Abstracts of oral presentations and posters

Québec exploration 2006

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Ressources naturelles et Faune
Québec

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Table of contents

Abstracts of oral presentations	7
Abstracts of posters	28
Abstracts of interactive sessions	55
Acronyms	58
List of exhibitors	59
Maps of exhibit rooms	62
Projects location	67



Message from the Minister of Natural Resources and Wildlife

As the minister responsible for the Québec mining, gas, and petroleum sector and minister responsible for two mining regions—Abitibi-Témiscamingue and Nord-du-Québec — I am very pleased to invite you to Québec Exploration 2006.

The Québec mining industry is booming. In 2005, over $200 million was spent on exploration and mineral deposit development in Québec. Gold, nickel, copper, and, to a lesser extent, diamonds, zinc, iron, and uranium are the substances attracting the most note.

In terms of the mining investment environment, Québec ranks number one in Canada and offers some of the biggest benefits in the world. Québec Exploration 2006 is the opportunity to discover Québec's mining, gas, and petroleum potential and increase your knowledge of exploration.

This must-attend convention will bring together some 1,500 people from Canada, the United States, and Europe and enable you to forge strategic partnerships to help advance your exploration projects. I would also like to take the opportunity to wish you a great stay in the historic capital of Québec.

Enjoy the convention!



Pierre Corbeil

Minister of Natural Resources and Wildlife

Message from the Chairman of the Québec Mineral Exploration Association

Once again this year, the Québec Mineral Exploration Association and Ministère des Ressources naturelles et de la Faune have joined together to present Québec Exploration. On behalf of AEMQ, I am delighted to invite you to take part in this event, whether as an exhibitor, conventioneer, or financial partner.

Over the years, Québec Exploration has grown to be one of the biggest mining conventions in Canada. I sincerely hope you join the 1,500 attendees from Canada, the United States, and even Europe who will be meeting in Québec City for this popular event.

Under the theme "Mineral Exploration at its Best," the organizing committee has put together a diverse program of conferences sure to interest you. It covers topics such as mineral and petroleum exploration, the environment, and access to land. Moreover, continuing a trend begun last year, we have added other activities tailored more towards financial industry stakeholders.

Of course, I invite all AEMQ members to take part in the Association general assembly on November 22 where the first results of the 2006–2011 strategic plan will be unveiled. In addition, a number of administrator positions will be available, and I encourage you strongly to get involved and support AEMQ in its ongoing goal to meet the objectives of its strategic plan.

And remember—Québec Exploration 2006 will be held in the world heritage city of Québec, so feel free to take full advantage of your stay to explore this marvelous travel destination.





Gérald Riverin

President, Québec Mineral Exploration Association



Message from the Honorary Chairman of Québec Exploration 2006

With Goldcorp's recent acquisition of the Éléonore gold project and involvement in Northwestern Québec, it is a privilege being asked to be Honorary Chairman for Québec Exploration 2006.

Mineral exploration is increasing throughout Québec with the mining and metals industry now providing nearly 50,000 jobs throughout the province.

Goldcorp is pleased to be part of this growing sector and investing in what we believe to be one of the most promising new gold districts in North America. It is my pleasure to invite you to attend Québec Exploration 2006, where you will be given the opportunity to make new contacts, share ideas and learn more about mineral exploration in Québec.

Ian Telfer

President & CEO

Goldcorp Inc.

Honorary Chairman of Québec Exploration 2006

Abstracts of oral presentations and posters

8:15

Official opening

Presented by the president of the Québec Mineral Exploration Association and executive director of Géologie Québec

Session 1

Mineral exploration in Québec in 2006

Chair : Georges Beaudoin (Université Laval)

8:30 **Keynote speaker**

Geological and mineral exploration in Québec: An overview

Robert Marquis, Sylvain Lacroix (MRNF)

9:00 **Keynote speaker**

E **Geological setting and discovery potential of world class gold deposits in Asia**

Richard Goldfarb (USGS) and Craig Hart (University of Western Australia)

9:50

Geology of the Roberto gold deposit, Éléonore property, James Bay, Québec

Jean-François Ravenelle (INRS-ETE), Benoit Dubé (CGC-QC), Michel Malo (INRS-ETE), Vicky McNicoll (CGC-Ottawa), Hervé Thiboutot (Goldcorp Inc./Mines Opinaca Ltée), Paul Archer (Mines Virginia), Daniel Bandyayera (MRNF), Michel Gauthier (UQAM)

10:10

Matagami Camp: A new concept–based approach

Gilles Roy, Michel Allard (Xstrata)

10:30

Assessing mineral potential for porphyry copper-gold-molybdenum deposits in Abitibi

Jean-Yves Labbé, Pierre Pilote, Daniel Lamothe (MRNF)

10:50

Composition of iron oxides: A new exploration tool

Georges Beaudoin, Patrice Gosselin (U. Laval), Michel Jébrak (UQAM)

Session 2

Assessing Québec's hydrocarbon potential using analogues in northeastern North America

(Session dedicated to the late Professor Pierre-André Bourque)

Chair: Denis Lavoie (CGC-Québec)

1:30

Perspectives and concepts on hydrocarbon exploration in Québec: A world of discovery!

Robert Thériault, Jean-Yves Laliberté (MRNF)

2:20

E **Petroleum on the Port au Port Peninsula, Newfoundland and Labrador**

Steven Millan (Canadian Imperial Ventures)

2:40

E **Development of the Ordovician hydrothermal dolomite play in the Appalachian Basin**

John Martin (NYSERDA)

3:00

E **The Michigan Basin Devonian Antrim Black Shale: Economic and technical evaluation of a natural gas resource play and how it relates to the potential of the Lower Paleozoic in the Québec Lowlands**

James Morabito (AGMEN)

3:20

West Point reef complex in Gaspésie: a "Sleeping Beauty?"

Pierre-André Bourque (U. Laval), Claude Morin, [1]Bernard Granger (HQPG)

3:40

E **Hydrocarbon prospectivity of the eastern Canadian Maritimes Basin: testing a North Sea analogue**

Peter Giles (Geological Survey of Canada)

[1] Speaker

E **Conferences will be given in English**

Simultaneous interpretation will be available for all conferences.

Session 3

Environment and land access

Chair: André Vachon (Roche Ltée)

8:30

Mineral exploration and the Regulation respecting standards of forest management for forests in the domain of the State

Guy Rochette (Forchémex Ltée)

8:50

Environmental assessment of mining projects in Agreement territory

Serge Tourangeau (Roche Ltée)

9:10

Agreements with Aboriginal Communities: Practical considerations

Jean M. Gagné (Fasken Martineau DuMoulin)

9:30

"La Paix des Braves" and mining activities in Eeyou Istchee

Jack Blacksmith (Cree Mineral Exploration Board)

9:50

The government's approach to protected areas in Québec: selection process for new protected areas on public lands

Michel Bergeron, François Brassard (MDDEP)

10:10

The government's approach to protected areas in Québec: socioeconomic evaluation with respect to mining activities

Sylvain Lacroix, Hélène Giroux, Sébastien Desrochers (MRNF)

10:30 **Keynote speaker**

E **Conference by honorary chair**

Ian Telfer, President and CEO (Goldcorp)

E **Conferences will be given in English**
Simultaneous interpretation will be available for all conferences.

Session 4

Nickel-copper-platinum group (Ni-Cu-PGE) exploration and mining

Chair: Danielle Giovenazzo (Xstrata)

8:30 Keynote speaker

E **How Komatiite deposits and Voisey's Bay advanced our understanding of Ni-Cu sulfide deposits**

Anthony J. Naldrett (University of Toronto)

9:20

Zone 5–8: Resource renewal at Raglan

Grant Arnold, Pascal Lessard (Falconbridge Ltd.)

9:40

E **Raglan South Nickel-Copper Project, an update**

Bruce Durham, James Mungall (Canadian Royalties)

10:20

E **Exploration at West Raglan, an integrated approach**

Harvey Keats (Knight Resources Ltd.), Richard Dutresne (AAEC)

10:40

The Labrador Trough and its Ni-Cu ±PGE deposits

Thomas Clark (MRNF)

11:00

E **Reid Brook: New Insights into the Voisey's Bay Nickel, Copper, Cobalt Deposit**

Dawn Evans-Lamswood, Robert Wheeler (Voisey's Bay Nickel Company Ltd.)

E **Conferences will be given in English**
Simultaneous interpretation will be available for all conferences.

Session 5

Taking a new look at the Abitibi Subprovince

Chair: James Moorhead (MRNF)

1: 30

Lithologic and stratigraphic synthesis of the Abitibi greenstone belt

Jean Goutier (MRNF), John Ayers (OGS), Phil Thurston (Laurentian University)

2 :00

E **Linking hydrothermal flow paths and VMS deposits in the Noranda camp and the Blake River group**

Bruce Taylor (CGC), Claude Dion (MRNF), Ben Berger (OGS), Benoît Dubé, Pierre-Simon Ross, Patrick Mercier-Langevin (GSC)

2 : 20

New geological and metallogenic data in the western portion of the Blake River Group and along a segment of the Larder Lake Cadillac Fault

Claude Dion, Marc Legault (MRNF), Olivier Rabeau (URSTM), Pierre-Simon Ross, Patrick Mercier-Langevin (CGC)

2 : 40

Potential and distribution of komatiite-associated Ni-Cu-PGE deposits in the Abitibi greenstone belt

Michel G. Houlé (OGS), Pierre Pilote (MRNF), C. Michael Lesher (MERC)

3 :00

E **The base metal exploration iImplications of new Abitibi Stratigraphic Models based on the results of the Greenstone Architecture Project, Discover Abitibi Initiative in the Timmins-Kirkland Lake area**

J.A. Ayer (OGS), P.C. Thurston (LU-MERC)

3 : 20

A new Megatem survey in the Chibougamau area

Pierre Keating (CGC), Régis Dumont (CGC), Benoît Dubé (CGC), Patrice Roy (MRNF), Patrick Houle (MRNF)

3: 40

A look at the gitology of the southern flank of the Doré Lake Complex in the Chibougamau mining district: Integrating data into a new 3D model

Patrice Roy, Patrick Houle (MRNF), Francine Fallara, Li Zhen Cheng (URSTM), Jean Girard (Ressources Campbell), Benoit Lafrance (Ressources Cogitore), Pierre Pilote (MRNF), Gérald Riverin (Ressources Cogitore)

Session 1 **8:30**

Geological and mineral exploration in Québec: An overview

Robert Marquis, Sylvain Lacroix (MRNF)

The mineral exploration sector remained very dynamic in Québec in 2006. Based on company spending intentions, exploration and deposit appraisal expenditures should reach $234.3M in 2006, breaking the $200M mark for the third consecutive year. Figures like these haven't been observed in Québec since the late 1980s.

The distribution of exploration and deposit appraisal expenditures in 2006 should remain relatively similar to that observed in 2005, when the bulk of expenditures ($209.2M, preliminary data) was allocated to the search for precious metals ($125.1M, 60%), mainly in the Abitibi-Témiscamingue and James Bay regions. An amount of $54.8M (26%) was spent on base metal exploration, which includes both the search for copper and zinc in northwestern Québec and the search for copper and nickel in the Ungava region. An amount of $21.4M (10%) was allocated for diamond exploration, whereas lower, albeit growing amounts were recorded for uranium ($3.9M, 2%) and iron ($1.2M, 0.6%) exploration.

The MRNF stepped up its geological exploration activities in 2006, namely to identify new exploration targets for copper and promote new discoveries likely to provide copper concentrate for the Horne smelter. Thus, the governments of Québec and Canada have committed a budget of some $2M each to perform geoscience work in order to address priorities listed in the Copper Plan, in conjunction with regional and industry stakeholders, the Geological Survey of Canada (Targeted Geoscience Initiative) and the Ontario Geological Survey. The main areas targeted for geoscience work in 2006 are located in the vicinity of Rouyn-Noranda, Lebel-sur-Quévillon, Matagami, and Chibougamau, as well as in the Opinaca area in the James Bay region.

Géologie Québec also completed several inventories covering the geology of the Côte-Nord region and the Réserve faunique des Laurentides, glacial deposits in the Near North, dimension stone in the Côte-Nord region, crushed and industrial stone in southern Québec, as well as many compilation projects, studies, and geological syntheses covering various parts of Québec's landmass.

Session 1 **9:00**

Geological setting and discovery potential of world-class gold deposits in Asia

Richard J. Goldfarb (USGS), Craig J. R. Hart (CET)

Among the most significant change in global exploration patterns during the past 10 to 15 years is the recognition of highly prospective regions throughout much of Asia, mostly as a result of rapidly changing world politics, economies and infrastructure. World-class gold resources are now being exploited across central Asia and are being evaluated throughout much of eastern Asia. The high degree of prospectivity reflects favourable geological settings mainly resulting from: (1) the middle Paleozoic-early Mesozoic suturing of the Siberia, Kazakstania, North China (NCC), South China (SCC), and Malaya crustal blocks along the northern and eastern edges of the Tethys Ocean, and (2) the late Mesozoic circum-Pacific plate reorganizations.

Despite abundant Archean and Paleoproterozoic rocks in Asia, important Precambrian greenstone gold deposits are unlikely targets, which reflects the exposure of mainly high-grade metamorphic basement rocks. The Neoproterozoic orogenic gold ores of the Yenisei Ridge Province (Olimpiada)—the oldest documented Asian gold systems—developed along an active margin of the Siberia craton within the ancient Panthalassic Ocean. The evolution of the Paleo-Tethys Ocean resulted in orogenic gold deposits forming via: (1) Ordovician accretionary orogenesis along the margin of Kazakstania (Vasilkovskoe, Bestyube), (2) similar Devonian-Carboniferous events along the active edges of the Siberia craton in the northern Altaids and Patom Highlands (Sukhoi Log), and (3) late Paleozoic terrane accretion onto the amalgamated Siberia-Kazakstania active continental margin, and subsequent Permian strike-slip along terrane sutures (Muruntau, Kumtor). Latest Devonian-Carboniferous epithermal and gold-rich porphyry deposits (Almalyk, Tuwu, Oyu Tolgoi) are world-class targets in preserved shallow levels of oceanic arcs in the southern Altaid accretionary orogen. Other important orogenic gold ores developed during the Triassic collision between the NCC and SCC to form the western part of the Qinling fold belt, and during final closure of the Amurian Seaway between Siberia and NCC in the Jurassic (Boroo). Although their tectonic evolution is still very poorly understood, the reactivated margins of the SCC block contain: (1) Permo-Triassic[?] orogenic deposits to the west (Boka) and south (Hainan Island), (2) Jurassic Fe-Cu-Au skarns and related porphyries to the NE (Yangtze River), and (3) mid-Mesozoic[?] Carlin-like deposits to the NW and SW.

Major Early Cretaceous gold provinces in the eastern parts of the southern Siberia, North China (Jiaodong, Qinling), and South China (Jiagnan) cratons represent orogenic gold targets restricted to uplifted, high-grade metamorphic core complexes. The giant Cretaceous mantle plume in the southern Pacific was likely the cause of ca. 125 Ma northern Pacific basin plate reorganization and the associated remarkable >2000-km-long string of orogenic gold systems that formed along the eastern Asia margin at this time. Economically important epithermal veins are the ca. 1 Ma deposits in NE Taiwan (e.g. Chinkuashih), where neotectonics along the Taiwan-Luzon volcanic arc were particularly favourable for the establishment of shallow metalliferous systems.

Session 1 **9:50**

Geology of the Roberto gold deposit, Éléonore property, James Bay, Québec

Jean-François Ravenelle (INRS-ETE), Benoît Dubé (GSC-Québec), Michel Malo (INRS-ETE), Vicky McNicoll (GSC-Ottawa), Hervé Thiboutot (Goldcorp Inc./ Opinaca Mines Ltd.), Paul Archer (Virginia Gold Mines), Daniel Bandyayera (MRNF), Michel Gauthier (UQAM)

U-Pb geochronological data is combined with property-scale geological mapping and core logging to present new insights on the geology of the sediment-hosted Au-As-B Roberto gold deposit. Efforts are focussed on determining the key parameters responsible for the formation of the deposit by defining the age of the principal lithological units in the district, the nature of the alteration and of the metallic signature, and the relative timing between ore deposition, deformational events, and metamorphism.

The Roberto deposit straddles the contact between the volcano-plutonic La Grande Subprovince and the metasedimentary Opinaca Subprovince. Conglomeratic metasedimentary sequences are unconformably deposited above mafic volcanic rocks in the upper part of the La Grande stratigraphy and may represent Timiskaming-type sedimentary sequences. The deposit is stratigraphically located above the conglomerate units and is hosted by polydeformed amphibolite-facies turbiditic units within which gold mineralization is primarily confined to quartz-tourmaline-actinolite-arsenopyrite-pyrrhotite stockwork zones associated with pervasive alteration characterized by microcline, quartz, tourmaline and fine arsenopyrite. Aluminous zones are present in the immediate hanging wall to the ore. Metamorphic grade increases gradually from the La Grande volcanic rocks towards the center of the Opinaca basin and metamorphic isograds are discordant to the stratigraphy. Roberto is located close to an isograd that delimits paragneiss units from the deposit's less metamorphosed host rocks. Structural analysis indicates the presence of at least three generations of structures in the district. The bulk of gold mineralization is located within a thinly bedded sedimentary package in the hinge area of an F2 fold and appears to have been introduced early in the deformational and metamorphic history of the region. D2 high strain zones with an intense down-dip strain component are present at and near the contact between La Grande volcanic rocks and overlying conglomeratic sequences; these zones may correspond to a major structure.

The deposit is near the Ell Lake diorite stock that hosts Cu-Au mineralization associated with chalcopyrite and tourmaline replacement zones. U-Pb geochronological dating indicates that the host sedimentary sequence is significantly younger than the intrusion, which rules out the hypothesis that Roberto is genetically related to the Ell Lake intrusion. Roberto is an epigenetic gold deposit analogous to non-carbonate disseminated-replacement type deposits. Although it has unique characteristics, the spatial association of sediment-hosted Au-As-B mineralization with a regional unconformity at or near the contact between two interpreted subprovinces indicates that the deposit, regardless of style, shares common attributes with Archean world-class gold deposits.

Session 1 **10:10**

Matagami Camp: A new concept-based approach

Gilles Roy and Michel Allard (Xstrata)

The Matagami mining camp is known for its zinc-rich massive sulphide deposits. In 1956, the use of one of the first airborne electromagnetic systems revealed the presence of sulphide bodies, the largest of which would become the Matagami Lake mine. Ten of the eighteen deposits discovered to date have been mined and have produced a total of 3.9 Mt zinc and 0.4 Mt copper. In August 2006, Falconbridge Ltd. announced the start-up of development on the Perseverance deposit discovered in 2000. With indicated and measured resources of 5.12 million tonnes grading 15.82% Zn, 1.24% Cu, 29.0 g/t Ag and 0.38 g/t Au in three lenses, the Perseverance mine will be the second largest producer in the history of the camp. Similarly to discoveries attributed to the 1956 survey, the Perseverance discovery is the result of the use of a new airborne electromagnetic system, in this case, MEGATEM.

The stratigraphic column of the area is relatively simple. The base consists of acidic lavas of the Watson Lake Group, overlain by a marker horizon called the Key Tuffite. The Key Tuffite marks the boundary between the Watson Lake Group and the Wabassee Group, dominated by basaltic rocks. The Galinée anticline, a regional structure, affects both groups. It is cored by a gabbroic-anorthositic intrusive complex, the Bell River Complex. Deposits in the camp, except for the New Hosco mine, occur along the interface between the Watson Lake and Wabassee groups.

Field observations, recent drilling, and a reinterpretation of historic data suggest that a vast area to the west of Matagami has the potential to host typical deposits as well as stratigraphically younger deposits. This hypothesis is based on three main points of evidence: 1) mineralized systems including massive sulphides were emplaced within the Wabassee Group; 2) the presence of horst and graben structures, such as the graben responsible for the preservation of the Perseverance deposit; and 3) the possible presence of folds of the same generation as the Galinée anticline, which would bring the target horizon at or near surface, as suggested by the stratigraphic setting associated with the Caber deposit.

Today, partners Donner Metals and Xstrata are aggressively exploring the camp. Taking advantage of more than 40 years of exploration and implementing leading-edge surveys on surface and in drillhole, these new exploration efforts target both known horizons and new areas.

Session 1 **10:30**

Assessing mineral potential for porphyry copper-gold-molybdenum deposits in Abitibi

Jean-Yves Labbé, Pierre Pilote, Daniel Lamothe (MRNF)

This presentation will discuss the results of a mineral potential assessment study for porphyry Cu-Au-Mo deposits in Abitibi, as well as the procedure used to prepare the favourability map. Porphyry Cu-Au-Mo deposits are relatively scarce in the Abitibi region, compared to VMS deposits for example, and they are essentially centered in the Chibougamau area. For these reasons, a knowledge-driven approach using fuzzy logic was preferred over a data-driven approach to develop the potential assessment model.

The assessment model is based on the geological characteristics typical of porphyry Cu-Au-Mo deposits in general, and those inherent to deposits in the Chibougamau area in particular. This model is based on three main geological components: favourable lithologies, alteration patterns, and indirect evidence of mineralization. A favourability map based on lithologies was produced using the geological map of the Abitibi and classifying felsic intrusions according to their size and origin (synvolcanic, syntectonic, etc.). The relative competency of lithological units was also taken into consideration. The favourability map based on alteration patterns takes into account the presence of modal sericite, chlorite, epidote, and chloritoid in the rocks, as well as the presence of normative sericite, chlorite, and epidote in geochemistry samples. The presence of hematite and magnetite in felsic intrusive rocks was also taken into consideration. Finally, the favourability map based on other indirect evidence of mineralization introduces various other parameters, namely electromagnetic anomalies, anomalous Cu, Au, or Mo content in the bedrock or in surficial deposits, and the presence of brecciated textures, fracturing, or multiple dykes. These three maps were combined using fuzzy logic operators to produce a favourability map for porphyry copper-gold-molybdenum deposits. From this map, it is possible to identify several exploration targets that warrant special attention for this type of deposit.

Session 1 **10:50**

Composition of iron oxides: A new exploration tool

Georges Beaudoin, Patrice Gosselin (U. Laval),
Michel Jébrak (UQAM)

Magnetite and hematite from several types of deposits (iron oxide-Cu-Au [IOCG], Kiruna, banded iron formation [BIF], porphyry Cu-Au-Mo, Ca-Fe and Cu-Au skarns, volcanogenic massive sulphides [VMS], Fe-Ti, Ni-Cu-PGE, chromitites) show variations in chemical composition according to the type of deposit. Iron oxides from BIF and Cr deposits are characterized by low V and Ti values, but respectively exhibit high Al and Cr values. VMS and Ni-Cu deposits have low V and Ti contents, but are respectively characterized by high Si and Ni contents. Oxides from Fe-Ti deposits are enriched in V and Ti, Cr, Al, and Mg. IOCG and Kiruna-type deposits exhibit distinct V and Ti values. IOCG deposits are also enriched in Al and Si relative to Kiruna-type deposits. Porphyry and skarn iron oxides show relatively high V and Ti values, but porphyry oxides are enriched in Al and Si, whereas skarn oxides are enriched in Ca and Mg. These variations in chemical composition may be used to build discrimination diagrams for deposit types, such as a Ti versus Ti/V diagram. Therefore, the chemical signature of iron oxides from an outcrop or a heavy mineral concentrate may be used to determine the deposit type of an iron oxide sample.

Session 2 **1:30**

Perspectives and concepts on hydrocarbon exploration in Québec: A world of discovery!

Robert Thériault*, Jean-Yves Laliberté* (MRNF)

Oil & gas exploration companies have been working to develop hydrocarbon resources in Québec for nearly 150 years. Nonetheless, Québec remains a frontier region, neglected in terms of hydrocarbon exploration, as illustrated by the 800 wells drilled since 1860, compared to some 20,000 wells drilled annually in Western Canada. Although very few deposits have been discovered to date, we could be on the verge of major discoveries, considering the fact that more than 7.3 million hectares are currently covered by licences in Québec, a record high since 1982. Moreover, the geological setting is largely similar to that observed elsewhere along the former Paleozoic continental margin of North America, where prolific sedimentary basins have become major producers. In this perspective, we will review the main types of targets currently explored for hydrocarbons in Québec, and look at analogies with nearby oil & gas basins in the American Northeast.

Prospective zones for hydrocarbons in Québec are located within Paleozoic sedimentary rocks occurring in sedimentary basins of the St. Lawrence Platform (including the St. Lawrence Lowlands and Anticosti), the Gaspé Belt, and the Magdalen Basin. Hydrocarbons are also present in Quaternary sediments along the St. Lawrence River axis. In this global setting, the main types of targets are as follows: **1- St. Lawrence Platform (Cambrian-Ordovician)**: a) karstic dolomites in the Beekmantown and Romaine groups; b) hydrothermal dolomites in the Trenton, Black River, and Mingan groups; c) shales in the Utica and Macasty groups; and d) thrust slices of the platform (St. Flavien type); **2- Gaspé Belt (Silurian-Devonian)**: a) reefs of the West Point Formation; b) hydrothermal dolomites of the La Vieille/Sayabec, West Point, and Indian Cove/Forillon formations; and c) sandstones of the Gaspé Sandstone Group; **3- Magdalen Basin (Carboniferous)**: sandstones of the Pictou and Cumberland groups associated with salt diapirs; and **4- Quaternary deposits**: sand beds in the Lac Saint-Pierre area and in the St. Lawrence Estuary.

Two new exploration concepts, namely hydrothermal dolomites and shale gas, are currently drawing special attention for hydrocarbons in Québec. These new exploration targets, the potential of which was unsuspected until very recently, appear to be very promising, if we consider recent major natural gas discoveries associated with hydrothermal dolomites in New York State as well as shales in the Barnett and Antrim fields, respectively located in Texas and Michigan.

* the two authors will give the presentation.

Session 2 **2:20**

Petroleum on the Port au Port Peninsula, Newfoundland and Labrador

Steven M. Millan, P.Geo.

The presence of hydrocarbons within the Humber Zone of western Newfoundland was recognized as early as 1812 from the numerous occurrences of oil and gas seeps, bituminous residues and oil shales. The first well was drilled in 1867 and minor production was achieved in the early 1900's from shallow wells drilled close to seeps. The first modern well drilled with the benefit of modern geophysics and geological knowledge was Hunt's Port au Port #1 discovery in 1995.

Hunt's interest in the area was sparked by the geological similarity to known producing areas in Texas and Oklahoma. The Appalachian-related productive trend includes producing fields as far north as northern New York State and southwestern Ontario, while hydrocarbon indications continue northward through Québec, western Newfoundland and the Hopedale Basin on the Labrador Shelf, where natural gas was tested at rates as high as 19.5 mmcf/d from a Paleozoic carbonate.

The Hunt discovery well produced sulphur-free 51º API oil and natural gas from an 18.5 m thick dolostone pay zone in the Aquathuna Formation. Oil rates were in the range of 1750 to 2400 b/d with gas at 1.2 mmcf/d and a 25% water cut. Over a 7-day test period, flow rates and pressures gradually decreased for reasons that were unclear.

Following the discovery, another four deep wells were drilled at other locations in the play area, none of which produced significant amounts of hydrocarbons. By the mid 1990's, in an environment of low prices and industry consolidations, interest in the area waned and Canadian Imperial Venture Corp. (CIVC) was able to establish a presence through farmouts and successful land sale bidding.

Since that time, CIVC has added to the knowledge base of the play through well testing, geophysics and drilling. This new information has added detail to the understanding of the play and reinforced the potential of the area to be a significant producer of hydrocarbons. The paper discusses insights and conclusions from the new data and presents the company's activity plans for the next 12 months.

Session 2 **2:40**

Development of the Ordovician hydrothermal dolomite play in the Appalachian Basin

John Martin (NYSERDA)

Structurally-controlled Ordovician Trenton/Black River (TBR) reservoirs are formed in narrow zones of hydrothermal dolomitization requiring high resolution seismic and other technical methods of identification. Key to developing this play is understanding the fault geometry and activation history as well as the fluid migration pattern.

Work by Jacobi et al. (2005) demonstrated a complex pattern of fault systems that affected the Ordovician section. Depositional patterns reflect the complexity and activity of faulting during Ordovician time. Migration of hydrothermal fluids along fractures promoted dissolution, dolomitization and vuggy porosity characteristic of carbonate reservoirs in the Trenton/Black River. Thinned Trenton/Black River sections, a characteristic of the TBR play, are associated with several of the structures observed on seismic reflection data. A number of fluid migration models have been proposed to explain this movement.

Hydrothermal dolomite plays are being pursued in New York, Pennsylvania, Ohio, West Virginia, Michigan, New Brunswick, Newfoundland and Québec. Reservoir characteristics in New York, Ontario and Ohio all demonstrate that diagenetic changes in the host limestone are the result of a structural control on fluid movements.

Since 1994, the natural gas industry has invested nearly US$1 billion in New York, primarily to develop the TBR reservoirs in and around the Finger Lakes region. As a result, New York's natural gas production set all-time records in both 2004 and 2005. New York's geology is quite similar to that of Québec. A clear opportunity exists throughout the entire region.

Session 2 **3:00**

The Michigan Basin Devonian Antrim Black Shale: Economic and technical evaluation of a natural gas resource play and how it relates to the potential of the Lower Paleozoic in the Québec Lowlands

James Morabito (AMQUE ULC)

Initially spurred by US tax credits, drilling for unconventional gas commenced during the late 1980's in shallow, low pressure Devonian Black Shale at depths between 500 and 2,400 feet. Early indications of gas were reported from gas shows in water wells and from "gas kicks" while drilling for known conventional oil and gas targets. As new and innovative completion practices increased peak production rates and reserves, the economics for the play rose substantially and the trend now has approximately 10,000 wells. Per well reserves are nearly 0.4 Bfc based on an 80-acre spacing.

These reserves are primarily from biogenic gas produced in a "sweet spot" just down-dip of the Antrim Shale subcrop. The Antrim has approximately 8% TOC and a natural fracture system that produces at economic rates when enhanced with fracture stimulated completions, even with gas prices below $4.00 per Mcf. Freshwater from overlying glacial deposits infiltrated the formation through the fractures and produced an environment of methane generation. The gas production rate increases as produced water decreases.

In response to the production rates and in order to maximize economics, a producing area is unitized (handling about 25 to 30 wells) and the natural gas gathered into a central processing facility for water separation and disposal. The natural gas is then compressed and transmitted for removal of CO_2 and subsequently moved into a sales line. Drilling success rates are greater than 95% for producing Antrim wells within the resource play fairway.

Session 2 **3:20**

West Point reef complex in Gaspésie: a "Sleeping Beauty"?

Pierre-André Bourque U. Laval), Claude Morin,
*Bernard Granger (HQGP)

Reefs and reef complexes in the Late Silurian to Early Devonian West Point Formation in the Gaspe Basin show many similarities in terms of facies with reefs of the Leduc complex in the Devonian Alberta Platform and with Silurian pinnacle reefs of cratonic basins in central North America. Two major phases are recognized in the West Point: major reef complexes in the Silurian West Point, totalling up to 800 metres in thickness, and pinnacle reefs in the Devonian West Point, reaching 300 metres in thickness. The Silurian West Point only outcrops in southern Gaspésie, but some evidence strongly suggests its presence in the sub-surface in northern Gaspésie. The Devonian West Point is well known in the north, but also locally in southern Gaspésie. Petrography and geochemistry studies show that the primary macroporosity of the West Point Formation is preserved to burial depths reaching 3 kilometres, and in certain cases up to 6 kilometres depth.

Tectonosedimentary models developed for the Gaspe Basin indicate that the West Point developed as a result of two coincidental events that took place at the end of the Silurian: (1) the formation of faulted blocks, showing a strong rotational component, during the Salinian phase, and (2) the eustatic drop in sea level, which brought the upper part of faulted blocks to shallow marine levels, favourable to the development of reef complexes. Proposed models associate reef complexes with block high points, proximal to fault zones. Reprocessing of seismic lines acquired by Soquip and Petro-Canada in 1980 and 1982 in northeastern Gaspésie has outlined the presence of faulted Salinian blocks, as well as seismic signatures suggesting the presence of reef complexes in the sub-surface, at depths on the order of 2,000 metres.

Unlike hydrocarbon-producing Devonian Leduc reefs and Silurian reefs of North American cratonic basins, the West Point shows little evidence of dolomitization on surface, which does not exclude however the presence of dolomitization in sub-surface reefs, near faults that could have channelled dolomitizing fluids. Considering the recent discovery of the Haldiman reservoir in a similar structural setting, the proximity of the source rock constitutes another positive element, which makes the West Point reef complex an interesting target that is begging to be explored.

*Speaker

Session 2 **3:40**

Hydrocarbon prospectivity of the eastern Canadian Maritimes Basin: testing a North Sea analogue

Peter S. Giles (NRCAN, GSC-Atlantic)

The Gulf of St. Lawrence succession, which is characteristic of the Late Devonian to Early Permian Maritimes Basin, lacks the capping succession of Mesozoic and younger strata that, on the outboard continental shelf, has dominated hydrocarbon exploration efforts and production in eastern Canada. In addition, the outboard Mesozoic (and younger) succession is seldom linked conceptually with any underlying Late Paleozoic succession, the distribution and nature of which is not well documented. Thus, the eastern Canadian offshore is considered a Mesozoic hydrocarbon fairway, and the adjacent and underlying Late Paleozoic Maritimes Basin is under-appreciated as a potential hydrocarbon source. If these two, seemingly disparate, sedimentary regimes are combined stratigraphically, as supported by data from a handful of wells on Canada's continental margin, an analogy with the North Sea basin is suggested. Hydrocarbon production from Late Paleozoic reservoirs in the North Sea is significantly overshadowed by production from younger rocks, as it is in eastern Canada, yet even the modest Late Paleozoic percentage of the very large North Sea production record documents an impressive hydrocarbon resource.

The North Sea and the Maritimes Basin of eastern Canada share key elements of Devonian and Carboniferous tectonic history, and hydrocarbon system elements of Late Paleozoic and Mesozoic age are broadly comparable in both basins. Viséan evaporites—arguably the most effective seals in the inboard Maritimes Basin—were documented in three of only five wells that intersected Devonian and Carboniferous rocks beneath Mesozoic cover on the continental shelf. In one of these three wells, Tournaisian source rocks comparable to those hosting the McCully natural gas field in southern New Brunswick underlie the Viséan evaporite seal. In another, Devonian black shales underlie the evaporite seal. In a fourth well, thick coal measures of Late Carboniferous age with potential to source natural gas were identified, and are well documented throughout the inboard Maritimes Basin. Can it be coincidental that so few wells provide essential data, yet each documents important facets of the Maritimes Basin's hydrocarbon system beneath the Mesozoic cover? Geological analogy between petroleum provinces at the scale of the North Sea and Canadian East Coast, paleogeographically separated by large distances, becomes more and more tenuous as details of tectonic and stratigraphic events are incrementally considered. However, even general analogues are both instructive and predictive, and an appreciation of the Late Paleozoic contribution to the North Sea production record suggests that the Maritimes Basin in eastern Canada warrants serious attention.

Session 3 **8:30**

Mineral exploration and the Regulation respecting standards of forest management for forests in the domain of the State

Guy Rochette, Antoine Proulx (GCF)

Mining titleholders who perform mining activities in a forest environment on public lands are subject to the **Forest Act** and its regulations. Titleholders must therefore apply to obtain a *Forest management permit for mining activities* from the Ministère des Ressources naturelles et de la Faune. It is the permit holder's duty to comply with the provisions of the Regulation respecting standards of forest management for forests in the domain of the State (RSFM).

Tree harvesting on a mining site, establishment of a borrow area or a camp, construction of access roads, crossing watercourses, protection of lake shorelines and watercourse banks, are all activities that a mining titleholder may eventually perform. All of these activities are governed by several provisions of the RSFM.

What are the main steps to follow to obtain a permit? Which provisions of the RSFM are the most relevant for mining-related activities? What are the main elements that ensure compliance with the RSFM? What sanctions are provided for in the Act in the case of non-compliance with the RSFM? All these questions will be answered during the presentation.

Session 3 **8:50**

Environmental assessment of mining projects in Agreement territory

Serge Tourangeau (Roche Ltd)

Located north of the 49th parallel, Agreement territory covers just over one million square kilometres, i.e. about ¾ of the total surface area of Québec, and is inhabited by a widely scattered population of about 45,000 inhabitants. This vast territory, which remains underexplored, hosts major ore deposits currently being mined, namely Raglan and Troilus, and many promising areas targeted by exploration, for example in the Monts Otish area, south of the Raglan mine, and in the Opinaca reservoir area.

Two special environmental protection regimes were introduced under the *James Bay and Northern Québec Agreement* (JBNQA). These regimes cover Agreement territory located on either side of the 55th parallel, and are translated in Chapter II of the Environment Quality Act (EQA). Schedules A and B of the EQA (and schedules 1 and 2 of chapters 22 and 23 of the JBNQA) list the types of development projects that are automatically subject to, as well as those that are automatically exempt from the environmental and social impact assessment and review procedure. Projects not listed in these schedules must be submitted to the Provincial Administrator of the JBNQA (the MDDEP Deputy Minister), who then decides if the project is subject or not to the procedure, by taking into consideration the recommendations of the Evaluating Committee (COMEV) or the decision of the Kativik Environmental Advisory Committee (KEAC). When the project is subject to the procedure, a directive is established to determine the scope of the impact study to be delivered; otherwise, a notice of exemption is sent to the project initiator.

Mining projects are subject to the environmental assessment procedure, whereas activities related to mineral exploration generally are not. However, many of these activities require environmental authorizations under various provincial regulatory provisions. Mineral exploration may require the establishment of a camp or of related services such as water intake, waste management, management of domestic sewage, and management of used oils and solvents. Exploration work may also require the construction of access roads with watercourse crossings (or any other type of work that may impact a body of water), excavation of trenches, overburden stripping, and extraction of a bulk sample. Environment-related regulatory requirements that apply to these activities will be reviewed.

Session 3 **9:10**

Agreements with Aboriginal Communities: Practical considerations

Jean M. Gagné (Fasken Martineau DuMoulin)

Developing good business relations in order to secure a long-lasting partnership with aboriginal communities is an aspect to consider in any project, of any nature, that touches these communities directly or indirectly. In this perspective, the purpose of this presentation is to review the preliminary steps to take to set up this type of project, namely determining the applicable legal framework and establishing modes of cooperation with involved aboriginal communities.

Determining the applicable legal framework

Many general laws and specific applications, both federal and provincial, govern aboriginal communities and incidentally, their relations with various stakeholders in a project. For example, we have the Constitution Act of 1867, the Constitution Act of 1982, the Indian Act, the James Bay and Northern Québec Agreement, the Northeastern Québec Agreement, the Act respecting Cree, Inuit and Naskapi Aboriginal persons, the Agreement concerning a new relationship between the Gouvernement du Québec and the Crees of Québec (Paix des Braves), as well as various agreements, claims, conventions, and ancestral treaties concluded with aboriginal communities. In short, the legal corpus relating to the aboriginal communities must be carefully studied to thoroughly understand key concepts.

Establishing modes of cooperation with aboriginal communities

Aboriginal communities have much to gain, and rightfully so, from getting involved in projects that impact their living environment in order to secure certain advantages and protect their rights. Therefore, it becomes critical to negotiate agreements that lay out modes of cooperation between the latter and project stakeholders. It is also in the promoter's interest to establish respectful and efficient modes of cooperation in order to take into account the concerns of aboriginal communities and help explain the nature of the project and its socioeconomic and environmental impacts. The involvement of aboriginal communities and the cooperation that can grow between the latter and the promoter may be beneficial in a number of ways and contribute in making the project run more smoothly and successfully.

Ideally, these agreements must therefore comprise several provisions to ensure the active involvement of communities and to meet their and the promoter's expectations.

From an economic standpoint, agreements may namely address such issues as training and hiring of aboriginal manpower, operational provisions, economic development, priority to aboriginal businesses, and financial considerations such as revenue sharing and other forms of compensation. Moreover, the mitigation, monitoring and control of the environmental impacts of the project as well as the application of the various legal aspects involved are all issues that can be addressed.

Finally, agreements may also include various social considerations, namely policies in terms of language, culture, drugs and alcohol, tobacco, hunting and fishing, the use of firearms, or other aspects.

Needless to say that the issues mentioned here vary from one project to another, depending on the nature of the project and the aboriginal communities involved.

The sharing process between aboriginal communities and promoters

We will examine the process that leads to the conclusion of a cooperation agreement that meets the needs and addresses the concerns of all parties involved. We will also analyze the content of a typical agreement as a potential model of cooperation between aboriginal communities and promoters in any type of project.

Session 3 **9:30**

"La Paix des Braves" and mining activities in Eeyou Istchee

Jack R. Blacksmith, Youcef Larbi (CMEB)

The Québec Exploration conference is an opportunity for the **Cree Mineral Exploration Board** (CMEB) to build its network and garner greater visibility. The CMEB will take this opportunity to talk about its structure and activities in Eeyou Istchee. The Board will also present several discussions concerning the Agreement between the Crees and the Government of Québec in the domain of mineral exploration and mining, and accessibility to the territories.

We will address the following issues during the talk:

1- The legal aspect (respect of the territories);

2- The terms of the present Agreement;

3- Shortcomings of the Agreement;

4- The traplines system;

5- Activities of the CMEB and training;

6- Mining industry activities in Eeyou Istchee.

The CMEB was formed pursuant to Chapter 5 of the Agreement entitled A*greement concerning a New Relationship between le Gouvernement du Québec and the Crees of Québec*. Its functions aim to develop and enhance mineral exploration in the Territory. Foreseen activities of the Board can be summarized in five programs: 1) Awareness and Promotion; 2) Training and Job Assistance; 3) Prospector's Assistance; 4) Project Development and Entrepreneur's Assistance; and 5) Geoscience Expertise and Technical Assistance. For these activities, the CMEB benefits from a fund from the Québec Government and the Cree Regional Authority.

The main purposes of the Mineral Exploration Board are to:

a) Assist the Crees in accessing mineral exploration opportunities;

b) Facilitate the development of mineral exploration activities by Cree enterprises;

c)Facilitate and encourage the access by the Crees and Cree enterprises to regular Québec program funding and other incentives for mineral exploration activities;

d) Act as an entry mechanism for services offered by Crees and Cree enterprises in the field of mineral exploration.

During the last three years, the CMEB increased the Cree employment pool for mineral exploration as well as the number of people employed in the industry. It has also increased Cree participation in mining activities as prospectors and as private companies. The Board offers several programs that target training and geoscience expertise for the communities. The results have been exceptionally positive, especially in the domain of training and employment.

Session 3 **9:50**

The government's approach to protected areas in Québec: Selection process for new protected areas on public lands

Michel Bergeron, François Brassard (MDDEP)

At the Earth Summit held in Rio de Janeiro in 1992, the Government of Canada ratified the *Convention on Biological Diversity*. In November 1992, the Government of Québec officially endorsed the objectives of the Convention and decided to implement the latter on its territory. With this gesture, Canada and Québec signalled their commitment to act in the field of conservation, namely by establishing on their territory a network of protected areas and by developing guidelines for the selection or creation of protected areas in which specific measures would be taken to preserve biological diversity.

To reach this goal, the Government of Québec adopted in 1996, a Biodiversity Strategy, which was modified in 2004. With the same goal of implementing the Convention, it prepared in 1999 a status report on the network of protected areas in Québec. This overview outlined the fact that Québec was lagging far behind in terms of biodiversity conservation. In fact, in 1999, protected areas covered less than 3% of Québec's territory; most of these were recent, restricted in size and clustered in the St. Lawrence River valley. The status report also revealed the lack of a genuine strategy to establish a network.

This realization led the Government of Québec to adopt, in June 2000, a number of major orientations on protected areas. The latter consist of:

- Setting aside 8% of the surface area of Québec for protected areas for 2005;
- Establishing a network of protected areas that represent the diversity of Québec's territory;
- Take into consideration the socioeconomic concerns of targeted populations.

In 2002, the National Assembly adopted the National Heritage Conservation Act. This Act marks a turning point in the history of conservation in Québec, since it creates new types of protected areas (biodiversity reserve, aquatic reserve, and manmade landscape) in order to better protect biological diversity in vast territories based on their unique ecological and social characteristics, while allowing sustainable use of certain constitutive elements. For example, in a biodiversity reserve or an aquatic reserve, recreational activities are generally permitted, whereas industrial activities are prohibited within the protected area (forest management, hydroelectric development, mineral exploration and mining).

Since 2002, the Ministère du Développement durable, de l'Environnement et des Parcs has expanded the network of protected areas by protecting new territories in the commercial boreal forest and in the northern environment. Recent additions to the network of protected areas, namely in Abitibi and northern Québec, are examples that clearly demonstrate the ability to reconcile the creation of protected areas in a region where the economy is dominated by the mining sector. However, more work needs to be done to achieve a better linkage between biodiversity conservation interests and mining interests on public lands in Québec.

Session 3 **10:10**

The government's approach to protected areas in Québec: Socioeconomic evaluation with respect to mining activities

Sylvain Lacroix, Hélène Giroux, Sébastien Desrochers (MRNF)

Québec's Strategy for Protected Areas (QSPA) calls for the selection of areas that are representative of the biodiversity of Québec's territory, while taking into account local and regional socioeconomic aspects. The MRNF is involved in this process, since its role namely consists in assessing impacts on the socioeconomic potential related to the territory and to land rights, as well as to energy, wildlife, forestry and mining resources.

In the mining sector, the principles guiding the assessment of areas of interest submitted to the MRNF by the MDDEP for the eventual creation of protected areas consists in making sure mining rights are respected, areas with a strong mineral potential remain accessible, and the excellent mining investment climate in Québec remains strong. The Energy and Mines Sector therefore examines the presence of mining rights and the mineral potential, then submits its evaluation to the mining industry for comments, before completing its sectoral notice. In areas deemed acceptable, the issuance of mining rights is then temporarily suspended, until the lands are withdrawn from staking or map designation, or are reserved to the State.

All MRNF sectors perform, in their respective fields of expertise, an evaluation of constraints and restrictions to the creation of protected areas in proposed areas of interest. Then, MDDEP and MRNF representatives meet, in a technical committee and a steering committee, in order to determine which protected area projects best reconcile the biodiversity representation potential and feasibility in terms of socioeconomic aspects. Regional meetings are then held with forestry stakeholders and other right holders that are significantly impacted by the protected area projects, to fine-tune the limits of areas to be protected.

Until now, the impact for the mining sector of the development of a network of protected areas has essentially consisted in the loss of access to lands which could be explored, over a total surface area of roughly 100,000 km^2, namely 5.8% of Québec. Nearly all of this land did not contain mining rights or established potential for mining development, and based on current knowledge, the mineral potential was fairly low.

Session 4 **8:30**

How komatiite deposits and Voisey's Bay advanced our understanding of Ni-Cu sulphide deposits

Tony Naldrett [University of Toronto]

Prior to the late 1960's the Sudbury camp was the principal producer of Ni, and the understanding of its geology at the time—that deposits occurred widely scattered over the base of a noritic/gabbroic layered intrusion—dominated the ideas driving exploration for such deposits. During the 1960's, the prevalence of komatiitic magmatism during Archean time was recognized and, almost simultaneously, Ni-sulphide deposits were discovered associated with these rocks in Western Australia. In retrospect, the detailed studies undertaken by geologists working on the mines, and the recognition that mineralization occurred in surface or near-surface conduits through which major magma flows were channelled, broke the Sudbury straightjacket and opened our minds to new environments of deposition. The importance of a dynamic hydraulic regime and the focussing of magma flow as processes leading to the separation and concentration of liquid sulphides from magma, rather than static gravity-driven settling, were appreciated for the first time. Additionally, the importance of the presence of nearby sulphide-bearing sediments became clear. Studies on the Noril'sk deposits in Siberia suggested that the recognition of chalcophile element depletion in the source rocks for magmatic sulphide deposits could aid in exploration. The discovery of the Voisey's Bay deposit ten years ago and our emerging understanding since then have confirmed many of the ideas that had been developing during the previous 30 years. The bulk of the ore lies within the dynamic environment of a dyke connecting a lower intrusion, where sulphides had developed, with an upper intrusion. More than one pulse of magma passed through the dyke, and the focussing of this flow enabled later magma to rework, upgrade and concentrate early-formed, low tenor sulphides. The Ni content of olivines in the Voisey's Bay troctolites provides evidence of both early chalcophile depletion and the passage of later, less depleted magma up the dyke. One of the most characteristic features at Voisey's Bay is the igneous breccia that bears testimony to the interaction of troctolitic magma with the country rocks. The Voisey's Bay magmatic environment is in stark contrast to that of Pants Lake, 80 km to the south. Here, a very similar magma interacted with identical country rocks to those at Voisey's Bay and formed identical breccias. Magmatic sulphides were formed, occurring mainly at the base of the sills. What is lacking is the focussed flow that occurred to the north, and the sulphides remain widely dispersed with low Ni tenors, never having been reworked by later magma pulses.

Session 4 **9:20**

Zone 5-8: Renewal of Raglan Resources

Pascal Lessard, Martin Lévesque, Terry Mallinson (Xstrata – Laval Exploration Office, Laval, Québec)

The Raglan property lies in the eastern part of the Cape Smith fold and thrust belt, which strikes east-west for 375 kilometres across the Ungava Peninsula of northern Québec. This belt of Paleoproterozoic rocks has been interpreted as being the extension of the Trans-Hudson Orogen that includes the Thompson Nickel Belt in northern Manitoba.

The stratigraphy of the Cape Smith belt is subdivided into a lower sedimentary group, a central division of tholeiitic basalts and sediments (Povungnituk Group), and an upper division of komatiitic basalts (Chukotat Group). Xstrata's Raglan property hosts 55 kilometres strike-length of intrusive and extrusive ultramafic rocks known as the Raglan Formation, which marks the base of the Chukotat Group. The Ni-Cu-(PGE) mineralization occurs in at least ten ultramafic complexes (Donaldson, Boundary, West Boundary, Zone 13-14, Zone 5-8, Katinniq, Zone 2, Zone 3, East Lake and Cross Lake) that outcrop over the property. To date, the Katinniq, Zone 2, Zone 3, East Lake and West Boundary complexes have been subjected to mining.

The exploration work is currently focussed on the eastern portion of the Zone 5-8 complex, where indications of a much larger resource were only first identified in 2003. Since then, the largest single lens ever discovered at Raglan, Lens 8H (2.3MT), and a multitude of sister lenses have been discovered. These should, in all likelihood, equal or eclipse the tonnage identified at Katinniq, the centre of current Raglan mining activities.

Lens 8H occurs along the northeastern portion of Zone 5-8 within a pronounced north-south oriented embayment feature in the gabbro footwall. The lens is characterised by a thick halo of disseminated sulphides that increase in abundance to form net-textured and occasionally massive sulphides. Another type of mineralization at Zone 5-8 is massive sulphide and sulphide breccia veins that appear to have been injected in the footwall rocks to the ultramafic units. These are referred to as the 7-Series Lenses and can be found up to 40 metres below the basal ultramafic contact.

The discoveries at Zone 5-8 are testament that a sustained exploration commitment and a disciplined, well-integrated exploration team can produce significant results over a relatively short period of time. It is also important to note that despite being explored for more than six decades, the true mineral potential of the Raglan area is only now beginning to be identified.

Session 4 **9:40**

Raglan South Nickel-Copper Project, an update

Bruce Durham, James Mungall (Canadian Royalties)

Since 2001, Canadian Royalties Inc. has been actively exploring the southern part of the Proterozoic Cape Smith Belt in northern Nunavik for Ni-Cu-PGE deposits. The recently completed Preliminary Economic Assessment (PEA) study envisaged the development of a series of four open pit mines over a 10-year period with ore being trucked to a central milling facility near the Expo deposit. The company began a full feasibility study for the project during the summer of 2006 and completed more than 25,000 metres of additional diamond drilling.

The significant Ni-Cu-PGE mineralization consists of massive and net-textured sulphides generally associated with the outer and lower contacts of the ultramafic bodies. Massive sulphides generally consist of more than 80% sulphides, and the net-textured type contains approximately 20 to 80% sulphides. The massive and net-textured types carry sufficiently high base and precious metal concentrations to be of economic interest. The net-textured mineralization is generally of much greater volume and extent than the massive sulphides, with the latter generally located at or near the bottom of the ultramafic bodies. Recent work has shown that the sulphide mineralization may extend into near-vertical, narrow vein-like bodies for at least 200 metres below the actual closure of the main ultramafic body.

Session 4 **10:20**

Exploration at West Raglan, an integrated approach

Harvey Keats (Knight Resources Ltd.),
Richard Dufresne (AAEC)

The West Raglan Project in northern Québec started as a geological concept by AAEC in 2001. AAEC interpreted the western extension of the Chukotat Group, the Povungnituk Group and the Raglan Formation into the West Raglan area. The 2002 field program of geological mapping and lithogeochemistry confirmed the interpretation.

Knight optioned the project from AAEC in 2003 and earned a 49% interest in 2005. Exploration is now carried out under a 51/49 joint venture. Since 2003, AAEC and Knight have discovered Raglan-style disseminated, net-textured and massive sulphides in boulders, outcrop and diamond drill holes using an integrated approach to exploration. The ongoing exploration program includes regional and detailed geological mapping, prospecting, fixed-wing and helicopter borne electromagnetic and magnetic surveys, ground electromagnetic and magnetic surveys, downhole electromagnetic surveys, lithogeochemistry, soil geochemistry, till geochemistry and diamond drilling.

The presentation will outline the integrated approach, provide an update on exploration results and discuss plans for the project.

Session 4 **10:40**

The Labrador Trough and its Ni-Cu ±PGE deposits

Thomas Clark (MRNF)

The Trans-Hudson Orogen is known for its two Ni-Cu ±PGE mining camps: the Thompson Nickel Belt and the Cape Smith Belt (Raglan). The Labrador Trough (Trough) is also part of this orogen, but no economic Ni-Cu ±PGE deposits have yet been discovered there although the Trough contains more than 90 Ni-Cu ±PGE showings, several of which have interesting grades and tonnages. Four types of magmatic deposits are recognized: (1) Ni-Cu-PGE in differentiated, aphyric sills composed of peridotite and gabbro; (2) Ni-Cu ±PGE in glomeroporphyritic gabbro sills; (3) Ni-Cu-PGE in picritic basalt; and, of lesser importance, (4) PGE-Ni-Cu associated with mafic pegmatite in differentiated gabbro sills. Evaluation of the Trough's potential for Ni-Cu ±PGE requires an examination of the tectonic context of the belt, the composition of the mafic magmas, the mode of emplacement of the magmas, and the nature of their host rocks. Rifting associated with the generation of the mafic magmas did not reach the stage where oceanic crust was formed. In spite of the large volume of mafic magma (transitional MORB) that was generated, primitive rocks rich in Mg are not abundant in the Trough, in contrast to the other two belts in which komatiites are common. However, rocks formed from relatively primitive magmas (10–18% MgO) are present locally in the southern part of the Trough, and in greater quantities in the extreme north where several type 3 deposits with sulphides enriched in Ni, Cu, and PGE (at 100% sulphides) have been discovered. Most of the showings in the Trough (types 1 and 2) are located in sills formed where more-evolved magmas intruded into sulphidic shales. Type 1 appears to be more promising than type 2 because of its association with magmas richer in Mg, the repeated injection of magma, the formation of massive sulphides, and the basal location of the sulphides. However, the emplacement conditions of magmas associated with types 1 and 2 led to only limited enrichment of the sulphides in metals. Because of the nature and primitive composition of the igneous rocks, the metal-enriched sulphides (type 3), and its proximity to the Cape Smith Belt, the extreme northern part of the Trough constitutes a good target for Ni-Cu ±PGE exploration.

Session 4 **11:00**

The Reid Brook zone: New insights into the Voisey's Bay Ni-Cu-Co deposit

Dawn Evans-Lamswood (Voisey's Bay Nickel Company Ltd.)

The Voisey's Bay Ni-Cu-Co sulphide deposit occurs within troctolites and olivine gabbros of the 1.34 Ga Voisey's Bay Intrusion. The Voisey's Bay Intrusion is a member of the Nain Plutonic Suite and straddles the ca. 1.85 Ga suture between Archean orthogneisses of the Nain Province to the east and Paleoproterozoic paragneisses of the Churchill Province to the west.

The Voisey's Bay Intrusion consists of troctolite to olivine gabbro in two large magma chambers connected by an east-west trending dike.

The Discovery Hill, Mini-Ovoid and Ovoid sulphide deposits occur within the subvertical dike system. Sulphide distribution appears to be controlled by conduit morphology, with sulphide traps occurring where the dike has a flexure or change in width. These morphological changes appear to be controlled by the interaction of multiple structural elements, including vertical E-W fractures and s-c fabrics within the gneiss.

The Eastern Deeps sulphide deposit is located within the base of a magma chamber where subhorizontal sill-like intrusions branch from the subvertical dike and enter the chamber. The geometry of the sill-like intrusions and the distribution of sulphides appear to be controlled by structural weaknesses produced through intersecting subvertical faults.

The Reid Brook zone is located adjacent to and west of the Discovery Hill deposit. Unlike the other known sulphide occurrences in the dike, massive sulphides in the Reid Brook deposit occur not only within the dike, but proximal to and within the adjacent paragneiss country rocks. The massive sulphides appear to have ascended through the dike as the last stage of a major mineralizing event. Mineralization propagates up through the dike along a trajectory defined and constrained by pre- to syn-tectonic faults. During the last stage of mineralization, massive sulphides were injected into the country rocks along open-space, subhorizontal fractures. The open-space fractures appear to be produced by the intersection of multiple syn-tectonic brittle faults.

Massive sulphides within the paragneiss of the Reid Brook zone represent a unique mineral domain not yet observed within other Voisey's Bay deposits. However, analogous structural relationships have been observed elsewhere along the mineralized trend and will be re-examined in light of the discovery of massive sulphides along similar structures at Reid Brook.

Session 5 **1:30**

Lithologic and stratigraphic synthesis of the Abitibi greenstone belt

Jean Goutier (MRNF), John Ayer (OGS), Phil Thurston (Laurentian University)

The last joint Ontario-Québec map of the Abitibi Subprovince (1/500,000 scale) dates back to 1984. We present a stratigraphy backed by several isotopic ages. This stratigraphy includes nine volcanic episodes: 1) pre-2750 Ma (Fecteau Formation, 2791 Ma); 2) 2750-2735 Ma (Pacaud Group and Gemini-Turgeon unit); 3) 2734-2724 Ma (Deloro, Hunter, Watson Lake groups and Waconichi Formation); 4) 2723-2720 Ma (Stoughton-Roquemaure and Cartwright Hills groups); 5) 2719-2710 Ma (Kidd-Munro, Kinojevis, and Malartic groups); 6) 2709-2704 Ma (Tisdale Group and Val-d'Or Formation); 7) 2704-2695 Ma (Hébécourt Formation and Blake River Group); 8) 2690-2687 Ma, calc-alkaline porphyritic volcanism (Krist Formation); and 9) 2690-2672 Ma, alkaline volcanism (Timiskaming Group and Haüy Formation). These episodes were defined based on vertical compositional variations and on the presence of unconformities. Episodes 4 and 5 combined form the largest volume of volcanic rocks in the Abitibi Subprovince. Episodes 2 to 7 are interpreted as a succession of three major volcanic cycles typically culminating with felsic volcanic centres and significant massive sulphide mineralization. Volcanic episodes and cycles do not show systematic younging from north to south, but rather a radial propagation. Thus, the youngest effusive centre in cycle 1 is in Matagami, the youngest in cycle 2 is at Kidd Creek, and the youngest in cycle 3 is in Rouyn-Noranda. Volcanic episodes 8 and 9 are characterized by their association with sedimentary basins. Volcanic rocks of episode 8 (Krist Formation) are only observed in the Timmins area, but numerous calc-alkaline QZ-PG porphyry dykes observed along the margins of turbidite basins could correspond to intrusive equivalents of the latter. The various turbidite basins (Taibi, Scapa-Chicobi, Kewagama, Cadillac) are nearly contemporaneous, since detrital zircons of the same age (2687-2685 Ma and 2698 Ma) were found in several locations, whereas the base of turbidites is inferred to be older in the north (~2705 Ma: Morris, Daubrée, Caopatina). Alkaline volcanism is known in two distinct regions (Kirkland Lake and Chapais). New ages reveal a minor difference of 10 Ma between the two alkaline systems (2691-2676 Ma in the north versus 2682-2672 Ma in the south). Thus, Timiskaming-type conglomerate basins, sometimes interdigitating with these alkaline volcanic rocks, are no longer restricted to the southern part of the Abitibi Subprovince. The Matagami Group and the Haüy Formation are therefore considered equivalents to the Timiskaming Group. The definition of volcanic episodes and major volcanic cycles should help identify new exploration targets. Thus, the top of the three major cycles represent massive sulphide-rich stratigraphic levels: end of cycle 1 (Normétal, Joutel, Matagami, Chibougamau); end of cycle 2 (Kidd Creek, Gonzague-Langlois); and end of cycle 3 (Rouyn-Noranda). This does not exclude however the presence of ore deposits in the lower part of volcanic cycles (e.g. Estrades or Louvicourt).

Session 5 **2:00**

Linking hydrothermal flow paths and VMS deposits in the Noranda Camp and the Blake River Group

Bruce Taylor (GSC), Claude Dion (MRNF), Ben Berger (OGS), Benoît Dubé, Pierre-Simon Ross and Patrick Mercier-Langevin (GSC)

Submarine hydrothermal systems associated with subvolcanic intrusions or deep faults cause oxygen isotope alteration due to water-rock reaction at various temperatures. Even more than mineralogical changes, isotopic alteration leaves a robust 'paleo-hydrothermal fingerprint' that can survive even the highest grades of metamorphism. Oxygen isotope mapping provides a reliable tool for characterizing paleo-hydrothermal systems (regional and local), flow paths and temperature gradients to guide exploration for volcanogenic massive sulphide (VMS) deposits.

Oxygen isotope mapping in the Noranda and Clifford-Ben Nevis areas of the Blake River Group [1, 2] supported by a recent Canadian Mining Industry Organization-GSC project (>1450 analyses, new and compiled; Taylor, in [3]), and in the Kidd Creek area (>620 analyses; [4, 5]), has demonstrated its general utility in defining VMS-mineralized hydrothermal systems in these areas despite their marked differences in isotopic alteration. At Noranda, the range of whole-rock $\delta^{18}O$ values is -0.3 to 13.4 ‰, but ca. 6.3 to 15.7 ‰ at Kidd Creek. Similarly, ore fluid oxygen isotope compositions were also different: at Kidd Creek, the $\delta^{18}O$ value of the fluid was as high as ca. 7.0 ‰ [6], whereas it was typically lower at Noranda (ca. 1-3‰, excluding the Horne mine), and more akin to slightly modified seawater. Despite these differences, several common features characterize both Kidd Creek and Noranda, including: (1) the larger size of mineralized systems compared to non-mineralized; (2) VMS deposits hosted by isotopically 'normal' rocks (unless hydrothermally overprinted) between footwall zones of high-temperature water-rock reaction marked by ^{18}O-depletion, and later-formed low-temperature zones of ^{18}O-enrichment in the hanging wall; (3) clear identification of upflow zones and hydrothermally significant synvolcanic faults; and (4) distinction among intrusions with and without associated submarine hydrothermal systems.

Regional oxygen isotope mapping is currently underway in selected areas of the Kidd-Munro assemblage and Blake River as part of the TGI-III Abitibi project. The isotope project aims to: (1) extend previous isotopic investigations; (2) document hydrothermal systems in both known mineralized areas and poorly known areas; and (3) assist VMS exploration. The 2006 field season sampling included the Bousquet-LaRonde area (ca. 75 samples); selected areas within the Blake River Group between the Clifford-Ben Nevis and Flavrian complexes, and east and north of the central Noranda camp (ca. 375 samples, plus additional samples to be obtained from MRNF archives); and the Kidd-Munro assemblage east of the Kidd Creek mine area (ca. 200 samples; NDM archives).

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Session 5 **2:20**

New geological and metallogenic data in the western portion of the Blake River Group and along a segment of the Larder Lake Cadillac Fault

Claude Dion, Marc Legault (MRNF), Olivier Rabeau (URSTM-UQAT), Pierre-Simon Ross (GSC), Patrick Mercier-Langevin (GSC)

The geological and metallogenic synthesis of the western Blake River Group and the Cadillac-Larder Lake fault continued in 2006. In partnership with the Geological Survey of Canada within the scope of the Targeted Geoscience Initiative (TGI-3 Abitibi), a series of thematic studies were also undertaken on the geology and volcanology of the main VMS deposits in this area (Ross-Montbray and Four Corners), the stable isotope geochemistry and the geochronology of volcanic and intrusive units.

To date, the Blake River Group synthesis covers an area extending from the Flavrian Pluton in the east, westward to Lac Montbray. The geology in this area is characterized by a bimodal sequence assigned to the Duprat-Montbray Formation, composed of largely transitional felsic volcanic rocks, and tholeiitic and transitional mafic-intermediate volcanic rocks. This sequence contains three main felsic centres (Montbray, Four Corners, Flavrian West) that form the core a major open anticline with a SE axial plane. This fold probably reflects the existence of paleo-relief associated with these volcanic edifices. Synvolcanic intermediate to felsic (e.g. Flavrian Pluton) and mafic-intermediate (e.g. Horseshoe Gabbro) intrusions, post-tectonic porphyritic syenite (Aldermac Pluton) and alkali granite (Twin Lake Pluton) intrusions, and Proterozoic gabbro-diabase dykes intrude the volcanic pile. The sequence is also cut by a number of faults trending NW (Mouilleuse fault) and NE to NNE (Quesabe and Hunter Creek faults). At least five types of mineral occurrences are known in the study area: (1) VMS-type polymetallic occurrences forming disseminated, stringer, and massive sulphide zones or exhalative layers; (2) Cu-Ni±PGE occurrences associated with mafic intrusions; (3) gold (± Cu, Ag, Mo) occurrences, associated or not with quartz veins, characterized by the presence of magnetite and pyrite and intense albite and hematite alteration; (4) magmatic-hydrothermal Cu (± Mo, Au, Ag, Pb, Zn) occurrences essentially related to the St. Jude Breccia, an intrusive and hydrothermal breccia zone associated with the Flavrian Pluton; and (5) gold-bearing mesothermal quartz-carbonate veins.

The synthesis also covers a segment of the Cadillac fault located near the town of Rouyn-Noranda as well as a 5-km strip on either side of the fault. Based on work done so far, the geological map of the Blake River Group was updated in the study area, the geochemistry coverage was improved, and the different types of gold occurrences in the area were inventoried and characterized. Furthermore, a 3D geological model was built for an area of 50 x 9.5 x 1 km, extending from the Ontario border to the McWatters mine. Available geoscience data was compiled and integrated into the model. The next step of the project will consist in defining alteration patterns in 3D, in order to locate the most promising areas for gold deposits.

Session 5 **2:40**

Potential and distribution of komatiite-associated Ni-Cu-PGE deposits in the Abitibi greenstone belt

Michel G. Houlé (OGS), Pierre Pilote (MRNF), C. Michael Lesher (MERC)

The main komatiitic units within the Abitibi Greenstone Belt (AGB) occur in four distinct stratigraphic and time intervals: 1) the Pacaud assemblage (2750-2735 Ma); 2) the Stoughton-Roquemaure assemblage (2723-2720 Ma); 3) the Kidd-Munro assemblage (2719-2711 Ma); and 4) the Tisdale assemblage (2710-2704 Ma). However, despite several periods of intense mineral exploration over the last century, komatiitic Ni-Cu-(PGE) deposits were discovered only in the two younger assemblages, namely the Kidd-Munro and Tisdale assemblages.

Based on current knowledge, Ni-Cu-(PGE) deposits form small clusters located in seven main areas of the AGB:
1) Shaw Dome (Langmuir #1-2, Redstone, McWatters, Hart);
2) La Motte (Marbridge #1-4, Bilson-Cubric);
3) Dundonald (Alexo-Kelex, Dundeal, Dundonald South);
4) Bannockburn (Zone C, Thalweg, Rahn Lake, Zone B);
5) Bartlett Dome (Texmont);
6) Halliday Dome (Sothman); and 7) Amos-Senneterre (Dumont).

The importance of volcanological processes in the formation and location of komatiitic Ni-Cu-(PGE) deposits was established many years ago. Around the globe, practically all orebodies are hosted in cumulate-rich units, interpreted either as lava channels or feeder sills. Many of the latter show evidence of interaction between country rocks and komatiitic magma (geochemical contamination, xenoliths) that demonstrates the dynamic nature of these systems. However, the morphofacies of komatiite units vary within a regional volcanic edifice, and even within individual flows. This makes the geometry of the regional komatiitic edifice quite complex and makes it difficult to predict areas with favourable volcanic morphofacies. Moreover, AGB komatiites commonly exhibit a complex subvolcanic-volcanic architecture, indicating interaction between komatiitic units and adjacent rocks located on or near the seafloor. This global environment plays a significant role in terms of where nickel sulphides are most likely to segregate and accumulate.

The evolution of our understanding of the volcanology and stratigraphy of AGB komatiites demonstrates that by increasing exploration efforts, the chances of discovering new Ni-Cu-(PGE) deposits are very good, both in underexplored areas (e.g. Bartlett Dome) and in more mature areas (e.g. Shaw Dome). In conclusion, a multidisciplinary approach, including geological mapping, physical volcanology studies, geophysical and geochemical surveys, is needed to support exploration for this type of deposit, and to help recognize favourable volcanic sequences likely to host nickel sulphides.

Session 5 **3:00**

The base metal exploration implications of new Abitibi stratigraphic models based on results of the Greenstone Architecture Project, Discover Abitibi Initiative in the Timmins-Kirkland Lake area

J.A. Ayer (OGS), P.C. Thurston (LU-MERC)

This project completed a number of bedrock mapping subprojects from Kamiskotia to the Québec border and focused on improving the understanding of camp and regional-scale controls on base metal and gold mineralization. Geochronology was an important component of the project and included 34 new TIMS and 11 SHRIMP U-Pb zircon ages. New insights from the project include revisions to our stratigraphic models and our understanding of the relationship of Abitibi base metal mineralization to stratigraphy. Six important revisions are: 1) the identification of Keewatin submarine unconformities both at assemblage contacts and within assemblages, some of which are important for the localization of VMS deposits; 2) recognition that the Pacaud (2750-35 Ma) and Deloro (2730-24 Ma) assemblages are now preserved on the margins of synvolcanic batholiths and in the cores of early anticlines, however widespread inherited zircons of these ages within younger assemblages indicate they were widespread basal units occurring throughout much of the Abitibi; 3) the Kidd-Munro assemblage has been subdivided into an early calc-alkaline unit (2719-17 Ma) overlain by a tholeiitic and komatiitic unit with high Cu-Zn (e.g. Kidd Creek and Potter mines) and Ni-Cu-PGE (Alexo and Marbridge mines) potential; 4) the Tisdale has been subdivided into a lowermost unit (2710-07 Ma) consisting of tholeiites and komatiites associated with Ni-Cu-PGE deposits (e.g. Langmuir and Redstone mines), and an uppermost calc-alkaline unit (2706-2704 Ma) that hosts Cu-Zn deposits (e.g. Cross Lake Prospect); 5) the Blake River assemblage has been subdivided into a lowermost unit (2703-2701 Ma) dominated by tholeiitic basalts and overlain by a tholeiitic and calc-alkaline unit (2701-2695 Ma) hosting the VMS deposits of the Kamiskotia district, which are similar in age and geochemical characteristics to the Cu-Zn deposits in the Rouyn-Noranda district; 6) work in the Ben Nevis area of the Blake River Group indicating that the ages, volcanic facies and geochemical characteristics of this area are similar to those hosting the gold-rich VMS deposits of the LaRonde district. The combined mapping, geochemical and geochronological approach of the Architecture Project has been successful in refining stratigraphy that helps both structural interpretations and the assessment of base metal potential.

Session 5 **3:20**

A new MEGATEM survey in the Chibougamau area

Pierre Keating, Régis Dumont (GSC-CCD),
Benoît Dubé (GSC-Q), Patrice Roy, Patrick Houle (MRNF)

An airborne MEGATEM electromagnetic (EM) and magnetic survey was conducted in the early winter 2006 in the Chibougamau-Chapais area. This survey was undertaken within the scope of the Abitibi Project, under the Targeted Geoscience Initiative of Natural Resources Canada. Flight lines were spaced every 200 metres and flown at an altitude of 120 metres. The survey was flown over four blocks, selected for their strong mineral potential, in cooperation with the MRNF and the mining industry. This EM system is able to detect conductive massive sulphides to a depth of about 250 metres. The objective was to identify new exploration targets, to promote mineral exploration, and to assist geological mapping in the area. The receiver measuring the magnetic field was located at a height of about 60 metres above the ground. Since it is impossible to maintain this nominal height exactly, corrections were applied to minimize the effect of altitude variations between adjacent lines. The second vertical derivative of the magnetic field, which clearly defines the structure of magnetic units, was then calculated. A total of 3,594 conductors were detected, covering a conductance range of 2 to 110 siemens (S), with an average conductance of 43 S. Depths, interpreted using a thin vertical plate model, range from the surface down to 175 metres, with an average depth of 50 metres. The survey located new conductors, which had not been detected by previous airborne geophysical surveys. These conductors are generally isolated and easy to recognize. A more sophisticated interpretation of many of these anomalies shows that the latter are located at depths reaching 150 or 200 metres. Many of these also show a strong conductance. Low-conductance anomalies, such as the anomaly associated with the Selco-Scott zinc-silver deposit, are also worthy of interest. In the latter case, the low conductance is due to the presence of sphalerite. Numerous conductors are associated with rocks with a high graphite content. However, certain orebodies can be located near these formational conductors. One such example is the Lac des Vents (Chesbar) copper deposit, which consists of chalcopyrite, pyrrhotite, pyrite, and sphalerite hosted in graphitic and felsic pyroclastic rocks of the Obatogamau Formation. This new EM survey will lead to new discoveries and will also enhance the knowledge base of the area.

Session 5 **3:40**

A look at the gitology of the southern flank of the Doré Lake Complex in the Chibougamau mining district: Integrating data into a new 3D model

Patrice Roy, Patrick Houle (MRNF), Francine Fallara, Li Zhen Cheng (URSTM-UQAT), Jean Girard (Campbell Resources), Benoit Lafrance (Cogitore Resources), Pierre Pilote (MRNF), Gérald Riverin (Cogitore Resources)

Mines in the Chibougamau mining camp are clustered along the north limb of the Lac Doré Complex. However, many occurrences discovered along the south limb suggest a favourable setting for copper, zinc, and gold exploration. The area covered by the 3D modelling project includes the Devlin and Corner Bay copper deposits and the East Showing gold deposit. It also includes the former Lemoine mine, known for its exceptional base and precious metal grades.

Most occurrences located along the south limb of the Lac Doré Complex and in volcanic rocks further south may be related to one of five known deposit models. The Lemoine mine and occurrences hosted in the Lemoine felsic member exhibit features typical of volcanogenic massive sulphides. The layered series of the Lac Doré Complex contains Fe-Ti-V-rich magnetitite beds. Porphyry Cu±Au occurrences are associated with the late phases of the Chibougamau Pluton. These phases were also the driving force behind the emplacement of Chibougamau-type Cu-Au veins in the Lac Doré Complex. Finally, several orogenic lode gold occurrences are associated with regional E-W deformation zones.

Within the same area, three groups of occurrences that do not fit existing models are observed: a) polymetallic veins associated with the granophyre zone of the Lac Doré Complex; b) Cu-Au veins occurring along NE-trending faults north of the La Dauversière Pluton; and c) Cu-Au occurrences located along late NNE-trending faults associated with the Grenvillian orogeny.

The MRNF, in cooperation with the URSTM-UQAT, GSC-Québec and mining companies, conducted fieldwork in order to revise the regional stratigraphy and ore deposit settings of the study area. The 3D model will help us validate the stratigraphy, standardize the database, and identify new regional exploration targets.

151

Contribution of 3D modelling to the geology of the Urban-Barry Belt

Pierre Rhéaume (MRNF), Francine Fallara, Li Zhen Cheng (URSTM-UQAT)

Géologie Québec conducted extensive geological work in the Urban-Barry Belt (UBB) to support intense mineral exploration efforts in this area over the last few years. The structure and stratigraphy of the UBB were substantially redefined following integration of data derived from mapping surveys and exploration work. A regional 3D model of the UBB was built in gOcad® in order to validate this new geology.

The model was built in such a way as to allow the integration of data from surface geology, drillholes, and regional geophysical surveys. The different types of information taken into consideration are lithology, stratigraphic affiliation, geochronology, structural fabric, degree of deformation, and magnetic susceptibility. Other types of information, namely cross-cutting relationships and interference patterns observed on outcrop were also integrated. The latter were factorized and used to systematically construct partial vertical geological cross-sections spaced two kilometres apart at most. These sections were designed in such a way as to reflect the local structural trend.

The validation process involves two phases. The first requires the resolution of cartographic problems such as "map-edge faults" and geometric ambiguities. The second consists in confronting the model with unconstrained and constrained geophysical inversions of the regional magnetic survey. This process provides an objective test of the adequacy of the model relative to a penetrative physical property, in this case magnetic susceptibility. The major limitation of this method remains the relative contrast between lithologies.

The proposed model outlines a number of geological relationships which were not obvious at the onset. More specifically, a series of interactions are observed between syntectonic plutons and Kenoran faulting. In certain cases, plutons deform faults while in others, the same faults guide the emplacement of intrusions.

152-153

Progress report on 3D modelling, phase 1: Ore deposit settings along the south limb of the Lac Doré Complex, Chibougamau mining district

Patrice Roy (MRNF), Francine Fallara (URSTM-UQAT), Patrick Houle (MRNF), Jean Girard (Campbell Resources), Benoit Lafrance (Cogitore Resources), Pierre Pilote (MRNF), Gérald Riverin (Cogitore Resources)

A 3D common-earth model was produced by the URSTM and the MRNF, in cooperation with mining companies involved in the area. It covers the south limb of the Lac Doré Complex, including the volcano-sedimentary belt to the south and part of the Chibougamau Pluton. The model will be used to identify lithostratigraphic and structural markers, geochemical alteration zones, and significant metal concentrations using a metallogenic approach based on known ore deposit models. Thus, the main objectives of the 3D common-earth model for the southern part of the Chibougamau mining camp are as follows:

1. Produce a 3D regional common-earth model (voxet of 36.10 x 20.45 x 1.55 km) integrating all available geoscience data.
2. Validate the new regional stratigraphic interpretation.
3. Characterize the various types of deposits present within the voxet.
4. Define the 3D distribution of areas favourable to the emplacement of 4 types of occurrences:
    i. Volcanogenic massive sulphides (i.e. felsic centres);
    ii. Porphyry Cu±Au (i.e. Chibougamau Pluton);
    iii. Cu-Au veins (i.e. Chibougamau-type in the Lac Doré Complex);
    iv. Orogenic gold (i.e. regional deformation zones).
5. Build queries based on geological, geophysical, and geochemical data to define new exploration targets.

A geological survey was carried out to complete and enhance the database for the model. The purpose of this survey is to: a) refine the stratigraphy of the area, particularly in felsic centres, in order to better understand the deposit setting for volcanogenic massive sulphide occurrences; b) characterize occurrences in the area, with special emphasis on porphyry Cu±Au occurrences in the Chibougamau Pluton and Chibougamau-type Cu-Au veins in the Lac Doré Complex.

The results of exploration work by Cogitore in the area were used to update the stratigraphy of the Lemoine member. The rhyolite extends over the entire member. The sequence evolves from a tholeiitic affinity in the footwall of the Lemoine ore deposit, to a transitional affinity in the hanging wall. Finally, basalts of the Gilman Formation, overlying the Lemoine member, have a geochemical signature typical of the upper Gilman.

In the Chibougamau Pluton, at least three late porphyry intrusions with Cu±Au mineralization were identified. Moreover, many Devlin-type breccias are found near the southern margin of the Chibougamau Pluton and in the Lac Doré Complex. Occurrences in the Lac Doré Complex are clustered in two areas, near the Corner Bay deposit and in the granophyre zone north of the Lemoine member. Occurrences in the Corner Bay area exhibit features comparable to Lac Doré deposits but with lower gold grades. Granophyre occurrences are

characterized by the presence of polymetallic veins subconformable to lithological contacts. Finally, several orogenic gold showings are concentrated along regional E-W fault zones.

154

The Abitibi-Témiscamingue 3D geological modelling centre: Summary of ongoing work by the URSTM-MRNF 3D team

Olivier Rabeau (URSTM-MRNF), Francine Fallara, Li Zhen Cheng (URSTM), Marc Legault (MRNF), Denis Bois (URSTM), Robert Marquis, Pierre Rhéaume (MRNF)

The production of reliable three-dimensional models involves the integration of large amounts of lithological, structural, geochemical, geophysical, and drilling data, derived from the private sector and from public databases. The Abitibi-Témiscamingue 3D geological modelling centre has acquired an expertise since its inception in 2000, in terms of using models as interactive tools for metallic deposit exploration. The query-building process using 3D data is emphasized to define exploration targets at depth. Although defined zones depend on constraints used to build the query, it is obvious that this technique can generate new targets and stimulate exploration activity in mature mining camps or in underexplored areas.

The 3D team has also acquired expertise in modelling and geophysical inversions. These techniques, mainly developed for mineral exploration, are used to quantitatively interpret gravity, magnetic, electric, and electromagnetic data at depth. Geophysical inversion methods are therefore very useful to validate newly built 3D geological models.

Furthermore, the team at the Abitibi-Témiscamingue 3D modelling centre continues to innovate by using new techniques. The latest innovations are as follows:

1. Probabilistic approach to 3D modelling to produce favourability maps for ore deposit types.
2. User-friendly links between 3D-GIS and multimedia applications to allow communication of graphic content on the Internet.
3. New inversion method to identify and quantitatively characterize various types of ore deposits (i.e. VMS).
4. New interpretation technique where geophysical and geological data are merged in order to minimize interpretation ambiguities.

155-156

Geology of the western Malartic Group: Regional correlations (1 of 3)

Pierre Pilote (MRNF)

Our objectives for the first year of a three-year geological revision and compilation project are as follows: 1) extend to the west the stratigraphic scheme of the Malartic Group recently developed in the Val-d'Or area by the MRNF, and 2) examine at a larger scale possible correlations between these lithologies and those in the Kidd-Munro area in Ontario. The study area covers the central part of the eastern half of NTS sheet 32D/07, namely the northern part of Cléricy Township and the western half of La Pause Township.

In the map area, the Malartic Group is composed, in stratigraphic order, of the La Motte-Vassan (2714±2 Ma), Dubuisson, and Jacola (2704±2 Ma) formations. Further east in the Val-d'Or area (map sheets 32C/03 and 32C/04), these lithologies are overlain by the Val-d'Or (2705 to 2704±2 Ma) and Héva (2702±2 Ma) formations. The La Motte-Vassan Formation is composed of ultramafic flows and sills with little or no spinifex, basaltic flows and volcaniclastic rocks. The Dubuisson Formation consists of massive and pillowed basalts characterized by the presence of epidote and fine-grained magnetite in pillow cores, as well as layers of lapilli and block tuff. Rhyolitic complexes occur in this formation near Ruisseau Dunn and Lac Patris (Py-Po-Au). They consist of massive flows and lobes overlain by tuffs and flow-top breccias. The Jacola Formation is composed of equal proportions of ultramafic and mafic volcanic rocks, with a few layers of volcaniclastic rocks.

Volcanic units of the Malartic Group form a steeply dipping, south-facing homoclinal sequence. The group is in faulted contact in the south (La Pause fault) with sedimentary units of the Kewagama Group (<2687 Ma). In the north, the group is bounded by an E-W-trending zone of complex faulting (e.g. Aiguebelle and Manneville faults) probably comprising subsidiaries of the regional Destor-Porcupine fault recognized further west. These faults bound sedimentary rocks of the Lac Caste Group (<2691±8 Ma) and ultramafic to felsic volcanic units of the Lanaudière Formation (2718±2 Ma), assigned to the Kinojevis Group. The regional S_1 schistosity trends WNW-ESE; it is reworked by an S_2 cleavage trending E-W, which produces Z folds at various scales. Overall, the metamorphic grade is generally in the upper greenschist facies, but commonly reaches the amphibolite facies.

Dykes are very abundant in this area. They are subdivided into (1) a diorite-tonalite suite and (2) a monzonite suite. Dykes of the first suite appear to be spatially associated with the extensive La Pause Pluton, interpreted as synvolcanic to syntectonic, whereas monzonitic dykes (with many Au and Mo showings) are likely associated with the Preissac Intrusive Complex (2681 to 2660 Ma).

157

Progress report on geological and metallogenic synthesis of the western Blake River Group

Claude Dion (MRNF), Pierre-Simon Ross (GSC-Québec), Patrick Mercier-Langevin (GSC-Québec)

The geological and metallogenic synthesis of the western Blake River Group, undertaken in 2004, continued over the summer. In partnership with the Geological Survey of Canada within the scope of the Targeted Geoscience Initiative (TGI-3 Abitibi), a series of thematic studies were also undertaken on the geology and volcanology of the main volcanogenic massive sulphide (VMS) deposits in the area (Ross-Montbray/Inmont and Four Corners), the stable isotope geochemistry and the geochronology of volcanic and intrusive units.

To date, the Blake River Group synthesis covers an area extending from the Flavrian Pluton in the east, westward to Lac Montbray. The geology of the area is characterized by a bimodal sequence assigned to the Duprat-Montbray Formation, composed of largely transitional felsic volcanic rocks, and tholeiitic and transitional mafic-intermediate volcanic rocks. In this sequence, the part examined to date contains three main felsic centres (Montbray, Four Corners, Flavrian West) that form the core of a major open anticline with a SE axial plane. This fold probably reflects the existence of paleo-relief associated with these volcanic edifices. Synvolcanic intermediate to felsic (e.g. Flavrian Pluton) and mafic-intermediate (e.g. Horseshoe Gabbro) intrusions, post-tectonic porphyritic syenite (Aldermac Pluton) and alkali granite (Twin Lake Pluton) intrusions, and Proterozoic gabbro-diabase dykes intrude the volcanic pile. The sequence is also cut by a number of faults trending NW (Mouilleuse fault) and NE to NNE (Quesabe and Hunter Creek faults). At least five types of mineral occurrences are known in the study area: (1) VMS-type polymetallic occurrences forming disseminated, stringer, and massive sulphide zones or exhalative layers; (2) Cu-Ni±PGE occurrences associated with mafic intrusions; (3) gold (± Cu, Ag, Mo) occurrences associated or not with quartz veins, characterized by the presence of magnetite and pyrite, and intense albite and hematite alteration; (4) magmatic-hydrothermal Cu (± Mo, Au, Ag, Pb, Zn) occurrences essentially related to the St. Jude Breccia, an intrusive and hydrothermal breccia zone associated with the Flavrian Pluton; and (5) gold-bearing mesothermal quartz-carbonate veins.

The main stripped outcrops where the Four Corners showing and the former Inmont producer (Robb-Montbray Zone 3) are exposed were sampled and mapped in detail. These VMS-type deposits, one of which is gold-bearing, are associated with felsic centres located on either side of the Hunter Creek fault. In the field, special attention was paid to volcanology, as well as alteration and mineralization. A geochemistry and petrography study is planned for the winter, based on roughly 40 samples. This detailed information will be integrated into a more regional mapping survey of the felsic centres in the area, planned for next summer.

158

Geology and metallogeny of the Blake River Group: Objectives and preliminary results of a joint GSC (TGI-3) – MRNF (Copper Plan) – OGS – Industry – University effort

Patrick Mercier-Langevin, Benoît Dubé, Pierre-Simon Ross (GSC-Québec), Claude Dion, Jean Goutier, Marc Legault (MRNF), Vicki McNicoll, Bruce Taylor, John Percival (GSC-Ottawa), Patrice Gosselin (GSC-Québec), Phil Thurston (Laurentian University)

The Blake River Group (BRG) in Abitibi represents one of the best exploration targets for Cu-Zn and Au-Cu-Zn-Ag volcanogenic massive sulphides (VMS). The purpose of the geological and metallogenic synthesis of the BRG, undertaken within the scope of a joint effort involving the GSC (Targeted Geoscience Initiative-3, Abitibi), the MRNF (Copper Plan), the OGS, industry and universities, is to enhance the mineral potential of this area through the acquisition of new public data and geological knowledge, and by training highly qualified personnel in exploration for base and precious metal deposits.

A number of studies were undertaken, at various scales and covering a large portion of the BRG in Québec and Ontario. Regional mapping in the western BRG continued, in conjunction with the synthesis and reinterpretation of geological, geochemical, and geophysical data available throughout the BRG, as well as 3D modelling of the western segment of the Cadillac-Larder Lake fault and the Noranda mining camp. A BRG-wide stratigraphic and structural study is also underway, involving the production of strategic sections, while major volcaniclastic units are mapped and characterized in detail, in order to better define the genetic framework of the BRG. Similarly, a study of dyke swarms typical of the BRG was launched to allow a better understanding of intrusive units. All these mapping and characterization activities targeting the main volcanic and intrusive units of the BRG are backed by an intensive geochronology program (U-Pb) and a large-scale isotope geochemistry (oxygen, carbon) program.

Special attention is given to mineralized systems (alteration, mineralization, geochemical and isotopic signature) observed during mapping surveys, while a number of thematic studies are underway: metallogenic synthesis of the Doyon-Bousquet-LaRonde mining camp, geology of the Inmont–Four Corners–Montbray area, geology and metallogeny of the Horne and Quémont ore deposits, characterization and distribution of volcanogenic alteration, role of synvolcanic intrusions and links with VMS, and synthesis of gold-rich VMS ore deposits and showings.

159

Hydrothermal systems, isotope signatures and exploration for volcanogenic massive sulphides in the Blake River and Kidd-Munro assemblages (past, present, and future studies)

B. E. Taylor (CGC), C. Dion (MRNF), B. Berger (OGS), B. Dubé, P.-S. Ross, P. Mercier-Langevin (CGC)

160

Preliminary results of the TGI-3 Abitibi project in the Chibougamau camp

Stratigraphic revisions in the Roy Group and implications for exploration

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A geological survey was carried out during the summer 2005 and 2006 in the Northern Volcanic Zone of the Abitibi Subprovince, along the south limb of the Chibougamau syncline (NTS 32G/16) north of the Lac Doré Complex. The objective was to elaborate the internal stratigraphy of the Gilman Formation (2nd volcanic cycle of the Roy Group), currently mapped as a monotonous sequence of massive to pillowed basaltic lavas intruded by differentiated sills. Based on the results of this survey, the various lithological assemblages of the Gilman Formation were divided into three distinct members.

The David Member corresponds to the lower Gilman. It is characterized by the presence of massive to pillowed lavas, sometimes highly vesicular, intruded by comagmatic differentiated gabbro sills. These lavas are interbedded with large km-scale bands of vitric lapilli and block tuffs, thin lenses of dacitic to rhyolitic rocks, Py-Mg exhalites and locally metasomatized iron formations that constitute the source of clasts for overlying tuffs.

The Allard Member designates an assemblage composed of lapilli and block tuff (mafic to felsic clasts, sulphides, chert), plagioclase crystal tuff, and rhyolitic flows, overlying the David Member and laterally continuous over more than 25 kilometres. This unit separates tholeiitic basaltic lavas of the David Member (lower Gilman) from calc-alkaline andesitic lavas of the Bruneau Member (upper Gilman). We propose a division of the Gilman along this volcaniclastic layer, with a type section at Parc Allard. The recognition of a volcaniclastic marker horizon of regional extent, with disseminated occurrences (Py-Po-Cp), semi-massive sulphide clasts (Py-chert), overlain by a unit of massive rhyolite and cut by synsedimentary faults, constitute indications of a favourable setting for the development of volcanogenic massive sulphides (VMS). In fact, VMS have already been identified above and below, in the David Member (Lac Wawbano and Lac Taché) and in the Bruneau Member (Bruneau mine).

The Bruneau Member designates the upper part of the Gilman Formation. It essentially consists of massive to pillowed andesitic lavas with a typically light beige to milky white weathered surface. In the vicinity of the Bruneau mine, exhalative horizons with massive Py-Mg mark the transition between lapilli and block tuffs and laminated cherts. Two fault and fracture networks, trending N-S and E-W, play a role in the alteration of andesites to chlorite and epidote, and the concentration of disseminated Py-Po-Cp mineralization.

161

High-resolution 2D seismic data from the Noranda central camp and implication for exploration: TGI-3 Abitibi project

Gilles Bellefleur, Eric de Kemp (GSC-Ottawa), Jean Goutier (MRNF), Michel Allard (Xstrata)

As part of Phase 3 of the Targeted Geoscience Initiative (TGI-3), the Geological Survey of Canada obtained access to industry seismic reflection data acquired along two profiles in the eastern Blake River Group. The two seismic lines (Amulet-001 and Ribago-001) were shot by Noranda during the summer of 2000. The Amulet and Ribago seismic profiles run approximately east-west and cross the Mine Series volcanics that host most of the deposits in the Noranda central camp. The seismic data, not previously available publicly, provide new information about the geology at depth in the Mine Series. In addition, the Amulet seismic data was re-processed to improve reflectivity in the shallow part of the section. Visual inspection of the reflection profile with Falconbridge's interpreted 3-D geologic model indicates improved correlation of reflections with geology in this part of the camp.

The Amulet seismic profile is approximately 6 km long and located south of Lithoprobe line 21-1, between the Dufault and Flavrian plutons. The Ribago line is 5 km long and located east of the Flavrian, just north of the Powell pluton. The data quality of the Amulet line is excellent and may partly be the result of the moderately dipping stratigraphy in this area of the Blake River Group. The strength and number of reflections in the field data are significantly lower for the Ribago profile, which runs over steeply dipping stratigraphy.

Changes in seismic reflectivity characteristics are used to define several geological domains. On the Amulet profile, one of the domains corresponds to the Flavrian pluton. It is characterized by strong east-dipping reflections embedded in a relatively low-reflectivity background. The prominent east-dipping reflections likely correspond to mafic intrusions and dykes observed in the Mine Series and Flavrian pluton. The contact between the Flavrian and overlying rhyolite produces a weak reflection. This is explained by the weak acoustic impedance contrast between these two rocks units. The mafic intrusions and dykes producing strong reflections within the Flavrian pluton have reduced amplitudes when in contact with mafic volcanic rocks. A reduction in amplitude along the mafic dyke-related reflections is therefore a possible indication of a transition between felsic and mafic volcanic rocks. The Mine Series volcanics are characterized by short crossing reflections with different dips that complicate reconciliation with rhyolitic-andesitic sequences in the area.

One implication for exploration from this study is that reprocessing these seismic surveys is worthwhile in order to provide depth validation for moderately dipping felsic-pluton and felsic-intermediate volcanic contact geometries down to depths of 4 km.

162

Is semi-automated generalization of 1/50,000 or 1/100,000 scale maps to 1/250,000 scale possible with ArcInfo? Test area: Chibougamau 32G, TGI-3 Abitibi project

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Over the years, many manual, semi-automated or automated methods have been developed and tested for the generalization of multi-scale maps. Nevertheless, the generalization of thematic maps is not a process that can be applied in a generic or global manner. Generalization is specific to each domain; there are no predefined rules or procedures. A set of specific standards must therefore be established, by performing first a needs analysis and a strict and rigorous evaluation of the repercussions, i.e. how each generalization tool affects the overall final product.

At the Geological Survey of Canada (Québec), preliminary work on the development of an appropriate generalization method was done in the years 2002-2003. At the time, 16 Quaternary geology maps of the Chibougamau area at 1/50,000 scale were used. The latter were to be linked, generalized to 1/100,000 scale and published as four A-Series maps (GSC). The semi-automated process was slow and required many manual interventions from the cartographer.

Today, within the scope of the TGI-3 Abitibi project, our goal is to improve this technique and apply it to generalize 1/100,000 scale maps to 1/250,000 scale. The first step was to perform a needs analysis that would meet our expectations as users. Then, we applied generalization tools currently available in ArcGIS 9.1 (ArcInfo Workstation and ArcMAP): deletion, replacement, aggregation, smoothing, exaggeration, and simplification. In the next step, we wanted to automate the procedure even more by using a cell-based generalization technique (Li. et al., 2001). The results produced by ArcGIS are currently used as a testbed to calibrate, verify and test the cell-based modelling method. Finally, the two products (ArcGIS versus Cellular) will be tested in terms of the initial needs analysis. Eventually, we hope to use the two methods separately or combined, to complete a final Québec-Ontario cross-border compilation at 1/500,000 scale, for the entire Abitibi.

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163

The polymetallic system in the Lac Line area, Chibougamau, Québec

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The Lac Line area, located in the northeastern Archean Abitibi Subprovince, encompasses a system of Au, Ag, Cu, and Zn occurrences that take on various forms, hosted in lithologies that constitute the top of the volcanic pile in the Chibougamau area. Mineral occurrences, among which polymetallic lenses, stockworks, and disseminations, have been interpreted as volcanogenic massive sulphides, porphyry-type, and possibly epithermal occurrences.

The main lithologies encountered in the Lac Line area consist of mafic to ultramafic intrusive rocks, calc-alkaline mafic to intermediate lavas, and fine-grained tuffs. The rocks have undergone lower to middle greenschist-grade metamorphism and very little deformation. This project focuses on disseminated sulphide occurrences and sulphide±magnetite veins, informally referred to as "Brosman-type" occurrences. Brosman-type occurrences take one of two forms. The first corresponds to magnetite-pyrite-chalcopyrite veins (Form I: Cu, Au, Ag), mainly hosted in mafic to ultramafic intrusive rocks altered to albite-chlorite-carbonates. The second form of mineralization corresponds to disseminated and stringer pyrite±chalcopyrite±pyrrhotite (Form II: Au), mainly hosted in fractured lavas altered to chlorite-quartz-white mica.

Field and laboratory observations indicate that the two types of mineralized structures predate the main ductile deformation event in the area. Moreover, they are spatially distributed along NW-SE and N-S-trending brittle faults, which suggests they are geometrically and chronologically related to the Lac Line stock, a porphyritic tonalite intrusion analogous to synvolcanic felsic intrusions known in the Chibougamau area.

"Brosman-type" polymetallic veins are therefore interpreted as synvolcanic in origin, having formed in a shallow environment, possibly above and peripheral to the Lac Line tonalitic stock. The latter may have acted as a subvolcanic chamber feeding calc-alkaline volcanism in the late stages of construction of a subaerial oceanic arc, with the development of a porphyry-type hydrothermal system leading to the emplacement of a wide variety of polymetallic occurrences, including "Brosman-type" occurrences.

164

Petrographic and metallogenic study of the MOP-II deposit, Chibougamau, Québec

Sylvain Lépine, Michel Jébrak (UQAM)

The Archean Chibougamau district is known for its atypical copper and gold lode occurrences, interpreted as the products of a porphyry system. Several other types of deposits are known, for example disseminated gold mineralization associated with porphyritic rocks (QFP and QP). The Gilman Formation is mainly composed of mafic to intermediate lavas. Within the latter, felsic intrusions host significant gold occurrences: the KOD zone at the Gwillim mine, the Monexco showing, etc.

Located five kilometres northwest of Chibougamau, the MOP-II gold deposit (SOQUEM Inc. and Ressources Itaminéraque Inc.) is essentially hosted in a felsic quartz-feldspar porphyry, occurring in intermediate to mafic tuffs, breccias, basalts, and gabbroic dykes. Within the QFP, four units were defined: a grey unit, strongly altered to silica, sericite and chlorite; a green unit, completely sericitized; an intensely carbonatized pink unit; and a white unit represented by m-scale dykes with sericite, chlorite, and strong carbonate alteration. These units contain an average of 2 to 30% disseminated pyrite, with traces of chalcopyrite and molybdenite. The average gold grade ranges from 0.1 to 0.8 g/t Au.

The heart of the deposit is composed of a series of cm-scale gold-bearing shear zones. These structures contain 5 to 90% coarse-grained automorphic pyrite and are characterized by high gold grades. Many observations suggest they locally remobilized gold and sulphides. For example, rocks bordering these zones exhibit a reduced sulphide content and lower gold grades.

South of the deposit, proximal to the contact with ultramafic rocks of the Roberge Formation, the MacAdam fault is a major fault. The sericite and silica alteration appears to become more intense near this structure.

Mapping of the various alteration facies will provide a new vision of the mineralized body.

165

Reprocessing of a metatransect across the Gaspésie Appalachians: Seismic imagery and structural evaluation

Martin Bêche, Dave Saucier (U. Laval)

The Gaspé Peninsula extends into the northeast part of the Quebec Reentrant and constitutes the northern extremity of the Appalachian mountain chain. Two orogenic phases affect the rocks of the Gaspé Peninsula: the Taconian orogeny during Late Ordovician time and the Acadian orogeny during the Devonian. The Taconian orogeny destroyed the passive continental margin of the Laurentia paleocontinent during a collision with an island arc archipelago. The Acadian orogeny deformed the Taconian successor basin during a continent-continent collision between the Laurentia and Gondwana paleocontinents.

An integrated approach combing geological and geophysical contributions was applied to the reprocessing and interpretation of a megatransect more than 160 km long. This megatransect comprises three segments of 2D seismic reflection data acquired by the *Ministère des Ressources naturelles du Québec* in 2001-2002. It consists of profile 2001-MRN-12, which runs along Rivière Cap-Chat (~50 km) and runs from north to south across the Cambro-Ordovician terrains outcropping northern Gaspésie, and profiles 2001-MRN-10a and 10b that run along Rivière Nouvelle (~90 km) and cross the Gaspé belt from north to south. The inversion of first arrivals in the seismic signals and tomography of the most evident reflectors were used to construct velocity models that best represent the constraints imposed by *a priori* geological knowledge. Migration of the seismic data was performed before summation of the seismic traces to create depth profiles (vertical axis in metres). Recently published gravimetric and aeromagnetic data were taken into account during the structural interpretation of the megatransect.

The results of this study include a north-south profile at a scale of 1:1 and a structural interpretation. A scenario of geodynamic evolution is presented. Among the issues addressed: 1) the geometry of Cambro-Ordovician rocks in the Taconian allochthons; 2) the geometry of Siluro-Devonian rocks in the Acadian belt; 3) the effects of the Salinic event at the end of Late Silurian (Pridolian) time; 4) the role of the Shickshock South fault during the various tectonic events affecting the region; 5) the possible involvement of the Grenvillian basement during the orogenies; 6) the deformation and/or reactivation of Taconian structures during the Acadian orogeny; and 7) an evaluation of the hydrocarbon reservoir potential along the megatransect.

166

Structural analysis of faults and fractures affecting the passive margin of Anticosti, Québec Appalachians

Esther Bordet (INRS), Michel Malo (INRS), Donna Kirkwood (GSC)

A structural analysis of western Anticosti Island, Québec, characterized joint sets, folds and faults in generally flat-lying Upper Ordovician to Lower Silurian rocks outcropping on the island. The objective was to determine a possible relationship among the features and to estimate the role of the Taconian and Acadian orogenies in their development even though Anticosti Island lies 70 km northwest of the Appalachian orogenic front. Two Jurassic dykes linked to the opening of the Atlantic Ocean may also have triggered the development of brittle structures.

Anticosti Island is part of the St. Lawrence Lowlands platform. The sedimentary sequence consists of Lower Ordovician to Lower Silurian carbonate ramp deposits and rests unconformably on Precambrian basement. Lower Ordovician rocks were deposited in a passive margin setting (Romaine Formation). The Taconian orogeny took place during the deposition of the lower Caradocian Mingan Formation. Younger rocks outcropping at surface on the island are globally flat lying or dip approximately 3° to the south. Fractures, faults and open folds are recognized in the field and on aerial photographs.

Systematic fracture analysis was undertaken at different stations spread through the different formations to represent the behaviour of fractures in both time and space. Systematic orthogonal joint sets can thus be recognized.

Largely open folds occur locally in the Vauréal (Ashgillian) and Ellis Bay (uppermost Ashgillian) formations, north and west of the island. However, repeated sets of folds occur in the Chicotte Formation (uppermost Llandoverian) southwest of the island.

Faults are minor and few in number, and not very obvious in the field. Aerial or Landsat images are necessary to trace them. One fault zone consisting of about eight normal faults has been studied in the northeast sector of the island. Other major Taconian faults were identified in subsurface.

The following issues need to be addressed: 1) fracture evolution in time and space and identification of regional (Taconian and Acadian orogenies) or local (dyke, fold or fault setting) stress fields that induced the development of the observed joint sets; 2) the nature and origin of folds, and their relationship with the jointing pattern; 3) the Taconian or Acadian origin of the faults, and possible reactivation of deep Taconian faults during the Acadian orogeny.

167

New geochemical data to support hydrocarbon characterization in the Gaspésie

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A study of the organic geochemistry and thermal maturation of oil and source rocks from the Gaspésie and Anticosti Island was conducted within the framework of a project that aims to characterize the oil and gas potential of the Siluro-Devonian basin in eastern Québec.

Thirty-two rock samples and seven oil samples were selected. The oils were from seven different wells in the Gaspésie. Six samples of hydrocarbon (HC) source rocks were taken from two wells on Anticosti Island, and the others were surface samples collected throughout the Siluro-Devonian Gaspé Basin. The following analyses were performed: elemental analyses (C, H and O), temperature-programmed pyrolysis (Rock Eval 6), S_2 analysis, the kinetics of kerogen cracking, andgas chromatography and biomarker analysis.

Rock samples were grouped according to maturity and carbon content using TOC values and the S_2 value at the peak of kerogen cracking obtained by Rock Eval 6. The great majority of the samples are both mature and rich, and have thus already generated most of their oil and gas potential. In contrast, four samples from the Macasty and York River formations are immature and rich; therefore these samples have not yet generated all their genetic HC potential.

The van Krevelen diagram in Figure 1 reveals that samples are immature (hydrogen index of about 500 mg HC/g C) or mature (hydrogen index less than 200 mg HC/g C), and that certain samples experienced oxidation (elevated O/C atomic ratio coupled with a low H/C ratio and hydrogen index). All samples belong to type II (sapropelic), with the exception of a single coal sample that is type III (humic). Although this latter sample lies within the oxidation zone, it was not oxidized (hydrogen index of about 400 mg HC/g C).

TheGas chromatography analyses confirm the results of the elemental analyses shown in the van Krevelen diagram. The chromatograms all display signatures typical of type II, with the exception of the coal sample, which correlates with type III. The immature, mature and oxidized samples also display distinctly different chromatograms.

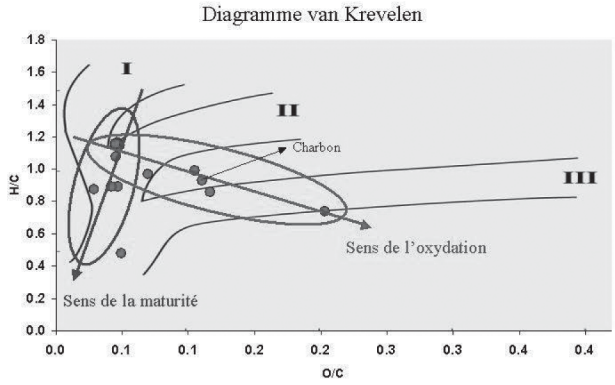


Figure 1

168

Ni-Cu-PGE metallogeny of the Portneuf-Mauricie Domain

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The Portneuf-Mauricie Domain, located about 100 kilometres west of Québec City, is composed of metasedimentary rocks and metatuffs of the Montauban Group (1.45 Ga), intruded by plutons of the La Bostonnais Complex (1.40-1.37 Ga). This assemblage formed in an island arc setting. Intrusive rocks of the La Bostonnais Complex and associated metasedimentary rocks were intruded by differentiated mafic-ultramafic plutons that host several Ni-Cu±PGE occurrences. The Ni-Cu potential of the area is confirmed by the presence of the former Lac Édouard mine, in operation in the 1970's (69,000 t at 1.5% Ni and 0.5% Cu), and by the presence of sulphide occurrences with higher Ni and Cu grades than most magmatic sulphide occurrences in the Grenville Province.

World-class Ni-Cu±PGE deposits share many common characteristics that help explain how they were emplaced. These characteristics were examined for five occurrences of the Portneuf-Mauricie Domain (Lac Matte, Lac Kennedy, Lac Édouard mine, Rousseau, Lac Nadeau) in order to develop a preliminary genetic model to explain the presence of Ni-Cu±PGE occurrences in this unusual magmatic arc setting. Occurrences in the Portneuf-Mauricie Domain are derived from relatively primitive magmas that presumably traveled along a major subduction zone located nearby to rise to the surface. Magma interaction with locally sulphide-bearing country rocks led to the felsification of magmas and the local assimilation of crustal sulphur by the magmas. These mechanisms are responsible for sulphide immiscibility. Magmas associated with the five occurrences may have undergone early sulphide segregation, leading to a depletion of chalcophile elements and precious metals in the magma. In occurrences of the Portneuf-Mauricie Domain, sulphide formation was followed by relatively numerous magma-sulphide interactions. These interactions are responsible for Ni and Cu enrichment in the sulphides, and in the southern part of the domain, in PGE enrichment. Due to a lack of information, the subsequent trapping of sulphides in or near a magmatic conduit could not be established.

Some relatively new Ni-Cu±PGE deposits elsewhere in the world are interpreted to be associated with magmatic arc settings (e.g. Aguablanca, Spain). Ni-Cu±PGE occurrences of the Portneuf-Mauricie Domain are a good example that can provide insight into the understanding of this new deposit type.

169

Mapping of volcanic facies in the southeastern part of the New-Senator Caldera, Blake River, Abitibi

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Archean synvolcanic faults are rarely exposed on surface and can be hard to document, particularly regarding the transition between a synvolcanic dyke complex and associated effusive rocks. The Glenwood fault, in the southern Blake River Group in Abitibi, is a good example of a well-preserved, weakly deformed synvolcanic fault. This structure is of strategic importance for exploration since it forms the eastern margin of the New-Senator Caldera, which hosts the Horne mine. It is generally acknowledged that faults bounding modern volcanic centres are favourable areas for hydrothermal fluid flow and metal precipitation.

The Master's project undertaken this summer involves mapping at 1/2,000 scale of a series of outcrops interpreted to correspond to one of the main extrusive vents for effusive rocks associated with the Glenwood fault. The objective is to document the transition between intrusions and volcanic outpourings, as well as associated volcanogenic alteration patterns. The study area (2 km^2) is located about two kilometres southeast of the Horne mine. Mapping has resulted in the identification of three andesitic facies and of a dyke complex. The stratigraphy changes from an environment of massive flows with thin basal amiboid breccias, to dominantly pillowed lavas toward the top of the pile. The sequence is monoclinal and faces northeast. Lateral variations in lava flow thickness suggest the existence of paleo-slopes along the edges of a central vent characterized by a feeder dyke complex that cross-cuts stratigraphy. On a regional scale, this complex is interpreted as the heart of the Glenwood fault.

The volcanic pile is cut by two types of veins. The first type consists of a network of quartz-epidote veins and veinlets with dolomitized selvages. These veins are parallel to feeder dykes, are locally cut by the latter, and presumably represent synvolcanic hydrothermal conduits genetically associated with the Glenwood fault. Some of these veins terminate in highly vesicular zones underlying volcanic breccia layers, suggesting a genetic link between the hydrothermal conduit and a degassing zone near the seafloor interface. The second type of vein consists of m-scale shear veins, with a brecciated texture and a quartz-carbonate-chlorite cement. These veins are considered to be orogenic and outline faults that offset volcanic units.

170

Influence of early structure on the geometry of propagation folds: reconstruction and direct kinematic modelling in 3D

Alexandre Aubiès-Trouilh, Donna Kirkwood, Jacynthe Pouliot (U. Laval)

The San Corneli anticline in the Central Pyrenees of Spain is a folded and faulted structure within a foreland setting. This compressional structure was emplaced during the development of a thrust belt over the Iberian plate during Meso-Cenozoic time. In terms of geometry, the San Corneli anticline is a propagation fold developed above the Boixòls thrust, which represents the most frontal structure in the Boixòls nappe. Pre-compression extensional structures were recognized at the core of the anticline and consist of a network of normal faults and early fractures that were active during sedimentation in Mesozoic extensional basins.

The goal of our research is to test the influence of these normal faults on the development of the San Corneli anticline, as well as their effect on the distinctive geometry of this propagation fold. Three-dimensional modelling is an indispensable tool for better understanding the relationships between early faults and the geometry during fold generation. The San Corneli anticline also outcrops, which offers the possibility of more easily modelling its geometry using surface data.

Our approach will be to first apply inverse 3D modelling. The solid geological model will be reconstructed using the "3D Reconstruction" module of gOcad. Inverse 3D modelling is based on cross sectional balancing. This technique will enable us to obtain a paleogeographic 3D model that we can use to deduce the emplacement and geometry of pre-existing normal faults during basin sedimentation. We can then begin a series of direct kinematic models that will test various hypotheses concerning the mode of anticline development. Three-dimensional direct kinematic modelling involves returning to the current deformational state of the model. This will help us better establish the chronology of events that affected the fold and determine if the faults influenced the evolution of these events.

171

From medicine to geology — Visualization of physical models using computed tomography

Jimmy Poulin, Elena Konstantinovskaya, Lyal Harris (INRS-ETE)

Modelling the development of geologic structures during deformation of the lithosphere can be done using analogue physical models. The models are created using various granular or ductile materials that simulate the rheological behaviour of different rock types at various depths in the crust and mantle. To obtain a dynamic similarity between the model and reality, the gravitational force can be increased using a geotectonic centrifuge. The traditional method of studying the deformation of models made only with cohesive layers is to cut the model and photograph the interior. The pieces are then replaced in the centrifuge and, after a new phase of deformation, a new cut is made and the interior photographed again. The resulting suite of photographs allows the deformation to be modelled through time. Nevertheless, after each stage of deformation, the model must be cut at a new location, which means that the progressive deformation cannot be studied along the same cross section. Furthermore, the cuts through the model introduce discontinuities that can influence the development of internal structures. This method can therefore only be used for planar deformation. Even with serial sections of the final model, any three-dimensional reconstruction remains imprecise given the non-negligible distance between the sections. In the case of sandbox models made of ductile basal layers and granular layers simulating the upper part of the upper crust, it is not possible to cut them before the experiment is finished, and it is therefore not possible to collect information about the progressive internal deformation.

To eliminate the problems listed above, computed tomography has been used in several physical modelling laboratories with applications to structural geology and geomechanics. Computed tomography is a medical imaging technique that can recreate the internal structure of an object by using the variable X-ray absorptions of the object's constituents. The object can be reconstructed in three dimensions with great precision using a series of closely spaced sections. The use of methods and techniques from other disciplines does bring with it many challenges and particularities. The main goal of the current project is to facilitate the link between computed tomography and physical modelling, particularly with respect to the choice of materials used to make the models and the techniques necessary for visualizing and reconstructing their three-dimensional internal structures.

172

Inventory of aggregate resources in the Réserve faunique des Laurentides (21M/14)

André Brazeau (MRNF)

Following the start-up of road repairs on Highway 175 between the towns of Québec and Saguenay, an ongoing inventory of aggregate resources was launched in 2003 in the Réserve faunique des Laurentides. Work performed in 2006, at 1/50,000 scale, covered NTS sheet 21M/14. The results will help locate and characterize sources of aggregate in order to assess their importance.

Fieldwork mainly consisted in examining a total of 86 sand and gravel pits, as well as several natural cross-sections and road cuts. Furthermore, 13 sand or gravel samples were collected and shipped to the laboratory to determine their physical and mechanical properties.

From a geomorphology standpoint, the area consists of a high plateau where altitudes range from 1100 metres to a little less than 500 metres. Average altitudes are between 700 and 900 metres. Deep valleys cut the plateau, namely along the Pikauba, Cyriac, and Apica rivers, creating escarpments of several tens, if not a few hundred metres. Many valleys are U-shaped, typical of valleys carved by the passage of glaciers.

The area is underlain by Precambrian rocks of the Grenville geological Province. These rocks include granitic gneiss and paragneiss intruded by granite, mangerite, gabbro and anorthosite. Local aggregates are a good reflection of the composition of underlying rocks and are of good quality.

Most sand and gravel deposits were emplaced when the ice cap began to recede from the area about 12,500 years ago. A number of moraine ridges and many fluvio-glacial accumulations mark the landscape, in both valley and plateau settings. These deposits are much thicker and more abundant in valleys however, where they most often occur as outwash, esker and kame terrace deposits.

Sources of aggregate are fairly abundant within the study area. However, near the path of Highway 175, these sources are much scarcer and mainly consist of sand of variable grain size. Sources of natural gravel are not abundant. The most significant deposits are found in the Rivière Pikauba valley, between kilometres 158 and 162; in the vicinity of Lac Fritzald; near Lac Vermeil at kilometre 167; along Highway 169 at kilometre 4; in the southeastern part of the area, near Lac des Bouleaux and Lac à Mars, as well as in the Rivière à Mars Nord-Ouest valley; in the southwestern part of the Rivière aux Écorces Nord-Est valley, and in the northwestern part of the Rivière du Moulin valley.

173

Assessment of the muscovite potential in the Escoumins area

N'Golo Togola (MRNF)

Fieldwork conducted during the summer 2006 in the Escoumins area (NTS sheet 22C/06) included sampling and detailed petrographic descriptions of quartzite, quartzofeldspathic gneiss and biotite-muscovite gneiss units as well as a pink muscovite granite. The purpose of this study was to define the muscovite potential of these rocks as a source of industrial minerals.

Quartzites form units from 10 cm to 1 m thick, interbedded with 1 to 10-cm beds of micaschist or quartzofeldspathic gneiss. Quartzite beds are generally massive. The rock is coarse-grained and contains minor amounts of muscovite (2 to 5%). Muscovite is somewhat more abundant along intense deformation planes, where sillimanite is also sporadically observed. However, micaschist beds show a greater muscovite content (20 to 30%). Quartzofeldspathic gneiss beds contain 5 to 10% muscovite, typically a bit more than quartzites.

Biotite-muscovite gneisses form fine-grained, granoblastic rocks. They are sometimes rich in biotite (10 to 25%) but contain very little muscovite.

The granite is medium to coarse-grained. It contains 2 to 5% muscovite and 1 to 5% garnet. Muscovite occurs as fine-grained flakes disseminated throughout the rock, whereas garnet occurs as isolated crystals or in fine-grained crystal aggregates.

Quartzite, quartzofeldspathic gneiss, and biotite-muscovite gneiss units are assigned to the lower member of the Port-aux-Quilles Formation (Saint-Siméon Group), whereas the pink muscovite granite is part of the Tadoussac Complex.

In examined outcrops, the amount of muscovite in quartzite (2-5%), quartzofeldspathic gneiss (5-10%), and muscovite granite units (2-5%) is low relative to the average 25% muscovite content in producing deposits. Only the micaschists, interbedded with quartzites, contain a significant amount of muscovite (20 to 30%). However, they represent a volumetrically minor component (5 to 10%) relative to other rock units.

Reference

Rondot, J., 1985 - Géologie de la région de Forestville-Les Escoumins, Ministère des Ressources naturelles, Québec; ET 85-05, 46 pages.

174

Update of the quarry inventory for the Estrie, Centre-du-Québec, and Mauricie regions

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The inventory of quarries for the Estrie, Centre-du-Québec, and Mauricie regions, created by the Québec government between 1992 and 1996, was updated in the summer of 2006. This work focused on crushed stone and industrial stone quarries. A total of 10 new quarries were identified, four of which produce more than 100,000 m^3 of rock. Moreover, 28 quarries which were already included in the database underwent considerable development, increasing their extracted volume by more than 100,000 m^3 and in some cases by several million cubic metres. Overall, roughly 27.8 million cubic metres of rock were extracted since the previous inventory. There are currently 46 quarries in operation. They are operated by about 20 businesses specializing in the field of construction materials or industrial products.

All active quarries in the **Estrie** and **Centre-du-Québec** regions are associated with rocks of the Appalachian geological Province. Most of the latter produce aggregate from sandstone, siltstone and mudstone. A few major quarries also extract basaltic lavas, felsic volcanic rocks and intrusive rocks. These quarries produce superior quality aggregate, used to manufacture finishing asphalt and concrete cement. Limestone, dolomite and marble units are also targeted for industrial purposes. These stones are used to produce fine aggregate for a variety of end uses, as well as soil conditioner and quicklime.

In the **Mauricie** region, most quarries lie within the Grenville geological Province. Charnockitic intrusive rocks are quarried, as well as tonalitic gneiss and paragneiss. These lithologies are used to produce highly durable aggregate of excellent quality. Limestones associated with the sedimentary sequence of the St. Lawrence Platform have long represented, and still represent today, an important source of crushed stone for the area. These rocks are currently extracted in an enormous quarry (>6,000,000 m^3) located north of Trois-Rivières.

175

Proterozoic dyke swarms of the Ungava Peninsula

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The SIGÉOM database was used to produce a thorough compilation of more than 1700 stations describing Proterozoic dykes in the Ungava Peninsula. The distribution of known dyke swarms was better described and new swarms were recognized. This compilation includes roughly 200 rock analyses, as well as 30 new Nd isotope determinations. Moreover, six new U-Pb ages from baddeleyite (ZrO_2) grains recovered from different swarms are pending.

The major element composition of most dykes indicates the latter represent tholeiitic basaltic liquids with a signature controlled by fractional crystallization. Various sources are required however to explain trace element variations. Swarms in the northeast of the peninsula are the most voluminous and show ages between ca. 2.21 Ga and ca. 2.16 Ga. They have low La/Sm ratios (1.2-2.5), high platinum group element (PGE) concentrations, and depleted εNd values (+0.6 to +4.2). To the west and south, swarms ranging in age from ca. 2.50 Ga to ca. 2.00 Ga record a number of magmatic events. They show higher La/Sm ratios (2.0-6.2), lower PGE concentrations and more enriched εNd values (+0.4 to -6.4) compared to dykes in the northeast. These compositional differences are independent of the age of emplacement, but do coincide with the seniority of the Archean craton and the thickness of the cratonic lithosphere. Thus, dykes in the northeast were emplaced in isotopically juvenile crust (T_{DM} = 2.8-3.0 Ga) with a relatively thin lithosphere, whereas dykes in the west and south traveled through enriched crust (T_{DM} = 2.9-3.8 Ga) with a deep lithospheric root (Boily et al., 2006; Faure et al., 2006). By evolving in distinct domains, dykes of the Ungava Peninsula acquired chemical signatures that may be used to map the morphology of the cratonic lithosphere. Rather than being derived from a lateral location from hypothetical asthenospheric plumes, these dykes are probably derived from subcontinental magma chambers in which basaltic liquids recorded the isotopic signature of the overlying craton. While the study of the distribution of Proterozoic dyke swarms helps improve our understanding of brittle fracture networks, the study of their chemical signature helps determine the regional distribution of cratonic domains favourable to the emplacement of diamond-bearing kimberlites.

176

Lithogeochemistry, petrogenesis and emplacement of granitic and pegmatitic intrusions in Minganie, eastern Grenville, Québec

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The geological section exposed along the coastline and Highway 138 between Havre-Saint-Pierre and Natashquan runs across three major geological entities, namely the Buit Complex, the south part of the Davy synclinorium, which contains the main corpus of the Wakeham Group, and the Aguanish Complex. The Wakeham Group, with an age of deposition of 1.5 Ga, essentially consists of a sequence of quartzite and meta-arkose. This pile is partially dismembered by metagabbro dykes and sills of the Robe-Noire Suite, which were intruded at about 1177 Ma, i.e. prior to the development of the Davy synclinorium and the regional Grenvillian metamorphism.

Intrusive and structural relationships between granitic orthogneisses of the Buit and Aguanish complexes and the Wakeham Group are unequivocal. These orthogneisses are variably recrystallized, foliated, gneissic or migmatitic, and locally exhibit flaser structures or augen textures of porphyritic origin. They share a number of geochemical, petrographic and structural features that define a close affiliation. Their distribution in space and time, between 1500 and 1480 Ma, illustrates the regional scope of this plutonism. Their intrusion signals a radical change in geodynamic setting, evolving from a stable pericratonic setting of Wakeham Group deposition, to an Andean margin driving the Pinwarian orogeny.

A gap of more than 400 million years separates this continental accretion episode and the intrusion, following the peak of the Grenvillian orogeny, of granitic-aplitic-pegmatitic stocks, sills, and dykes of the La Galissonnière Suite between 1000 and 980 Ma.

The Lac Turgeon pluton and satellite granitic, aplitic and pegmatitic intrusions in the Baie-Johan-Beetz area exhibit geochemical characteristics and magmatic and emplacement structures that help establish their genetic affiliation and define their modes and conditions of intrusion in the laminated pile of rocks of the Wakeham Group and Robe-Noire Suite. Cross-cutting relationships provide evidence of the coeval nature of numerous granite, aplite and pegmatite dykes and sills. The mode of intrusion, via successive sills, made it possible to inject massive amounts of magma without destroying the laminated structure of country rocks. The abundance of tourmaline indicates boron enrichment, which explains the low viscosity of the magma required for this mode of intrusion. Devolatilization and magmatic fractionation explain the origin of white albite-rich pegmatites. Enrichment in radioactive minerals is also due to magmatic fractionation.

This study is a follow-up on previous work conducted within the scope of Phase 1 of the Targeted Geoscience Initiative.

177

The new laboratory for physical simulations at INRS-ETE: Applications to mineral and petroleum exploration

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By investigating the behaviour of rheologically and dynamically similar systems, analogue (physical) simulations in the new laboratory at INRS-ETE provide innovative insights into the temporal and spatial evolution of geological structures. A better understanding of the progressive development of complex structural geometries through physical modelling aids the interpretation of field, seismic and earth-sensing data.

Experiments simulating upper crustal deformation are undertaken using sandboxes and deformation tank apparatus under normal laboratory conditions. Dry unconsolidated sand layers simulating upper brittle crust overlying ductile silicone putty ± modelling clay layers are used to replicate the progressive development of structures during rifting and subsequent shortening in sedimentary basins and fold-thrust belts. X-ray computed tomography using the Québec Multidisciplinary Tomographic Laboratory, combined with particle imaging velocimetry, enables visualization of the progressive 3D evolution of structures and strain trajectories. Synthetic seismograms are developed based on model profiles. The examples presented illustrate how basement structures control normal fault and transfer zone geometries during rifting, and how they affect the style and orientation of structures in fold-thrust belts. Normal faults developed during rifting first underwent reverse reactivation, then progressively flattened and new shallowly dipping thrusts developed. Thrusts and overturned folds formed in the strong ductile layer above basal discontinuities. Results help define petroleum traps and prospective zones for gold and base-metal mineralization related to deep-seated basement structures or extensional or inverted structures in fold-thrust belts.

A high-acceleration centrifuge specifically adapted for geological modelling achieves dynamic similitude in models of intermediate- to deep-crustal structures using silicones, modelling clays and their mixtures. Centrifuge models are especially suited where body forces or gravitational instabilities are important (e.g. deformation associated with salt or shale diapirs in deformed sedimentary basins, diapiric pluton emplacement, melt migration, and core-complex formation in high-grade metamorphic terrains), and to study remobilization of nickel sulphides in shear zones and compare horizontal versus vertical tectonic models in Archean granite-greenstone belts. Results presented illustrate fold and shear zone development associated with fault reactivation with variable friction along faults (e.g. reflecting localized fluid flow), syntectonic diapirism and folding associated with ductile flow between boudinaged competent horizons during layer-parallel extension.

The laboratory is funded by the Canadian Foundation for Innovation, the Quebec Ministry for Education, Leisure and Sport, and INRS-ETE, with contributions from the Applied Geodynamics Laboratory at the University of Texas in Austin, LaVision Inc., Sun Microsystems, NORSAR, and Seismic Microtechnology. Research was supported by the donors of the American Chemical Society Petroleum Research Fund and NSERC.

178

ITRAX Core Scanner™: A new non-destructive tool applied to the assessment of mineral potential in drill core and rock samples using high-resolution micro-radiography and micro X-ray fluorescence

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Louise Corriveau (GSC)

The ITRAX Core Scanner™ is a non-destructive tool for high-resolution (100 µm) chemical analysis by XRF (X-ray fluorescence) scanning and micro-radiography analysis of rock and sediment cores. The operation is based on the simultaneous acquisition of a sample's microvariations in density (micro-radiography) and chemical composition (micro- XRF) by using two distinct X-ray detection systems. An optical camera in linear scan mode is incorporated into the system to provide an image of the sample. The analysis is done without touching the sample surface and is completely non-destructive. Compositional variation profiles can be recorded for a wide range of chemical elements. Concentrations of these elements are determined simultaneously (analysis is possible for elements from silicon to uranium using a molybdenum X-ray tube) with detection limits down to 20 ppm depending on the element, analytical time and the composition of the matrix. The use of this technique on rock samples enabled us to obtain geochemical variation profiles at the millimetre scale for major elements. We are studying the possibility of detecting trace elements, rare earth elements and platinum group elements across observed alteration zones in the samples. In contrast to traditional geochemical analyses that combine a rock's internal compositional variations, this technique enables us to monitor such variations at the millimetre or even micrometre scale. Integrated with field and geochronological data, it provides us with a better understanding of the geochemical evolution of a system through time and space.

179

Shedding light on the geological complexity of Chaleurs Bay using a multidisciplinary approach

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Denis Lavoie (GSC-Québec)

Geological syntheses of the Gaspésie region traditionally emphasize a series of lithotectonic assemblages separated by major strike-slip faults broadly trending E-W. For this reason, previous palinspatic reconstructions did not take into account structures with different orientations, considered as second-order structures. Recent geophysical data however has shown that geological bodies with contrasting density or magnetic susceptibility relative to adjacent rocks have boundaries showing various orientations. In order to fully grasp the difference between these geological and geophysical interpretations, we decided to compare these two data sets in the Chaleurs Bay area.

The highlights of the study are as follows:

1- A dextral fault oriented ~N120 that cuts the eastern end of the Ristigouche syncline marks the probable extension of the geophysical lineament bordering Chaleurs Bay between New Richmond and New Carlisle;

2- N0 to N20 faults (including the Mont Saint-Joseph fault, associated with a strong gravity gradient, suggesting a steeply dipping contact and a relatively shallow source) are characterized by sinistral strike-slip movement with a minor component of east-verging thrusting;

3- The positive gravity anomaly near Carleton appears to be entirely bounded by faults which may have been active during sedimentation at the base of Silurian conglomerates outcropping nearby (Armstrong Brook Formation);

4- East of New Carlisle, a ~N75 fault borders Chaleurs Bay and bounds to the north volcanic rocks probably correlated to the Dalhousie Group (Lower Devonian); multiple offsets of magnetic markers indicate that this fault includes a dextral strike-slip component;

5- The presence of several boulders of acidic magmatic rocks in the Black Cape volcanic breccia may indicate the presence of an intrusion, which would explain the positive magnetic anomaly and negative gravity anomaly located south of New Richmond in Chaleurs Bay.

All of these elements suggest that the Chaleurs Bay synclinorium does not correspond to a single structural assemblage and that any attempt at basin reconstruction must take into account the entire set of structures. These data also show that the Chaleurs Bay synclinorium comprises several structural blocks, probably characterized by different relative substrata (rocks predating the end of the Ordovician). The preliminary interpretation of potential field data suggests that rocks equivalent to the Maquereau Group may constitute the relative substratum of the Carleton structural block.

180-181

Multidisciplinary studies along the western part of the Cadillac Fault, Abitibi Subprovince: Searching for new ore deposits

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The Cadillac Fault (CF) represents a major tectonic feature of the Abitibi Subprovince and an important regional structural control for the emplacement of gold occurrences. The western segment of the Québec portion of this structure is the least known and least prolific in gold. Within the scope of a joint MRNF-UQAT project, a geological revision was undertaken, along with a metallogenic study and 3D model of a 50-km segment of the fault, between the Ontario border and the former McWatters mine.

The metallogenic study undertaken in 2005 led to the conclusion that most gold occurrences in the area are associated with quartz-carbonate veins typical of orogenic deposits. However, other less common types of occurrences are also present, namely occurrences spatially associated with syenites. Several copper-rich occurrences, among which Proterozoic veins, are also observed in the area. The project will also result in a potential assessment for volcanogenic copper along this part of the Blake River Group.

Geological work carried out in the summer of 2006 revealed the presence of several felsic volcanic units cut by ENE-WSW shear zones, to the north and west of the former Francoeur mine. These volcanic rocks locally exhibit intense iron carbonate alteration, which does not appear to be strictly related to the shear zones.

The modelling project integrates new field interpretations derived from 2006 work as well as a tremendous amount of geoscience data available for the area. The involvement of several mining companies provided several thousand items of drilling data that will be useful to develop a global overview of elements controlling the emplacement of gold mineralization.

Although the area has great mining potential, it also contains a unique geomorphology feature, namely the hills associated with the Cobalt Group. Various recreational activities that contribute to the quality of life of inhabitants in nearby communities take place in these hills that trend parallel to the CF. The authors hope that this study will help define areas with a high mining potential, so as to create protected areas that will not prove harmful to the economic development of the region.

182

Geochemistry of igneous clasts from the Upper Ordovician Garin Formation in the Gaspé Appalachians: Correlation with the Exploits subzone

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Three populations of igneous clasts can be defined in conglomerates of the Upper Ordovician Garin Formation, the basal unit of the Middle Paleozoic Gaspé Belt in the Gaspé Appalachians of Québec. All three populations can be correlated with igneous rocks of the Exploits subzone from different regions of the Gaspé Peninsula (Quebec), New Brunswick and northern Maine, and can be related to the tectonic evolution of the Dunnage oceanic tract during Ordovician (post-Taconic) time. (1) The felsic-intermediate calc-alkaline suite shows variations in HREE abundances that allow two subgroups to be defined, with internal geochemical variations consistent with fractional crystallization processes. HREE-rich amygdaloidal and plagioclase-phyric andesites and rhyolite compose the first subgroup, whereas HREE-poor monzonites, feldspar-quartz-hornblende-phyric dacites, rhyodacites and rhyolites compose the second one. HREE-rich andesites and rhyolite of the Miguasha-Est no.1 well are included in the suite. Rocks of the calc-alkaline intermediate-felsic suite are interpreted to record magmatism of the Andean-type Popelogan arc, or remelting of crust during Gander margin continental extension. (2) Rocks of the tholeiitic-to-alkaline suite are more mafic and include one ophitic diabase and one hypabyssal basaltic andesite. These rocks have enriched geochemical signatures typical of within-plate settings, with a minor continental crust contamination component. They are interpreted to record magmatism associated with the rifting and initiation of the embryonic Tetagouche-Exploits back-arc basin. (3) The mafic-intermediate suite is characterized by gabbro, diabase and monzogabbro, as well as amygdaloidal and plagi oclase±clinopyroxene-phyric basalts and andesites. Rocks of this suite range from tholeiitic to calc-alkaline, with primitive mantle-normalized multi-element patterns ranging from generally flat to slightly LREE-enriched, with weak to strong negative Nb-Ta and Ti anomalies indicating the influence of a subduction component. Such geochemical signatures are commonly found in oceanic arcs. Rocks of this suite are interpreted to represent the products of spreading and off-axis magmatism on the Tetagouche-Exploits back-arc basin.

The occurrence of non-deformed clasts within the Garin formation derived from both the Andean-type Popelogan arc and the Tetagouche-Exploits back-arc basin (both part of the Dunnage oceanic tract) implies that both source terranes were located near the Garin depocenter during late Caradocian (Ordovician) time (*C. spinifirus* Zone). The good correlation between volcanic rocks of the Miguasha-Est no.1 well and volcanic rocks of the Popelogan Inlier in New Brunswick indicate that rocks of the Popelogan Inlier probably extend across Chaleurs Bay to the Gaspé Peninsula, buried under Middle to Late Paleozoic sedimentary cover sequences.

183

Geographic extent and nature of structures associated with the Saguenay Graben, Québec

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The Saguenay Graben is an important crustal structure in the Grenville Province that runs perpendicular to the St. Lawrence rift and to which the Saint-Honoré (540 Ma) and Crevier (unknown age) carbonatites are associated. Relatively little work has been done on this structure; only a few studies exist on the interpretation of Landsat and magnetic lineaments in the Saguenay and Charlevoix regions. The extent and nature of fracturing related to the Saguenay Graben in the Archean craton of the Superior Province are also poorly documented.

Federal magnetic data and a digital terrain elevation model prepared by NASA were used to identify more than 500 rectilinear lineaments between the Grenville Front to the west and the St. Lawrence rift to the east. Lineaments correspond to clean breaks in magnetic anomalies and/or to narrow, linear topographic valleys. A field reconnaissance along the Saguenay river and fjord was conducted to characterize the structure of some of these lineaments. In these areas, lineaments appear to correspond mainly to networks of variably spaced joints, more rarely to cataclastic breccia zones that outline normal or strike-slip brittle faults, or to a network of veins and breccias with quartz-calcite cement. The orientation of structures in the field generally reflects the orientation of sets of lineaments. On outcrop, several faults show apparent displacement directions compatible with those recognized along certain geophysical lineaments.

Two dominant lineament orientations were established: NE-SW, and E-W to WNW-ESE. NE-SW lineaments are subparallel to the St. Lawrence rift and the Grenville Front, and are concentrated along three zones that probably define a major horst and graben structure. E-W to WNW-ESE lineaments are concentrated along a corridor parallel to the Saguenay River between Tadoussac and Lac Saint-Jean. West of Lac Saint-Jean, this structural corridor widens and changes direction toward the Grenville Front. This change in direction of lineaments toward the Grenville Front may be explained by the morphology of the underlying lithospheric mantle. The Saint-Honoré and Crevier carbonatites in the Grenville Province, and the Lac Shortt and Montviel carbonatites in the Superior, are possibly associated with this corridor, suggesting that a better structural understanding of the Saguenay Graben could have important implications in terms of exploration for niobium and rare earth element deposits.

184

A regional exploration guide for diamonds using seismic tomography

Stéphane Faure (CONSOREM), Stéphanie Godey (European Mediterranean Seismological Centre), Francine Fallara (URSTM-UQAT)

The diamond potential of a region depends first and foremost on favourable pressure and temperature conditions fossilized at depths greater than 150 km in the underlying continental lithospheric mantle. The tectonically stable regions of the mantle in Archean cratons are particularly fertile since trapped diamonds were preserved there since Archean time and subsequently brought to the surface by kimberlites. Understanding the 3D architecture of cratonic keels thus becomes an essential component of regional-scale diamond exploration.

We present a high-resolution surface wave tomographic model within the framework ofbuilt using 3D data from the kimberlite fields of North America. This deep-penetrating geophysical tool makes it possible to better understand spatial variations in seismic velocity, which depend primarily on the temperature and composition of the mantle. Higher velocities indicate the presence of colder and relatively iron-depleted mantle compared to average subcontinental mantle.

The seismic structure of the upper mantle from 50 to 250 km reveals that Archean cratons in Canada are agglomerated at depths between 100 and 200 km. Lithospheric roots for cratons single out at about 200 km, and reach a maximum of 240 km under the Hearne Province. At several locations, Archean cratonic roots continue beyond surface exposures of Archean rocks, extending beneath Proterozoic belts and sedimentary rock basins. This leads us to propose new prospective areas for diamond exploration in Canada, including along the Grenville Front. Seismic velocities in the southern Superior Province are slower compared to those in the central and northern parts, confirming that this part of the mantle was affected by a number of tectonothermal events since Proterozoic time, an observation that is corroborated by petrologic studies of mantle xenoliths. This permanent scar affected the diamond stability field, consequently reducing the possibility of finding economic kimberlites in this region.

Most kimberlite fields lie along the margins of the deepest lithospheric roots (160 to 190 km) and are vertically correlated with steep slopes and/or abrupt changes in mantle morphology. We interpret these characteristics as deep-seated structures or as boundaries between mantle blocks. Economic kimberlites are located in specific high-velocity zones that do not necessarily correspond to the surface positions of Archean cratons.

185

Application of artificial neural networks to continental-scale mineral potential mapping for diamondiferous kimberlites in North America

Sylvain Trépanier, Stéphane Faure (CONSOREM)

The number of diamondiferous kimberlites in North America has increased dramatically over the last ten years. We estimate that about 825 kimberlites are known, with about half being diamondiferous. The large number of new discoveries now makes it possible to apply empirical diamond potential mapping techniques. The mineral potential model we present for diamondiferous kimberlites at the scale of North America is based on an artificial neural network.

The North American continent was divided into 250-km^2 cells. The following layers of data were transformed to this cell size and used as inputs to the neural network:

- Raleigh wave disturbances and horizontal velocity gradients at 10-km intervals between depths of 30 and 250 km (3D tomography);
- Digital elevation model;
- Bouguer gravity anomalies;
- Residual total magnetic field; and
- Moho topography.

A "multilayer perceptron" neural network was trained to distinguish cells that contain diamondiferous kimberlites from those in which kimberlites have not been discovered. A number of cells were also used as *a posteriori* test cells. The confusion matrix for test cells indicates a very good percentage of classification (around 80-90%). Sensitivity analysis for the trained network suggests that the most favourable areas are characterized by fast velocities and high horizontal velocity gradients in the lower parts of the lithospheric mantle (140 to 210 km deep), high wave velocities in the upper parts of the mantle (40 to 60 km), and negative gravity anomalies.

These results are compatible with the depth of the diamond stability field and the lithosphere-asthenosphere boundary as estimated by studies of kimberlitemantle xenoliths. The strong association with high horizontal seismic gradients further suggests that the most prospective terrains for diamonds are at the boundaries between blocks with contrasting thermal and compositional properties. The mineral potential map reveals a large east-west trending zone of high potential that connects the Hudson Bay Lowlands in Ontario (Attawapiskat) to James Bay and the Otish kimberlites in Québec. This prospective zone directly overlies a major horizontal discontinuity in the lower lithospheric mantle.

186

The Blake River Group in the Abitibi Subprovince: New developments in 2005-2006

Vital Pearson (CONSOREM)

The Blake River Group (BRG) belongs to the Southern Volcanic Zone of the Abitibi Subprovince. The CONSOREM developed a new exploration model based on the concept of imbricated calderas (poster 138, Québec Exploration 2005). This model integrates lithological, geochemical, geophysical, and structural data available for this unit. The model is based on the following key elements: distribution and concentric and radial arrangement of synvolcanic mafic dykes, interpretation of several orders of regional synvolcanic faults, and peripheral distribution of pyroclastic assemblages and small synvolcanic stocks. Furthermore, the geometric model may be used to determine the distribution of hydrothermal alteration zones and locate volcanogenic massive sulphide occurrences in a predictive framework. The model involves three phases of collapse that successively produced three calderas, namely the Misema, New Senator, and the well-known Noranda caldera.

Special attention was paid to the definition and delineation of the New Senator Caldera (NSC). Based on geological and geophysical data, the NSC represents a structure 15 km wide by more than 30 km long along a NW axis, on either side of the Flavrian pluton. The presence of internal arcuate faults within the northwest part of the NSC may be interpreted as the result of successive collapses following a progressive migration from the NW to the SE culminating with the formation of the Noranda caldera. The south part of the NSC is well defined along its western margin, occupied by the McPhee mafic dyke. Several N-S to NE-SW-trending synvolcanic faults were recognized in the centre of the NSC, namely the Glenwood fault, which is the topic of an ongoing Master's project by David Paquin.

Synvolcanic faults of the NSC are interpreted as the dominant elements controlling volcanogenic occurrences. Thus, the Macanda, Aldermac, Gan Copper, Four Corners, Inmont, Yvanex occurrences and the recent discovery by Alexis Minerals (Montbray) are all located along the western margin of the NSC. The northeastern margin, on the other hand, is masked by the subsequent development of the Noranda caldera. Certain potential remains are represented by the McDougall and Despina faults, which were presumably reactivated during the Noranda episode.

187

DIVEX geochemical and geophysical exploration tools

1) The chemical composition of iron oxides: a new mineral exploration tool

Georges Beaudoin, Patrice Gosselin (U. Laval), Michel Jébrak (UQAM)

The chemical composition of magnetite and hematite from several types of deposits display compositional variations according to deposit type: iron oxide Cu-Au (IOCG); Kiruna; banded iron formations (BIF); Cu-Au-Mo porphyries; Ca-Fe and Cu-Au skarns; VMS; Fe-Ti; Ni-Cu-PGE; and chromite. Iron oxides from BIF and chromite deposits are characterized by low V and Ti values, but respectively exhibit high Al and Cr values. VMS and Ni-Cu deposits have low V and Ti contents, but are respectively characterized by high Si and Ni contents. Oxides from Fe-Ti deposits are enriched in V and Ti, Cr, Al, and Mg. IOCG and Kiruna-type deposits exhibit distinct V and Ti values. IOCG deposits are also enriched in Al and Si relative to Kiruna-type deposits. Porphyry and skarn iron oxides show relatively high V and Ti values, but porphyry oxides are enriched in Al and Si, whereas skarn oxides reveal an additional enrichment in Ca and Mg. It is thus possible to assign a unique iron oxide signature to a particular deposit.

2) Geophysical signatures of kimberlites

Michel Chouteau, Benoit Tournerie and Abdelmadjid Chemam (Poly)

The objective of the project is to determine the geophysical signatures associated with kimberlites with the aim of assisting exploration companies in their search for diamonds in Québec. The first step will be to establish a database of the physical properties and geophysical signatures of known kimberlites in Québec, the rest of Canada and worldwide. This will allow us to characterize specific similarities and differences between the geophysical responses, physical properties, and other parameters like age, geological context, level of erosion and mineralogy. The second phase of the study will focus on measuring the physical properties of kimberlites in the Canadian Shield by performing direct measurements of density, magnetic susceptibility and electrical conductivity on samples of kimberlitic rocks. Added to the database, these measurements will allow us to constrain the analysis and inversion of measured geophysical data, thus improving our evaluation of kimberlitic intrusion geometry and volume. Magnetic remanence is a very significant property for kimberlites that must be taken into account if associated magnetic anomalies are to be properly interpreted. Since measuring remanence is difficult and costly, we developed an interpretive method that allows a total magnetization vector to be extracted and, when combined with a few independent pieces of information, the remanent magnetization can be determined from the magnetic data.

188

Metamorphic environments and preliminary results for new 2006-2007 DIVEX projects

1) Mineralogy of non-sulphide zinc assemblages in disseminated zinc deposits of the Grenville Supergroup marbles

Jean-François Larivière, Michel Gauthier (UQAM)

Two types of disseminated zinciferous mineralization occur in southwestern Québec: sulphides at Cadieux, and silicates and oxides at Bryson. The latter deposit type constitutes a new mineral target for the industry. Our study confirms the existence of non-sulphide zinciferous parageneses analogous to those of the large hypogene deposits of Franklin and Sterling Hill in New Jersey. The discovery of such an exotic mineralogy in Québec opens new exploration perspectives that were previously unsuspected. The systematic mapping we performed in the area extending from Bryson to south of Renfrew in Ontario allowed us to specify the lithological controls on zinciferous mineralization. This work also revealed new disseminated sphalerite showings in addition to the non-sulphide occurrences. Two of these new sphalerite showings occur on Grand-Calumet Island and appear to link the non-sulphide zinc deposits of Bryson with the former New Calumet polymetallic mine.

2) New DIVEX projects for 2006-2007

Michel Malo (INRS)

Eight new research projects were launched in the spring of 2006. The projects are diverse and bring together researchers from all the earth science departments in Québec, as well as researchers from provincial and federal natural resource ministries. The following companies are also involved: Breakwater Resources, Falconbridge, Goldcorp, Osisko, and the Table jamésienne de concertation minière. The eight projects are:

Cu-Au-Ag mineralization at the Lac Ell showing and implications for the genesis of the Roberto gold deposit on the Éléonore property, James Bay - Michel Malo (INRS), Benoit Dubé (GSC), Michel Gauthier (UQAM)

Iron oxides: a new mineral exploration tool - Georges Beaudoin (Laval)

Porphyry gold mineralization in Malartic - Michel Jébrak (UQAM), Anthony Williams-Jones (McGill)

Detection of deep-seated conductive deposits by expeditious magnetotelluric interpretation - Michel Chouteau (Poly)

Misema caldera, Abitibi belt: inner-outer ring subaqueous pyroclastic deposits and associated hydrothermal carbonate alteration - Wulf Mueller (UQAC)

Selenium isotopes as a tool for sulphide ore exploration - Richard Cox, Paul Bédard and Sarah-Jane Barnes (UQAC) and Marc Constantin (Laval)

Glacial transport and flow in the James Bay sector: implications for mineral exploration in areas with thick sedimentary cover in the Abitibi and James Bay regions - Martin Roy and Ross Stevenson (UQAM)

3D mapping and gold potential evaluation along the western segment of the Québec segment of the Cadillac Fault in Québec, Phase 2 - Denis Bois (UQAT), Robert Marquis (MRNF)

189

3D geology at DIVEX

1) Gold potential evaluation along the western segment of the Cadillac Fault in Québec – Phase 1

Olivier Rabeau (UQAT), Marc Legault (MRNF), Li Zhen Cheng (UQAT), Robert Marquis (MRNF), Denis Bois (UQAT)

The purpose of this project is to bring attention to the western segment of the Cadillac Fault in Québec by developing new tools for gold exploration through a regional metallogenic synthesis and 3D modelling. Compilation work on known gold showings and a revision of the geological map for the sector were undertaken within the framework of this project. The work enabled us to perform 3D modelling of Proterozoic sediments belonging to the Cobalt Group, which cover the fault for more than 30 km, and to estimate the trace of the Cadillac Fault under these sediments in a realistic manner. Favourable areas for gold exploration were identified where the sedimentary cover is thin near the Cadillac Fault.

2) Development of a 3D topological query tool for the analysis of geological models

Karine Bédard, Bernard Lachance, Donna Kirkwood, Georges Beaudoin, Jacynthe Pouliot (U. Laval)

In order to optimize the use of 3D geological models, we developed a prototype for a 3D topological query tool – TQuery – which is compatible with the 3D geological modelling software of gOcad. TQuery enables the user to export gOcad objects (points, lines, surfaces and solids) into a data storage structure that standardizes the topological relationships between the 3D objects. Metrical and topological spatial analysis can be performed automatically on the data. The result of the queries can then be imported into gOcad as an object that the user can visualize and manipulate. One of the advantages of TQuery is that it can be used by people who are not experts in 3D modelling. TQuery was tested on the 3D geological model of the Transfiguration property (Témiscouata, Québec), a red bed-type copper deposit within the Silurian Robitaille Formation.

In addition to being a user-friendly tool, the prototype developed within the scope of this research project also offers the possibility of making metrical and topological spatial queries on a geological model constructed using gOcad software. TQuery could thus become a powerful decision-making tool for mineral exploration by promoting exchanges between specialists and non-specialists, and by improving our knowledge of complex geological systems.

190

Geological reconnaissance of the volcano-sedimentary cycles in the Labrador Trough (Schefferville area) and of geochemical anomalies (Cu, Au) in the Zeni Lake area

Thomas Clark (MRNF), Alain Leclair (MRNF), Peir Pufahl (Acadia University)

The Labrador Trough comprises two main volcano-sedimentary cycles dated by the U-Pb method at 2.17–2.14 Ga and 1.88–1.87 Ga. The limit between the two cycles has traditionally been placed at the contact between the Attikamagen Group (Denault, Dolly, and Fleming formations) and the Ferriman Group (Wishart, Ruth, and Sokoman formations). However, carbon isotopes in the Denault Dolomite suggest that the age of this formation is younger than 2.06 Ga. We have therefore studied the succession that includes the contact between the two cycles in the Schefferville area. Our observations suggest a continuity in sedimentation style across this contact; there is no evidence of a major unconformity or disconformity between the Attikamagen and the Wishart at the studied locations. It is therefore possible that the Denault has more affinity with the second cycle than the first, and that part of the large hiatus between the two cycles is located below the Attikamagen. We also examined the base of the Menihek Formation (second cycle) at three localities in order to determine whether radioactive rocks previously reported at two sites have a regional distribution. At each site visited, radioactive black shales occur at or near the base of the formation. These shales occupy the lowest two metres of the formation at two localities and are situated eight metres from the base at the third site; radioactivity reaches 10 times background locally. We therefore conclude that the black shales at the base of the Menihek Formation are a metallotect of regional importance in exploration for syngenetic and epigenetic uranium deposits.

The Zeni Lake volcano-sedimentary complex, located 150 km east of Schefferville in the hinterland of the Labrador Trough, is composed mainly of mafic rocks (hornblende-biotite gneiss, amphibolite, metagabbro and metabasalt), along with masses of felsic rocks representing metamorphosed tuffs (Taner, 1992; MB 91-19). A lens of felsic metatuffs, 5 km long by 2.5 km wide, coincides with Cu-Au anomalies in lake-bottom sediments. Our reconnaissance work on this lens has not confirmed the presence of volcanogenic felsic rocks. Rather, we observed centimetre- to decimetre-scale intercalated bands of amphibolite, metagabbro and granite with a strong, NW–SE-oriented mylonitic foliation. In addition, rusty amphibolite bands, several metres thick and hundreds of metres long contain disseminated sulphides (pyrite-pyrrhotite-chalcopyrite), which may explain the strongest geochemical anomalies.

191

Geology of the Lac Olga area

Jean Goutier, Jean-François Leclerc-Cloutier (MRNF)

The Lac Olga area lies between the Matagami and Chibougamau mining camps. The objective of this project launched in 2002 was to establish regional geological correlations and complete the geological mapping coverage, part of which dated back to the 1930's and 1950's. In 2006, geological surveys covering parts of map sheets 32F/16, 32K/01, 32K/02 and 32F/09 were carried out; field checks were also conducted in map sheets 32F/15 and 32F/14. The geology of the Lac Olga area touches both the Abitibi and Opatica subprovinces of the Superior Province. Most volcanic and sedimentary rocks in the area are metamorphosed to the amphibolite facies and are deformed. The metamorphic grade laterally changes, to the west and east, to the greenschist facies. The contact between the Abitibi and Opatica consists of a mylonite zone in amphibolite-grade areas. Further west, the boundary is characterized by a series of weakly deformed tonalitic and dioritic intrusions that mask the contact. Volcanic rocks are assigned to the Bell River Volcanics (basalt) and the Dussieux Formation (andesite and dacite, 2720 Ma). The Bell River Volcanics are direct equivalents to mafic volcanic rocks of the Gilman Formation. The sedimentary Morris (west) and Daubrée (east) formations are probably lateral equivalents, although they are not physically connected. All these rocks are at least partly affected by the Nottaway shear zone, a major dextral mylonite zone trending WNW. The centre of the shear zone is characterized by the presence of pink granitic pegmatite dykes with a porphyroblastic texture. The Rivière Waswanipi structure in map sheet 32F/09 does not correspond to a fault affecting the Waswanipi-North pluton, but rather to a contact between foliated intrusions in the north, where the fabric parallels the river, and weakly deformed to undeformed equigranular to pegmatitic granites in the south. The area also comprises Proterozoic gabbro and kimberlite dykes, the alkaline Montviel intrusion (1894 Ma) and many cm-scale alkaline dykes. Furthermore, a new band of alkaline lapilli tuff, probably Archean in age, was traced over a strike length of 10 kilometres by 800 metres thick along Rivière Waswanipi (32F/14). In terms of composition, it corresponds to a potassic trachybasalt. The Lac Olga area is both a window into the deep Archean bedrock and a region of alkaline rocks of various ages.

192-193

Geology and metallogeny of the northern part of the Baie-Comeau area (map sheets 22F/07, 22F/08, 22F/09, 22F/15, 22F/16)

Abdelali Moukhsil, Pierre Lacoste, Serge Perreault, Martin Simard (MRNF)

The study area (22F/07, 22F/08, 22F/09, 22F/15 and 22F/16) constitutes Phase I of an extensive regional mapping project, the purpose of which is to acquire new geological and metallogenic data in Grenvillian rocks of the Côte-Nord region.

Mapping at 1/125,000 scale led to the identification of several lithological assemblages. Rocks of the Vallant Suite cut across the central part of the area from east to west. The Vallant Suite is an anorthositic complex composed of recrystallized anorthosite and leuconorite, with coronitic leucotroctolite, gabbronorite, and pyroxenite. The area to the south of this complex is underlain by rocks of the plutonic Varin Suite, composed of megacrystic, porphyritic and porphyroblastic mangerite and monzonite. The area north of the complex and the southeastern part of the study area comprise strongly foliated to gneissic intrusive rocks of various compositions (tonalite, granite to monzonite, gabbro) as well as metasedimentary rocks (garnet paragneiss, sillimanite paragneiss, quartzite, etc.).

The regional metamorphic grade ranges from the lower amphibolite to the granulite facies. In many locations, the amphibolite facies appears to represent retrograde metamorphism that affected rocks with pre-existing granulite-grade assemblages.

The rocks in the area underwent at least two phases of deformation. Phase of deformation D1 is responsible for the dominant foliation G1, which produces the regional structural trend. The penetrative G1 fabric takes the form of a gneissosity or a strong foliation. It is disturbed by isoclinal, often recumbent folds, related to phase of deformation D2, with a locally developed axial foliation (G2). The two fabrics are best exposed in migmatitic rocks, where layers of mobilizate have recorded traces of the two phases of deformation. Many faults and shear zones affect the rocks in the area. Some of the latter are associated with an important structure that involves thrusting of the anorthositic Vallant Suite onto units located further north.

The entire area offers promising mineral potential, as shown by the presence of many Cu-Ni and Fe-Ti showings. During our mapping survey, new oxide-type showings (Fe and Ti) associated with the anorthositic Vallant Suite were recognized as well as a few Ni-Cu and Pt-Pd occurrences associated with mafic to ultramafic rocks. Potential architectural stone prospects were also identified.

194-195

Gold in lake sediments of the eastern LaGuiche Basin

Marc Beaumier (MRNF)

We performed new ICP-MS analyses on 6096 lake sediment samples collected by the MRNF in the years 1983 (Beaumier, 1986) and 1987 (Beaumier, 1989). These surveys covered almost entirely the Caniapiscau regional county municipality (72,640 km^2). Analyzed elements include gold and its indicator elements (Ag, Sb, Se, Te) as well as Nb, which represents an indicator of alkaline ultramafic rocks such as kimberlites when correlated with Cr and Ba. The project was jointly funded by the Caniapiscau Local Development Centre (CLD), the Ministère du Développement économique, de l'Innovation et de l'Exportation (MDEIE), the Ministère des Ressources naturelles et de la Faune (MRNF), and Exploration Québec-Labrador Inc.

Regional metallogenic settings namely include:

- Metasedimentary rocks possibly representing the lateral extension of the Opinaca, which hosts the Roberto gold deposit (Lamothe et al.,1999);
- The Courcy-2 gold showing, occurring in an E-W-trending volcanic belt (Brûlis Group). The latter is analogous in many ways to the Eastmain greenstone belt, which hosts the MSV gold deposit.

In addition to these two ore deposit settings, various element associations observed in geochemistry anomalies namely suggest the presence of the following:

Element associations	Suggested type of mineral occurrence
Au-Fe-U	Olympic Dam-Kiruna
Cu-Mo-Au-Ag-Se	Porphyre
Au-W	Gold-bearing quartz veins
Au-Ag-Se	Gold-bearing sulphide-free veins
Au-As-Sb	Roberto
Au-Ag-Se-W-Bi-B	Skarn

The entire area is relatively underexplored. Based on lake sediment data, the area referred to as "Opinaca East" (Lamothe et al., 1999) shows the greatest mineral potential in the Opatica. The Ashuanipi shows very little geochemical dispersion.

In total, 108 gold dispersal trains and 13 Nb+Ba+Cr dispersal trains were identified. An interpretation (Beaumier, 2003) of work conducted by BHP (GM-59085 and 59086) also shows the presence of numerous kimberlite indicator minerals.

Dispersal trains display a central axis (suggested by the strongest anomalies) parallel to the direction of the earliest glacial movement (SE). A detailed study of the data also reveals the influence of movements associated with the last glacial maximum (SW), and in certain localities, with the penultimate glacial maximum (NNE or NNW). These polyphase dispersal trains, described by Parent et al. (2004), are also observed for the main gold anomalies.

Maps in .pdf format are available from the Caniapiscau CLD (cld@caniapiscau.net).

196

Geology of the Rivière Tourilli area (21M/04) and the SW corner of the Lac Batiscan area (21M/05)

Claude Hébert (MRNF)

This project is the first phase of a geological mapping project in the Réserve faunique des Laurentides. The study area lies northeast of the town of Rivière-à-Pierre, well known for its many quarries for architectural stone. This survey is adjacent to the west to a previous survey in the Talbot area (31P/01), which led to a revision of the regional lithostratigraphic framework (Hébert and Nadeau, 1995).

Porphyritic monzogranites of the Rivière-à-Pierre Suite (RAPS) constitute one of the most important units in the area. They show many distinct facies, including a "charnockitic" facies, characterized by an olive green colour in fresh surface, particularly interesting as a variety of architectural stone. This facies contrasts with the more common light grey to pinkish variety. The latter is widespread throughout the Talbot area further west, and occupies the southwestern corner of map sheet 21M/04, as well as most of the western edge of the map area.

The north-central part of map sheet 21M/04 and the south part of the Lac Batiscan area are underlain by an intrusion, well constrained on the aeromagnetic map, which we associated with the charnockitic facies of the RAPS. This body is characterized by: i) a distinctive porphyritic texture where isolated feldspar phenocrysts are embedded in a medium-grained groundmass, and ii) the presence of a discontinuous border facies of ferrodiorite and ferrogabbro, which locally host anorthositic enclaves. Moreover, the proximity of a small anorthositic body along the northern edge brings to mind the typical lithological associations of AMCG suites (anorthosite-mangerite-charnockite-granite).

Intrusions of the RAPS are scattered in vast expanses of igneous felsic and intermediate rocks assigned to the Parc des Laurentides Complex (Hébert and Nadeau, 1995). These rocks, which are generally foliated, augen-textured or gneissic, exhibit various shades of green in fresh surface. They locally contain remnants of a rapakivi or antirapakivi porphyritic texture. Various intrusive relationships illustrate the composite nature of this complex. Of particular interest, augen-textured rocks in the northeastern corner of map sheet 21M/04 clearly cross-cut, to the south, a medium-grained foliated facies.

Finally, sub-km-scale screens of dioritic-tonalitic orthogneiss typical of the La Bostonnais Complex, and paragneisses akin to those of the Montauban Group (Hébert and Nadeau, 1995) outcrop in the southern part of the area and are scattered in gneisses of the Parc des Laurentides Complex, namely along the edges of intrusions of the RAPS.

Reference

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197-198

Geology and metallogeny of the Opinaca area (NTS 33C/09 and 33C/16)

Daniel Bandyayera, Alexandra Fliszar (MRNF),
Jean-François Ravenelle (INRS)

The Opinaca mapping project covers an area extending from Opinaca Reservoir to the east, westward to the coast of James Bay. This area was targeted for geological mapping based on the following criteria: 1) low amount of geological knowledge relative to other parts of the James Bay region; 2) strategic position to understand links between the La Grande, Eastmain and Opinaca areas; 3) the mineral potential is very high at the eastern end (Roberto gold deposit), but virtually unknown in the west.

Phase 1 of 3 of the Opinaca project consists of a mapping survey at 1/50,000 scale in map sheets 33C/09 and 33C/16. The south of the area is underlain by Archean rocks of the La Grande Subprovince. In the centre of map sheet 33C/09, a volcano-sedimentary sequence is draped around a multi-phase intrusive dome of diorite-granodiorite-porphyritic tonalite some 15 km in diameter. Although the contact between sedimentary and volcanic sequences is generally faulted, conglomerates are locally observed unconformably overlying mafic volcanic rocks and intermediate or felsic volcaniclastic rocks. This contact is strongly deformed and also occasionally hosts gold mineralization. Conglomerates are overlain by mudstone, biotite±hornblende wacke, and sandstone units in which primary sedimentary structures are well preserved. All these units are injected with tourmaline-bearing (5-20%) pegmatite and cut by Proterozoic mafic or ultramafic dykes.

In the north of map sheet 33C/09, the metamorphic grade gradually or suddenly changes from the lower to the middle or upper amphibolite facies. The actual boundary between the La Grande and Opinaca subprovinces corresponds to the path of this metamorphic isograd.

In the map area, the Opinaca Subprovince consists of bands of moderately to strongly migmatized paragneiss essentially trending E-W and injected with pegmatitic migmatites with no tourmaline. Paragneiss bands occur in topographic lows, whereas pegmatites form positive relief features.

Our work reveals promising potential for three types of mineral occurrences: 1) epigenetic gold occurrences associated with metasomatic quartz-tourmaline-pyrrhotite-pyrite-arsenopyrite veins in sedimentary sequences (Roberto deposit); 2) Au-Cu-Ag occurrences associated with quartz-tourmaline-pyrrhotite-chalcopyrite stockworks in dioritic intrusions; and 3) gold occurrences associated with a regional deformation zone along the contact between conglomerates and volcanic rocks (Beaufield showings). Aluminous metasedimentary rocks with strong tourmaline and andalusite alteration, typical of the Roberto area, were observed from west to east along the margins of the diorite-granodiorite-tonalite dome.

199

MISA: Geosciences and Drilling Section

Michel Thibert (Misa)

200

Kimberlite indicator mineral dispersal trains and the glacial geology of the Lac de l'Argentier area, Québec — potential diamond-bearing kimberlite region

Scott Russel, Gordon Parsons, S.R. Hicock, T.F. Morris
(University of Western Ontario)

Understanding the Quaternary history of the Ville-Marie area of the Témiscamingue region, in southwestern Québec, is vital in utilizing drift prospecting as a tool to locate diamond-bearing kimberlites and other mineralization (i.e. Au) within the region. The main ice-flow direction (or multiple stages) within an area was estimated using striae orientations, till fabric, and paleocurrent analysis. There is a strong indication of a southwestward flow towards the eastern part of the region, shifting to a southward flow in the central portion of the region, then to a southeastward flow in the western portion of the region. The variation in ice-flow directions may indicate the formation of two distinct ice lobes, retreating and re-advancing in different directions during deglaciation at about 10.5 ka to 9.5 ka. Ground-truthing during the summer of 2005 coupled with stereoscopic air photo interpretation resulted in the creation of a detailed Quaternary geology map of the Lac de l'Argentier area. These Quaternary investigations can provide a sequence and relative importance of major ice flows in the area during the last glaciation, and may provide an indication of the deglaciation of the area.

The kimberlite indicator mineral (KIM) counts recovered from 1200 overburden samples collected by Superior Diamonds Inc. have been interpreted to represent a number of KIM dispersal trains in the Lac de l'Argentier area. The location of the KIM or Au dispersal trains, coupled with grain chemistry interpretation and a strong knowledge of the Quaternary history of the area will allow for recommendations to be made for localized potential kimberlite-target drilling programs and for further kimberlite and Au exploration within the area.

201

Outstanding geological sites (OGS): Status report (MRNF)

Marc Bélanger, Daniel Brisebois, N'golo Togola,
Pierre Verpaelst (MRNF)

The Ministère des Ressources naturelles et de la Faune (MRNF) took up the mandate in 2001 to create outstanding geological sites (OGS). When Bill 121 to amend the Mining Act was adopted on December 16, 2005, the Government of Québec granted legal status to OGS. Géologie Québec launched in 2006 the designation process for the very first outstanding geological sites, which should be officially classified as such in early 2007. OGS should contribute to the Strategy for Protected Areas, by helping to preserve Québec's natural heritage.

An outstanding geological site (OGS) means "land whose geological, geomorphic, landscape or biological characteristics are of educational value, or of interest for scientific research or conservation purposes, and that deserves to be protected, in particular because it is threatened, rare or vulnerable". Outstanding geological sites must: 1) help provide a better understanding of the evolution of physical settings, of life and thus of our own evolution; 2) be accessible to everyone, meaning that no one can alienate them for their exclusive benefit; 3) contribute to regional economic development; and 4) contribute to the protection of the world's natural heritage. The aesthetic value of the site is also taken into account.

The OGS designation process involves a number of steps: 1) inventory of interesting geological sites likely to be classified as OGS; 2) characterization of each potential site; 3) evaluation of sites based on specific criteria; 4) consultation with government partners (MDDEP, MRNF sectors, etc.), regional (MRC, CRÉ, native communities) and industrial (AMQ, AEMQ) stakeholders; and finally, 5) official designation by the Minister.

A site proposal form, developed by the working group responsible for OGS designation, will serve as a starting document for each site, from the initial evaluation through the consultation and designation process. Evaluation of the first series of OGS will be completed this fall.

202

Glacial sediment prospecting in the Normétal/Lebel-sur-Quévillon area, TGI-3 Abitibi project — Preliminary results of the 2006 drilling campaign

Michel Parent (GSC-Québec), Pierre Rhéaume (MRNF), Serge J. Paradis (GSC-Québec), Éric Boisvert (GSC-Québec)

To counter the fact that the thick cover of Quaternary sediments masking the Normétal/Lebel-sur-Quévillon volcano-sedimentary belt considerably hinders mineral exploration in the area, the Ministère des Ressources naturelles et de la Faune (MRNF) and the Geological Survey of Canada (GSC) launched a joint regional geochemistry program to generate new exploration targets. This project is based on new boreholes in glacial sediments that will also provide data for the creation of 3D geological models integrating stratigraphic architecture, paleoglacial dynamics, and clastic and geochemical dispersion. These models will help guide regional exploration in this area affected by a complex glacial dynamic setting.

This project is based on a diamond drilling campaign (HQ-3) in which Quaternary sediment cores that have undergone a minimum of reworking will be recovered, as well as cores from the underlying basement. A compilation of available drilling data indicates that the thickness of Quaternary sediments averages about 20 metres in the study area. The 2006 drilling campaign, centered in map sheet 32F/04, will be performed along a 2-km grid spacing, and the 70 or so projected holes will produce about 700 metres of glacial sediment cores and about 200 metres of rock cores, which will also be useful to characterize the bedrock geology. This drilling method will help establish a reliable Quaternary stratigraphy and will produce high-quality geochemical and mineralogical data. Since the compositional variability of tills is much greater in the vertical dimension than in a horizontal dimension, the sub-sampling interval will be fairly small in cores (50 cm or less), such that the number of analyzed till samples should reach 1400. The drilling program will extend to the west toward Normétal over the next few fiscal years.

The compositional analysis of glacial sediments will include geochemistry of the fine-grained matrix (<0.063 mm) and of heavy mineral concentrates in the sand fraction (1.0-0.125 mm). Geochemistry data obtained in the vicinity of known deposits or showings will be used to establish regional models of provenance and glacial dispersion. These models will then guide the interpretation of more isolated exploration data. Previous work, e.g. Veillette (2004) and Paradis (2005), established a complex sequence of regional ice flow movements. Consequently, a significant amount of polyphase glacial dispersion is expected, which may be tested using empirical models (Parent et al., 1996).

References

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203

Association québécoise des Sciences de la Terre: A second year of achievements

204

Geology of Ag-Pb-Zn veins in the Belt-Purcell basin, southeasthern British Columbia

Jean-Philippe Paiement, Georges Beaudoin (U. Laval), Suzanne Paradis (GSC)

The Belt-Purcell basin is well known for the SEDEX-type Pb-Zn-Ag Sullivan deposit in British Columbia, and for its swarm of Ag-Pb-Zn veins in the Cœur d'Alène district in Idaho, which is a classic Ag-Pb-Zn vein-type deposit. The Pb-isotope composition and 40Ar/39Ar dates demonstrate that there were two ages for the emplacement of Ag-Pb-Zn veins in the Cœur d'Alène district: Pb-Zn veins are Proterozoic, whereas the Ag-Pb-Zn veins are younger (Cretaceous to Tertiary). In British Columbia, Ag-Pb-Zn veins hosted by rocks of the Purcell Supergroup display Pb-isotope compositions that are analogous to those of the Cœur d'Alène district, which suggests that the Ag-Pb-Zn veins in British Columbia were also formed during two distinct events. It is therefore pertinent to compare veins hosted by rocks of the Belt Supergroup in Idaho to those hosted by rocks of the Purcell Supergroup in British Columbia to determine their mineralogical and geochemical characteristics and propose new exploration guides for this type of deposit.

During the summer of 2006, fieldwork performed within the scope of the Geological Survey of Canada's Targeted Geoscience Initiative produced samples and descriptions of 22 vein-type Ag-Pb-Zn deposits. The deposits, selected from MinFile data, are oldformer producers that represent vein-type Ag-Pb-Zn mineralization hosted by rocks of the Purcell Supergroup in British Columbia. Two types of veins are distinguished based on mineralogy and structure:

1) Veins of galena, sphalerite, pyrrhotite and pyrite (Pb-Zn-Ag) hosted by the lower units of the Purcell Supergroup; three Pb-Zn-Ag vein deposits (Fors, St-Eugène and Estella) display a Pb-isotope composition analogous to that of Proterozoic veins in the Cœur d'Alène district.

2) Veins of galena, tetrahedrite, sphalerite and pyrite (Ag-Pb-Zn) rich in quartz; some deposits, like Midway and Anderson, have a Pb-isotope composition similar to that of Mesozoic veins in the Cœur d'Alène district.

Field observations suggest that the two types of veins in the Cœur d'Alène district are also found in the rocks of the Purcell basin in British Columbia. An important difference is the absence of siderite in the Mesozoic veins hosted by rocks of the Purcell basin.

210

New seismic data now available on SIGPEG

Jean-Yves Laliberté, Robert Thériault, Stéphane Beauséjour (MRNF)

The Ministère des Ressources naturelles et de la Faune (MRNF) has an important seismic database that is available to clients in oil and gas exploration. This public collection, possibly the largest of its kind in North America, has recently been significantly enhanced following the acquisition of a large amount of seismic data transferred to the MRNF by the former State-owned SOQUIP. This new addition represents an increase of more than 60% of all seismic profiles available in TIF format, and more than 85% of all raw data currently in the public domain. The MRNF now offers its clientele, via its e-commerce site SIGPEG (http://sigpeg.mrnf.gouv.qc.ca), 669 seismic profiles in TIF format, including 65 in SEG-Y format and 158 as raw data. All of the seismic profiles put together cover a distance of more than 13,500 km. Here is a brief summary of the current seismic coverage by geological region:

St. Lawrence Lowlands: 403 seismic profiles (including 275 new profiles, i.e. 68%);

Gaspésie: 112 seismic profiles (including 37 new profiles, i.e. 33%);

Anticosti and St. Lawrence Estuary: 72 seismic profiles (including 30 new profiles, i.e. 42%);

Gulf of St. Lawrence: 58 seismic profiles (including 55 new profiles, i.e. 95%);

Bas-Saint-Laurent: 37 seismic profiles (including 31 new profiles, i.e. 84%).

This new seismic database will be very useful for companies and other agencies specializing in oil and gas exploration in Québec, and represents an indispensable tool which may ultimately lead to the discovery of hydrocarbon deposits in Québec.

211

Source rock potential of the Utica Group, and hydrocarbon potential and thermal maturation of reservoir rocks in Ordovician successions of the St. Lawrence Lowlands and the external domain of the Québec Appalachians

Rudolf Bertrand (INRS-ETE), Virginie Lavoie (Junex Inc.)

The age of platform successions in the St. Lawrence Lowlands spans a period from the Early Cambrian to the Late Ordovician. The tectonic pile of the external structural domain of the Appalachians is composed of a basal platform succession overlain by tectonic slices of similar origin and capped by allochthonous nappes of more distal facies.

Based on pyrolysis (Rock Eval) and total organic carbon (TOC) analyses, the main source rocks in the two geological provinces belong to the Utica Group and its stratigraphic equivalents (Late Ordovician). These shales contain up to 15% TOC, with an average of 1.6%. The hydrocarbon (HC) content of these successions ranges between 0 and 104 kg HC/t of rock. Overall, TOC contents decrease from the platform toward the Appalachians (average TOC = 6.5% in the Saguenay outlier, 3.7% in the Anticosti platform, 1.2% in the platform southwest of Québec, 0.9% in the Appalachians). However, Appalachian successions locally contain up to 5.5% TOC and 13 kg HC/t of rock.

Expressed as vitrinite reflectance (R_o), the thermal maturation of the Utica Shale increases from east to west and from the Lowlands to the Appalachians, both in outcrop ($0.7<R_o<4.4\%$) and in the subsurface ($1.2<R_o<8.8\%$). It correlates with the current seismic signature of the Trenton roof. On surface, a reflectance gap is locally observed between the Lowlands and the Appalachians. At depth, the gap disappears and the epizone is reached under Appalachian nappes ($R_h > 6.0\%$).

Based on their maturation, reservoir rocks of the Black River and Trenton groups in the Lowlands are commonly suitable for oil or condensates, although gas is the dominant phase. Rocks of the Beekmantown Group in the Lowlands and Appalachians, generally composed of dolomites, are more favourable to the conservation of dry gas than condensates.

Tectonic burial by nappes during the Taconian orogeny is presumably the major cause of maturation of platform successions in the Appalachian domain. Certain duplexes in these successions predate the peak of maturation, while others postdate the latter. Hydrothermal fluids locally invaded these fault zones and permeable horizons in platform successions. The thermal maturation of platform sequences in the Lowlands is due to syn- to post-Taconian sedimentary burial. Hydrocarbon generation in the Lowlands postdates generation in the Appalachians, and is probably Siluro-Devonian in age.

212

Evaluation of hydrocarbon potential in Paleozoic sedimentary basins of Eastern Canada: Status report

Denis Lavoie, Nicolas Pinet, Sébastien Castonguay, Mathieu Duchesne (GSC-Québec)

Evaluating the hydrocarbon potential of sedimentary basins involves identifying source and reservoir rocks, cover rocks and traps, determining the thermal maturation and the relative timing between these various elements. Our knowledge of these different parameters for Paleozoic sedimentary basins in Eastern Canada and particularly in Québec is highly variable.

The best source rocks are in the Middle (TOC=10.7%, HI=266) and Upper (TOC=14%, HI=633) Ordovician. Recent GC-MS data (biomarkers) and GC-IRMS data (carbon isotopes) link these source rocks with hydrocarbons and bitumen derived from Ordovician to Devonian successions.

Québec's current hydrocarbon production comes from sandstone reservoirs (Lower Devonian, Gaspésie) and hydrothermal dolomites (Lower Devonian, Gaspésie). Hydrothermal dolomites are also known in the Lower and Middle Ordovician (St. Lawrence Platform), in the Lower Silurian (Matapédia and Gaspésie), and in the Upper Silurian and lowermost Devonian (Gaspésie).

Stratigraphic and combined (tectonic and stratigraphic) traps form exploration targets in Devonian sandstones of the Gaspésie region. For hydrothermal dolomites, although fluid circulation requires the presence of extensional fractures, the dolomitization process generates its own lateral traps of diagenetic origin. Recent data from unconsolidated and Paleozoic successions in the St. Lawrence Estuary reveal the presence of Quaternary stratigraphic traps overlying open traps in the St. Lawrence Platform.

Our knowledge of the thermal maturation of Paleozoic successions is variable. The Cambrian-Ordovician domain is only very locally favourable to oil preservation; its potential is mainly for natural gas. In contrast, the Silurian-Devonian domain is suitable for the preservation of both oil and natural gas. The area between Québec and Témiscouata is the only zone where maturation data requires an important revision, and this work is currently underway.

The presence of hydrocarbon reservoirs in the Devonian suggests that the relative timing of thermal maturation, generation-expulsion-migration of hydrocarbons and the formation of reservoirs and traps is favourable. By analogy with producing reservoirs in New York and Newfoundland, these conditions are also probably present in the Ordovician. The presence of bitumen in reservoirs of the Lower Silurian suggests that at least locally, the conditions required for the formation, migration and accumulation of hydrocarbons were attained.

213

Geophysical data in the St. Lawrence Estuary: Towards a better understanding of its oil and gas systems

Mathieu J. Duchesne, Nicolas Pinet, Andrée Bolduc (GSC-Q), Calvin Campbell (GSC-A), Denis Lavoie (GSC-Q), Gilles Bellefleur (GSC-O)

Since 2003, the Geological Survey of Canada and its partners acquired and reprocessed 4,600 km of single channel and multichannel high-resolution seismic reflection profiles, and amassed 4,400 km^2 of multibeam data (very high resolution bathymetry) for the St. Lawrence Estuary between Tadoussac and Pointe-des-Monts. Two of the goals for the interpretation of the geophysical data were to improve regional geological knowledge and to better understanding the area's oil and gas systems.

Analysis of the geophysical data identified the following: 1) more than 600 pockmarks commonly arranged in a linear fashion or in clusters on the seafloor; and 2) more than 40 seismic chimneys causing perturbations of the basement reflections and the reflections of Quaternary units, either in whole or in part. More specifically, numerous bright spots and pull downs (negative relative seismic velocity anomalies) were identified Quaternary successions, many of which are related to the seismic pipeschimneys.

The seismic signature of the basement was also documented for all profiles. On some seismic lines, shallow dipping reflectors (~20°) observed in the basement at a time-depth of 100 milliseconds defined open folds. These open folds are characteristic of the style of seismic reflections in the St. Lawrence Platform.

The interpretation of geophysical data reveals that the platform covers 60% of the study area. Moreover, 74% of the pockmarks and 95% of the seismic pipeschimneys are located over the platform. These observations suggest the presence of gas of thermogenic origin emanating from the platform. The relationships established between geophysical anomalies and seismic reflections in the roof of the platform allows us to propose that gas migrated from fractured source rocks or breached reservoirs along faults or glacial erosion features, into the Quaternary sediments and towards the sea-floor. In light of this interpretation, it is proposed that a high-quality mature source rock exists in the St. Lawrence Estuary and that an oil and gas system was or is still active.

November 21 and 22

The renewal of copper resources in Abitibi

Jean Goutier(MNRF), Mr. Jack Parker, (Ontario Geological Survey), Dr. Benoît Dubé, (Geological Survey of Canada)

Géologie Québec, in partnership with the Geological Survey of Canada and the Ontario Geological Survey, is working in the Abitibi greenstone belt to accelerate the renewal of copper resources near existing facilities. This work is part of Québec's Copper Plan and the federal government's Targeted Geoscience Initiative III.

The projects to be carried out will be multidisciplinary and integrated. A new Megatem survey has already been financed in Chibougamau and major Quaternary geochemistry work will also be undertaken in 2006-2007. The sectors of prime interest are located in the Rouyn-Noranda and Chibougamau areas as well as along an east-west corridor linking Lebel-sur-Quévillon to Normétal.

Time: 11:00 a.m. to 12:00 p.m.

Place: Salon Saint-Louis

Free

November 22 and 23

The geological map: a new model, a new vision!

Charles Roy, Nelson Leblond, Louis Madore, (MRNF)

SIGEOM has been operational for nearly 12 years. Now, we wish to improve the update cycle of the geological maps and the way they are released. It is planned, among other things, to simplify the preparation of the printed version of some map types and to eliminate the scale notion applied to basic data.

We also plan to encourage even more digital publication. This kind of publication allows for more flexibility to satisfy the needs of a variety of clients (maps with technical, synthesis, and promotional contents, and combined products). Furthermore, clients will be able to draw from this vast set of information to integrate the geoscience data of Géologie Québec into their own work. It goes without saying that the withdrawal of the MicroStation format for ArcGIS and MapInfo formats will encourage this type of use.

Géologie Québec offers this session to explore, with its partners, new ways to produce the geological map. Your participation is important to us!

Time: 11:00 a.m. to 12:00 p.m.

Place: Salon Québec

Free

Acronyms, list of exhibitors, maps of exhibits rooms and project location maps

Acronyms

- **CMEB** : Cree Mineral Exploration Board
- **OGS** : Ontario Geological Survey
- **LU** : Laurentian University, Mineral Exploration Research Centre
- **UL** : Université Laval
- **HQPG** : Hydro-Québec Pétrole et Gaz
- **URSTM-UQAT** : Unité de recherche et de service en technologie minérale – Université du Québec en Abitibi-Témiscamingue
- **MRNF** : Ministère des Ressources naturelles et de la Faune
- **AAEC** : Anglo American Exploration (Canada) Ltd.
- **CGC-DCC** : Commission géologique du Canada, division du Centre du Canada
- **CGC-Québec** : Commission géologique du Canada, Québec
- **GSC-CCD** : Geological Survey of Canada, Central Canada Division
- **GSC-Qc** : Geological Survey of Canada, Quebec
- **USGS** : United States Geological Survey, Denver
- **CET** : Centre for Exploration Targeting, University of Western Australia, Perth
- **UQAM** : Université du Québec à Montréal
- **NRCAN, GSC (Atlantic)** : Natural Resources Canada Geological Survey of Canada (Atlantic)
- **NDM** : Northern Development and Mines
- **INRS** : National Scientific Research Institute
- **GSC-Ottawa** : Geological Survey of Canada - Ottawa
- **CGC-Qc** : Commission Géologique du Canada - Québec
- **CGC-Ottawa** : Commission Géologique du Canada- Ottawa
- **MDDEP** : Ministère du Développement durable, de l'Environnement et des Parcs
- **MERC** : Mineral Exploration Research Centre, Laurentian University, Ontario
- **NYSERDA** : New York State Energy Research and Development Authority
- **GCF** : Groupe conseil Forchemex Ltée
- **Hartwick** : Department of Geology and Environmental Science, Hartwick College, Oneonta, NY, USA
- **CONSOREM, UQAM** : Consortium de Recherche en Exploration Minérale, Université du Québec à Montréal
- **CONSOREM** : Consortium de Recherche en Exploration Minérale
- **Poly** : École Polytechnique
- **McGill** : Université McGill
- **UQAC** : Université du Québec à Chicoutimi
- **UQAM** : Université du Québec à Montréal
- **UQAT** : Université du Québec en Abtibi-Témiscamingue
- **CGC-A** : Commission Géologique du Canada-Atlantique
- **CGC-O** : Commission Géologique du Canada-Ottawa

Salle de Bal

1. Abitibi Géophysique inc.
2. Ressources Appalaches
3. Géophysique GPR International
4. Tres-Or Resources Ltd.
5. Exploration Dios inc.
6. Goldbrook Ventures Inc.
7. Osisko Exploration ltée
8. Vior inc.
9. IOS Services Géoscientifiques inc.
10. Systèmes Géostat International inc.
11. Hélicoptères Canadiens ltée
12. Cambior inc.
13. Quinto Technology Inc.
14. Prospectors & Developpers Association of Canada(PDAC)
15. N.B. Natural Resources
16. Centre géoscientifique de Québec
17. Ontario Ministry of Northern Development and Mines (OM-NDM)
18. Activation Laboratories Ltd.
19. Exploration Typhon inc.
20. SRK Consulting
21. Mira Geoscience Ltd.
22. Groupe Fordia ltée
23. SOQUEM inc.
24. SGS Mineral Services
25. Université du Québec en Abitibi-Témiscamingue (UQAT)
26. Ressources Metco inc.
27. Golden Valley Mines Ltd.
28. Fugro Airborne Surveys
29. Newfounland and Labrador Dept. of Natural Resources
30. MIR Télédétection inc.
31. Héli-Transport inc./Heli-Max ltée
32. Terraplus Inc.
33. Exploration Azimut inc.
34. Commissaire au lobbyisme du Québec
35. Société de développement de la Baie-James
36. Alschemex Chimitec
37. Alexis Minerals Corporation
38. Quantec Géoscience inc.
39. Mines d'Or Virginia inc.

Salle Bellevue

40. Nolinor Aviation
41. Geonics limited
42. Diagnos inc.
43. Scintrex Ltd.
44. Crone Geophysics et Géophysique TMC
45. Ressources naturelles Canada/Centre d'information topographique
46. Groupe Système Forêt inc.
47. Scott Wilson Roscoe Postle Associates

Salon Verchères

60. Canadian Royalties Inc.
61. Instrumentation GDD inc.
62. Les mines Agnico Eagle ltée
63. Geotech Ltd.
64. Aeroquest Ltd.
65. Goldcorp inc.

Salle Place d'Armes

90. Ressources Majescor
91. GESST
92. Université McGill
93. ESRI Canada ltée
94. Knight Resources Ltd./Donner Metals Ltd
95. Ressources Beaufield
96. GEOTIC inc.
97. Ressources Cogitore
98. Maxwell Geoservices

Salle Jacques-Cartier

101. Ministère des Ressources naturelles et de la Faune, Secteur Énergie
102. Ressource et Énergie Squatex
103. Société Pétrolière de l'ICM, Section de Québec
104. ICM
105. Gastem inc.
106. AMQUE ULC
107. Pétrolia Inc.
108. GCP Énergies
109. Nouveau-Brunswick Department natural resources, Petroleum Tenure
110. Junex inc.

Booth 121 to 135 (suites 2201 to 2221)

121. (A) 2iC Australia Ltd./Jexplore Inc.

122. (A) Forest Gate Resources Ltd

123. (A) Blue Note Metals Inc.

124. (A) Wesdome Gold Mines Ltd

125. (A) Globex Mining Entreprises Inc.

126. (A) Corporation minière NioGold

127. (A) Direction générale du développement minéral - GESTIM Plus

128. (A) Direction générale du développement minéral - GESTIM Plus

129. (A) Direction générale de l'information géographique

130. (A) SIGEOM - Centre de services des Mines

131. (B) Ressources Dianor inc.

132. (B) Communications d'affaires CG

133. (B) Fond minier Innu Nitassinan

134. (B) Golder Associés ltée

135. (B) Placer Gold Design

Salon Rose

151 Contribution of 3D modelling to the geology of the Urban-Barry Belt

152-153 Progress report on 3D modelling, phase 1: Ore deposit settings along the south limb of the Lac Doré Complex, Chibougamau mining district

154 The Abitibi-Témiscamingue 3D geological modelling centre: Summary of ongoing work by the URSTM-MRNF 3D team

155-156 Geology of the western Malartic Group: Regional correlations (1 of 3)

157 Progress report on geological and metallogenic synthesis of the western Blake River Group

158 Geology and metallogeny of the Blake River Group: Objectives and preliminary results of a joint GSC (TGI-3) – MRNF (Copper Plan) – OGS – Industry – University effort

159 Hydrothermal systems, isotope signatures and exploration for volcanogenic massive sulphides in the Blake River and Kidd-Munro assemblages (past, present, and future studies)

160 Preliminary results of the TGI-3 Abitibi project in the Chibougamau camp — Stratigraphic revisions in the Roy Group and implications for exploration

161 High-resolution 2D seismic data from the Noranda central camp and implications for exploration: TGI-3 Abitibi project

162 Is semi-automated generalization of 1/50,000 or 1/100,000 scale maps to 1/250,000 scale possible with ArcInfo? Test area: Chibougamau 32G, TGI-3 Abitibi project

163 The polymetallic system in the Lac Line area, Chibougamau, Québec

164 Petrographic and metallogenic study of the MOP-II deposit, Chibougamau, Québec

165 Reprocessing of a metatransect across the Gaspésie Appalachians: Seismic imagery and structural evaluation

166 Structural analysis of faults and fractures affecting the passive margin of Anticosti, Québec Appalachians

167 New geochemical data to support hydrocarbon characterization in Gaspésie

168 Ni-Cu-PGE metallogeny of the Portneuf-Mauricie Domain

169 Mapping of volcanic facies in the southeastern part of the New-Senator Caldera, Blake River, Abitibi

170 Influence of early structure on the geometry of propagation folds: Reconstruction and direct kinematic modelling in 3D

171 From medicine to geology – Visualization of physical models using tomodensitometrycomputed tomography

172 Inventory of aggregate resources in the Réserve faunique des Laurentides (21M/14)

173 Assessment of the muscovite potential in the Escoumins area

174 Update of the quarry inventory for the Estrie, Centre-du-Québec, and Mauricie regions

175 Proterozoic dyke swarms of the Ungava Peninsula

176 Lithogeochemistry, petrogenesis and emplacement of granitic and pegmatitic intrusions in Minganie, eastern Grenville, Québec

177 The new laboratory for physical simulations at INRS-ETE: Applications to mineral and petroleum exploration

178 ITRAX Core Scanner™: A new non-destructive tool applied to the assessment of mineral potential in drill core and rock samples using high-resolution micro-radiography and micro X-ray fluorescence

179 Shedding light on the geological complexity of Chaleurs Bay using a multidisciplinary approach

180 - 181 Multidisciplinary studies along the western part of the Cadillac Fault, Abitibi Subprovince: Searching for new ore deposits

182 Geochemistry of igneous clasts from the Upper Ordovician Garin Formation in the Gaspé Appalachians: Correlation with the Exploits subzone

183 Geographic extent and nature of structures associated with the Saguenay Graben, Québec

184 A regional exploration guide for diamonds using seismic tomography

185 Application of artificial neural networks to mineral potential mapping for diamondiferous kimberlites in North America

186 The Blake River Group in the Abitibi Subprovince: New developments in 2005-2006

187 DIVEX geochemical and geophysical exploration tools: 1) The chemical composition of iron oxides: a new mineral exploration tool 2) Geophysical signatures of kimberlites

188 Metamorphic environments and preliminary results for new 2006-2007 DIVEX projects : 1) Mineralogy of non-sulphide zinc assemblages in disseminated zinc deposits of the Grenville Supergroup marbles 2) New DIVEX projects for 2006-2007

189 3D Geology at DIVEX : 1) Gold potential evaluation along the western segment of the Cadillac Fault in Québec – Phase 1 2) Development of a 3D topological query tool for the analysis of geological models

190 Geological reconnaissance of the volcanosedimentary cycles in the Labrador Trough (Schefferville area) and of geochemical anomalies (Cu, Au) in the Zeni Lake area

Corridor Bellevue

191 Geology of the Lac Olga area

192-193 Geology and metallogeny of the northern part of the Baie-Comeau area (map sheets 22F/07, 22F/08, 22F/09, 22F/15, 22F/16)

194-195 Gold in lake sediments of the eastern LaGuiche Basin

196 Geology of the Rivière Tourilli area (21M/04) and the SW corner of the Lac Batiscan area (21M/05)

197-198 Geology and metallogeny of the Opinaca area (NTS 33C/09 and 33C/16)

199 MISA: Geosciences and Drilling Section

200 Kimberlite indicator mineral dispersal trains and glacial geology of the Lac d'Argentier area, Quebec— Potential diamond bearing kimberlite region

201 Outstanding geological sites (OGS): Status report (MRNF)

202 Glacial sediment prospecting in the Normétal/ Lebel-sur-Quévillon area, TGI-3 Abitibi project – Preliminary results of the 2006 drilling campaign

203 Association québécoise des Sciences de la Terre: A second year of achievements

204 Geology of Ag-Pb-Zn veins in the Belt-Purcell Basin, southeastern British Columbia

205 New tools for mineral exploration in Québec

210 New seismic data now available on SIGPEG

211 Source rock potential of the Utica Group, and hydrocarbon potential and thermal maturation of reservoir rocks in Ordovician successions of the St. Lawrence Lowlands and the external domain of the Québec Appalachians

212 Evaluation of hydrocarbon potential in Paleozoic sedimentary basins of Eastern Canada: Status report

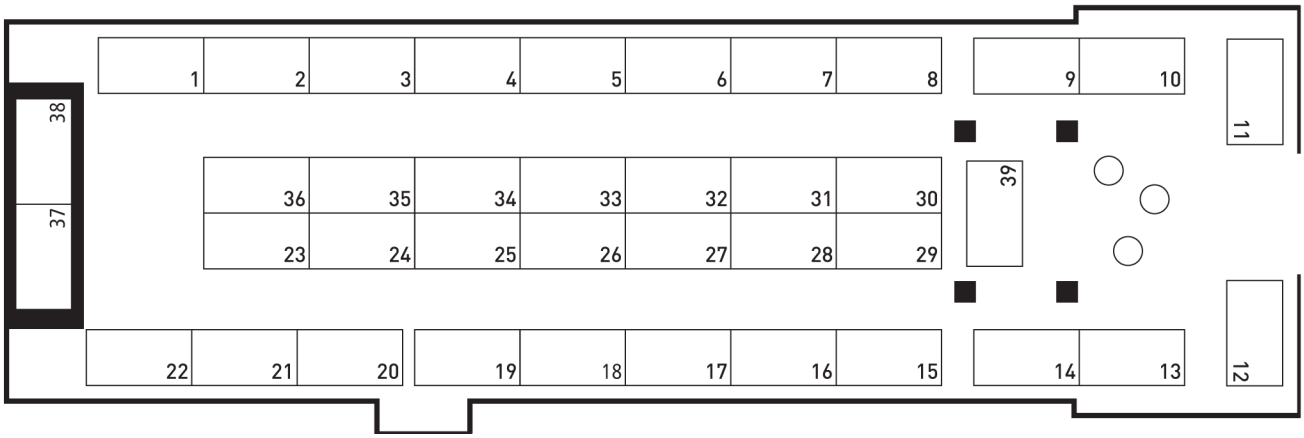
213 Geophysical data in the St. Lawrence Estuary: Towards a better understanding of its oil and gas systems

Prospectors room

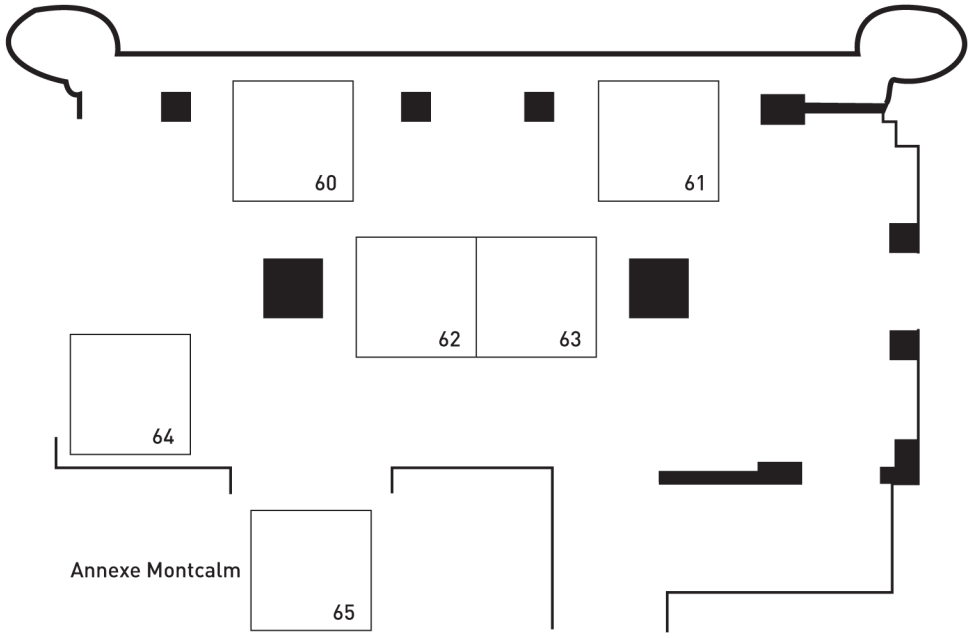
- La Table jamésienne de concertation minière;
- Le Fonds régional d'exploration minière de la Côte-Nord;
- Le Fonds régional d'assistance à la prospection minière de la Gaspésie et des Îles-de-la-Madeleine;
- Exploration Flair;
- Le Conseil Cri sur l'exploration minérale;
- Le Fonds minier du Saguenay–Lac-Saint-Jean;
- Denis Cyr, prospecteur.

Maps of exhibits

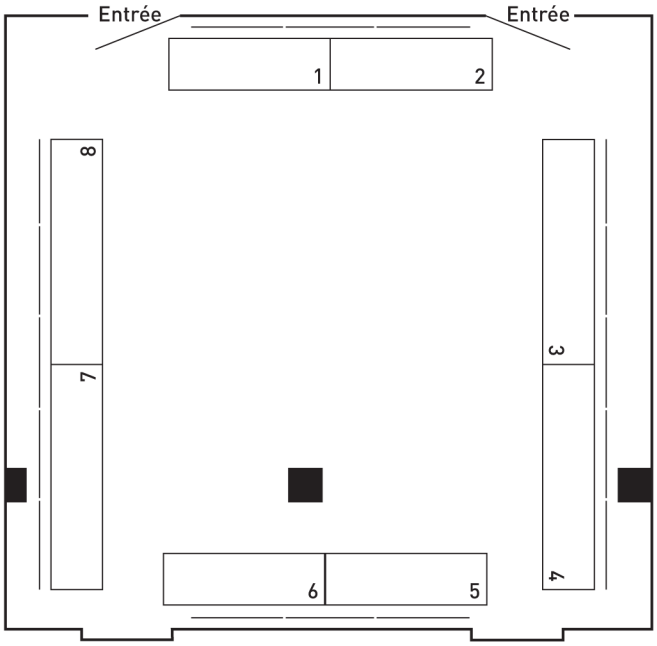
Salle de Bal
exposition commerciale



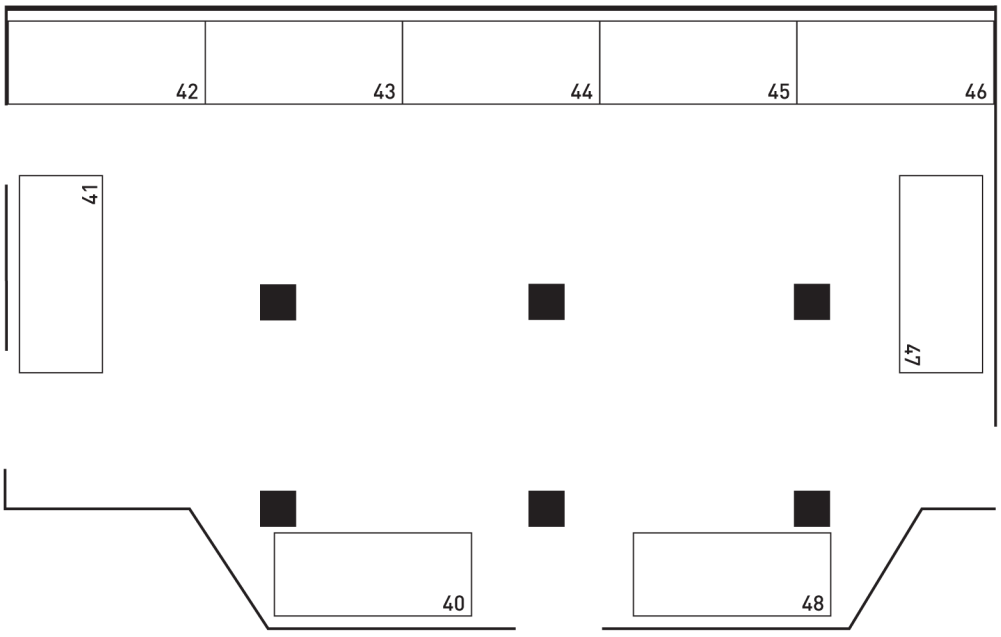
Verchères
exposition commerciale



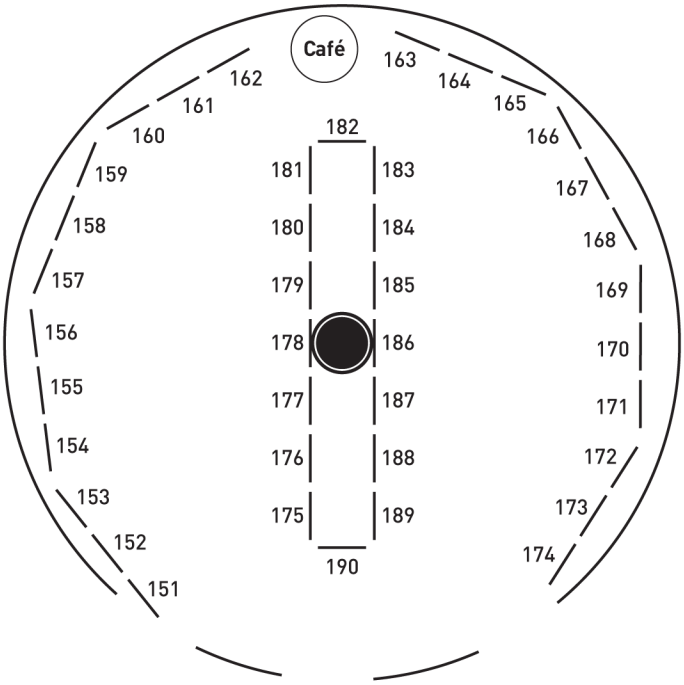
Montcalm
salon des prospecteurs



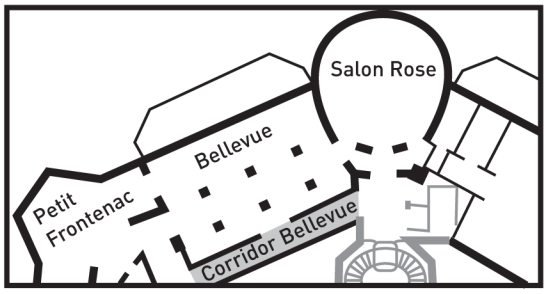
Bellevue
exposition commerciale



Salon Rose
exposition géoscientifique



Corridor Bellevue
exposition géoscientifique

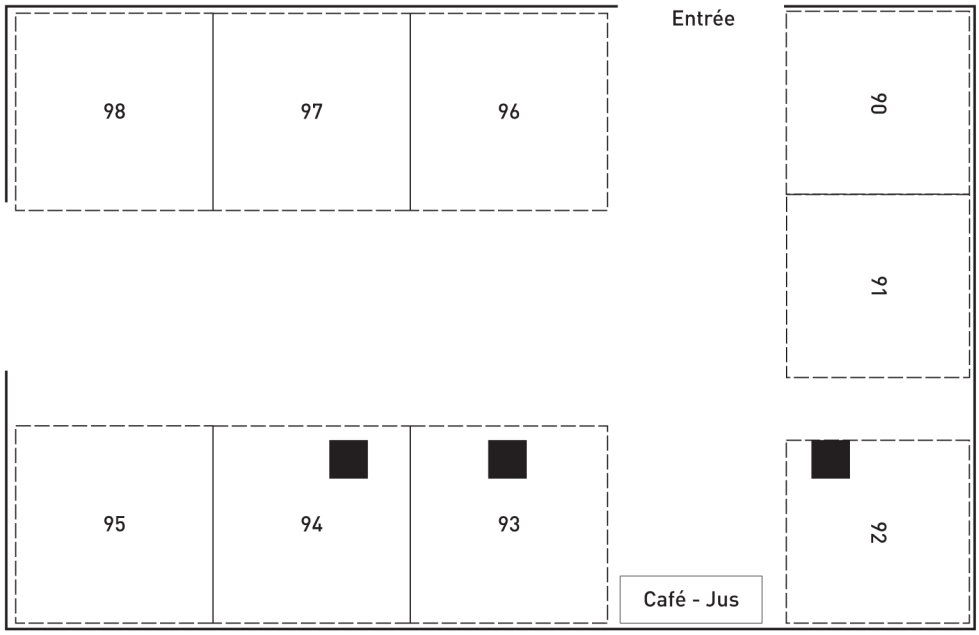


Entrée Bellevue

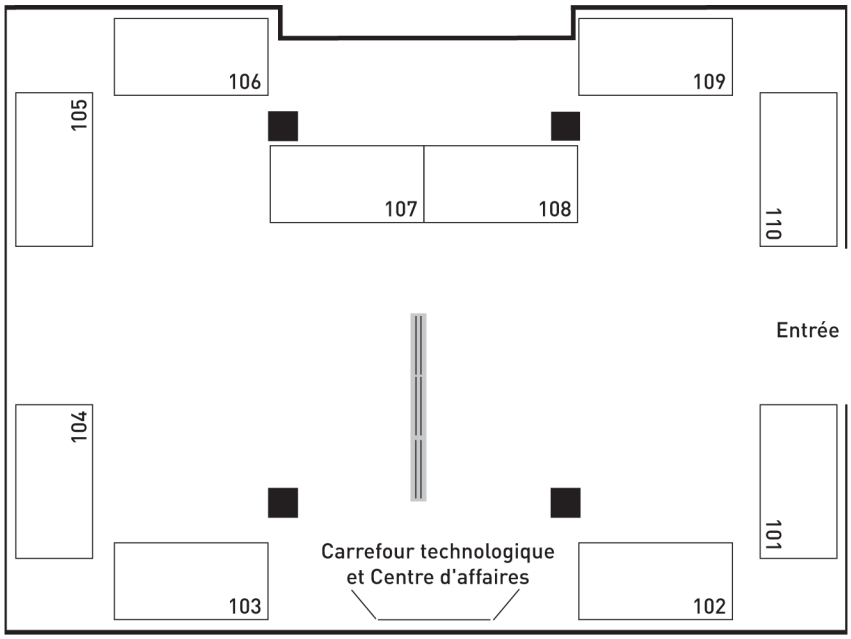
Salon Rose →

191 192 193 194 195 196 197 198 199 200 201 202 203 204 205

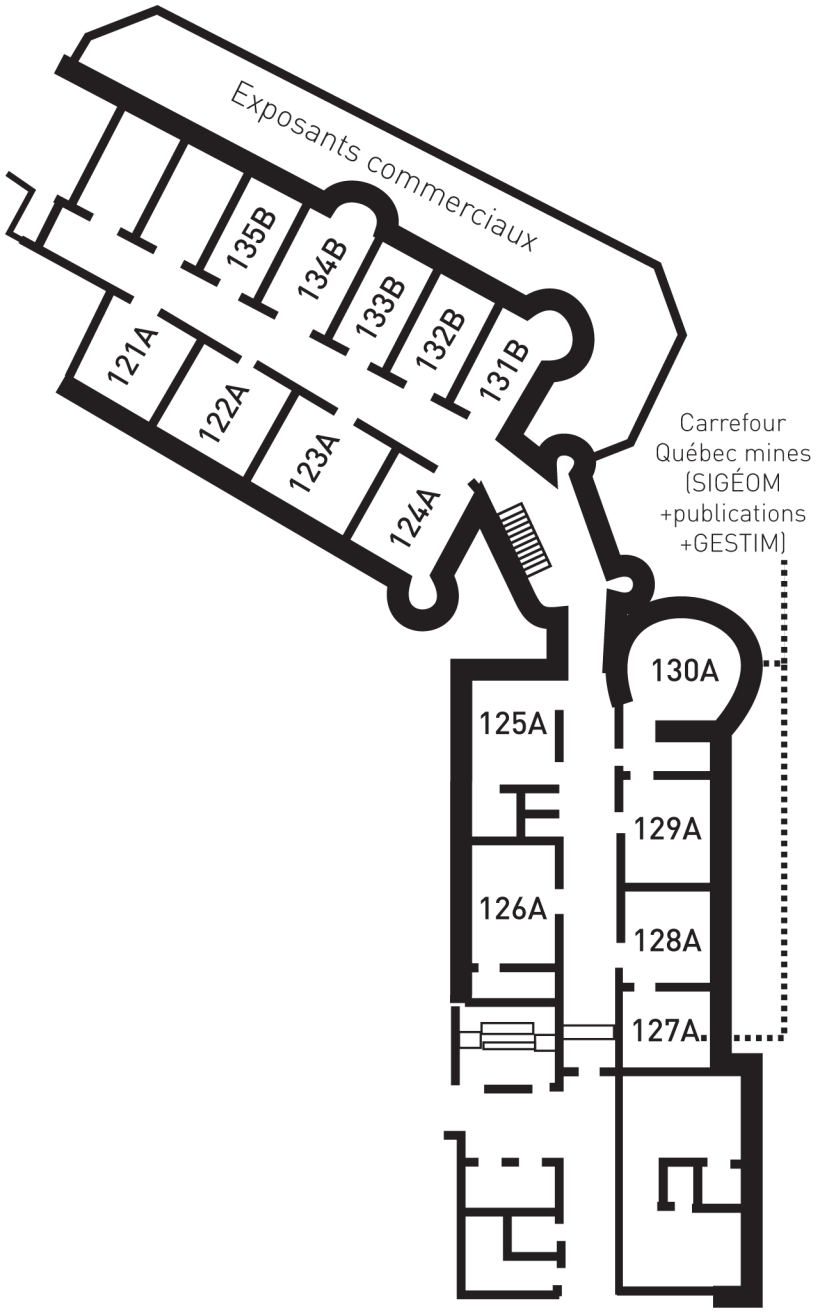
Place d'Armes
exposition commerciale

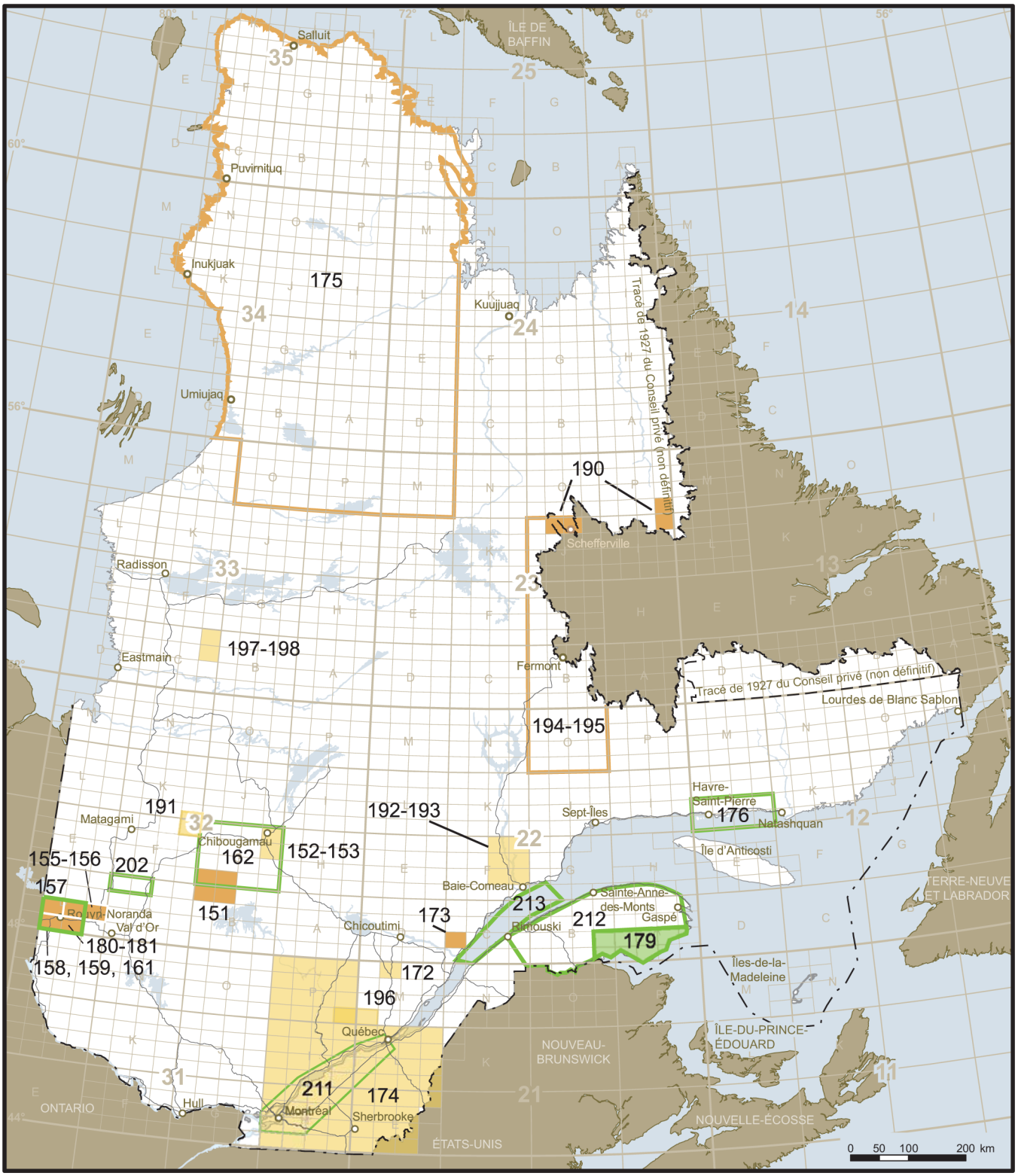


Jacques-Cartier
exposition gaz et pétrole



Booth 121 to 135 (suites 2201 to 2221)
exposition commerciale




Salluit
ÎLE DE BAFFIN
35
25
Puvirnituq
Inukjuak
175
34
Kuujjuaq
24
14
Tracé de 1927 du Conseil privé (non définitif)
Umiujaq
190
Schefferville
Radisson
33
23
13
Eastmain
197-198
Fermont
Tracé de 1927 du Conseil privé (non définitif)
Lourdes de Blanc Sablon
194-195
Havre-Saint-Pierre
176
Natashquan
191
192-193
Sept-Îles
12
Matagami
32
Chibougamau
152-153
22
155-156
202
162
157
Île d'Anticosti
Baie-Comeau
213
Sainte-Anne-des-Monts
151
212
Gaspé
Rouyn-Noranda
Val d'Or
Chicoutimi
173
Rimouski
179
180-181
158, 159, 161
172
Îles-de-la-Madeleine
196
Québec
NOUVEAU-BRUNSWICK
ÎLE-DU-PRINCE-ÉDOUARD
31
211
174
21
11
ONTARIO
Hull
Montréal
Sherbrooke
NOUVELLE-ÉCOSSE
ÉTATS-UNIS
0 50 100 200 km
Inventories
Studies
Geological Survey of Canada

