitic and calc-alkaline rocks. Pearson (2005) and Daigneault and Pearson (2006) recognized three major caldera-forming events in the Blake River Group, which include the E-W striking 2704-2707 Ma Misema megacaldera (Lafrance et al., 2002; preliminary U-Pb data by Mueller and Mortensen 2005), the 2701-2704 Ma (approximation from previous ages) NW-striking New Senator and the classic ENE-striking Noranda caldera (< 2701 Ma). The caldera structure is defined by a double ring fault structure 65 and 45 kilometres across, which are assumed to be the locus of the inward and outward dipping faults respectively (e.g. Roche et al., 2000) or alternatively a double collapse structure with a major difference in structural and topographic rings. Synvolcanic mafic ring and dyke swarms delineate caldera, and the recognition and organization of these diorites and gabbros into a coherent geometry lead Pearson (2005) to define the Misema structure. The first step of re-interpretation of the Blake River Group was born. Pearson (2005) recognized that significant pyroclastic debris was associated with this fault system. The Misema collapse is associated with andesitic ignimbrites and outflow sheets located along the double ring faults. To put these pyroclastic rocks in a historical context, they were informally termed Fiskites (after Dick Fiske who said they were subaqueous pyroclastic rocks in 1978; famous for the benchmark paper Fiske and Matsuda 1964; subaqueous explosive volcanism), and was only partially mapped by Mueller and White in 1991, as the subaqueous fountaining eruptions of the Hunter Mine Group had precedent (Mueller and White, 1992). A detailed volcanic lithofacies study is now being conducted on these deposits to better understand the characteristics and transport processes of subaqueous pyroclastic flows (PhD thesis, Claude Pilote, UQAC). Similarly, the MRN and the GSC are actively participating in this endeavour, whereby P.S Ross (GSC) and J. Goutier (MRNQ) are mapping the pyroclastic rocks (Dalembert tuff) and the northern mafic rim of the Misema caldera, respectively. Age determinations to fine tune the framework of the Misema event are currently under investigation (Mueller and Mortensen, 2006; GSC, 2006 and MRNQ 2006).

The New Senator caldera (NSC) is another newly identified structure in the Blake River Group. This caldera is a complex nested structure within the heart of the Blake River Group. It is composed of thick massive mafic sequences that Lyndsay Moore (PhD, UQAC), based on detailed volcanic facies mapping, has inferred to be a subaqueous magma lake during the early stages of NSC evolution. This would be the first Archean identification of a magma lake (commonly referred to as lava lakes) in a subaqueous caldera. The up-section change to felsic volcanism needs to be considered, as does its characteristics and synvolcanic dyke-faults systems (David Paquin, MSc. UQAM). In addition, the change from NSC to the classic Noranda caldera may require some new thinking, as the Horne Mine may well be part of the NSC rather than the Noranda caldera (Daigneault and Pearson, 2006). In short exciting times are awaiting us; we will keep you posted!

Excursions

The Blake River Group has been a centre of major interest in 2006 with several excursions at the international, national and local level. It was really good to see a renewed interest in the physical volcanology and geochemistry of Archean sequences especially after being spoiled by the great 'think-tanks' of the early 80's represented by Drs E. Dimroth (UQAC) and L. Gélinas (UdM). Many of us in Québec are products of these two amazing gentlemen. I think we have done them justice. The following excursion photos lead by Consorem show this new level of enthusiasm.

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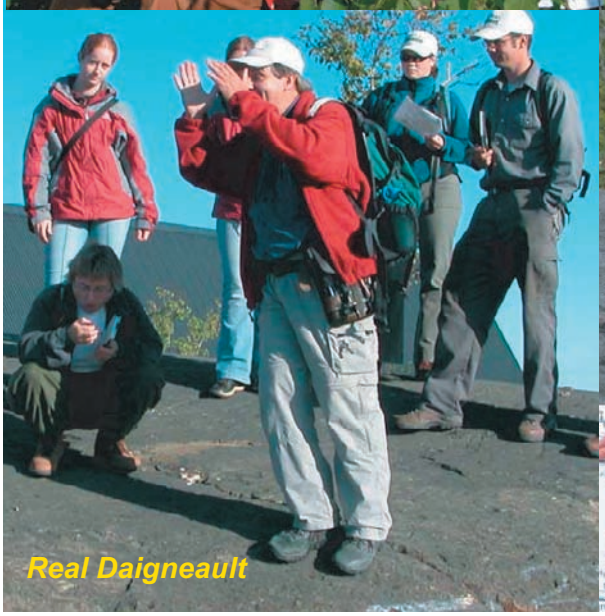
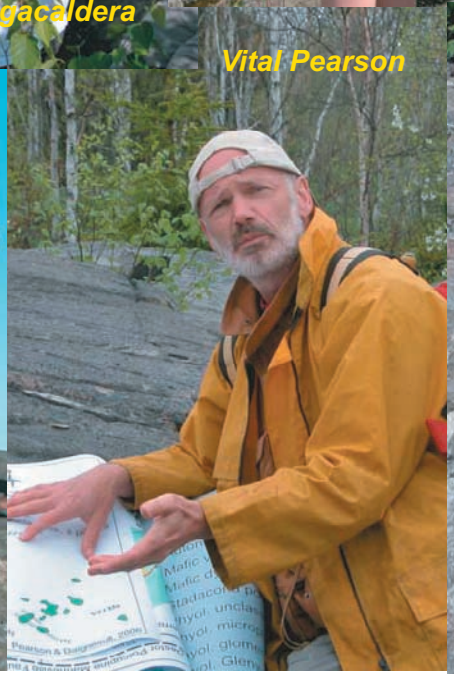
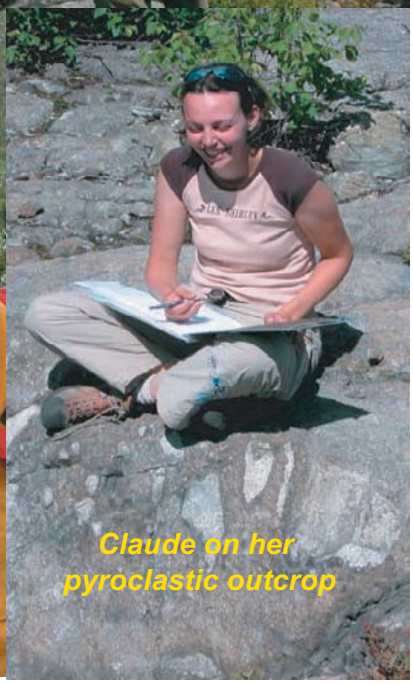
Consorem Excursion on the
Blake River Megacaldera: June 21st - 2006
The Group


Consorem Excursion on the
Blake River Megacaldera


Lyndsay and Valerie on magma lake:
June 2006


Real Daigneault


Vital Pearson


Claude on her
pyroclastic outcrop

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Meeting Announcements

GAC-MAC 2007

Yellowknife will host the first spring GAC-MAC conference north of 60°. "Yellowknife 2007, For A Change Of Climate" will feature a full technical program that highlights Canada's North: its climate, its culture, its mining heritage, and its future.

Symposia will include:

- Mitigation of Environmental Impact of Mining in the North
- Permafrost
- Mineral Deposit Models and Regional Exploration Symposium and Workshop

Special sessions are:

- Submarine Volcanism and Associated Mineralization: Modern vs. Ancient
- Geospatial Information and Tools in Support of Geosciences in the Canadian Arctic
- Recent advances in the geology of Laurentia
- Short-lived magmatic events of the Slave Province and environs: critical time markers and indicators of tectonic processes
- Northern Energy and Sedimentary Basins
- Northern Mineral Deposits
- Geoscience Skills Development for Canadian Comunities
- Diamonds: Exploration to Production - a northern Canada perspective
- Sustainable Mineral Resources Development: Critical Issues for Canada's North

Hydrothermally altered rhyolite cliffs at Artist's Point in Yellowstone National Park. Photo courtesy of Pete Hollings

Columnar jointing at the Obsidian Cliffs in Yellowstone National Park. Photo courtesy of Pete Hollings

- Northeast Canada and Greenland: Geology, correlations, and resource potential
- Comparative planetary geology: Terrestrial analogues to Mars in the Arctic
- International Polar Year Research

Pre- and post-conference short courses and workshops include:

- The Geology of Gem deposits
- Remote Predictive Geological Mapping,
- Oceanic Volcanism and Mineralization
- Application of Till and Stream Sediment Heavy Mineral and Geochemical Methods to Mineral Exploration in western and northern Canada will be presented.
- Towards an Integrated Future in Geoscience Education and Outreach
- Mineral Deposit Models and Regional Exploration Symposium and Workshop

Six field trips are also planned in conjunction with the meeting:

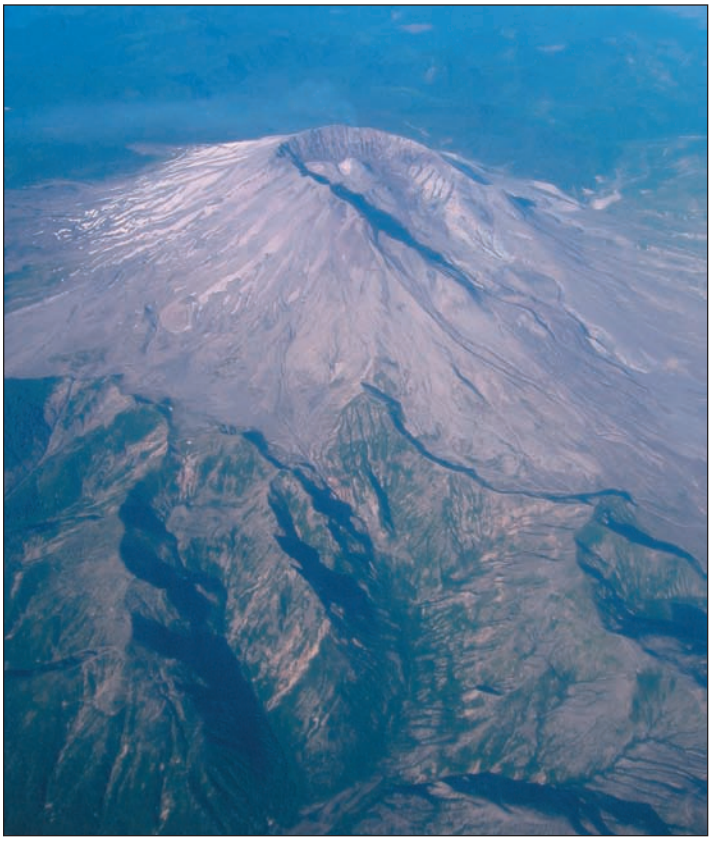
- Transect through the Southwestern Slave Craton
- Pine Point and Hay River Area: Middle and Upper Devonian Carbonates
- Yellowknife Geoheritage, Emphasizing Submarine Volcanic Eruptions, Unique Sedimentary Deposits, and Continental Glaciation
- A Geological Transect of Trans-Hudsonian Orogen from the Superior Craton to the Rae Craton: Geology of Northern Quebec, Baffin Island, and Western Greenland.

Archean Terranes

The Volcanology and Igneous Petrology Division has agreed to be one of the main sponsors of the Archean symposium, "A Global Comparison of Archean Terranes". The symposium will take place from August 19th-25th, and involves a two-day conference at the University of Western Ontario and a 3-day fieldtrip in the Abitibi greenstone belt. The Abitibi belt of the Superior Province, Canada, is the largest and best-studied greenstone belt in the world. Komatiites, and mafic and felsic volcanic rocks ranging in age from 2724-2703 Ma, late-Archean (2690-2670 Ma) strike-slip basin deposits, and 2710-2686 Ma turbidite deposits are well-exposed throughout the volcanic belt. The 3-day field trip will provide an opportunity to visit critical outcrops and discuss significant issues with respect to Archean processes, including volcanic sequences, sedimentary successions, geochemistry, structural geology, geochronology, early life, ancient crustal evolution, mineral deposits, impact events, and the state of the early atmosphere. Igneous rocks will be one of the main focuses of the fieldtrip, with special emphasis on the physical volcanology of basalts, komatiites and rhyolites. These volcanic deposits represent a variety of depositional settings, such as ocean floors and plateaus, and caldera complexes. The past Chair of the Volcanology and Igneous Petrology Division, Wulf Mueller (UQAC), Real Daigneault (UQAC), and Vital Pearson (CONSOREM and UQAC) will be leading the fieldtrip. The Archean symposium is being organized by Patricia Corcoran (University of Western Ontario), a member of the Volcanology and Igneous Petrology Division, and a past winner of the Leopold Gelinas Gold Medal.

Contact Patricia Corcoran at pcorcor@uwo.ca for more details

Flow banded obsidian at the Obsidian Cliffs in Yellowstone National Park. Photo courtesy of Pete Hollings



Mt. St. Helens on July 20, 2006 from Alaska Airlines Flight 637, about 8 am local time. Smoke plume to southeast, Mt. Hood in background. Photo courtesy of Harmen J. Keyser, P.Geol., Landmark Minerals Inc.

Institute on Lake Superior Geology

The 53rd Annual meeting of the ILSG will be held in Lutsen, Minnesota on May 10 & 11, 2007 with field trips both before and after. Proposed field trips include the North Shore Volcanic Group, the Duluth Complex and the Proterozoic dykes and intrusions associated with Midcontinrnt Rift. Visit the ILSG website for more details.

Oceanic Volcanism and Mineralization: Modern versus Ancient

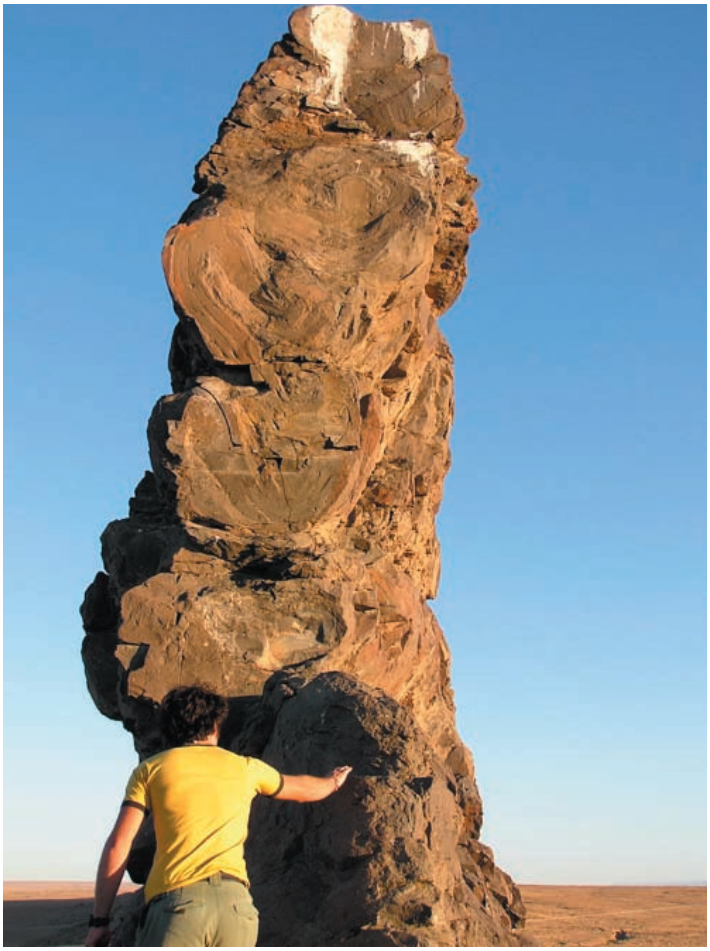
Organizers: Brian Cousens and Steve Piercey

The Volcanology and Igneous Petrology and Mineral Deposits Divisions will sponsor a short course entitled "Oceanic Volcanism and Mineralization: Modern vs. Ancient" at the 2007 Annual GAC-MAC meeting in Yellowknife. The goal of the short course is to recap recent advances in the physical volcanology and geochemistry of seafloor volcanic suites and to contrast modern volcanic examples with those in the rock record (Archean through Phanerozoic). The link between known or inferred tectonic setting and the style of hydrothermal (and other) mineralization will be emphasized. The material will be aimed at the non-specialist in both the fields of petrology and ore deposits, and one goal of the course is to bridge the professional gap between these two groups. The short course volume will be peer-reviewed, and the volume is to become a publication of the VIP/GAC or VIP/MDD subsequent to the 2007 meeting and will hopefully gain an international readership.

To date, six potential presenters have been identified and invited to participate. They are Richard Fiske, a specialist in explosive volcanism; David Clague, reknowned for his work at Hawaii, mafic pyroclastic volcanism, and hydrothermal mineralization on the seafloor; Wulf Mueller, with extensive experience in caldera systems and Archean through modern mineralization; Steve Piercey, who applies field, geochemical (major, trace, REE), stable (C-O-H-S) and radiogenic isotopic (Nd-Sr-Pb) techniques to understanding problems in economic geology, petrology and tectonics; Tim Kusky, a specialist in ophiolite complexes; and Mark Hannington, an economic geologist with extensive experience in mid-ocean ridge, island arc and back-arc systems and associated mineralization.

We are currently planning a two-day short course, with a second-day field trip to the superb Giant Section and other volcanological highlights in the Yellowknife town area, led by specialists in Yellowknife geology with strong industry backgrounds. Registration fees are estimated to be $200CDN for professional geologists and $100CDN for students.

For further information, contact Brian Cousens by e-mail at brian_cousens@carleton.ca or Steve Piercey at spiercey@laurentian.ca.



Unusual textures in a dyke radiating from Shiprock in New Mexico. This photo was taken during an undergraduate field trip and I struggled to explain the presence of these "slump" or "flow" structures in a dyke. If anyone can explain these features to me it would be much appreciated. Photo courtesy of Pete Hollings.

Please send contributions to the next Ashfall to

peter.hollings@lakeheadu.ca.