Atlantic Geology

Abstracts
Atlantic Universities Geological Conference 2002, October 24—26, 2002: Conference hosted by: The Bailey Society, University of New Brunswick, Fredericton, New Brunswick

Volume 38, numéro 2-3, 2003

URI : https://id.erudit.org/iderudit/ageo38_02_03abs01

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Éditeur(s)

Atlantic Geoscience Society

ISSN

0843-5561 (imprimé)
1718-7885 (numérique)

Découvrir la revue

Citer ce document

(2003). Abstracts: Atlantic Universities Geological Conference 2002, October 24—26, 2002: Conference hosted by: The Bailey Society, University of New Brunswick, Fredericton, New Brunswick. *Atlantic Geology*, *38*(2-3), 197–204.

Atlantic Universities Geological Conference 2002

October 24–26, 2002

ABSTRACTS

Conference hosted by:
The Bailey Society, University of New Brunswick

FREDERICTON, NEW BRUNSWICK

Again this year, abstracts from the annual Atlantic Universities Geological Conference (AUGC) are published in *Atlantic Geology*. This provides a permanent record of the abstracts, and also focuses attention on the excellent quality of the presentations and posters and the interesting and varied geoscience that they cover. Preceding these is a conference report from M.K. Gingras and R.K. Pickerill.

THE EDITORS

The 52nd Atlantic Universities Geological Conference was held at the University of New Brunswick, in Fredericton, New Brunswick, between October 24th and 26th, 2002. Participants arrived from Acadia, Dalhousie, Memorial, Saint Mary's and St. Francis Xavier universities. In all, 121 students registered for the conference. A complement of several professionals and university academics from Atlantic Canada supplemented the registrants. Sixteen students delivered papers at the conference: a new AUGC record. All presentations were of exceptional quality.

Christine Cunningham, the student chair of the conference, raised $15,000 to support the related activities. Donations were received from Imperial Oil, Shell Canada, Atlantic Provinces Council on the Sciences (APICS), the Atlantic Geological Society, Conoco Canada Resources Limited, Canadian Society of Petroleum Geologists, Maritimes and Northeast Pipelines, Association of Professional Engineers and Geoscientists of New Brunswick, Devon Canada, the City of Fredericton, Jacques Whitford Associates, Major Grilling Group, and the Potash Corporation of Saskatchewan. Well done to the organizer and our generous sponsors!

The activities began with registration and a social. Almost all the participants spent the evening discussing student life and geological interests over refreshments and karaoke.

October 25 was dedicated to geological field trips, offered by UNB faculty and a member of New Brunswick's Department of Natural Resources. The field trips comprised: acid mine drainage in the Minto coalfields, by Drs. Tom Al and Karl Butler; metallogeny at Mount Pleasant and Clarence Stream, by Dr. Dave Lentz; and, a look at the Albert Formation near Sussex, New Brunswick, by Drs. Murray Gingras and Dave Keighly (with help from Ian Armitage and Paul Wilson). The day was capped with a huge barbeque, hosted by Jason Kellog.

Presentations of the student research in Atlantic Canada occurred on October 26. As mentioned above, 16 papers were delivered. Each presenter (both oral and poster) received a certificate from the AGS, and a one-year subscription to Atlantic Geology. Dr. Dave Keighley, DNRE New Brunswick's hydrocarbon geologist, presented the certificates.

Les Fyffe (DNRENB), Dallas Davis (Geological Consultant), Dave Keighly (DNRENB) and Murray Gingras (UNB Geology) judged all of the talks. The posters were adjudicated by Jennifer Undershutz (Imperial Oil). The following awards were presented. The APICS award, primarily based on the scientific quality and relevance of the topic, the amount of the original work done by the student, and his/her understanding of the subject, was received by Amy Tizzard of Acadia University and was presented by Les Fyffe. The Frank Shea Memorial Award for the best paper dealing with Economic Geology was earned by Patrick Collins of Dalhousie University, and was presented by Dallas Davies. The Canadian Society of Petroleum Geologists Trophy, for the best presentation of a paper, was awarded to Nicolette Stanley, who studies at UNB. Murray Gingras presented the trophy. The Imperial Oil Best Poster was won by Sarah Eaton of Memorial University and awarded by Jennifer Undershutz.

A cocktail reception, ably conducted by Shahin Dastgard, provided the context for the awards presentation. Following the awards, a boat race between the participating universities ensued. Teams from each representative university competed against each other with a team of professors and professionals thrown in for good measure. The team of indentured boat racers (Brendan Murphy, Sandra Barr, Chris White, Dave Keighley and Murray Gingras), the Professornals, easily won the meet.

The conference could not have succeeded without all of the many students who volunteered their time. Thanks to Larry Amskold, Tamara Holmes, Ian Armitage, Jillian Hudgins, Vernon Banks, Jason Kellock, Matt Clark, Rob Richard, Shahin Dashtgaard, Nicolette Stanley, Aaron Desroches, Nesha Trenholm, Lynn Diamond, and Barton Blakney for jobs well done. Several faculty and staff of the UNB Geology Department contributed to and supported the conference, especially Karen Shea and Christine Lodge.

M.K. Gingras and R.K. Pickerill

Provenance of clasts in conglomerate units in northeastern mainland Nova Scotia and southwestern Cape Breton Island

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Coarse conglomerate units are common in the Guysborough – Isle Madame area of northeastern mainland Nova Scotia and southwestern Cape Breton Island. Maps of the area assign the conglomerate sequences to various units of several different ages, including the mid-Devonian Guysborough Group (Glenkeen Formation), the upper Devonian – lower Carboniferous Horton Group (Clam Harbour River Formation), and the Viséan Windsor Group. The Guysborough – Isle Madame area is located along part of the boundary between the Avalon (to the north) and Meguma (to the south) terranes, and hence the provenance of the clasts in the conglomerate units, as well as any differences in clast provenance in units of different ages, may provide information about the history of terrane juxtaposition.

Clasts were sampled from conglomerate units on Petit de Grat Island (Glenkeen Formation), in the Arichat area (Windsor Group), in the Guysborough area (both Glenkeen and Clam Harbour River formations), and at Cape Argos. Clasts from the Glenkeen Formation in both areas sampled are dominantly rhyolitic and dacitic lithic-crystal lapilli tuff, together with minor rhyolitic flow rocks. Crystals in the tuffaceous clasts are mainly quartz and plagioclase. Clasts of moderately mature quartz arenite are abundant in some sections of the conglomerate units, and rare clasts of granophyric granite were found in the conglomerate on Petit de Grat Island. Sericitic and chloritic alteration is pervasive, but the clasts have not been metamorphosed. The quartz arenite is well indurated and has the appearance of quartzite in hand specimen, but thin section examination shows that it retains a sedimentary texture. True quartzite clasts with sutured or polygonal quartz were observed in the Glenkeen conglomerate near Guysborough, where minor coarse-grained granitic clasts were also found. Like that in the Glenkeen Formation, conglomerate in the Clam Harbour River Formation has abundant felsic volcanic clasts.

Clasts from the Windsor Group north of the Arichat fault on Isle Madame are mainly deformed and recrystallized fine-grained granite/rhyolite and amphibolite-facies metamorphic rocks such as garnet-mica schist. These clasts appear to have been locally derived from the adjacent belt (within the Arichat fault zone) of metamorphic rocks of uncertain age. Quartz arenite and quartzite clasts are also present. The conglomerate at Cape Argos is of uncertain age, and differs from the other conglomerate sequences in that it contains mafic/intermediate volcanic clasts.

Older units of the Guysborough Group, underlying the Glenkeen Formation, are potential sources for the volcanic clasts in the conglomerate units, although the abundance of felsic clasts is not consistent with the reported dominance of basaltic rocks in those units. Other possible sources are the late Precambrian volcanic belts of southeastern Cape Breton Island, and Silurian volcanic units in the Antigonish Highlands.

Deep-sea corals: their use as climate change indicators

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The need for climate change modeling is becoming a major issue, with the increasing concern of global warming. Within the past 15 years, the use of corals to measure changes in temperature has led to a new way of determining climate change. Corals record the surrounding seawater temperatures through element partitioning, i.e. Sr vs. Ca. Deep-sea corals record bottom water temperatures, which do not vary seasonally, thereby limiting the variations in temperature to long-term changes. The coral species *Flabellum alabastrum*, found along the Atlantic coast on the continental slope, can be analyzed for Sr/Ca ratios to calibrate bottom temperatures over the past 100 years on the slope. *Flabellum alabastrum* shows annual banding that can be individually analyzed using an electron microprobe. To ensure accuracy, several samples from the same area are compared in this study. Banding must be continuous, otherwise dissolution has occurred and records will be lost. In addition to recording temperature, deep-sea corals may also yield valuable information for the oil and gas sector. If the source of carbon is organic, the coral must be feeding on organic carbon, such as oil or gas from seeps in the ocean floor.

The life and death of a Pennsylvanian meandering river

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A detailed description is provided on the evolution of a Pennsylvanian meandering channel in northern Nova Scotia. The channel succession is located in the upper part of the Thorburn Member of the Stellarton Formation, which is a broad, partly fault-bounded, pull-apart graben-fill unit that developed in response to dextral movement on the Cobequid and Hollow fault systems during the Westphalian B Maritime Disturbance. Recent quarrying of the Thorburn Member using a twenty-foot mining saw to access a coal seam has resulted in an unparalleled exposure of a meandering stream succession lying above the coal seam. The quarry-face offers a detailed record of the impact a fluctuating climate can have on the evolution of a fluvial channel. The meandering sedimentary system which has produced a series of scroll bars is preceded and followed by periods of sheet flood deposition. The sheet flood successions were deposited under a relatively dry climate with a short and intense wet season, while the meander channel deposits are the manifestation of a more humid climate with steady precipitation that supported arborescent life. The sheet flood deposits contain pedogenic siderite bands and exhibit a complete lack of fossil trees. Fossil trees are, however, found on the embankment surface that is contemporaneous with the active meander channel. An occasional return to a more uniform, less-seasonal climate is indicated by a number of well-defined channel-cuts within the sheet flood deposits that overlie the meander channel. These channel-cuts concentrated in the pre-existing depression that dates from the time when the meander channel was active. The last of these channel-cuts was not filled by sheet flood deposits, but from flow velocity reduction of the channelized stream that excavated it. This channel fill deposit marked the final episode in the life of the meander.

Diagenetic pyrite in a petroleum reservoir in Cretaceous volcanics in the Andes replaced by hydrothermal copper

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El Soldado, Chile, is a giant stratabound copper deposit hosted in Lower Cretaceous basalt and rhyodacite. Previous work had suggested that copper was concentrated preferentially where hydrothermal copper-rich solutions replaced preexisting, low-temperature, diagenetic pyrite, which is generally associated with bitumen (solidified petroleum). Doubt remained on whether some deep zones with massive crystalline pyrite veins, and massive chalcopyrite, bornite and chalcocite ores, could represent a net input of sulphur from hydrothermal, magmatically-derived sources. Magmatic related sulphur has a $\delta^{34}S$ value close to zero per mil. Conversely, diagenetic, low-temperature crystallization of pyrite, especially with the aid of sulphur-reducing bacteria in a degrading petroleum reservoir, would have led to extreme fractionation of sulphur and a wide range of $\delta^{34}S$ values, which would be locally available to form Cu sulphides during the hydrothermal phase.

Polished sections of ores were studied under the reflected light microscope. There is textural evidence of pre-existing diagenetic pyrite, as well as textures indicative of new hydrothermal growth. Diagenetic pyrite is characterized by framboidal structures of ca. 16μm diameter or smaller; colloform textures found in pyrite also suggest a low-temperature genesis. Although controversial, the general consensus is that framboids may grow with bacterial involvement. A range of stages of development of massive crystalline aggregates is observed in the samples: individual microcrysts, framboids, framboid clusters, recrystallized megacryst overgrowths, and banded concentric zones. Hydrothermal or high-temperature textures are characterized by idioblastic pyrite cubes or pyritohedra suspended in late calcite matrix. Temperatures from fluid inclusions in calcite indicate maximum (pressure corrected) temperatures of ca. 300 °C, and minimum temperatures of over 100°C.

$\delta^{34}S$ values from analysis of sulphide separates have a range of 24.5‰, from −7.4‰ to + 17.1‰. This variation is characteristic of a compartmentalized system that has been incompletely fractionated, and is compatible with bacterial interaction. Several samples yielded $\delta^{34}S$ values overlapping with that characteristic of magmatic sulphur, thus allowing for the possibility of some degree of input of homogenized sulphur, perhaps (but not necessarily) from a magmatic source.

Microprobe analyses indicate the presence of local concentrations of arsenic within the core of framboidal structures and also in fresh overgrowths on idiomorphic pyrite, probably inherited from the diagenetic phase.

Facies and porosity distribution of the Gays River Formation, southside Antigonish Harbour

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The Gays River Formation consists of fossiliferous carbonate buildups found at the base of the Windsor Group. It is best developed in areas where the Windsor Group onlaps directly onto the pre-Carboniferous basement, which, in this case, is a granodiorite. This formation is of interest because of its potential as a reservoir rock for oil and gas. It is overlain by evaporites of the Windsor Group, creating a natural stratigraphic trap, and underlain by shales of the Horton Group, which are good source rocks. The rocks can be separated into four different lithofacies: a bafflestone, a wackestone, a mixed wackestone-bafflestone, and a mixed wackestone-grainstone. The bafflestone is a mound deposit that directly overlies the granodiorite. As distance from the inlier increases, wackestone becomes the dominant facies. The mixed lithologies are found between the bafflestone facies, and the wackestone. The highest porosities are found in the wackestone, and mixed wackestone-bafflestone facies.

Methods in the sampling and studying of natural abundances of 15 N in lichens

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Lichens have been used as biomonitors in the study of atmospheric pollution since the early 19th century. They are sensitive to atmospheric pollution and the natural abundances of stable isotopes can be studied using mass spectrometry. The lichen species *Alectoria sarmentosa* will be sampled and studied throughout this project. Three sites have been selected for the study of the natural abundances of nitrogen (15N). The 15 N abundances can be studied using Continuous Flow Mass-Spectrometry (CF-IRMS).

Joints, Faults and Lamprophyres of the Monashee Complex, BC

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Thor-Odin dome, a metamorphic core complex, is located within the Monashee complex, part of the Canadian Cordillera. The geology of the Monashee complex has been shaped by at least five phases of deformation of folding, shearing and re-folding, the last involving extension during the Eocene, and the intrusion of lamprophyre dykes during extension through to after regional cooling, with marked changes in composition between individual dykes. This period is also related to brittle deformation – faulting and jointing, with varying amounts of displacement. There appears to be 3-4 distinct groups of faults throughout the studied area, and also throughout the Thor-Odin dome. The main fault groups are steeply dipping: trending around 200°, 170° and east-west. The joints follow the same orientations as the faults. Often, faults contain slickenlines, but no obvious offsets. The lamprophyres have the same orientations as the 200° and 170° trending faults, indicating that lamprophyres intruded through existing steeply dipping faults in the upper crust, with no or minimal movement occurring on the faults after intrusion. The lamprophyres cross-cut all other structures, and are weakly metamorphosed, probably due to cooling after emplacement, and metasomatism. There is one exception, however, a recrystallized, foliated lamprophyre mingling with a pegmatite in a shear zone. This could represent the start of a period of dyke intrusion, with lamprophyres being emplaced throughout the extensional period, however concentrated in the post-cooling time-frame.

Glacial Geology of the Peggy's Cove Region

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Precisely documenting glacier ice volume and geometry, and the timing and rate of ice marginal retreat in Atlantic Canada is important for the reconstruction of past climate changes, evaluating the role of glaciers in epierogenic uplift and shelf sedimentation, and understanding lithospheric responses to sudden glacier loading and unloading. Glaciation of the Peggy's Cove region during the last glacial advance streamlined the bedrock into stoss-lee ridges and deposited large granodioritic boulders. The interaction between coeval ice retreat and sea level is not yet fully understood in this region. Ice is thought to have persisted until 11.0 kyr (non-calibrated ^{14}C), or 13.1 to 12.8 kyr calibrated ^{14}C. These ages are taken from sample sites far removed from the Peggy's Cove region and there is a lack of adequate time control. However, the boulders may have been deposited after a local re-advance during the Younger Dryas.

Cosmogenic ^{10}Be and ^{26}Al produced *in situ* in quartz will be used to determine the deglacial history and net glacial erosion thickness in the Peggy's Cove region. The terrestrial *in situ* cosmogenic nuclides (TCN) are products of the interaction between secondary cosmic rays and exposed minerals near Earth's surface. Sampled coarse-grained granodioritic boulders have > 2m diameter, have horizontal (2σ) surfaces, experienced no vegetation cover, have little probability of snow cover, have not rolled since deposition, and exhibit weak indications of weathering. Bedrock samples with similar exposure attributes are taken adjacent to four sampled boulders. Sample preparation is done in two parts: physical processing and chemical processing. Physical processing is used to crush, grind, and sieve the samples to obtain 600 g of the optimum grain size, 350-500 μm, to be used in the chemical processing. Chemical processing requires the separation and isolation of Be and Al from the sample. The ca. 1.5 mg of BeO and Al_2O_3 powders are then loaded into metal targets and sent to a particle accelerator for measurement of the ratio of cosmogenic isotope to a stable isotope (typically ca. 10–12 to 10–15). Measurements of the stable Be and Al abundances are completed at Dalhousie Metallurgic Engineering AAS.

The reduced data (concentrations of TCN in quartz) provide a means of estimating the duration of exposure since deglaciation to within 1 kyr (total uncertainty, 1σ). Combined with a glacial geology map compiled at 1:20,000, the results will help determine the timing and rate of ice marginal retreat, sea level involvement, and paleoclimate influences. The glacial geology and deglacial chronology will complement nearby offshore records to improve our understanding of Maritime glaciation and deglaciation during the late Pleistocene. A total thickness of bedrock removed from streamlined ridges will be calculated by comparing the ^{10}Be and ^{26}Al concentrations of the boulders and adjacent bedrock surfaces. The bedrock concentrations will be higher than the mean boulder concentration if glacial erosion of the bedrock did not completely strip the surface to remove TCN produced prior to the last glacial cover. The differences between the concentrations in boulders and bedrock will be proportional to the thickness of bedrock removed. For glacial removal of more than 3 m, the boulders and bedrock surfaces should have equivalent TCN abundances.

Petrology and tectonic setting of the Wedgeport Pluton, southwestern Nova Scotia

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The Wedgeport Pluton outcrops approximately 10 km southeast of Yarmouth in southwestern Nova Scotia. Recent 1:10 000 scale bedrock mapping related to the Southwest Nova Mapping Project has better defined the contact relations and extent of this intrusion. Previous work had focused on the economic potential of the granite, and no systematic study had been completed on the petrography and tectonic setting of the pluton. This work is being undertaken as a B.Sc. Honours Project at Acadia University.

The Wedgeport Pluton is mainly medium- to coarse-grained, grey, equigranular biotite monzogranite. Locally the pluton contains biotite-rich granodioritic enclaves, and pink coarse-grained granitic porphyry. The pluton commonly displays convolute compositional banding, possibly related to magmatic flow contacts with the country rock. In the biotite monzogranite, subhedral plagioclase is typically slightly- to heavily altered to sericite, and biotite is partially altered to chlorite. Microcline has characteristic cross-hatched twinning and shows perthitic texture. Quartz displays varying degrees of undulatory extinction. Based on petrographic characteristics the pluton can be divided into two units; a garnet-rich monzogranite in the northwestern portion of the intrusion, and a garnet-poor unit that comprises the remainder of the pluton. All units in the Wedgeport Pluton contain abundant accessory minerals, including titanite and zircon. Epidote is also abundant, but of uncertain origin.

The Wedgeport Pluton is poorly exposed inland due to thick glacial till deposits and large salt marshes, although some outcrops occur in the bottom of gravel pits. Most of the outcrop is exposed on the coast or in drill core extracted by Shell in the 1970s. The Wedgeport Pluton intruded the Cambrian to Lower Ordovician metasedimentary rocks of the Goldenville Formation of the Meguma Group. Along the west side of Pinkneys Point, an intrusive contact is exposed and is typically parallel to bedding in metasandstone of the Goldenville Formation. The intrusion formed a narrow contact metamorphic aureole consisting of garnet-bearing hornfels. Other contacts are not exposed, although the location of the eastern margin of the pluton is inferred by the presence of small granitic dykes, presumably related to the pluton, in the Goldenville Formation.

East-west trending fractures and shear zones in the Wedgeport Pluton typically contain tin mineralization and in the past have been explored for their economic potential. Aplitic and pegmatitic dykes are visible in outcrop, and mafic dykes can be seen in drill core.

Mineral analyses by electron microprobe and whole-rock geochemistry (major, trace and rare earth elements) are in progress and should help to determine the tectonic setting and origin of the Wedgeport Pluton.

Laser ablation ICP-MS geochronology of the Dog Bay Line area, Newfoundland, with respect to the Botwood Basin gold occurrences

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The scope is to provide provenance zircon data studies for samples from those of the Badger, Botwood, Davidsville and Indian Islands groups (BBDI) from the Notre Dame Bay to Gander Bay region located on either side on the Dog Bay Line area using the LAM-ICP-MS as a geochronometer.

The BBDI samples are of interest because the Dog Bay Line denotes the boundary between opposed sides of the ancient Iapetus Ocean and therefore the samples should reflect relative Laurentian and Gondwanan detrital influences. The determination of provenance will have important implications for the exploration of the Botwood Basin sediment-hosted disseminated gold occurrences by defining absolute ages for the hosts to mineralization and their tectonic depositional environments.

Quaternary and Late Tertiary seismic stratigraphy of the central Scotian Slope from high-resolution seismic

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High-resolution single channel seismic reflection profiles collected by the Geological Survey of Canada Atlantic (GSCA) have been used to define the Quaternary and Late Pliocene seismic stratigraphy of the central Scotian Slope, southwest of Sable Island Bank.

High-resolution reflection profiles used in this study have a dominant frequency at 180 Hz providing near 1 m vertical resolution. This resolution, approximately tenfold that of industry data, is ideal for describing the seismic facies and seismic stratigraphy of Quaternary and late Tertiary strata of the central Scotian Slope.

Down-dip thinning and pinch-out of coherent, laterally continuous reflectors indicate the general mode of sediment deposition is by turbidity currents and hemipelagic drape. The turbidite intervals appear to emanate from outer shelf/upper slope till tongues, tying into major shelf-crossing Quaternary glaciations. Several key reflectors have been identified and correlated throughout much of the study area. Isochron maps constructed from these reflectors show that late Tertiary sediment accumulated uniformly on the slope, whereas Quaternary sediment accumulated preferentially on the upper slope. In addition, numerous examples of slope instability were observed, including sediment failures, mass transport complexes, and structures related to near-surface salt deformation.

Geochronological study of a previously defined geochemical stratigraphy for the Buchans Group, Buchans area, Newfoundland, using LAM-ICP-MS

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The Buchans mine, to date, is the largest producer of VMS-style ore mineralization discovered on the island of Newfoundland. The site has been characterized as a classic Kuroko type deposit exhibiting a well-preserved alteration halo, and mechanically transported ore. *In situ* and transported ores were mined at the site beginning in 1927 until its closure in 1984. Since the closure of the Buchans mine, exploration has been hindered by the stratigraphical and structural enigmas of the surrounding area. With the understanding of the hanging wall and footwall chemostratigraphy of the ores, the study of the stratigraphy is a key exploration tool.

Geochronological data obtained using zircon grains are presented for the Buchans Group to support recent geochemical advances made in the region. Zircon is a mineral that is commonly used in geochronology due to its robust nature. It contains little common lead (providing more precise ages) and is very resistant to weathering or alteration processes that may affect the system.

Samples were obtained from (1) the Sandy Lake Formation, (2) the Lucky Strike footwall, and (3) the Prominent Quartz Rhyolite. Sample preparation and analytical procedures were carried out at the Department of Earth Sciences, Memorial University of Newfoundland laboratories using LAM-ICP-MS (Laser Ablation Microprobe-Inductively Coupled Plasma-Mass Spectrometer) as a geochronometer and a SEM (Scanning Electron Microprobe) to determine the extent of zonation or inclusions. U-Pb dating of zircons using this technique provides efficient and rapid age analysis of in situ and detrital zircons in rocks. These data help pinpoint likely sources for detrital zircons in the Sandy Lake conglomerate and provide ages for the in situ volcanic rocks.

Ilmenite-pyrophanite and niobian rutile in the South Mountain Batholith

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Ilmenite and rutile are ubiquitous, but modally scarce, minerals in relatively unaltered granitoid rocks of the differentiated peraluminous South Mountain Batholith (SMB). Ilmenite occurs as blocky 0.05–0.90 mm grains in biotite, and as discrete larger anhedral grains along silicate grain boundaries. Ilmenite grains show compositional zoning toward the pyrophanite ($MnTiO_3$) end-member, ranging from 3–15 wt.% MnO in the cores to 5–23 wt.% MnO on the rims. Rim-core differences range from 2–12 wt.% MnO, generally with larger variations in the more fractionated rocks. With increasing fractionation in the batholith as a whole, the MnO content of the ilmenite tends to decrease, albeit with considerable scatter. Texturally and chemically, the ilmenite-pyrophanite solid solutions appear to be primary magmatic minerals of the SMB throughout its crystallization history. Rutile occurs as 0.03–0.70 mm, euhedral to anhedral, grains as inclusions in biotite. Compositionally, most rutile contains Nb_2O_5 (up to 4 wt. %) and Ta_2O_5 (up to 2 wt. %), both elements becoming more highly concentrated in rutile from the more fractionated granitic rocks (from 0.5–1.5 wt. % Nb_2O_5+Ta_2O_5 in the early rocks to 0.1–3.5 wt. % Nb_2O_5+Ta_2O_5 in the most evolved rocks). Texturally and chemically, the niobian rutile also appears to be a primary magmatic phase of the SMB throughout its crystallization history. During evolution of the batholith, whole-rock Nb+Ta remains roughly constant at about 10–15 ppm, but the latest and most evolved rocks show a wide variation, ranging from 5–50 ppm Nb+Ta. With this differentiation, the whole-rock Nb/Ta ratio decreases from ~15 to 3, whereas the rutile Nb/Ta ratio increases from ~5 to ~20. Niobium-tantalum fractionation, as indicated by the variation in whole-rock and rutile Nb/Ta ratios, has implications for the formation of tantalum mineral deposits in the late stages of differentiation of the batholith.

Economic Opportunities Associated with the Geology of Labrador, Canada

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The geology of Labrador has played a major role in the lives of its peoples for centuries. Stones and boulders left by glaciers in northern Labrador provided the means for housing and spiritual gathering places. The Inuit utilized chert from Ramah Bay to make tools for hunting and gathering. Now, the people of Labrador are looking for new ways to prosper from the geology around them. The Torngait Ujaganniavingit Corporation (TUC), a subsidiary of the Labrador Inuit Development Corporation (LIDC), has sole ownership of a labradorite-granite quarry at Ten Mile Bay near Nain, Labrador. The rock is used as dimension stone and business is directed primarily towards a European market. The most recent exploration effort by LIDC is focused on several pegmatite bodies near Churchill Falls, Labrador, informally termed the Black Bear pegmatite. Work by LIDC is ongoing and will likely continue into 2003. The pegmatite may be an economically viable source of potassium feldspar for use in the ceramic and ceramic glaze industries. The primary focus of this project is on exploration performed in conjunction with LIDC on the Black Bear pegmatite, and follow-up studies of the mineralogy of the pegmatite bodies.

Passive treatment of mine drainage using sulphate-reducing bacteria: a field experiment

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The research was based at the Mount Pleasant Mine site in southern New Brunswick where Fe, Zn and As-contaminated water drains from the mine portal. The project involves the use of bacterial sulphate reduction to precipitate metals from the water as insoluble metal-sulphide minerals in anaerobic columns. The columns were filled with a permeable reactive mixture that would promote the growth of sulphate-reducing bacteria (SRB). Water samples were collected at six points along the 16 m column flow path, and analyzed for the concentrations of major cations, anions, and trace metals, as well as, pH, Eh and alkalinity.

The data suggest that sulphate-reducing conditions have been attained intermittently within the columns. During these time periods the SO_4 concentration decreased by between 30 and 70 %. With the onset of sulphate reduction, a decrease in Fe, Zn, and As was not immediately achieved as might be expected. Instead, during the first few intervals of sulphate-reduction, the concentration of Fe increased from approximately 10 mg/L up to a maximum of 20 mg/L, and the As concentration increased also from 4 mg/L up to a maximum of 70 mg/L. The increases can be attributed to the coexistence of Fe(III)-reducing bacteria and sulphate-reducing bacteria. Prior to the onset of sulphate-reducing conditions, Fe(III) oxy-hydroxides from the mine water accumulated in the columns. As sulphate-reducing conditions were attained in the columns, conditions were also favourable for the reductive dissolution of Fe(III) oxyhydroxides. These reactions reduce iron to the soluble Fe(II) form, and also mobilize As which is associated with the Fe(III) oxy-hydroxides through adsorption and co-precipitation. After 200 days of running the experiment, the iron concentration started to decrease across the columns from 12 mg/L to 8 mg/L. This is an indication that the SRB became the predominant microbial colony in the columns and that the excess iron hydroxides hade been depleted.

During time periods when sulphate reduction was occurring, the concentration of Zn decreased significantly versus distance along the flow path, with initial concentrations of 4.5 mg/L declining to less than 1 mg/L. Sulphate reduction generally results in an increase in pH from 6 to 6.5 across the columns; however, during the last period of sulphate reduction the pH increased to 8.

Currently the columns are not achieving sulphate reduction continuously. The sulphate-reducing bacteria need an optimal anaerobic environment with a continuous source of organic substrate to remain active. The temperature and flow rate are also variables that can change the activity of the SRB. The minimum temperature and maximum flow rate for the survival of the bacteria have not been determined. If sulphate reduction is to be used for passive treatment of the mine water then changes in these conditions would have to be studied. The data could be used to determine the minimum residence time in the reactive material required to treat the water and whether the organic substrate used will be a limiting ingredient.

Structural geology and basement-cover relations in the southeastern Cape Breton Highlands, Nova Scotia: preliminary results

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The southeastern Cape Breton Highlands consist of various pre-Carboniferous plutonic, volcanic and metamorphosed basement rocks of the Bras d'Or terrane, with Carboniferous sedimentary material in the adjacent valley and coastal regions. Field investigations in the past have shown the geological irregularity in this area of Cape Breton Island that the older basement rocks lie at equal, if not higher, topographic elevations than the nearby Carboniferous sedimentary units. This study attempts to resolve the structural relations between the Carboniferous sedimentary units and adjacent pre-Carboniferous basement rocks in this area using geological mapping with an emphasis on lithological contact configurations, structural data constructions such as cross-sections, three-point problems and stereoplots, thin section petrography to decipher a potential provenance source of many of the sedimentary units, and the degree of alteration of parts of the basement material, and a comparison of these data with geophysical maps and satellite imagery.

Mapping of the area around the basement-cover contact has shown faulting, shearing and unconformities. Structural analyses confirmed the field mapping in the Goose Cove – St. Ann's area, showing that the dip of the contact plane between the basement and sedimentary units is shallow, with an average dip angle of 14·8°. Thin section petrography has revealed a wide range of basement conditions from completely unaltered to mylonitic. Interpretation of gravity data in the southeastern Highlands suggests that the basement has no root, particularly in the Goose Cove – St. Ann's field area.

These observations have several implications for the development of the southeastern Highlands, the most significant being that a thrust sheet of basement material appears to have been transported over the younger sedimentary units verging eastward in this area of Cape Breton Island. Potentially a large part of the Cape Breton Highlands may be allochthonous.