



Toward sustainable
mineral
exploration!

November 23 to 26, 2009

**ABSTRACTS OF ORAL PRESENTATIONS
AND POSTERS**



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PHOTOGRAPHS

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An Invitation from the Minister for Natural Resources and Wildlife

As the Minister for Natural Resources and Wildlife, I am very pleased to invite you to the 2009 edition of Québec Exploration, the annual mining exploration event that will be held this year under the theme “**Toward Sustainable Mining Exploration!**”

I am delighted that Québec Exploration has made sustainable development its theme for 2009. A few weeks ago, I released the Québec government mineral strategy, Preparing the Future of Québec's Mineral Sector, with the determination to make mineral development an example of sustainable, environmentally sound development that creates wealth and furthers social progress. It's the first time a government has developed a coordinated strategy to ensure the future of the mining sector and have it play an ongoing role in the prosperity of our communities and regions.

With the mineral strategy, we will develop mining initiatives to foster the discovery of new deposits and drive the industry forward to keep it competitive and attractive to young workers while clearing the way for the development of new mineral exploration and mining methods. This strategy is a key tool in the development of Northern Québec - a vast region brimming with resources that we intend to harness in compliance with the principles of sustainable development. We believe that mineral development can and must be something that benefits all Quebecers, and we are committed to ensuring that it is.

Québec Exploration 2009 will reflect the new ways in which various industry players are working together in order to ensure the mining sector's harmonious development.

Take advantage of this seventh edition of Québec Exploration to perfect your knowledge, forge new partnerships, and learn about the most recent developments in the mineral exploration sector.

Have a great conference!

Serge Simard

Minister for Natural Resources and Wildlife

An Invitation from the AEMQ President

Association de l'exploration minière du Québec (AEMQ) is happy to be associated with Ministère des Ressources naturelles et de la Faune du Québec in presenting the seventh edition of Québec Exploration. This year's theme, "**Toward Sustainable Mining Exploration**", accurately reflects the importance of mining exploration in our society. The role of mining companies is to ensure that mineral resources are renewed with a view to sustainable development. Québec is recognized for the abundance of its mineral resources, but finding and renewing them remains a major challenge for the industry, the government, and the communities concerned.

The objective of non-renewable resource management is to develop these resources in harmony with the environment, while maximizing the economic and social spinoffs to benefit local communities and future generations. At AEMQ, we believe we can reach this objective with the support of the communities affected by mineral development.

Around the world, the year 2009 got off to a rocky start with talk of bailout plans, recovery plans, stock market lows, financial scandals, and other bad news. Never before have financial headlines figured so prominently in the news. We may be inundated with bad news, but the mining sector remains optimistic with respect to recovery. Our industry is capable of weathering economic crises and the market cycles associated with them.

Despite these difficult economic times, there is still some good news: for the second year in a row, Québec was ranked highest of the world's 71 mining regions studied by (or included in a study by) the Fraser Institute. This outstanding ranking is thanks in part to Québec's mining policies, which are considered the best in the world, but also thanks to its mineral potential, which is the best in Canada and the second best in the world. The considerable progress the mining industry and various government ministries have made in the last 20 years has yielded a regulatory framework that is environmentally friendly, modern, strict, and well adapted to the situation in Québec. We have every reason to be very proud of Québec's performance.

We believe that Québec's mineral strategy and efforts to develop Northern Québec will help give Québec the tools it needs and set it apart in the way it is developing its territory while enabling it to continue to be a world leader in mineral exploration.

In conclusion, I strongly encourage you to take part in the many activities offered at Québec Exploration 2009 and would like to extend a special invitation to all AEMQ members to attend the annual general meeting, which will be held on Monday, November 23.

Ghislain Poirier

President of Association de l'exploration minière du Québec



An Invitation from the Honorary Chair of Québec Exploration 2009

As honorary chair, I am delighted to invite you to Québec Exploration 2009. Given that Québec is internationally known for its mineral potential and its highly favorable mineral exploration and development environment, this annual meeting is especially important. It has become a must for both geoscientists who work in the field and those who plan on exploring in Québec.

Once again this year, the organizers have put together a top-notch program based on the theme “**Toward Sustainable Mining Exploration**”. It highlights Québec’s mineral potential, the latest discoveries, the newest concepts and geoscientific data, and sustainable development. The program also offers numerous occasions to talk with colleagues and students or to reconnect with business partners.

Despite the difficult economic times and skittish investors, the fundamental factors that have helped spur the growing demand for metals and raw materials remain. It is therefore important to continue our efforts to bring to light the latest discoveries so we can promote them in the next bull market phase.

Québec Exploration 2009 is a one-of-a-kind opportunity to fill up on ideas, forge new partnerships, and put them to use to harvest the benefits in a more favorable environment.

I encourage you to come to Québec City this November and join the 2,000 others who are expected to attend. I look forward to the opportunity to meet you there!

François Robert

Chief Geologist, Barrick Gold Corporation



Abstracts of oral presentations and posters

ORAL PRESENTATIONS

Tuesday ■ November 24

- 8:15 Official opening of Québec Exploration 2009**
Ghislain Poirier, President of Association de l'exploration minière du Québec (AEMQ) and Robert Marquis, Executive Director of Géologie Québec (MRNF)
- 8:30 Géologie Québec, Moving Forward**
Robert Marquis, Executive Director of Géologie Québec (MRNF)

SESSION 1

New Frontiers and New Knowledge in Northern Québec and Labrador

Chairs: Sylvain Lacroix and Thomas Clark (MRNF)

- 8:50 Towards a Northern Plan: Geoscience Aspects**
Sylvain Lacroix and Robert Marquis (MRNF)
- 9:10 Mining and Exploration in Newfoundland & Labrador in 2009 - An Overview**
E Richard J. Wardle and David G.E. Liverman (Mines Branch, Natural Resources, Newfoundland and Labrador)
- 9:30 Chronology of Rifting and Nature of the Lithosphere of the Northeastern Superior Province in the Paleoproterozoic Era**
Charles Maurice (MRNF), Jean David (GEOTOP) and Don Francis (McGill University)
- 9:50 Summary of the Stratigraphic and Tectonic Evolution of Northern Québec in the Proterozoic Era**
Normand Goulet (UQAM)
- 10:10 New Geological Mapping East of Schefferville**
Jean Goutier, Hanafi Hammouche (MRNF), Claire Legoux (URSTM), Claude Dion (MRNF) and Laura Petrella (URSTM)
- 10:30 Geology and Mineralization in Labrador: New Developments**
E Andrew Kerr, Alana Hinchey and Lawson Dickson (Geological Survey of Newfoundland and Labrador, Department of Natural Resources)
- 10:50 Keynote speaker**
What are the Models for Uranium Deposits in Northern Québec and Labrador?
Michel CUNEY (Nancy-Université)
- 11:30 Nickel Potential in the Southern Portion of the Ungava Orogen in Québec**
E Jim Mungal (Univ. of Toronto) and Grant Arnold (Canadian Royalties)

SESSION 2

Mining Investment—What's In Store for 2010?

Chairs: Louis Morin (Investor Relations Consultant) and Jacques Bonneau (Mining Investment Consultant)

Partner:



- 1:30 Word of Welcome**
Michel Champagne (Sidex)
- 1:40 Mining Activity in Québec in 2008: Salient Statistics**
Raymond Beullac (Institut de la statistique du Québec) and Jean Désilets (MRNF)
- 2:20 Will China Live Up to Expectations in 2010?**
Martin Lefebvre (Fédération des caisses Desjardins)
- 2:40 Gold – A Safe Investment During an Economic Crisis?**
Éric Lemieux (Laurentian Bank Securities)
- 3:00 Keynote speaker**
E **David Coffin (HRA)**
- 3:20 Victor Gonclaves (ENE)**
- 3:40 Michael Berry**
- 4:00 Round Table**

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Conferences will be given in English

All talks are available with simultaneous translation.

Place: Salon Frontenac

Reruns: Salon Petit Frontenac

Wednesday ■ November 25

SESSION 3

New Developments in Gold Deposits

Chairs: Patrick Mercier-Langevin (GSC) and Claude Dion (MRNF)

Partner:



8:30

Keynote speaker

World-Class Gold Deposits in the Superior Province: Diversity of Styles, Chronology and Exploration Implications

Benoît Dubé (GSC), John Ayer (OGS), Jean-François Ravenelle (INRS-ETE), Vicki McNicoll, Patrick Mercier-Langevin (GSC), Kenneth Williamson (INRS-ETE, Goldcorp), Michel Malo (INRS-ETE), Dan Kontak (Laurentian University), Robert Creaser (University of Alberta), Valérie Bécu (GSC), Vladimir Ispolatov, Roger Bateman and Bruno Lafrance (Laurentian University)

9:15

Progress on the Westwood Advanced Exploration Project, Abitibi, Québec, from June 2008 to Present: Geology, Mineralization, Resource and Infrastructure

Nicole Houle, Claude Bernier, Armand Savoie, Patrice Simard (IAMGOLD), Patrick Mercier-Langevin (GSC) and Abhidheya Wright-Holfeld (INRS-ETE)

9:35

Canadian Malartic Gold Mineralization: Structure and 3D Modeling

Christian Beaulieu, Michel Jébrak (UQAM), Anthony Williams-Jones, Jim Clark (McGill University) and Robert Wares (Osisko)

9:55

Detour Lake – Discovery of a World-Class Gold Deposit in Ontario, Canada

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Gérald Panneton (Detour Gold Corp.), James P. Siddorn (SRK Consulting), Roger Aubertin and Pat Donovan (Detour Gold Corp.) - The talk will be given by Laurie Gaborit (Detour Gold Corp.)

10:15

The Meadowbank Gold Mine, Nunavut: Geology and Development

Eric Ramsay, Bruno Perron, Eric M. Lamontagne, Daniel Doucet and Joseph Hettinger (Agnico-Eagle Mines)

10:35

Characterization and $^{40}\text{Ar}/^{39}\text{Ar}$ Dating of Gold-Bearing Structures in the Val-d'Or Region, Abitibi: Preliminary Findings and Tectonic Implications

Alain Tremblay (UQAM), Jérémie Lemarchand (UQAM-Université de Rennes I), Gilles Ruffet (CNRS-Université de Rennes I) and Claude Gobeil (Alexis Minerals Corporation)

11:00

Keynote speaker

Greenstone Gold Exploration: A Major Company Perspective

François Robert (Barrick Gold Corporation)

SESSION 4

Industrial Minerals: At the Core of Québec's Mineral Diversification

Chairs: Jean-Yves Labbé (MRNF) and Serge Perreault (SOQUEM)

Partner:



1:20

Keynote speaker

Mineral Commodities and Industrial Minerals – Perspective

Normand Grégoire (GENIVAR)

2:00

Industrial Minerals in Québec: An Overview of Exploration and Mining Activities

N'Golo Togola and Germain Girard (MRNF)

2:20

Québec: Future Major Phosphorus Producer – The Lac à Paul Deposits

Nadège Tollari, Bernard Lapointe and Daniel Boulianne (Ressources d'Arianne)

2:40

Limestone Processing and Its Everyday Uses

Roch Bégin (Graymont (Qc))

3:00

Graphite and Timcal's Activities in Québec

Jean L'Heureux (Timcal Canada)

3:20

Heavy Rare Earth Signature: The Lure of the Kipawa Complex

Frédéric Fleury (Matamec Explorations), Patrice Barbe and Martin Demers (Aurizon Mines)

3:40

Resource Expansion at the Renard Diamond Project, Québec

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Matt Manson (Stornoway Diamond Corporation)

E

Conferences will be give in English

All talks are available with simultaneous translation.

Place: Salon Frontenac

Reruns: Salon Petit Frontenac

Thursday ■ November 26

SESSION 5

Evaluating Mineral Potential and Target Selection Methods: Recent Developments

Chairs: Daniel Lamothe (MRNF) and Denis Bois (UQAT)

Partner:



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|--------------|---|
| 9:00 | Recent and Future Developments in Mineral Potential Assessment in Québec
Daniel Lamothe (MRNF) |
| 9:20 | Enhancement of Geochemical Anomalies in Regional Lake Sediment Surveys: Examples in Québec and Labrador
Sylvain Trépanier (CONSOEM) |
| 9:40 | Distribution of Gold Deposits Along Archean Deformation Zones: Contribution of 3D Geomechanical Modeling
Olivier Rabeau (URSTM-UQAT), Marc-Olivier Titeux (CRPG), Michel Jébrak (UQAM), Jean-Jacques Royer, Alain Cheilletz and Guillaume Caumon (CRPG) |
| 10:00 | Generating Drilling Targets Using 3D Mineral Potential Modeling in GOCAD
Gervais Perron (Mira Geoscience) |
| 10:20 | The MRNF's Regional 3D Common-Earth Models on the Web
Francine Fallara, Olivier Rabeau, David Bouchard and Li Zhen Cheng (URSTM-UQAT) |
| 10:40 | Scott Lake: A New Lens Detected at 400 m with InfiniTEM®
Circé Malo Lalande (Abitibi Geophysics) |
| 11:00 | Soil Geochemistry in the Abitibi Supported by Partial/ Selective Extraction Methods
Charles Beaudry (IAMGOLD) |
| 11:20 | Evaluation of Mineral Potential Using IT: Challenges, Expectations and Examples
Michel Rheault (MIR Télédétection) |

SESSION 6

Sustainable Development and Responsible Exploration

Chairs: Marco Gagnon (Adventure Gold Inc.) and Pierre Verpaelt (MRNF)

Partner:



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|-------------|--|
| 1:30 | Keynote speaker
e3 Plus: A Framework for Responsible Exploration
Jon Baird and Brenda Dalglish (PDAC) |
| 2:00 | The Inevitable Shift to Sustainability
Jean-Sylvain Lebel (MRNF) |
| 2:30 | Québec's Mineral Strategy: Impact on the Industry of Upcoming Legislative Changes
Jean-Pierre Thomassin (AEMQ) and Jean-Claude Belles-Iles (AMQ) |
| 2:50 | Mineral Exploration and Protected Areas: Is Cohabitation Possible?
Luc Gratton, Adina-C. Georgescu and Antoine Brosseau-Wéry (MTP) |
| 3:10 | Exploration and Protection: A Winning Combination!
Édith van de Walle (MDDEP) |
| 3:30 | Canadian Malartic Project: A Mining Project in an Urban Setting
Jean-Sébastien David (Osisko Mining Corporation) |
| 3:50 | The Fonds Restor-Action Nunavik – A Success Story to Make the Industry Proud!
André Gaumont (Virginia Mines), Nancy Dea (Kativik Regional Government) and Denis Blackburn (MRNF) |



Conferences will be give in English

All talks are available with simultaneous translation.

Place: Salon Frontenac

Reruns: Salon Petit Frontenac

Session 1 ■ 8:50

Towards a Northern Plan: Geoscience Aspects

Sylvain Lacroix and Robert Marquis (MRNF)

Géologie Québec's mandate consists in acquiring, processing and disseminating geoscience knowledge on Québec's mineral resources, in order to assess and promote, in a sustainable development perspective, the mineral potential of regions. Through *the Act to establish a Mining Heritage Fund*, passed in June 2008, Géologie Québec expects to have an annual budget of \$7M in the future for the acquisition of new geoscience data, including an amount of \$5M specifically for geoscience work conducted on lands located north of the 49th parallel.

To prepare the very first geoscience component of the Northern Plan, the first step involved identifying the main priorities for geoscience knowledge acquisition in Northern Québec. Here are the main priorities identified to date, per type of work and per geological region:

- Complete the mapping coverage at 1/250,000 scale of areas not covered under the Far North Program, namely the Superior geological Province north of Radisson, between the 54th and 55th parallels, and the Churchill Province south of Ungava Bay;
- Complete the mapping coverage at 1/50,000 scale of the area covering the contact between the La Grande and Opinaca subprovinces, and LG-3 eastward in the Baie-James region;
- Improve the mapping coverage in the Grenville Province between Sept-Îles and Fermont;
- Cover a large part of the Baie-James region and the Eastern Churchill Province with aeromagnetic surveys, local spectrometer surveys, and eventually electromagnetic surveys, at the same level of quality and resolution as what is available in the Abitibi Subprovince;
- Complete the lake-bottom sediment geochemistry coverage in the Eastern Churchill and the Northeastern Grenville geological provinces.

This presentation of the geoscience component of the Northern Plan is intended to elicit comments from the various industry and regional stakeholders on the broad priorities identified during Québec Exploration 2009. Over the next five years, priorities and projected work will be continuously re-evaluated based on evolving budgets and geoscience knowledge, on the results obtained and the measured impact in terms of mineral exploration. Changes may be introduced during the planning and consultation process leading to the annual geoscience programming. Our geoscience work will continue to focus on the values of our organization, namely on partnerships between governments and with universities, as well as training the next generation.

Session 1 ■ 9:10

Mining and Exploration in Newfoundland & Labrador in 2009 - An Overview

Richard J. Wardle and David G.E. Liverman (Mines Branch, Natural Resources, Newfoundland and Labrador)

The mining industry in Newfoundland and Labrador produces more than a dozen mineral commodities that contribute to our economy and quality of life, including iron, nickel, copper, zinc, gold, as well as industrial minerals, aggregates and dimension stone.

The value of mineral shipments rose sixfold from 2004 to 2008 to culminate in a record \$4.65 billion. This was largely due to an increased value of nickel shipments from Voisey's Bay and a higher price for iron ore from western Labrador, but diversification of the minerals produced in the province due to new mine openings was also a contributing factor. Shipments in 2009 will be at a much reduced level of \$2.2 billion due to decreased production at several mines and a steep decline in commodity prices. However, this value will still be the fourth highest on record. Direct employment in the Newfoundland and Labrador mineral industry is projected at 4,128 person years for 2009, an increase of 115 over the 2008 estimate. The projected employment increase results chiefly from the start-up of construction at the Vale Inco nickel processing facility project at Long Harbour, which has offset reductions at other mines and in exploration. No new mines opened in 2009, but several projects are in advanced stages, including direct shipping iron ore in western Labrador, fluorspar on the Burin Peninsula and copper on the Baie Verte Peninsula.

Expenditures on mineral exploration and deposit appraisal, driven by surging commodity prices, rose 308% from 2005 to 2007-08 when record values of \$148-\$146 M were achieved. The current downturn in the economy is having a negative effect on exploration spending in 2009 with a forecast of \$58 million expenditure for 2009. Exploration in recent years was focused on Labrador, particularly for uranium. A combination of a three-year moratorium on uranium mine development instituted by the Nunatsiavut government, and the economic downturn, has led to a decrease in Labrador activity in 2009, with most exploration focused on a variety of projects in Newfoundland.

There are encouraging signs for 2010, with increased iron ore prices resulting in a rebound in western Labrador, and several promising exploration projects moving into the feasibility and environmental assessment stages.

Session 1 ■ 9:30

Chronology of Rifting and Nature of the Lithosphere of the Northeastern Superior Province in the Paleoproterozoic Era

Charles Maurice (MRNF), Jean David (GEOTOP) and Don Francis (McGill University)

Mafic (diabase) dyke swarms constitute ideal markers to reconstruct the history of crustal fracturing and investigate the nature of the underlying mantle. In the Northeastern Superior Province (NESP), these Paleoproterozoic (2.51 to 2.00 Ga) dykes are for the most part older than supracrustal rocks surrounding the NESP (2.04 to 1.88 Ga). Two swarms dated at 2.51 Ga, of similar composition and extent, do not have volcanic equivalents suggesting they represent the remains of aulacogens. Following a magmatic hiatus of 280 Ma, the northern part of the NESP experienced intrusion of numerous dykes between 2.23 and 2.20 Ga. The earliest dykes show enriched signatures ($\epsilon\text{Nd}_{(t)}$ $< +0.4$, $\text{La/Yb} > 4$), whereas younger more voluminous dykes are relatively depleted (2209-2199 Ma; $\epsilon\text{Nd}_{(t)}$ $> +1.4$, $\text{La/Yb} < 4$). The presence of the latter in the thinnest NESP lithosphere, which corresponds in part to juvenile crust in the Rivière Arnaud Terrane (RAT; $T_{\text{DM}} < 3.1$ Ga), may indicate the ascent of asthenospheric magma following delamination of the Archean lithospheric root. Younger dykes (2.17 Ga) with identical compositions constrain to the NE the extent of rifting of a neoformed lithosphere, simultaneously with the emplacement of the oldest basalts in the Labrador Trough. The youngest dykes in the NESP (2.15 to 2.00 Ga) occur in the southern part, in thicker lithosphere containing evolved crust of the Hudson Bay Terrane (HBT; $T_{\text{DM}} = 3.1\text{--}4.3$ Ga). The latter record fracturing prior to the emplacement of most of the supracrustal belts surrounding the NESP and share, with the earliest Richmond Gulf and Belcher Island basalts (ca. 2.03 Ga), enriched isotopic compositions ($\epsilon\text{Nd}_{(t)} = -1.5$ to -7) suggesting crustal assimilation. The gradual decrease in $\epsilon\text{Nd}_{(t)}$ values of these dykes over time implies increasing crustal assimilation, until the lithosphere disappeared along the cratonic margins, channelling the eruption at ca. 2.0 Ga of depleted basalts.

Major element compositions of RAT mafic dykes indicate that the latter are largely derived from melting of a lherzolitic mantle at ~1.5 GPa. Most of the HBT dykes require a similar source, although some of these dykes are derived from a deeper (~5 GPa) lherzolitic or pyroxenitic mantle, an Fe-rich mantle, or a harzburgitic mantle. The presence of these various types of dykes in the HBT reflects the heterogeneous nature of the lithospheric mantle and can be used to map its architecture in the Paleoproterozoic era.

Session 1 ■ 9:50

Summary of the Stratigraphic and Tectonic Evolution of Northern Québec in the Proterozoic Era

Normand Goulet (UQAM)

The structural and stratigraphic edifice of Proterozoic units in Northern Québec was essentially built during the Torngat Orogen to the east, the New Québec Orogen to the west, the Ungava Orogen to the north, and the Grenville Orogen to the south.

A simplified reconstruction of accretionary and collisional events during the Proterozoic may be summarized in three phases, characterized by:

- accretion of microcontinents during the 2.2-1.83 Ga interval;
- collision of the Superior and Nain provinces at about 1.83-1.78 Ga; and
- migration of deformation toward the southeast margin of Laurentia between 1.78 and 1.20 Ga, followed by the Grenvillian orogeny recycling this part of the Laurentian margin at ca. 1.20-1.00 Ga.

Within these tectonostratigraphic assemblages, Archean units were also recycled during the various orogenic events.

During the Paleoproterozoic, all three major orogens in Northern Québec are characterized by the presence of partially eroded thrust sheets. Klippes, occasionally with frontal and lateral ramps, southeast-verging in the Ungava Orogen, west-verging in New Québec thrust sheets (with extensive dextral shearing near the eastern edge), and doubly verging in the Torngat Orogen (as a result of transpressional collision, which produced extensive sinistral shearing). Also present in these orogens are autochthonous, parautochthonous and allochthonous zones.

In external zones, major décollement surfaces occur at the contact between Archean units and supracrustal units, or at the contact between the main lithological assemblages of Paleoproterozoic age. In internal zones, allochthonism incorporates Archean basement and transpression zones clearly outline orogenic border zones.

Stratigraphic correlations may be proposed between units of the Ungava Belt and the northern Labrador Trough, whereas platform sediments in the Torngat area possibly represent a continental margin that originally covered an extensive surface area.

Uranium occurrences (1790 Ma) recently discovered in the Torngats and associated with metamorphosed epicontinental platform sediments of the Paleoproterozoic Lake Harbour Group occur near Archean domes that underwent polyphase deformation. Uranium enrichment in this new metallogenic province may have benefited from the presence of anomalous U in the granitic Archean basement, which was presumably leached and deposited during the Paleoproterozoic in arkose and carbonate rocks. The uranium was subsequently remobilized by tectonic processes and/or metamorphic fluids.

Session 1 ■ 10:10

New Geological Mapping East of Schefferville

Jean Goutier, Hanafi Hammouche (MRNF), Claire Legouix (URSTM), Claude Dion (MRNF) and Laura Petrella (URSTM)

The Lac Merville area, located east of Schefferville, was the focus of a new geological revision field program in the summer of 2009 at 1/50,000 scale. NTS sheets covered by the MRNF this year are: 23P02 and 23P03, as well as the Québec portions of 23I10, 23I11, 23I14, and 23I15. This project to update geological maps was conducted within the scope of the geoscience component of the Northern Plan, in collaboration with the Department of Natural Resources of Newfoundland and Labrador. This work was also conducted in conjunction with the new federal Geo-mapping for Energy and Minerals (GEM) program. The main contribution from the GEM program to this project is the completion of a new aeromagnetic survey, an essential tool for the map revision. The survey was conducted along flight lines spaced at 250-m intervals.

The Lac Merville area is located in the southeastern Churchill geological Province. The latter comprises two major entities composed of Archean and Proterozoic rocks: the New Québec Orogen (NQO) and the Core Zone (CZ). These two entities are divided into zones and domains, which are, from west to east in the study area: the Rachel-Laporte Zone and the Kuujuaq and McKenzie River domains in the NQO, and the Crossroads, Orma and Zeni domains in the Core Zone. The regional metamorphic grade ranges from the middle amphibolite to the granulite facies.

The Rachel-Laporte Zone is composed of supracrustal rocks that are the metamorphosed equivalents of Proterozoic rocks in the Labrador Trough. The Kuujuaq (north) and McKenzie River (south) domains are composed of Archean gneisses, wedged between the two main entities in the extensive Lac Tudor Shear Zone (LTSZ). These gneisses probably represent a fragment of Superior craton detached during incipient rifting upon opening of the Labrador Trough. The Crossroads domain includes the Proterozoic De Pas Batholith as well as its orthogneissic country rocks to the east (Archean) and west. The lack of lithological heterogeneity in the LTSZ suggests the Crossroads domain is probably not allochthonous relative to the rocks further west. The Orma domain includes orthogneisses (Archean?) and Proterozoic granitic intrusions. The Zeni domain is very heterogeneous lithologically. This domain may have a distinct history from units further west. Areas with the best mineral potential include: amphibolites and gabbros in the Rachel-Laporte Zone, and a silicate-oxide-sulphide-facies iron formation in the Zeni domain.

Session 1 ■ 10:30

Geology and Mineralization in Labrador: New Developments

Andrew Kerr, Alana Hinchey and Lawson Dickson (Geological Survey of Newfoundland and Labrador, Department of Natural Resources)

Labrador became a nickel producer of global significance when mining commenced at Voisey's Bay in 2005. Magmatic sulphides are widespread in plutonic rocks of the Nain Plutonic Suite, and also in other Mesoproterozoic igneous suites. However, the intense exploration effort that followed the Voisey's Bay discovery was focused in a restricted area within 200 km of the site, and emphasized the near-surface environment. Mafic rocks elsewhere in Labrador remain largely unassessed for Ni-Cu-PGE deposits, despite some recent discoveries of interest. The last decade also saw a remarkable renaissance of uranium exploration, focused mostly within the previously defined Central Mineral Belt (CMB). The total uranium resource of the Central Mineral Belt has now increased fivefold over estimates made in the late 1970s. Uranium metallogenesis in Labrador is very diverse, including several styles of mineralization that make important contributions to global production elsewhere. As in the case of Ni-Cu deposits, the current exploration effort is geographically focused, and much of the territory remains to be systematically evaluated. Iron ore, long a cornerstone of the Labrador economy, has also rebounded. There is increasing interest in large, low-grade "taconite" resources, and new grassroots exploration in western Labrador, where prospective formations are widespread. The region is believed to also have significant potential for base metals, gold and uranium, so this renewed interest in iron ore may yet lead to unexpected destinations. Rare metals (Zr, Y, Be, REE) are also attracting much interest, notably around the Strange Lake deposit.

The Geological Survey of Newfoundland and Labrador (GSNL) is active across Labrador, and these activities are in part coordinated with the Geomapping for Energy and Minerals (GEM) strategy of Natural Resources Canada. Recent scientific initiatives include bedrock mapping programs in Paleoproterozoic and Mesoproterozoic basins and surrounding areas of the Central Mineral Belt and in northwestern Labrador. The latter is linked to high-resolution airborne geophysical surveys funded through the GEM program, and mapping programs in adjacent regions of Québec by le Ministère des Ressources Naturelles et de la Faune (MRNF). Associated metallogenic studies presently emphasize magmatic sulphides and uranium, with some work on other commodities, including gold and base metals. Systematic surficial geochemical surveys completed in several parts of Labrador complement these activities and also provide valuable new information to help focus exploration. In addition to these direct activities, ongoing compilation and integration of voluminous industry geophysical data provide a valuable resource important to both current geoscientific activities and future mineral exploration.

Session 1 ■ 10:50

What are the Models for Uranium Deposits in Northern Québec and Labrador?

Michel CUNEY (Nancy-Université)

Northern Québec and Labrador mainly consist of extensive Archean domains and Paleoproterozoic belts, at high metamorphic grades except for the New Québec Orogen. Maps showing uranium anomalies in lake-bottom sediments and aerial spectrometry in these regions show strong uranium enrichment over extensive areas. These domains represent uranium-rich source zones from which several mechanisms may have come into play to form economic concentrations. The most important sources are the high-potassium Archean to Paleoproterozoic granites, sediments and acidic volcanic rocks emplaced after 2.2 Ga on epicontinental platforms, and pegmatoids derived from their partial melting. In such settings, the following ore-forming processes may have operated:

(i) **syn-sedimentary with placer-type mechanical segregation**, <2.2 Ga (pre-orogénisation), although this type of basin is very poorly preserved in the region;

(ii) **hydrothermal-diagenetic with inter- or intra-formation redox control** in sandstones or carbonates >2.2 Ga, although these formations were metamorphosed at 1.8 Ga;

(iii) **hydrothermal metamorphic** in the weakly metamorphosed New Québec Orogen (Mistamisk-type);

(iv) **partial melting** of U-rich formations leading to the emplacement of the most commonly observed uranium occurrences in this domain, in the form of disseminated uraninite in pegmatoids, Rössing-type alaskites being the closest analogy, or in skarns (Mary Kathleen-type), although conditions conducive to economic-scale accumulations have yet to be found;

(v) **alkaline metasomatism**: the best example is the Michelin deposit, where alteration zones affect acidic volcanic rocks; this type of system is probably one of the most promising for this region;

(vi) **IOCG**: although some characteristics of this type of system are locally observed in the region, the exceptional character of the only known deposit of this type makes such a discovery highly improbable;

(vii) **hydrothermal diagenetic with redox control along the basement/basin unconformity**: this model may be applicable, but a better knowledge of the age and paleohydrology features of basins is required; intra-basement occurrences of this type located underneath now-eroded basins also represent potential exploration targets;

(viii) **hydrothermal associated with granites**: this is a promising model given the importance of available U sources, however known vein-type occurrences should be studied in order to establish genetic models and date ore-forming processes.

Session 2 ■ 1:40

Nickel Potential in the Southern Portion of the Ungava Orogen in Québec

James E. Mungall (University of Toronto) and W. Grant Arnold (Canadian Royalties)

The Paleoproterozoic Cape Smith fold belt hosts several economically significant deposits of Ni, Cu and platinum-group elements (PGE) that were emplaced within a passive margin sequence above thinned lithosphere of the Archean Superior Province of northern Québec. Very minor alkaline volcanism of unknown age accompanied the initial rifting event, followed by deposition of several km of clastic and chemical sediments of the Dumas Fm. At 2038 Ma ultramafic sills were emplaced within the Dumas Fm, while several km of tholeiitic basalt and intercalated clastic sediments of the Beuparlant Fm were emplaced at the seafloor. The monotonous flood basalts of the Beuparlant Fm and its ultramafic feeder sills are similar to modern tholeiitic ocean island basalts. They are impoverished in PGE and Cu, either reflecting extraction from a source mantle containing residual sulphide phases, or due to the segregation of sulphide liquids in a crustal magma chamber below the current level of exposure. No significant sulphide occurrences are known from these intrusions. After another hiatus marked by deposition of several km of siltstones of the Nuvilik Fm, the Raglan large igneous province (LIP) generated lavas of the Chukotat Group and coeval ultramafic intrusions of the Raglan Fm and the Expo Intrusive Suite. The parental magma of the Raglan LIP was a sulphide-undersaturated basaltic komatiite containing about 18 % MgO and 10 ppb each of Pt and Pd. Assimilation of metasediments of the Beuparlant and Nuvilik Fms caused the komatiitic magma to become saturated with sulphide liquid within the conduits that fed the eruption of the Chukotat Group lavas. Ultramafic dikes cut metasediments and lavas of the middle Beuparlant Fm, terminating downwards against the massive basalts of the lower Beuparlant Fm. These lower terminations served as collection sites for massive and net-textured bodies of magmatic sulphide, forming the Ivakkak, Vaillant, Mequillon and Tootoo deposits. Higher along the flanks of the dikes, the Expo Ungava, Mesamax NW and Allammaq deposits formed within sill-like apophyses of the main intrusions. The deposits of the Raglan camp formed at the highest structural levels of the system, in shallow subvolcanic intrusions of the Raglan Fm and perhaps also within deeply incised thermal erosion channels at the bases of komatiitic lavas in the Chukotat Group. There is high potential for further discoveries of PGE-rich Ni sulphides in ultramafic intrusions that served as feeders for either the Povungnituk or the Chukotat lavas.

Session 2 ■ 1:40

Mining Activity in Québec in 2008: Salient Statistics

Raymond Beullac (Institut de la statistique du Québec)
and Jean Désilets (MRNF)

The Institut de la statistique du Québec compiles complete data on mineral exploration and mining activities in Québec, with the participation of companies who fill out the questionnaires they are sent. Here are the main highlights for the year 2008.

The value of mineral shipments, which considerably increased in recent years largely due to rising prices for mined commodities, reached 5.2 billion dollars, a 6% drop relative to 2007. In Canada, this amount was up 11.7%, reaching 45.3 billion dollars. Mining investments on the other hand reached 1.9 billion dollars in Québec, an 18% increase.

Capital expenditures stood at 680 million dollars, up 52%, whereas exploration and deposit appraisal spending was down 9%, at about 435 million dollars. Exploration and deposit appraisal expenditures in Canada were 2.8 billion dollars, similar to 2007 spending levels. Junior companies are still responsible for the bulk of exploration and deposit appraisal expenditures in Québec, with 79%. Companies with their head office in Québec accounted for half of this amount. Incidentally, the cost per metre of exploration drilling increased by 169% from 2002 to 2008.

Reserve inventories for gold, copper, and nickel (in tonnes) improved in 2008, but declined for zinc.

Session 2 ■ 2:20

Will China Live Up to Expectations in 2010?

Martin Lefebvre (Fédération des caisses Desjardins)

China is back on track with solid growth buoyed by an important fiscal package. Is this the promise of a new dawn for commodity prices or are there much more adjustments needed to be made for global demand to pick up significantly? Is G7 central bank reflation working and will the economic recovery be strong enough to maintain the current renewed enthusiasm in the markets? Well, China's booming activity has certainly made a difference over the past few years, but it seems world fundamentals are not yet in place for a sustainable rise in commodity prices. Oil and base metals prices have rebounded from last year's extreme lows, helped in part by strong imports from China, but things already appear to be stretched out.

Session 2 ■ 2:40

Gold – A Safe Investment During an Economic Crisis?

Éric Lemieux (Laurentian Bank Securities)

For some time now, gold has attracted interest as an investment. Is it a safe haven? Opinions differ, but one thing is certain: gold has really shone during the current crisis. Despite a price drop in October and November of 2008 (US\$712.50/ounce on October 24, 2008), undoubtedly related to the massive repatriation of assets and the hedging of funds in the United States, gold began to rise at the end of 2008 and during 2009, which we believe restored its reputation as a safe haven. Gold maintained its value against several currencies during the collapse of the stock markets and there was a notable surge in its demand as an investment vehicle. No, the yellow metal did not explode towards US\$2,000/ounce, but this was not a sign of weakness, rather an indicator of stability that was reinforced after the drop in petroleum prices and the appreciation of the American dollar.

The symbolic level of US\$1,000/ounce was reached again in February and September of 2009, a level that we believe will serve as a springboard into the future and a solid price floor for years to come. We do not necessarily subscribe to the notion of gold breaking US\$2,000/ounce, as this would create micro-inflation within the mining industry, slashing profits. On the other hand, we emphasize that the supply of gold, notwithstanding recycling, has diminished in terms of mine production and sales by central banks. This decline in supply occurs in a context in which quality mineral deposits are increasingly rare. In addition, we believe that concerns about the possible return of inflation to industrialized countries will also sustain gold prices in years to come. Combined with the advent of China as an economic power and its growing gold reserve (and above all, its opinion about the importance of gold), the yellow metal will probably play an increasingly important monetary role that should sustain a minimum price floor of US\$600/ounce. We foresee gold prices remaining in the US\$800/ounce to US\$1,300/ounce range for 2010-2011.

Session 3 ■ 8:30

World-Class Gold Deposits in the Superior Province: Diversity of Styles, Chronology and Exploration Implications

Benoît Dubé (GSC), John Ayer (OGS), Jean-François Ravenelle (INRS-ETE), Vicki McNicoll, Patrick Mercier-Langevin (GSC), Kenneth Williamson (INRS-ETE, Goldcorp), Michel Malo (INRS-ETE), Dan Kontak (Laurentian University), Robert Creaser (University of Alberta), Valérie Bécu (GSC), Vladimir Ispolatov, Roger Bateman and Bruno Lafrance (Laurentian University)

The Superior Province has unique metallogenic credentials with a gold endowment of more than 350 million ounces. It hosts a significant number of giant and world-class Archean gold deposits of different styles and with variable alteration footprints. Some examples are presented here and some implications are discussed.

The LaRonde Penna gold-rich volcanogenic massive sulphide deposit was formed at 2698 Ma and represents a type example of a synvolcanic gold deposit. It is characterized by Zn-Au-Ag-Cu-Pb massive sulphide lenses and stringer zones associated with Mn-garnet and aluminous alteration assemblages. The Dome, Pamour and Hollinger-McIntyre gold deposits represent syn-deformation (late orogenic) greenstone-hosted quartz-carbonate vein systems that are located north of the Porcupine-Destor Fault. Dome is characterized by multistage hydrothermalism with low-grade crustiform carbonate veins formed between 2690-2674 Ma whereas the bulk of the mineralization is post-2673.9 ± 1.8 Ma, which is the age of a mineralized Timiskaming conglomerate. The Hollinger-McIntyre deposit contains Cu-Au-Ag-Mo mineralization but the bulk of the gold ore corresponds to quartz-carbonate veins that cut a 2672.8 ± 1.1 Ma albite dike, ruling out the genetic link to known 2690 Ma porphyry intrusions. The Campbell-Red Lake deposit is mainly characterized by high-grade arsenopyrite-rich ore zones hosted by silicified epizonal colloform-crustiform carbonate ± quartz veins and by altered Balmer basalt. The bulk of the mineralization is pre-2712 ± 2 Ma. However, a second stage of spectacular mineralization/remobilization is post-2702 ± 1 Ma, which is the age of gold-bearing lamprophyre. The Kirkland Lake deposit is a post-Timiskaming (2681-2668 Ma) epizonal deposit mainly hosted by syenites and characterized by syn-deformation high-grade gold-tellurium quartz veins filling brittle faults north of the Larder Lake-Cadillac Fault Zone. The deposit shares analogies with tellurium-rich syn-deformation gold deposits associated with alkaline magmatism.

The Upper Beaver deposit, currently reassessed, and the recently discovered Roberto deposit further illustrate the diversity of styles and settings of gold mineralizations in the Superior Province. The Upper Beaver deposit is characterized by magnetite-chalcopyrite-epidote-rich Cu-Au mineralizations associated with magnetite-sericite-feldspar-actinolite-epidote-tourmaline-carbonate-silica alteration zones and veins centred on a syenite complex. The relative chronology indicates that Upper Beaver is a structurally-controlled intrusion-related hydrothermal system that shares some analogy with the magnetite sub-group of the IOCG deposits. The Roberto deposit, James Bay, is a metamorphosed upper-greenschist to lower-amphibolite sediment-hosted Au-As-Sb-B deposit that is hosted by post-2675 Ma Timiskaming-age wackes, paragneisses and local high-grade quartz and quartz-feldspar veins. The deposit is spatially associated with several generations of pegmatites near the contact between the La Grande and the highly metamorphosed

Session 3 ■ 9:15

Progress on the Westwood Advanced Exploration Project, Abitibi, Québec, from June 2008 to Present: Geology, Mineralization, Resource and Infrastructure

Nicole Houle, Claude Bernier, Armand Savoie, Patrice Simard (IAMGOLD), Patrick Mercier-Langevin (GSC) and Abhidheya Wright-Holfeld (INRS-ETE)

Opinaca subprovinces. It shares some common attributes with amphibolite-grade greenstone-hosted Archean gold deposits and illustrates the gold potential of the northern part of the Superior Province and of the entire contact between the Opinaca and La Grande subprovinces. It also indicates that the contact between the sediment-dominated (English River, Quetico and Pontiac) and the volcanic-dominated (Uchi, Wabigoon and Wawa-Abitibi) subprovinces, may be underexplored.

The diversity of styles and timing of the world-class gold deposits of the Superior Province reflects variations in term of genesis, but more importantly it illustrates the need to use multiple models and sets of criteria when exploring for Archean gold deposits in deformed terranes. However, all these deposits are empirically associated with a major structure and/or a regional unconformity in greenstone belts and their associated clastic sediments. The major fault zones juxtaposed gold deposits of different types, formed at different crustal levels and at different times. The timing of the gold deposits relative to deformation and metamorphism has a major influence on their distribution, geometry, mineralogy and state of preservation. Complex geological settings including ore hosted by structures inherited from earlier favourable architecture, strain increment(s) or deformation event(s) as well as superimposed hydrothermal/mineralizing events are documented and may represent critical elements responsible for their exceptional gold content. The local "heritage" and provinciality (endowment) of a region or district, in addition to ore-forming processes, may also be a fundamental factor.

Although there are recurrent characteristics, the diversity of styles and the local specificity of each deposit, including its pressure-temperature evolution through time, partly explain the difficulty to reach consensus on a unified genetic model for Archean gold deposits.

The Westwood Project is located in the Doyon-Bousquet-LaRonde mining camp of northwestern Québec, about 2 km east of the Doyon Mine. The property is underlain by Archean volcanic and intrusive units of the Blake River Group, bordered by sedimentary rocks of the Kewagama and Cadillac groups. This mining camp hosts an estimated 25.5 M oz in gold all categories combined (production + *in situ*) (145 Mt at 5.49 g/t Au).

The detailed stratigraphy of the camp was defined through a collaborative effort involving mining companies, government agencies (GSC and MRNF) and universities. Local lithologies strike E-W and are steeply dipping to the south. Gold deposits belong to one of four main deposit types: 1) gold-rich VMS (LaRonde-Penna, Bousquet 2-Dumagami, Warrenmac); 2) veins, stockworks, and disseminated sulphides with Au ± Cu-Zn (Bousquet 1, Westwood, Ellison); 3) intrusion-related sulphide-rich Au-Cu epizonal vein systems (Doyon); and 4) shear-related sulphide-rich Au-Cu veins (Mouska, Mic Mac).

The ongoing exploration program began in 2002 when surface drill holes intersected significant gold intervals associated with the North Corridor and Westwood zones to the east of the Bousquet Fault. In 2004, a 2.6-km-long exploration drift was driven eastward from Doyon Mine infrastructure at 840-m depth (level 14). This drift, excavated to test favourable stratigraphy in the east part of the property, led to the discovery of the first ore lenses on the west side of the Bousquet Fault in 2006, and to the first resource estimation (Zone 2, North Corridor, Westwood). The subsequent scoping study (2007) came to the conclusion that better access was required to adequately test the lower portion of mineralized zones within an acceptable time frame.

IAMGOLD management thus decided to invest in the sinking of an exploration shaft. In parallel, a project to drive a ramp toward the Warrenmac massive sulphide lens, a development program to upgrade part of the resources, and a bulk sampling program in Zone 230 were approved and implemented. This work should also help confirm the orientation, continuity and grade of the structure, as well as optimize mining methods to be used.

The latest resource estimation (summer of 2009) is 3.4 M oz (cut-off grade of 6 g/t Au and 2 m true thickness). The presentation will include photographs illustrating how the work has progressed over the past year.

Session 3 ■ 9:35

Canadian Malartic Gold Mineralization: Structure and 3D Modeling

Christian Beaulieu, Michel Jébrak (UQAM), Anthony Williams-Jones, Jim Clark (McGill University) and Robert Wares (Osisko)

The Canadian Malartic mine (1935-1965) was largely mined for its high-grade gold zones developed in altered lenses of Pontiac greywacke or in quartz veins in unsilicified porphyry. Osisko Mining Corporation acquired the property a few years ago and has since then conducted assessment and development work in order to resume mining operations at Canadian Malartic, in an open pit. Following extensive drilling performed by Osisko, we now have the means to understand this major Archean gold deposit better, both in terms of 3D distribution of gold and associated alteration patterns, as well as the major structures controlling gold zones.

Brecciation constitutes an important control mechanism for gold mineralization in the Canadian Malartic deposit, although breccias are not evenly developed across the deposit. Three major breccia types are recognized, attesting to different phases in the genesis of Canadian Malartic. The first type is a chemical breccia with a biotite-calcite-pyrite $\pm$ silica matrix, with highly corroded clasts altered to silica and biotite. This type of breccia is enriched in Au-Ag-Bi-W. The second type is a breccia with a siliceous matrix; two crosscutting sub-types are observed. The earlier breccia, with greyish cryptocrystalline quartz, shows evidence of hydraulic fracturing, with angular, contiguous, weakly corroded clasts and a limited grain size distribution. This hydraulic breccia is cut by a later hydrothermal breccia, with coarser milky quartz and commonly corroded fragments. This second sub-type is the only type of breccia encountered in porphyry units; no hydraulic breccias were observed in the latter rock type. The last type of breccia is characterized by a carbonate-sericite-chlorite $\pm$ K-feldspar stockwork that shows no correlation with gold grades.

The geometry of the contact between the monzodioritic porphyry and Pontiac greywackes was established through 3D modeling of the ore deposit, along with the distribution of gold grades and the main alteration patterns in the Malartic mining camp, namely carbonate alteration (calcite), silicification, and pyritization. Modeling of these hydrothermal alteration patterns shows a very strong spatial association with the West Porphyry and its related structures. Further east of the ore deposit, gold and alteration are correlated with the porphyry contact and extend into the sediments along existing planes of weakness, bedding planes and faults.

Session 3 ■ 9:55

Detour Lake – Discovery of a World-Class Gold Deposit in Ontario, Canada

Gérald Panneton (Detour Gold Corp.), James P. Siddorn (SRK Consulting), Roger Aubertin and Pat Donovan (Detour Gold Corp.)*

The Detour Lake gold project is located in northeastern Ontario, approximately 300 km northeast of Timmins, within the northwestern portion of the Abitibi greenstone belt, Superior Province. Historically the Abitibi greenstone belt has produced approximately 150 million ounces of gold, largely from narrow-vein underground mining.

The Detour Lake project is a site of extensive past exploration since 1974, as well as underground and limited open pit mining activity (1983-1999), during which it produced 1.8 million ounces of gold. Underground mining focused on narrow-vein conventional shrinkage and mechanized longhole stoping. After acquiring the property, Detour Gold Corporation initiated a comprehensive drill campaign in January 2007 to define the potential for an open-pit gold high-tonnage resource.

Gold mineralization at Detour Lake is associated with a large-scale deformation zone (Sunday Lake Deformation Zone; "SLDZ") that occurs at the contact between 2.72 Ga Detour Lake Formation mafic metavolcanics and 2.69 Ga Porcupine Assemblage metasediments.

The bulk of the gold mineralization is associated with the Quartz Hanging Wall Zone of the SLDZ, a stockwork of auriferous quartz veins that splay from a flexure in the deformation zone. The Quartz Hanging Wall Zone forms a 200-350 m wide auriferous corridor extending 3 km along the strike of the mafic metavolcanic assemblage from surface to at least 1,000 m depth. The richest gold zones are commonly associated with quartz veins with strong biotite alteration and local zones of pyrrhotite-chalcopryrite-pyrite-gold enrichment formed during the deformation of the quartz vein system.

From 2007 to present, Detour Gold has completed over 300,000 m of diamond drilling. The pre-feasibility study completed in September 2009 defined an open pit mineral reserve of 8.8 million ounces of gold, which is Canada's largest undeveloped gold reserve. Detour Gold is continuing with a feasibility study and development of the project for a potential startup at the end of 2012.

* The talk will be given by Laurie Gaborit (Detour Gold Corp.)

Session 3 ■ 10:15

The Meadowbank Gold Mine, Nunavut: Geology and Development

Eric Ramsay, Bruno Perron, Eric M. Lamontagne, Daniel Doucet and Joseph Hettinger (Agnico-Eagle Mines)

The Meadowbank gold mine is located in the Kivalliq region of Nunavut, approximately 70 km north of the village of Baker Lake (109 km by all-weather road). The Meadowbank deposits were first investigated by Cumberland Resources in 1994, and subsequently acquired by Agnico-Eagle Mines in 2007. Since then, Agnico-Eagle Mines has done major exploration and drilling and as of January 2009, total reserves stood at 32.8 Mt grading 3.45 g Au/t, totalling 3.6 M oz of gold. Infrastructures, including a processing plant, a service building, a 500-men camp, an airstrip, dewatering dykes and support infrastructure, are being completed and production is scheduled for 2010. The mine is estimated to produce an average of 350,000 ounces of gold per year over a nine-year mine life from a number of open pits with a combined stripping ratio of 6.37-to-1 and an output of 3.1 Mt of ore per year. Ore processing will include gravity, cyanide leaching and carbon-in-pulp circuits.

The Meadowbank area is underlain by a series of Archean volcanic and sedimentary rocks forming the Woodburn Lake Group that is part of the Rae Subprovince of the Western Churchill Province. The mine includes three separate deposits, named Portage, Goose and Vault. Development is currently focused on Portage deposit. Both the Portage and Goose deposits are located close to one another and are hosted by a strongly folded sequence of banded iron formation lenses and intermediate volcanic rocks, whereas the Vault deposit is hosted in intermediate to felsic volcanic rocks, about 7 km NE of Portage and Goose.

Gold mineralization in the Portage and Goose deposits is spatially related to banded iron formation units and occurs in areas displaying replacement of magnetite-rich layers by pyrrhotite and/or pyrite and in quartz- and sulphide-filled fractures in and around iron formations. The best gold grades are clearly associated with the sulphides but there are no direct correlations with either pyrrhotite or pyrite abundance. The mineralization at Vault is rather characterized by highly strained lenses of disseminated pyrite in strongly sericitized and chloritized schists. The significant amount of pyrrhotite in both the ore and surrounding host rock requires on-going characterization to identify potentially acid-generating rock to allow for proper disposal.

The current interpretation for the formation of the Meadowbank deposit favours a syn-deformation introduction for the gold, with strongly folded magnetite-rich iron formations as preferential sinks and traps for the ore-bearing fluids. Current exploration and development by Agnico-Eagle Mines is focusing in and around the known deposits.

Session 3 ■ 10:35

Characterization and $^{40}\text{Ar}/^{39}\text{Ar}$ Dating of Gold-Bearing Structures in the Val-d'Or Region, Abitibi: Preliminary Findings and Tectonic Implications

Alain Tremblay (UQAM), Jérémie Lemarchand (UQAM-Université de Rennes I), Gilles Ruffet (CNRS-Université de Rennes I) and Claude Gobeil (Alexis Minerals Corporation)

U/Pb and $^{40}\text{Ar}/^{39}\text{Ar}$ ages measured in certain lode gold deposits in Val-d'Or and Malartic are variable and their interpretation is the subject of controversy. According to Powell *et al.* (1995), these gold deposits were emplaced in a diachronous fashion, between ~2620 and ~2590 Ma. Based on their relation with regional structures, Robert (1994) identified two types of lode deposits: (1) "early" quartz-carbonate-chlorite veins (>2696 Ma); and (2) "late" quartz-tourmaline veins (<2680 Ma). The latter are particularly abundant in the Bourlamaque Pluton, a synvolcanic intrusion with a U/Pb age of 2700 ± 1 Ma (Wong *et al.*, 1991). They are typically hosted in E-W-trending ductile shear zones that formed during structural and hydrothermal episodes coeval with the Cadillac Tectonic Zone, a major fault considered as a first-order structure that channelled gold-bearing fluids toward second- and third-order structures, the latter hosting the main veining systems. Our work indicates that many second-order structures are in fact "late" north-dipping faults that crosscut gold mineralization. The main faults identified to date in the Bourlamaque Pluton are: the "K" Zone and the Beaufor, Beacon, and Lac Herbin South faults.

The Bourlamaque Pluton forms an isotropic body of granular rock, an ideal site for an $^{40}\text{Ar}/^{39}\text{Ar}$ study on amphiboles and micas, where ages corresponding to crystallization, to mylonitic deformation associated with gold-bearing veins and/or "late" deformation, can be measured. More than 60 samples were collected for dating purposes. To date, 28 have been analyzed, including 15 from the Lac Herbin mine and 5 from the Beaufor mine. Amphibole grains from undeformed facies yielded crystallization ages of ~2690 Ma, coherent with the U/Pb age of the pluton. Results on muscovite grains from quartz veins and related mylonites at Beaufor and Lac Herbin are comparable and coherent with incremental development over several tens of million years. Muscovite grains from sheared veins yield ages ranging from 2610 to 2540 Ma, whereas those from the mylonitic host rocks yield high-temperature ages concordant with those of associated quartz veins, but show evidence of disturbance as late as 2515-2520 Ma, indicating that deformation continued after the peak of hydrothermal activity. These structural analysis and preliminary geochronology results suggest the need to review/update the typology of gold-bearing structures in the Val-d'Or area, and suggest that quartz-tourmaline veins are most likely not related to regional metamorphism and associated structures.

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Session 3 ■ 11:00

Greenstone Gold Exploration: A Major Company Perspective

François Robert (Barrick Gold Corporation)

Major gold producers have to find a very significant amount of gold every year in order to maintain and grow their reserve base. This requires a strategy focused on acquiring or finding giant deposits that can sustain high production rates over a long mine life. Exploration efforts must target the most prospective districts and be based on the best possible area selection criteria. The magnitude of the challenge is illustrated by the fact that there are only ~65 known deposits with >20 Moz, many of them mined out or sub-economic. The increasing exploration maturity and limited land access in well-established gold districts also present additional challenges.

Greenstone belts contain a large number of giant gold deposits and represent an attractive exploration environment for major companies, especially those in Archean cratons such as Superior (>300 Moz), Yilgarn (>325 Moz) or Eastern Congo (>90 Moz). Although small gold deposits and occurrences are widely distributed in the greenstone belts of these cratons, giant deposits are rare and cluster in specific camps, with the top 20% deposits containing 80% of the gold. In addition, the bulk of the gold is typically concentrated in one greenstone belt, for example in Southern Abitibi, which contains ~65% of all gold in Superior craton. Selecting the right greenstone belt and the right areas to explore within them is therefore critical to the discovery of new giant gold deposits. However, the distinguishing characteristics of the most prolific greenstone belts and camps remain somewhat elusive.

A comparison of greenstone belts and camps from Superior, Yilgarn and Eastern Congo cratons provides a few clues. The best-endowed belts follow long-lived crustal structures that influenced volcanism, coarse clastic sedimentation, and late-stage deformation, and that acted repeatedly as conduits for magma and hydrothermal fluids. These belts are also marked by a high preservation of supracrustal rocks and contain the youngest volcanic and sedimentary rocks of their host craton. The largest camps are marked by conglomeratic units and underlying angular unconformities, by clusters of porphyry intrusions, and by structural domes. Finally, the best-endowed belts and camps all contain different styles and ages of gold mineralization, resulting from syn-volcanic (sub-seafloor), syn-plutonic (magmatic-hydrothermal) and syn-orogenic (deformation-metamorphism) processes. The multiple overprinting processes that lead to the formation of significant gold deposits at these locations indicate an enhanced gold fertility perhaps reflecting a unique combination of fundamental crustal structure and composition of sub-crustal mantle.

Session 4 ■ 1:20

Mineral Commodities and Industrial Minerals – Perspective

Normand Grégoire (GENIVAR)

Mineral commodities and derivative products represent more than 90% of materials consumed by industrialized societies. Their consumption has grown by a factor of about 16 over the past century, compared with a factor of 4 for the population. North American demand (Canada and USA) is currently on the order of 3.7 billion tonnes per year (fuels not included); it represents nearly one third of global demand.

Most of these mineral-based materials have come into use only recently. Of all those consumed during the 20th century, half have been in use only in the past 25 years.

Of some 50 useful metals, only 5 account for nearly 98% of consumption. These metals include steel, aluminium, copper, lead, and zinc products. Steel products alone account for nearly 90% of the 142 Mt of metals consumed each year in North America.

Non-metallic minerals and their derivatives (sand, gravel, and crushed stone not included) are generally grouped in the category of industrial minerals. In the latter case, the same 98% of global consumption relies on the use of more than 20 out of 100 useful commodities in this category. North American demand for non-metallic mineral commodities amounts to more than 3.5 billion tonnes per year, including some 450 Mt for industrial minerals alone. Industrial mineral use has been growing at a much faster rate than metal use.

The following key figures illustrating variations in recent mining production reflect this trend:

1990-2008 Evolution:

- Metals (tonnes) - World: + 76.1%
- Industrial minerals (tonnes) - World: + 100.3%

1990-2008 Evolution:

- Metals (\$) - Canada: + 68%
- Non-metallic minerals (\$) - Canada: + 278%
- Industrial minerals (\$) - Canada: + 506%
- Metals (\$) - USA: + 122%
- Non-metallic minerals (\$) - USA: + 109%
- Industrial minerals (\$) - USA: + 97%

Trends in mineral commodity use and key market figures indicate supply restrictions for Canadian users and demonstrate the need to search for and develop mineral products.

A final look at the importance of international competition, and in particular on the quickly changing situation in China, will also provide the opportunity to comment on the importance of considering certain exploration plays or industrial mineral processing opportunities.

Session 4 ■ 2:00

Industrial Minerals in Québec: An Overview of Exploration and Mining Activities

N'golo Togola and Germain Girard (MRNF)

Industrial minerals produced in Québec in 2008 include chrysotile asbestos, ilmenite, graphite, mica, rock salt, brine, silica, limestone, dolomite, marble, shale, and peat.

Chrysotile asbestos is extracted in one mine in the Estrie region. Ilmenite is produced at the Lac Tio mine, north of Havre-Saint-Pierre. Flake graphite is mined at the Stratmin mine in Lac-des-Îles south of Mont-Laurier, and mica at the Lac Letondal mine in Suzor Township, northwest of La Tuque in the Mauricie region. Rock salt is extracted at the Seleine mine in the Îles-de-la-Madeleine, whereas brine is produced from five wells in the Bécancour area. Shales are quarried in the Montréal area and are used to manufacture bricks. The main sources of silica are: quartzite (five quarries), sandstone (four quarries), and natural sand (two operations). Limestone, dolomite and marble are mined for industrial purposes in more than 15 quarries. Peat is harvested from about 40 different sites located in the Bas-Saint-Laurent, Côte-Nord, and Saguenay-Lac-Saint-Jean regions.

Ongoing exploration work for industrial minerals is namely focused on diamonds, apatite, lithium, rare earth elements, aluminous clay, and peat. Several exploration projects are in the advanced stages: for diamond in the Otish area, for apatite in the Lac à Paul (Saguenay-Lac-Saint-Jean) and Sept-Îles (Côte-Nord) areas, for lithium in the Baie-James region, for graphite in the Lac Knife and Lac Guéret areas (Côte-Nord), and for aluminous clay near Grande-Vallée (Gaspésie). Inventory studies are also underway in peat-producing areas, in order to consolidate reserves.

Geological mapping programs conducted by the MRNF in the Mont-Laurier area from 1996 to 2004 led to the discovery of sillimanite and graphite occurrences associated with paragneiss units, of sillimanite and muscovite occurrences in diatexite, of garnet in amphibolite, and phlogopite and apatite in ultrapotassic alkaline rocks. Recent geological mapping conducted by the MRNF in the Labrieville, Baie-Comeau and Baie-Trinité areas led to the discovery of apatite, ilmenite and magnetite showings associated with gabbro-norites, as well as quartzite and sillimanite occurrences associated with paragneiss units.

Session 4 ■ 2:20

Québec: Future Major Phosphorus Producer – The Lac à Paul Deposits

Nadège Tollari, Bernard Lapointe and Daniel Boulianne (Ressources d'Arianne)

The primary interest of phosphate-rich rocks, of which more than 85% of global production is used for agricultural purposes, lies in the fact that phosphorous is absolutely necessary for the growth of all plants, whether cultivated or in the wild.

Canada currently has only one phosphorus-producing mine (Agrim in Kapuskasing); activities at this mine should gradually decrease and eventually cease completely around 2017. If Canada hopes to remain relatively self-reliant in terms of its fertilizer and agricultural needs (and thus of its food sources), new deposits must be brought into production. Two of the major projects currently in the development phase are located in Québec, namely a project by Soquem in Sept-Îles and Ressources d'Arianne's project in Lac à Paul.

Phosphorous deposits in Lac à Paul are located in the north part of the Saguenay-Lac-Saint-Jean anorthositic Complex in Québec. Although some of these deposits have been held by Ressources d'Arianne for 10 years, the growing demand for phosphate-rich rocks in recent years has prompted the company to reassess its holdings. The selling price for phosphate concentrate has increased by CAN\$55/t, reaching CAN\$440/t in 2007-2008; it currently stands at about CAN\$150/t despite the current economic downturn. This price increase is essentially caused by:

- Escalating demand for global food production;
- A strong increase in biofuel plantations and crops;
- Rising demand from China and the end of its exports.

A NI 43-101 report filed in the spring of 2009 indicates a resource of 304 Mt at 6.8% P_2O_5 and 7.81% TiO_2 (cut-off grade at 2% P_2O_5). Ore concentration tests indicate a recovery rate of nearly 90% for apatite, and production of a concentrate ranging from 38.6 to 39.9% P_2O_5 . This is markedly higher-grade than concentrates currently available on the market, which grade about 30% P_2O_5 on average (igneous and sedimentary deposits combined). Previous tests on titanium indicate that it is also possible to produce an ilmenite concentrate grading 45% TiO_2 at a recovery rate of more than 50%. Titanium thus constitutes a significant added value for this deposit.

Exploration work conducted in the summer of 2009 revealed other areas enriched in phosphorous and titanium. The fall drilling program should result in an expanded resource for the area. Finally, a Preliminary Assessment Report will examine some of the economic parameters of the project in the fall of 2009.

Session 4 ■ 2:40

Limestone Processing and Its Everyday Uses

Roch Bégin (Graymont (Qc))

Throughout the years, lime has played a large part in our everyday life.

The processing of high-quality limestone in the Estrie region started as far back as 185 years ago.

Since then, Graymont has modernized its plant using state-of-the-art technology, in order to stay competitive on the North American market.

We will follow the path taken by the stone, from its formation to its uses in different markets.

Graymont has a rich history but is also paving the future by using different operating technologies and staying focused on its objective to produce quality quicklime in sufficient quantity, within a market that continues to grow even today.

Session 4 ■ 3:00

Graphite and Timcal's Activities in Québec

Jean L'Heureux (Timcal Canada)

Natural graphite is a mineral with a long history. Used as early as the 16th century, new applications are still discovered today, some in very high-tech fields.

Like diamond, graphite is composed exclusively of carbon and shares the same origin. The main difference between the two minerals lies in their atomic structure. The structure of graphite, which could be compared to a deck of cards, is what gives the mineral its unique properties: high thermal and electrical conductivity, lubricant, very high chemical stability, water repellent, etc. These properties are the reason why graphite is so useful in a wide range of extremely diverse applications.

Natural graphite occurs in disseminated deposits throughout the world. However, only a few of the latter have what it takes to make a profitable mining operation. The Lac-des-Îles graphite deposit is in fact the only one currently in operation in North America.

In Québec, Timcal owns and operates two industrial facilities: the Lac-des-Îles mine near Mont-Laurier in the Laurentians, and a natural graphite processing plant in Terrebonne, north of Montréal. Timcal also has five other plants throughout the world: in Switzerland, Belgium, China (2) and Japan.

At Lac-des-Îles, graphite ore is extracted from an open pit mine then liberated by milling and separated by flotation. The end product, a concentrate reaching up to 98% pure graphite, is either sold as is or sent to another Timcal plant for further processing.

The Terrebonne plant performs two main operations. The primary activity consists in exfoliating then grinding chemically treated (purified and intercalated) natural graphite. The secondary activity consists in grinding non-chemically treated natural graphite.

Unprocessed natural graphite is used in the refractory industry, to manufacture expanded graphite sheets, in brake pads, lubricants, etc. Ground graphite is used in powder metallurgy, in pencils and in lubricants. Finally, exfoliated natural graphite is one of the best conductive additives for alkaline batteries; it can also be used as a heat-conductive additive in plastics.

Session 4 ■ 3:20

**Heavy Rare Earth Signature:
The Lure of the Kipawa Complex**

Frédéric Fleury (Matamec Explorations), Patrice Barbe
and Martin Demers (Aurizon Mines)

Matamec and Aurizon Mines own mining properties that cover most of the Kipawa Alkaline Complex (1033 ± 3 Ma), located in the south part of the Témiscamingue region in Québec, about 270 km northwest of Ottawa. This intrusive complex is known for its Y-Zr-REE (rare earth elements) occurrences and minor Th-U occurrences. It forms a thin sheet, a few tens to hundreds of metres thick, within a shallowly dipping thrust sheet. Surrounding country rocks, at high metamorphic grade, show evidence of metasomatism along the margins of the alkaline complex. Exploration work conducted in the past three years has resulted in the development of the Kipawa Y-REE deposit (Matamec) and the discovery of new showings (Matamec and Aurizon Mines). All of these occurrences are characterized by enriched heavy REE signatures.

In the north part of the complex, the Eagle and Snake showings (Aurizon) were discovered 11 km and 19 km respectively from the Kipawa deposit. Reconnaissance work identified mineralization associated with Na-amphibole and biotite replacement zones at the contact or directly within the syenite. The best prospecting results graded 9.65% light rare earth oxides (REO), 0.28% heavy REO, and 0.44% Y_2O_3 . These new discoveries illustrate the significant recurrence of REE concentrations along the entire contact zone with the intrusive complex.

In the south part of the complex, the Kipawa deposit (Matamec) is hosted in Al-depleted syenites (agpaitic) and skarns. Vertically, the deposit is subdivided into three broad zones: (1) a eudialyte-rich zone at the structural top, underlain by (2) a zone dominated by yttrio-titanite and mosandrite, and (3) a basal zone of britholite-rich skarn. The deposit contains well crystallized grains that are easily separated. The REE distribution in the deposit is strongly enhanced in heavy REE relative to the main deposits currently in production worldwide. Moreover, Matamec recently channel-sampled four historical previously-sampled trenches to provide a more complete portrait of the spatial distribution of all REE (best interval: 33 m grading 1.09% light REO, 0.27% heavy REO, and 0.27% Y_2O_3).

Future work will include definition drilling of the Kipawa deposit (Matamec) and of the various REE showings (Aurizon and Matamec), and a potential assessment study for gold within the intrusive complex and its metasomatized country rocks (Aurizon).

Session 4 ■ 3:40

**Resource Expansion at the Renard Diamond Project,
Québec**

Matt Manson (Stornoway Diamond Corporation)

The Renard Diamond Project, located in the James Bay region of north-central Québec, is a 50:50 joint venture between Stornoway Diamond Corporation and SOQUEM. In December 2008 Stornoway released the first formal National Instrument ("NI") 43-101 Mineral Resource Statement for the project and a Preliminary Economic Assessment. At that time, the project was shown to have a 7-year mine life with a 14.2% pre-tax IRR based on an Indicated Mineral Resource of 7.0 million carats and an Inferred Mineral Resource of 4.5 million carats. The conceptual mine plan, prepared by Agnico-Eagle Mines, included a combined open pit and underground mine with a 560-m deep ramp for a total capital cost of \$308 million (including contingency), a blended all-in operating cost of \$50.35/tonne and a processing capacity of 1.3 million tonnes a year.

Starting in January 2009, Stornoway and SOQUEM initiated a drill program targeted at upside tonnage in the Renard 2 and Renard 3 kimberlites within the scope of the existing mine plan, with the aim of extending the mine life of the project and improving the project economics. In March 2009 Stornoway reported that a large amount of new kimberlite had been intersected at depth in Renard 2, the body that provided the bulk of the mineable tonnage in the conceptual mine plan. Renard 2 had previously been estimated to contain 3.4 million tonnes (Indicated) at an average grade of 81 carats per hundred tonnes ("cpht") and 1.8 million tonnes (Inferred) at 86 cpht. The new drilling reported in March supported a better constrained geological model for Renard 2, with a potential mineral deposit estimated at between 10.5 and 12.3 million tonnes to 712 metres below surface, a substantial increase over the previous estimate.

At time of writing, a 9,500-metre delineation drill program is ongoing in support of a revised mineral resource statement due later in the fall. A revised mineral economic assessment will follow thereafter. The growing scale of the Renard Diamond Project, taken together with the Québec government's recent announcement of major capital funding for the regional Route 167 Extension project, confirms it as one of the best undeveloped diamond projects in the world. A review is given of the exploration work on the project to date, a potential development schedule, and the implications for further resource expansion opportunities given the new Renard 2 discoveries.

Session 5 ■ 9:00

Recent and Future Developments in Mineral Potential Assessment in Québec

Daniel Lamothe (MRNF)

A brief overview of the MRNF's mineral potential assessment program provides an opportunity to measure its benefits. Since 2005, the MPMPs has generated more than 400 mineral potential maps covering the Abitibi and Baie-James regions. Analysis of 3 metallogenic models applied to these regions has generated 844 targets, on which nearly 4,050 mining claims have been recorded since their publication. The predominance of certain companies in the acquisition of published targets shows that this tool has now been integrated into corporate exploration strategies. Reported exploration spending figures show that at least \$2.5M have been invested on these claims from 2005 to 2007, whereas MRNF production costs for the potential assessment studies amount to about \$300K.

The MPMPs must now tackle three broad objectives: 1) take part in the land use planning process, by providing province-wide strategic products that will contribute in protecting mineral potential; 2) assess the mineral potential of the New Québec Orogen using methodologies already tried and tested in the Abitibi and Baie-James regions; and 3) assess the uranium potential of Québec, considering the growing demand worldwide for this strategically important commodity in reducing carbon emissions.

To reach the first stated objective, a set of maps showing concentrations in surficial sediments were generated for the 15 following elements: Ag, As, Au, Ce, Cr, Co, Cu, La, Li, Mo, Ni, Th, U, W and Zn. The database used to produce the maps includes, in addition to data from previous years, more than 50,000 ICP-MS results from new surveys and re-analyses conducted by the MRNF in 2008-2009. The maps were generated using the ModelBuilder modules in ArcGIS, making it possible to automate spatial analysis and integration processing steps. In the selected procedure, the different sample types (lake sediment, stream sediment, till, soil) are extracted separately, and raw values and their percentile equivalent for the selected element are interpolated by the natural neighbour method. A distance buffer, established based on the estimated mobility of the element and the type of sample, is then applied. Grades are recalculated into natural log values and the resulting image is sequentially cut into 25 portions corresponding to: 2 geological provinces (Appalachians, Saint Lawrence Lowlands), 4 Churchill subprovinces, 13 Superior subprovinces, and 6 lithological assemblages in the Grenville Province. Populations in each portion are then separated into 25 classes using the natural breaks method and eventually recombined at the end of the process.

For each element, two types of targets are proposed: 1) target areas for certain geological subdivisions where it was possible to measure the spatial association of higher-value natural breaks classes with known deposits containing the element of interest; and 2) isolated targets calculated using the spatial regression method developed by Sylvain Trépanier of CONSOREM.

Session 5 ■ 9:20

Enhancement of Geochemical Anomalies in Regional Lake Sediment Surveys: Examples in Québec and Labrador

Sylvain Trépanier (CONSOREM)

There are many different methods to delineate geochemical anomalies that can be applied to regional lake sediment surveys. The simplest methods are based on non-spatial univariate statistics. Other more complex methods take into account spatial or multivariate aspects of the data and are generally better able to distinguish anomalies associated with mineral occurrences.

The selection of a simple vs complex method to delineate anomalies depends, conceptually, on the ratio between the signal caused by anomalies and the geochemical background. This signal-to-noise ratio varies according to the chemical element, the sampled medium, and the study area.

The signal-to-noise ratio of an element in lake sediments may be quantified using the following formula: 99.5 percentile/ (difference between the 10th and the 90th percentile). In lake sediment survey # 1997520, calculations indicate that Au, As and U show the highest ratios (>20). Consequently, these elements are most likely to generate easily identifiable anomalies using simple processing methods in lake sediments within the study area. Base metals such as Ni, Cu, Pb and Zn show much lower signal-to-noise ratios, between 4 and 6, which suggests that for these elements, signal enhancement is required.

A study of regional lake sediment surveys covering three major deposits in Northern Québec and Labrador supports these conclusions. The arsenic signal around the Roberto Au-As deposit is very clear and simple, univariate statistics are sufficient in this case. Simple univariate statistics are however unable to clearly detect Ni-Cu anomalies near the Voisey's Bay deposit in Labrador, or Cu anomalies near the Coulon Zn-Cu-Pb deposit in Québec. At Coulon however, a Zn anomaly is fairly obvious (55th Zn value out of 25,446 samples).

Using the residual values of geographically-weighted regression makes it much easier to detect anomalies associated with Coulon and Voisey's Bay. Ni-Cu anomalies become quite apparent near Voisey's Bay. The Zn anomaly already visible in unprocessed values at Coulon is markedly enhanced by processing, and a Cu anomaly becomes quite obvious. These results outline the importance of using an effective method to enhance anomalies for metals of interest characterized by weak signal-to-noise ratios.

Session 5 ■ 9:40

**Distribution of Gold Deposits
Along Archean Deformation Zones:
Contribution of 3D Geomechanical Modeling**

Olivier Rabeau (URSTM-UQAT), Marc-Olivier Titeux (CRPG),
Michel Jébrak (UQAM), Jean-Jacques Royer, Alain Cheilletz
and Guillaume Caumon (CRPG)

The purpose of this study is to delineate zones showing enhanced structural permeability during a deformation episode coeval with the emplacement of orogenic gold deposits. In an environment where fluids are overpressurized during deformation, dilation zones may represent potential conduits where mineralizing fluids are channelled.

In order to delineate dilation zones, a geomechanical model was built on a selected segment of the Cadillac-Larder Lake Fault, within an area of about 11 x 7 x 1 km, using a finite element code integrated in Gocad geomodeling software. Deformation is reproduced by attributing movement vectors to each structural discontinuity. The selected code takes into account lithological heterogeneities as well as the rheological properties of rocks. Dilation is then calculated based on the variation of volumes within the model.

Structural permeability zones are then compared with the location of known mineral occurrences and fluid circulation zones.

Session 5 ■ 10:00

**Generating Drilling Targets Using 3D Mineral Potential
Modeling in GOCAD**

Gervais Perron (Mira Geoscience)

Mineral Potential Modeling (MPM) is increasingly used in the planning of mineral exploration programs. The basis for this quantitative multidisciplinary integration method is directly related to specific metallogenic models. In most cases, MPM is applied in a regional setting and essentially uses 2D surface data.

In Québec, with the publication of a series of mineral potential maps by the MRNF, regional MPM provides direct support for the staking of mining claims by exploration companies. However, the transition from a regional scale to the scale of a mining camp or a mine almost inevitably requires a transition to 3D. With the addition of drilling data, the geological framework becomes more complex, and the delineation of drilling targets takes place in a 3D setting. We propose an approach inspired by the basic notions applied in 2D MPM, but adapted to the 3D reality inherent to an exploration setting at a more local scale. The addition of a third dimension has direct implications on the use of geophysical, geochemical and drilling data in mineral potential modeling.

Moreover, a software platform was developed in the form of a GOCAD module, to provide the geoscience community with the tools needed to implement 3D MPM. Thus, it is now possible to generate drill targets based on a multidisciplinary approach and in doing so, to reduce the risk associated with targets defined using a single criterion.

An example is presented, where the proposed method is applied in a geological setting associated with volcanic massive sulphides in the Central Camp. Drilling targets, defined using six exploration criteria and combined using a knowledge-driven approach, were generated and ranked in order of priority using the Targeting Workflow module in GOCAD. Because it is so intimately linked with the emplacement setting of the selected type of ore deposit, MPM can be applied to all commodities, and contrary to popular belief, it does not necessarily require a high density of data.

Session 5 ■ 10:20

The MRNF's Regional 3D Common-Earth Models on the Web

Francine Fallara, Olivier Rabeau, David Bouchard and Li Zhen Cheng (URSTM-UQAT)

The Unité de recherche et de service en technologie minérale (URSTM) has been developing 3D geological modeling since January 2000. It has produced, on behalf of the MRNF, a number of 3D metallogenic syntheses at the scale of a mining camp, namely for the Joutel, Porcupine-Destor, Doyon-Bousquet-LaRonde, Urban-Barry, Grenville Front, Western Cadillac Fault and Chibougamau areas. Building these models using the gOcad® platform enabled us to:

1. Optimize the use of geological data in the study areas;
2. Generate exploration targets at very little cost for MRNF clients;
3. Add to the geological knowledge base; and
4. Lead to a deeper understanding of metallogenic settings.

A 3D common-earth model is a dynamic exploration tool that can be queried using various proposed criteria, and that can provide a better understanding of the geometry or spatial relations between various geoscientific properties. The construction and use of 3D common-earth models requires highly specialized and often costly software, experienced and well-trained users, and powerful computers. Also, viewing or sharing a queryable model was, until now, practically impossible without purchasing a viewer, which is hardly applicable for widespread use of models.

In this perspective, the URSTM developed, under the MRNF 2007-2008 programming, version 1.0 of a viewer for 3D geological models, available on the Internet through the *Explorer* browser. In 2008-2009, following a series of consultations with MRNF and industry geologists, the WEB-3D viewer was made more user-friendly, making it possible to optimize the use of 3D common-earth models available at the MRNF. Finally, since March of 2009, four 3D common-earth models from the MRNF are available online using the WEB-3D viewer (<http://www.3dgeoviewer.com/>), namely the Joutel, Porcupine-Destor, Urban-Barry, and Chibougamau models. This tool now makes it possible to access 3D common-earth models at any time, from any where, to view and to query the models.

Eventually, the URSTM would like to generalize the functionalities of the viewer to all of the 3D models available at the MRNF and also introduce new functionalities, namely to be able to build more complex combined queries, to add new public data, and to allow users to integrate their own data.

Session 5 ■ 10:40

Scott Lake: A New Lens Detected at 400 m with InfiniTEM®

Circé Malo Lalande (Abitibi Geophysics)

In late 2008, Cogitore Resources discovered a new volcano-genic massive sulphide (VMS) deposit (West Lens) on its Scott Lake property located in the vicinity of Chibougamau (Québec). The West Lens has been found at a depth of more than 400 m and is an excellent case history of successful combination of clever geological analysis and optimized geophysical application.

The Scott Lake project is another great example of the contribution of geophysics to VMS discovery. Regional airborne Mag and TEM (Time domain electromagnetism) surveys were used to map key geological contacts and to investigate the top first hundred metres of the property. Ground TEM surveys were then carried out to detect deeply buried conductors throughout the property. The selection of the InfiniTEM® configuration was key to the discoveries. A test over a shallower lens, Central Lens buried at 200 m, has confirmed that the coupling between the primary electromagnetic field and the targeted conductor has to be optimal in order to get a response, especially for weakly to moderately conductive targets. Follow-up drilling on the most promising geological area, coincident with an InfiniTEM® anomaly led to the intersection of large and new massive zinc and copper-rich mineralized zones (West Lens, Central Lens extension and 1750 Lens). At that stage, borehole TEM is the ideal tool to confirm the boundaries or possible extensions of sulphide lenses. Indeed, borehole TEM results have closed the upper limit of West Lens at 400 m depth, indicating that this massive sulphide body never reached surface and has not been eroded at all.

Session 5 ■ 11:00

Soil Geochemistry in the Abitibi Supported by Partial/Selective Extraction Methods

Charles Beaudry (IAMGOLD)

Soil geochemistry in the Abitibi is very difficult due to the transported nature of unconsolidated deposits covering the bedrock. Basal tills that could contain trains of mineralized material are often quite complex to interpret and are invariably overlain by ablation till, sand and gravel, and in the western Abitibi, by several metres of impermeable glaciolacustrine clay, all of these exogenous materials that mask practically any type of geochemical signal from the bedrock. In this setting, it is quite doubtful that a metalliferous deposit can generate a geochemical response at surface. But now, recent research conducted by CAMIRO in cooperation with the governments of Canada and Ontario (OMET) as well as research done by Xstrata Canada, confirm that not only do partial/selective extraction anomalies exist, but also that pH anomalies on surface are commonly observed above sulphide lenses or ultrabasic bodies covered by these deposits. The method, although not perfect, can in ideal conditions, make a distinction between sulphide conductors and graphite conductors, and between ultrabasic rocks and iron formations. Nonetheless, several problems must be resolved in order to minimize false anomalies. The level of response in partial/selective extraction methods is extremely variable depending on the soil type and condition. For example, organic soils, given their reducing nature, tend to concentrate metals, whereas in mineral soils, metals are naturally leached from the B horizon. This results in very different background levels for the two settings, and our interpretation must take this into account. Also, the grade of many elements in partial/selective extraction analyses is strongly influenced by the concentration of certain metals such as iron or manganese that are fairly abundant in soils, and are also influenced by the pH level. On the other hand, a lower pH may be due to oxidation of H^+ ions in the surficial zone, ions that may be derived from the bedrock as a result of the oxidation of sulphides or ultrabasic minerals, a classic electrochemical principle. Finally, the ICP-MS analytical method with its ultra-low detection limits, required to detect these anomalies, is subject to wide analytical variations that commonly bias the interpretation of results. This problem can only be circumvented by the randomization of samples, so that the analytical sequence is independent of the sampling sequence.

Session 5 ■ 11:20

Evaluation of Mineral Potential Using IT: Challenges, Expectations and Examples

Michel Rheault (MIR Télédétection)

While costly to set up, information technologies are now generating the expected benefits. Originally implemented in large financial institutions, they helped facilitate the management of internal operations, and improved client services and the overall performance of these establishments. The mining industry is no exception to this rule: information technologies allow major mining companies to manage information derived from their offices throughout the world in an integrated manner.

The integration of spatially referenced and seamless geoscientific data into information technologies now produces remarkable spatial analysis abilities. Integrations improve the understanding and precision of structural geology and lithology patterns, as well as the identification of exploration targets, while reducing the financial risks associated with exploration. For regions where existing geological information is fragmented or less available, or where the terrain is difficult to access, integrated IT also provides a means of first contact and information gathering for a given study area, thus reducing the time needed to adapt in the field.

In summary, IT, used as a preliminary step in exploration programs, has proven to be a low-cost starting point that provides an overview of the study area and an opportunity for initial knowledge gathering. Combined with geoscientific databases, which are becoming increasingly available, information technologies can generate testable exploration targets. The ability to reduce the size of the study area and to identify and prioritize targets result in greater efficiency during fieldwork and reduced costs.

Session 6 ■ 1:30

e3 Plus: A Framework for Responsible Exploration

Jon Baird and Brenda Dalglish (PDAC)

Exploration crews are viewed as the ambassadors of the global mining community. Their performance in managing the environmental and socio-economic aspects of projects demonstrates a commitment - or lack thereof - to environmentally and socially responsible exploration and mining. The Prospectors and Developers Association of Canada (PDAC) has introduced a new program to help companies better manage these "above ground" issues and retain their social license to operate.

e3 Plus: A Framework for Responsible Exploration – Principles and Guidance is a voluntary benchmark that exploration and mining companies can tailor to meet the needs of individual projects and foster excellence in social responsibility, environmental stewardship and health and safety. It was developed by the PDAC through extensive stakeholder consultations involving workshops and focus groups over several years.

The Framework encourages mineral explorers to aim for excellence in eight principles. Accompanying the principles are guidance notes that help practitioners convert the principles into action. The guidance notes are aligned with a set of three practical online toolkits, which provide easy access to the most up-to-date information on good practices in each area. The guidance notes describe what should be done, the principles explain why it should be done and the toolkits provide techniques to illustrate how it should be done.

In Phase 2 of *e3 Plus*, the PDAC will introduce objectives to help companies measure their performance as well as reporting criteria that will provide guidance on disclosing their performance to stakeholders in a clear and transparent manner. Following that, verification procedures, which will provide confirmation to outside stakeholders on reported performance, will be determined. Phase 2 is scheduled for completion in 2010.

e3 Plus is available free-of-charge to PDAC members and non-members in Canada and around the world on the *e3 Plus* website at www.pdac.ca/e3plus.

Session 6 ■ 2:00

The Inevitable Shift to Sustainability

Jean-Sylvain Lebel (MRNF)

Many things have changed since the first mine opened in Québec. Working conditions have improved tremendously. Gone is the image of the weary miner covered in dust at the end of his shift. Gone too, are the mines that leave their waste wherever they want. Technological advances now make it possible to be more productive, but also to do so with greater respect for the environment.

The mining industry must face many challenges over the coming decade: environmental challenges, productivity challenges, workforce renewal, resource replenishment, etc. But the single most important issue is sustainable development: it encompasses all of the concerns expressed by the industry and the population.

Sustainable development is too often confused with environment. Yes, it's true that the environment is a very important element of sustainable development. Two other pillars of sustainable development must also be taken into consideration: the economic aspect and the social aspect. Both mining companies and government agencies are comfortable with the economic aspect. For many decades now, economic parameters have been used to measure human progress, company progress. However, just consideration of the social aspect is relatively new. More complex than the economic and environmental aspects that meet economic benchmarks or technical regulations, the social aspect is constantly evolving. It reflects the relationship that humans entertain with their living environment.

The mining sector is particularly concerned by the principles of sustainable development. Participation and involvement of citizens and of the groups that represent them are necessary to build a concerted vision of development and to ensure its sustainability in terms of the environmental, social, and economic aspects. Thus, how do we consider the needs of local communities, including aboriginal communities? How do we plan, from the start of a mining project, the post-mining era?

The challenge therefore lies in successfully integrating all three aspects of sustainable development in our discourse, but first and foremost, in our reflections, our planning, our project evaluations, so that this can lead to concrete actions. This talk by Mr. Jean-Sylvain Lebel, Associate Deputy Minister for Mines, will attempt to define what it means to integrate these three aspects in the development of mining activities in Québec.

Session 6 ■ 2:30

Québec's Mineral Strategy: Impact on the Industry of Upcoming Legislative Changes

Jean-Pierre Thomassin (AEMQ) and Jean-Claude Belles-Iles (AMQ)

The Québec government announced last summer the policy directions of its first Mineral Strategy. It seeks the harmonious development of our economy, by linking wealth creation to social progress and environmental protection, all the while ensuring sustainable use of the province's mineral resources.

Specifically, the strategy aims to promote mining development and increase its benefits for Québec and its regions, while ensuring the participation of local and aboriginal communities as well as balanced land use and environmental protection.

But in order to implement the strategy, the Mining Act must be amended. The new Mining Act will adopt stricter standards for exploration and mining, to help achieve the goals set out in the strategy. In his report, the Auditor General of Québec also revealed certain inconsistencies and recommended various measures to better monitor the mining sector.

This new framework will surely raise many questions. Potential increases in royalty payments, stricter rehabilitation measures for exploration and mining sites, consultation and accommodation of communities concerned by mining projects, and many other changes. Representatives from the two associations representing the mining sector in Québec will discuss the impacts of proposed changes.

Session 6 ■ 2:50

Mineral Exploration and Protected Areas: Is Cohabitation Possible?

Luc Gratton, Adina-C. Georgescu and Antoine Brosseau-Wéry (MTP)

The Québec government's resolution to increase its protected areas to cover 8% of its territory and even potentially 12%, inevitably affects the province's mining industry. Mineral exploration and mining are in fact both affected. This presentation will address the rights given by the government to mining explorationists and their scope, the restrictions on mineral exploration in protected areas, the Northern Plan and the Mineral Strategy of Québec's Liberal government, as well as the restrictions on mineral exploration deriving from Native rights. To illustrate the stakes involved in this issue, a practical case will be discussed, namely the Rivière George protected area.

These topics will be discussed in light of the different laws governing protected areas, mining activities and Native rights, and also in light of government policies and the economic interests of various stakeholders.

Session 6 ■ 3:10**Exploration and Protection: A Winning Combination!**

Édith van de Walle (MDDEP)

Exploration work, depending on its scope, is likely to have environmental impacts, particularly on natural ecosystems. Developers who intend to perform exploration work must fulfil certain environmental obligations and must meet various requirements under the Environment Quality Act. Drilling work generally does not require a certificate of authorization, unless it is performed in a wetland area other than a peatland. A certificate of authorization is required prior to activities such as overburden stripping, exploration trenching, and bulk sampling of ore, among other things, in accordance with the Environment Quality Act.

In Northern Québec, on lands subject to the James Bay Agreement, Chapter II of the Environment Quality Act applies and specific authorization procedures are prescribed. The mode of application of the environmental and social impact assessment and review procedure makes it possible, as the case may be, to take into account the concerns of Cree, Naskapi, and Inuit communities depending on the target area.

Directive 019 pertaining to the mining industry details what type of information must be submitted to the Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP) in order to obtain an environmental authorization. The application must include a detailed description of the project and indicate its exact location. It must also include an assessment of contaminants likely to be released in the environment, as well as the measures taken to eliminate or minimize the latter as much as possible.

The Centre de contrôle environnemental du Québec (CCEQ) plans inspection programs for mine sites and exploration sites that are subject to an environmental authorization. It also responds to environmental complaints filed with the MDDEP and investigates each situation. Mechanisms are in place to ensure offending companies implement the appropriate remedial measures.

Remember that in exploration, environmental protection is certainly your best bet for the future!

Session 6 ■ 3:30**Canadian Malartic Project: A Mining Project in an Urban Setting**

Jean-Sébastien David (Osisko Mining Corporation)

The Canadian Malartic Project consists in the construction and operation of an open pit gold mine located near the town of Malartic. With an annual processing capacity of 55,000 tonnes of ore per day for an average annual output of 600,000 ounces of gold, the mine will be the second largest gold mine in Canada. The Canadian Malartic Project is a mining project that will use simple large-scale mining methods in a complex socio-economic setting.

The government decree was issued last August 20th, but the project had to face many challenges prior to obtaining this authorization. These issues were successfully addressed thanks to Osisko's approach, which was implemented as soon as the property was acquired in 2004. Our actions were guided by the three major components of sustainable development, namely: the environment, the social aspect, and the economy.

This approach may be summarized as follows: transparency with the Malartic population in order to gain social acceptance for the project; open and constant communication with stakeholders; project designed in such a way as to minimize impacts on the environment and the population, and to maximize local and regional economic benefits, while ensuring an interesting rate of return on an investment of nearly one billion dollars.

Sustained efforts were deployed during drilling programs in an urban setting, in the creation of a monitoring committee with citizens, in the design of the mining project, during the resettlement of the southern sector of Malartic, the construction of the new neighbourhood in the north part of town, relocation of residences, approval and construction of new institutional buildings, and during the preparation for BAPE hearings and the government's review of the project.

At this time, the Canadian Malartic Project has achieved 98% of the resettlement of the southern sector of Malartic; all institutional buildings have been built and we have begun delivery to the various clients. Construction of the mining complex commenced the week after the government decree, and the project financing is 95% complete. We continue our exploration efforts, are examining business and development opportunities, and will proceed with the hiring of permanent workers during the year 2010, in order to implement training programs prior to the start-up of operations, scheduled for the first quarter of 2010 and the achievement of commercial production in April 2011.

Session 6 ■ 3:50

The Fonds Restor-Action Nunavik – A Success Story to Make the Industry Proud!

André Gaumond (Virginia Mines), Nancy Dea (Kativik Regional Government) and Denis Blackburn (MRNF)

From the 1940s to the 1980s, extensive mineral exploration programs were carried out in Northern Québec above the 55th parallel, especially in the Labrador and Ungava Troughs.

Before 1976, some mining companies took the initiative to clean up their exploration sites once they completed their exploration programs, whereas others simply left the area, abandoning buildings, motors, core trays, heavy equipment (generators, compressors, bulldozers, etc.), petroleum tanks, barrels (some still containing residue), batteries, transformers, chemical products, salts and acids.

In the early 1990s, Inuit communities started worrying about possible environmental contamination. In 1997, more than 100 litres of highly toxic concentrated acid, generally used in chemical exploration, were discovered improperly stored in an area accessible to the local population, 10 km south of the Katinniġ mine. In 2000, abandoned dynamite was also discovered close to Tasiujaq.

The presence of these materials left on the land is a great concern to the Inuit and Naskapi peoples. The fragility of arctic ecosystems, the threat posed by melting permafrost (destabilizing mining structures and tailings storage), and the immediate and long-lasting effects to the food chain all pose direct threats to public and environmental health.

In the summer of 2000, the combined results of interviews conducted in 14 communities, along with a consultation of existing MRNF documentation, revealed the possible existence of 595 abandoned mineral exploration sites in Nunavik.

In 2001 and 2002, teams under the supervision of the Kativik Regional Government visited many of these sites, and the current estimate is 275 abandoned exploration sites in Nunavik. In the fall of 2006, the Fonds Restor-Action Nunavik was created with the goal of contributing, in cooperation with the provincial government and local Inuit communities, to the restoration of priority mining and exploration sites in Northern Québec (Nunavik region).

The Fonds Restor-Action Nunavik brings together many mineral exploration companies currently active throughout Québec, all working cooperatively towards the common purpose of cleaning up and restoring abandoned mining sites. The new generation of mining and exploration companies wishes to demonstrate that in addition to adopting rigorous environmental management and socially responsible practices, it is willing to take concrete action to remediate selected priority sites and ensure proper compliance with established environmental standards during ongoing and future activities.

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Geology and Economic Potential of the Réservoir Laforge 1 Area (NTS 33I)

Martin Simard and Isabelle Lafrance (MRNF)

This survey was conducted during the summer of 2009 at a scale of 1/250,000 in the Réservoir Laforge 1 area (NTS 33I). The centre of the map area is located about 75 km NNE of the LG-4 hydroelectric complex.

The area lies at the junction between two subprovinces of the Superior Province, namely the Minto Subprovince in the northwest half, and the La Grande Subprovince in the south-east half.

The Minto Subprovince is mainly composed of heterogeneous units comprising several phases of biotite-hornblende intrusive rocks of granitic, granodioritic, and monzodioritic compositions. These rocks contain substantial amounts of earlier tonalitic remnants. Units of pyroxene-bearing felsic intrusive rocks also occur in the north part of the area. The La Grande Subprovince is composed of tonalite and quartz diorite units with biotite or biotite-hornblende assemblages, with an earlier unit of tonalitic and dioritic gneiss. It also includes three volcano-sedimentary belts: 1) the Bellamant Belt (new belt) in the northeast; 2) the Laforge Belt in the central part; and 3) the Aquilon Belt in the southeast, known for its gold potential. Rocks in both subprovinces are cut by younger granitic intrusions and by Proterozoic diabase dykes.

The regional metamorphic grade is the amphibolite facies. Garnets were observed in tonalitic and dioritic gneisses of the La Grande Subprovince.

Rocks in the Minto Subprovince are affected by a regular foliation that gives it its dominantly NW-SE structural pattern. The structural trend in the La Grande Subprovince is more irregular due to the presence of numerous folds and of two overlapping fabrics, an earlier fabric associated with gneiss sequences and a more recent fabric, well developed in younger tonalitic intrusions.

Rusty zones some 10 cm to 10 m wide were observed in layers of amphibolite, paragneiss, felsic tuff, and iron formation in the Aquilon and Laforge belts. An altered brecciated zone injected with quartz veinlets over at least 50 by 100 metres was identified in the northwest corner of the map area. Mineralized zones were also observed in association with quartz veins, dismembered iron formations, alteration zones, as well as mafic and ultramafic intrusions.

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New Aeromagnetic and Gamma Ray Spectrometer Surveys in the Baie-James Region

Isabelle D'Amours (MRNF) and Camille St-Hilaire (UQAT)

In order to identify new strategic areas for mineral exploration and to promote the mineral potential of the various regions of Québec in a sustainable development perspective, Géologie Québec has conducted, since 2007, extensive airborne geophysical surveying in the north part of the Baie-James region. The objective is to provide high-quality geophysical coverage in the most active exploration area in the Baie-James region, *i.e.* within a triangle defined by three advanced projects: Renard (diamond), Éléonore (gold) and Coulon (zinc-copper).

In 2008-2009, 40 NTS sheets at 1/50,000 scale were covered by an aeromagnetic survey, among which 12 map sheets (32H09 to 32H16, 33I01 to 33I04) were also covered by a gamma ray spectrometer survey. This coverage, in addition to the 28 map sheets already covered by an aeromagnetic survey conducted in 2007-2008, means that a total of 68 map sheets are now available in SIGÉOM, including grids and databases (DP 2009-01, DP 2009-02, DP 2009-03).

This coming year (2009-2010), magnetic and gamma ray spectrometer surveys are currently underway in 12 new map sheets at 1/50,000 scale (33A09 to 33A16 and 33B09, 33B10, 33B15, 33B16). These surveys will cover an aggregate surface area of more than 74,500 km² and total about 335,000 line kilometres.

The part of the Baie-James region covered by these surveys lies in the central Superior Province and covers three geological subprovinces, which are from north to south: the La Grande, Opinaca, and Eastmain subprovinces. Composed of volcano-plutonic and sedimentary assemblages, these subprovinces are cut by numerous shear zones trending E-W to WNW-ESE and NE-SW. Rocks are metamorphosed to the greenschist facies in the centre, grading to the upper amphibolite facies near their contacts. These assemblages are cut by numerous granitic intrusions assigned to various plutonic suites (Moukhsil *et al.*, 2003). The mineral potential of this area continues to grow, thanks in part to recent mapping programs by the BEGQ that resulted in the discovery of new mineral occurrences. Airborne magnetic and spectrometer surveys will be very useful to further mapping programs and to identify new prospective zones, whether for gold, uranium, diamond, or base metals. A few interesting exploration targets have already been defined based on a preliminary interpretation of the airborne data.

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Geology and Metallogeny of the Lac Brune (33G07) and Baie Gavaudan (33G10) Areas, Baie-James

Daniel Bandyayera, Pénélope Burniaux (MRNF)
and Simon Bourassa (UQAM)

Géologie Québec recently completed an extensive detailed aeromagnetic survey in the north part of the Baie-James region that namely covered areas mapped at a scale of 1/50,000 in the Lac Brune (33G07) and Baie Gavaudan (33G10) areas. The objectives of the project are to establish regional geological correlations and to acquire new metallogenic data in this area where the last geological mapping surveys took place around 1975.

The study area straddles two subprovinces : La Grande and Opinaca. To the north, the La Grande Subprovince comprises the poste Le Moyne Pluton (tonalite and diorite; 2881 Ma), the Langelier Complex (gneiss and tonalite; 3360 to 2788 Ma), the Guyer Group (komatiite, basalt, felsic lava and tuff, wacke, iron formation; 2820 Ma) and the Ekomiak Formation (wacke and conglomerate; <2747 Ma). To the south, the Opinaca is represented by the Laguiche Complex, mainly composed of migmatized paragneiss with 20 to 50% mobilizate.

At the contact between the La Grande and Opinaca subprovinces, the metamorphic grade gradually or abruptly changes from the lower amphibolite facies to the upper amphibolite to granulite facies. The actual boundary between the two subprovinces is a mylonite zone, locally masked by late intrusions of pegmatite, tonalite and diorite. Many kinematic indicators outline dextral strike-slip zones and a thrusting movement from north to south. Within the La Grande Subprovince, the contact between the Langelier Complex and the Guyer volcano-sedimentary sequence is also marked by a major shear zone in which multiple back-arc-type intermediate to ultramafic intrusions were emplaced.

Historical showings and occurrences discovered during our fieldwork show that the region hosts several exploration targets with significant potential for gold and Ni-Cu deposits. The main mineral occurrences are observed in the volcano-sedimentary sequence of the Guyer Group. They are associated with gold-bearing iron formations, with volcanogenic alteration zones (Cu-Zn-Ag $\pm$ Au), and with quartz-sulphide veins (Cu-Ag $\pm$ Au). A few Ni-Cu $\pm$ PGE occurrences are also present, associated with komatiitic flows and ultramafic sills. A new molybdenite showing with pockets and disseminated mineralization, associated with quartz veining in a white garnet-bearing pegmatite, was discovered in the Langelier Complex. The latter also hosts disseminated sulphide occurrences in tonalitic rocks.

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Metamorphic and Isotopic Study of the Opinaca Area: Influence of the Emplacement of Anatectic Magmas

Samuel Morfin, Edward W. Sawyer (UQAC)
and Daniel Bandyayera (MRNF)

A petrology study of migmatized metasedimentary rocks from the southern margin of the Opinaca Subprovince indicates that two episodes of partial melting took place. The results presented here are based on field observations and on a study of samples collected during the 2008 Opinaca mapping program by Québec's Ministère des Ressources naturelles et de la Faune. The first episode of partial melting is characterized by the presence of orthopyroxene, cordierite, and garnet. All assemblages indicate partial melting in anhydrous granulitic conditions, *i.e.* at temperatures above 820°C and pressure conditions between 4 and 5 kbar. The second episode of partial melting, associated with the main deformation event and with rehydration, is characterized by Qz + Bt + Pl + K-fs $\pm$ Tl $\pm$ Crd mineral assemblages with films of interstitial magma. This indicates temperatures of at least 720°C at 3 kbar.

The origin of the fluid responsible for hydration during the second episode of partial melting was investigated by analyzing whole-rock δO^{18} values in 14 samples of metasedimentary rocks and 3 samples of felsic rocks, collected during the 2008 mapping program. Values largely fall within the 7.8-10‰ range, indicating that metasediments re-equilibrated with aqueous fluids of metamorphic or felsic magmatic origin. Moreover, tourmaline is commonly observed in white pegmatite dykes and white granites. It is also included in the mineral assemblage typical of the second partial melting episode. Tourmaline is considered as evidence of fluids released during the crystallization of S-type, often pegmatitic, magmas. The fluid responsible for hydration and melting of metasediments at 720°C is therefore derived from magmatic sources that crystallized in the Opinaca. These magmas are probably derived from the partial melting of sedimentary sources such as metagreywackes located at greater depth.

These results not only indicate partial melting of Opinaca sediments, but also reveal the influence of the crystallization of magmas derived from deeper sources than the exposed structural level. Part of the felsic magmas observed in Opinaca migmatites are therefore not autochthonous but probably migrated pervasively from granulitic terrains through the continental crust. These anatectic magmas thus contribute to the "migmatitic" morphology of Opinaca terrains, thereby creating a complex arrangement of multiple felsic magma injections in migmatized metasedimentary rocks.

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Geological Mapping East of Schefferville (23I10, 23I11, 23I14, 23I15, 23P02 and 23P03)

Hanafi Hammouche (MRNF), Claire Legoux (URSTM),
Jean Goutier, Claude Dion (MRNF) and Laura Petrella (URSTM)

A geological mapping program was undertaken by the MRNF in the Lac Merville area, about 120 km east of Schefferville, which will result in a geological revision at a scale of 1/50,000 of the SE Churchill Province.

Two major structural entities make up this area: the New Québec Orogen to the west and the Core Zone to the east. The New Québec Orogen is represented here by the McKenzie River domain and the Rachel-Laporte Zone. The first constitutes the orogen's Archean basement. It is composed of tonalitic gneiss with minor paragneiss, originally from the Superior Province.

To the west, the Rachel-Laporte Zone consists of Paleoproterozoic mafic metavolcanic rocks, metagabbro, schist, marble, calc-silicate rocks, paragneiss, and quartzite, which are metamorphosed equivalents of rocks in the Labrador Trough.

The Core Zone comprises three lithotectonic domains:

- The Crossroads domain, composed of the Paleoproterozoic De Pas Batholith and its Archean gneissic country rocks. The eastern part of the batholith consists of generally porphyritic tonalite, granodiorite and granite, whereas the western part shows charnockitic compositions, dominated by dioritic-monzonitic rocks.
- The Orma domain, adjacent to the east of the Crossroads domain, is mainly composed of Archean tonalitic gneiss and migmatized paragneiss.
- The Zeni domain, to the east of the previous two, shows a heterogeneous composition. It contains amphibolites, derived from mafic volcanic rocks and gabbros, but also contains intermediate and felsic intrusive rocks.

Widespread late intrusions of various compositions intrude lithologies in all the domains listed above.

The area shows a N-S to NNW-SSE-trending structural pattern. The various zones and domains are bounded by major shear zones, characterized by mylonitization of rocks over widths on the order of 100 metres. Foliations are steeply inclined and lineations plunge weakly to the north. They are the result of significant dextral strike-slip motion.

The rocks in the area are generally metamorphosed to the amphibolite facies, although granulite-grade rocks are present in the Crossroads domain and locally in the Zeni domain.

Oxide and sulphide-facies banded iron formations were discovered in the Zeni domain, in metasedimentary units and in contact with amphibolites. The Rachel-Laporte Zone also shows potential for Cu-Zn (Ag) mineralization, and for Cu-Ni (PGE) in late gabbroic sills.

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Mapping of the Rivière Allard Area, Matagami Project, Phase 2 of 3

Pierre Rhéaume (MRNF)

The second phase of the Matagami project consists in surface mapping at a scale of 1/20,000 of NTS sheet 32F12-201, as well as adjacent portions of map sheets 32F13-101, 32E09-202, and 32E16-102. This area extends in an east-west direction from the Perseverance mine to the Phelps-Dodge deposit and southward to the Casa-Berardi deformation Zone.

The objectives of this project were to clarify structural and stratigraphic relationships between the Watson Lake and Wabasee groups and the McIvor and Cavelier plutons to the south and west of the Galinée Anticline, to provide a better understanding of the regional geology.

The area is mainly underlain by rocks of the Wabasee Group, largely composed of various facies of intermediate and mafic volcanic rocks. It was possible to locate and follow the vesicular calc-alkaline andesite marker horizon defined in 2008 along the south flank of the Galinée Anticline.

The contact between the McIvor Pluton and the Wabasee Group is marked by intrusive breccia zones. Volcanic rock fragments in these breccias and volcanic country rocks are weakly deformed and metamorphosed to the greenschist facies. This pluton shows an external diorite zone and an internal tonalite phase. Our observations to date are consistent with emplacement of the McIvor pluton coeval with volcanism; this hypothesis will be tested with a U-Pb date. In contrast, enclaves and volcanic country rocks around the Cavelier Pluton, largely composed of granodiorite, are strongly deformed and metamorphosed to the amphibolite facies, suggesting the latter intrusion is rather late relative to the volcanic sequence.

A horizon of felsic effusive volcanic rocks of tholeiitic affinity with geochemical characteristics similar to those of the Watson Lake Group extends to the south of the McIvor and Cavelier plutons, from the Phelps-Dodge deposit to the Lynx-Yellowknife deposit. This horizon is considerably thinner than the Watson Lake Group in the south flank of the Galinée Anticline, and possibly discontinuous. A comparison of this horizon with the stratigraphy and geochemistry of the south flank will be the focus of further investigations. Moreover, a second geochronology sample was collected in these rocks in order to clarify the position of this horizon within the Matagami stratigraphy. Preliminary observations suggest the horizon is north-facing, which leads us to propose that the Galinée Anticline is bordered to the south by a syncline.

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Geology of the Chapais Area (32G15-200-0101) – Potential for VHMS-type and Cu-Au Vein-type Deposits

François Leclerc, Patrick Houle (MRNF), Lyal B. Harris (INRS-ETE) and Claude Larouche

In the Chapais mining camp (Abitibi Subprovince, Québec), the Springer, Perry, Robitaille, and Cooke mines produced nearly 1.1 billion pounds of copper from 1953 to 1991, from quartz veins with $\text{Cp-Py-Po} \pm \text{Sp} \pm \text{Gn} \pm \text{Mo}$ injected in gabbros in the hinge of a synclinal structure. The area is also known for its potential for volcanic-hosted massive sulphide (VHMS) deposits, given the presence of deposits at Scott Lake (0.7 Mt @ 0.4% Cu and 6.9% Zn) and Lac Laura (Au-Ag-Cu-Zn-Pb), not to mention the 100 million tonnes of massive sulphides at Astoria ($\text{Py-Po} \pm \text{Sp} \pm \text{Cp}$). This mapping project, conducted within the scope of the Copper Plan and the Targeted Geoscience Initiative III – Abitibi Project (TGI-3), has two main objectives: a) to investigate the potential for VHMS-type deposits to the south of Chapais and the Kapunapotagen shear zone, in the Obatogamau and Waconichi formations; and b) to reinterpret the geology of the area located between the Chapais mining camp and Lac Laura.

In the south part of the map area, an anticlinal structure exposes the oldest section of the Roy Group, composed of the Chrissie Member and assigned to the Obatogamau Formation. Mafic lavas at the base (lower member) are overlain by a unit of felsic rocks composed of breccias, lapilli tuffs, rhyolites, $\text{Py-Po} \pm \text{Sp} \pm \text{Cp}$ exhalites and argillites (upper member), which suggest the end of a volcanic cycle that predates volcanism in the Obatogamau and Waconichi formations. On a regional scale, these early units may be coeval with the Des Vents Member and the Fecteau Formation. West of the town of Chapais, the Waconichi Formation is composed of rhyolite flows (Scott Member), overlain by intermediate to felsic volcanoclastic rocks (Allard Member). East of Chapais, in the vicinity of the Lac Laura deposit, mafic volcanic rocks of the Gilman Formation and felsic volcanoclastic rocks of the Blondeau Formation host volcanogenic Py-Po-Cp-Sp mineralization. Showings recently discovered in this area are closely correlated with anomalies from the 2005 MEGATEM survey. North of Chapais, the Chapais synclinal structure folds Ventures and Bourbeau sills that host ore lenses at the Springer, Perry and Robitaille mines. Interpretation of aeromagnetic data acquired in 2005 during the MEGATEM surveys, of recent drilling results and of field mapping indicates sinistral displacement along the Gwillim shear zone and suggests equivalent potential does exist to the south of the latter structure; correlation of units formerly assigned to the Lac Springer intrusion with the Ventures and Bourbeau sills is based on the recognition of massive Cp-Po-Py mineralization in Ventures magnetic gabbros and the mapping of finer-grained non-magnetic gabbros typical of the Bourbeau. Also, aeromagnetic data processing outlined a positive anomaly corresponding to the Cu-Au Cooke mine, at the top of the Bourbeau sill, as well as other similar anomalies along the contact between the sill and the Blondeau Formation.

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New U-Pb Ages from the TGI-3 Abitibi Project/Copper Plan: Implications for Geological Interpretation and Base Metal Exploration

Vicki McNicoll (GSC-O), Benoît Dubé (GSC-Q), Jean Goutier (MRNF), Patrick Mercier-Langevin (GSC-Q), Pierre-Simon Ross (INRS), Claude Dion (MRNF), Thomas Monecke (CSM), Phil Thurston (LU), Pierre Pilote (MRNF), Jean Bédard (GSC-Q), François Leclerc (MRNF), Valérie Bécu (GSC-Q), John Percival (GSC-O), Marc Legault (MRNF), Harold Gibson (LU) and John Ayer (OGS)

The Abitibi Targeted Geoscience Initiative III (TGI-3) project was designed to improve and expand the geoscience knowledge in areas of high base metal potential in established mining districts in the Abitibi, Québec and Ontario. A targeted high-precision U-Pb dating program is associated with new geological mapping, geophysical, geochemical and till surveys, 3D structural and stratigraphic models, and integrated compilations.

U-Pb geochronology is a key component of a multidisciplinary project to better understand the geology and numerous base and precious metal deposits of the Blake River Group (BRG). Important objectives of this high-precision U-Pb dating program include: defining the age of the volcanic units to assist with stratigraphic correlations, constraining the chronology of the formation of the different massive sulphide deposits, and contributing to better defining the complex and multistage evolution of the volcanic successions. The Blake River Group is host to two large Archean Au-rich VMS deposits (Horne, LaRonde) and a large VMS deposit (Bouchard-Hébert). These deposits were formed during three distinct time periods: 2702 Ma Horne; 2698-2697 Ma LaRonde-Bousquet; 2696 Ma Bouchard-Hébert. The Blake River Group has generated large VMS deposits throughout its entire evolution and over a vast area. Understanding the role of mafic/intermediate intrusions in the evolution of the BRG is also addressed. These intrusions represent a variety of rock types, ages (2698 Ma, 2695 Ma), and relationships to country rocks and to syngenetic mineralization.

New age constraints on volcanic rocks of the Kinojévis Group in Québec (2716 Ma Lanaudière Formation; 2719-2718 Ma Deguisier Formation) aid in testing potentially correlative units of the 2719-2711 Ma Kidd-Munro assemblage, host to the giant Kidd Creek VMS deposit in Ontario. Results from dating in the Chibougamau area impact the understanding of stratigraphy, and consequently VMS exploration. New U-Pb dates obtained during Abitibi TGI-3 and their implications will enhance the understanding of the stratigraphic and structural framework and metallogeny of the Abitibi.

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Malartic West Project, Geology of the Lac Figuery Area – NTS 32D08-NE

Pierre Pilote (MRNF), Vicki McNicoll (GSC-O),
Réal Daigneault (UQAC) and James Moorhead (MRNF)

Since 2006, the MRNF has undertaken an important geological revision program in the west part of the Malartic Group, the east part of the Kinojevis Group, and the south part of the Lower Figuery Group at a scale of 1/20,000. These units are located in the south-central part of the Archean Abitibi Subprovince. The study area this year represents the NE quadrant of NTS sheet 32D08. The objectives of the project are to examine regional correlations between these various units, to highlight their mineral potential, and at a larger scale to establish potential analogies between these units and lithologies in the Kidd-Munro Assemblage (KMA) in Ontario, which host the Kidd Creek VMS-type (Zn-Cu-Ag-Au) ore deposit.

From north to south, the area comprises the Lower Figuery Group (LFG), the Kinojevis Group (KG), the Caste Formation (CF; $< 2,691 \pm 8$ Ma), the La Motte (2640 Ma) and La Corne (2670 Ma) plutons, and finally the basal part of the Malartic Group (MG; 2714 ± 2 Ma). The regional metamorphic grade reaches the upper greenschist facies and locally the amphibolite facies near the plutons. All of these groups and formations are separated by major E-W-trending fault zones and/or deformation corridors. The LFG is mainly composed of mafic volcanic rocks with thin rhyolitic layers. It is bounded to the south by the Lyndhurst Fault, which can be traced for more than 70 km and is commonly defined by EM conductors. The KG includes the Deguisier (DF) and Lanaudière (LF) formations. The DF is composed of basalt, voluminous gabbro sills, felsic lavas and volcanoclastic rocks. The LF is characterized by the presence of komatiitic and basaltic lavas, accompanied by many layers of tholeiitic felsic volcanic rocks as well as many late tonalitic to monzonitic intrusions. The DF yielded ages of 2719.4 ± 1 Ma and 2718.1 ± 1.3 Ma in our study area, whereas the LF yielded ages of 2718.7 ± 0.7 Ma and 2716.2 ± 0.8 Ma. These ages, supported by the close association in time and space of ultramafic lavas and coeval rhyolitic complexes, suggest that these formations may well be correlated with the Lower KMA. The DF and LF are separated from one another by the Aiguebelle Fault. The LF is bounded to the south by the Manneville North fault.

The Aiguebelle Fault marks the northern edge of a distinct structural domain that is characterized by moderate and very regular dips toward the north (35° to 45°) of the regional S1 schistosity and S0 bedding, both subparallel. Younging directions are reversed and commonly face south. This domain also includes the CF. The La Motte pluton exhibits a magmatic fabric with the same orientation. This fault extends along many small sedimentary basins that locally contain conglomerate facies, quartz sandstones, and graphitic argillites. These elements are reminiscent in certain aspects to the Casa-Berardi Fault. In the central part of the map area and eastward, the Aiguebelle Fault separates into two splays, trending ENE and ESE, that border the Landrienne Formation (2727 ± 2 Ma). This domain, bounded by the Aiguebelle and Manneville North faults, is interpreted as a major thrust zone that accommodated transport to the south of the LF and the folded structure incorporating the Landrienne Formation over the CF and the MG. This north-dipping thrust zone, called the Destor-Manneville Deformation Corridor (DMC), juxtaposes various lithotectonic assemblages with distinct ages, thus forming one of the most important shear zones in the southern Abitibi. Some fault segments that make up the DMC are commonly deformed, folded or truncated by E-W-trending subvertical faults with extensive ankerite or albite alteration halos. These subvertical faults occasionally host lode Ag-Au showings, or sets of late tonalitic-monzonitic intrusions. The clearly late nature of these vertical faults make them analogous and potentially coeval with the "Destor-Porcupine" mineralizing episode, well documented to the west of the area and on the other side of the Ontario border. This observation suggests a strong gold potential for the entire DMC, in addition to the potential for VMS deposits that is already established. These elements suggest that the Aurora Group, identified to the north and east of Val-d'Or (NTS 32C05, 32C06 and 32C03), may be correlated with the LF, which, as mentioned above, constitutes a time equivalent to the Lower KMA.

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Synthesis of High-Resolution Aeromagnetic Data in the Abitibi: Québec and Ontario

Pierre Keating (GSC), Denis Lefebvre (MRNF),
Desmond Rainsford (OGS) and Benoît Dubé (GSC)

The first aeromagnetic maps of the Abitibi were completed by the GSC in the early 1950s, in order to assist geological mapping and mineral exploration. Flight lines were spaced every 800 m and were flown at an altitude of 300 m. These surveys were an important source of geoscience data, particularly in areas where the Quaternary cover hindered geological mapping and proved to be an obstacle for mineral exploration. The situation has tremendously improved today, since most parts of the Abitibi have now been covered by high-resolution electromagnetic and/or magnetic surveys with flight lines spaced every 200 m or less, flown at an altitude of 120 m or less. The data used in this compilation are derived from surveys conducted for the MRNF, the OGS and the GSC since 1970. To ensure the homogeneity of the compiled data, data from airborne surveys conducted at a flight altitude of less than 120 m were upward-continued to this height. The quality of compiled data is variable: recent surveys use magnetometers with 0.01 nT accuracy and generate GPS-located data, whereas earlier surveys have an accuracy of 5 nT and contain many errors in data positioning. During the synthesis, the more modern data were used whenever many surveys overlapped. Magnetic data were microleveled in order to minimize leveling errors in the original data; certain inaccurately located line segments were also removed.

At first glance, one can see that this new map shows the location of numerous faults and shear zones and can also be used to trace fault extensions. The presence of a NNW-trending magnetic low, more than 100 km wide and starting in the west part of the Blake River Group may possibly be related to a deeper structure, the origin of which remains to be determined. This is either an artefact or an effect of a lack of calibration in the regional aeromagnetic surveys used as a reference level during compilation of the high-resolution magnetic grid for Ontario. Future studies will determine its exact nature. This synthesis will provide a global image of the entire Abitibi, and will help clarify large-scale geological features and thus contribute to a better understanding of the distribution of its exceptional metal content, while providing new data and thus helping the mining industry make new discoveries.

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Advanced Exploration and Mining Development Highlights for 2009 in the Abitibi-Témiscamingue Region

Pierre Doucet and James Moorhead (MRNF)

Despite the fact that the number of projects for the year has not yet been compiled, we are expecting reduced levels of mineral exploration activity in the region for 2009. In the Abitibi-Témiscamingue region, here are the main highlights on advanced exploration and mining development projects:

- **Aurizon Mines** continued exploration work on its Joanna property located 20 km east of Rouyn-Noranda, in order to delineate a near-surface resource. The deposit contains measured and indicated resources of 33.8 Mt at 1.4 g/t Au and an inferred resource of 28.4 Mt at 1.4 g/t Au.
- West of Cadillac, **IAMGOLD-Québec Management** advanced construction of surface infrastructure at the Westwood project, located east of the Doyon mine.
- **Agnico-Eagle Mines** celebrated the start-up of production at the Lapa mine on August 27, 2009. This deposit contains proven and probable reserves of 3.8 Mt at 8.9 g/t Au. The expected mine life is eight years.
- **Alexis Minerals Corporation** announced a positive pre-feasibility study on its Lac Pelletier project in Rouyn-Noranda. Dewatering of underground excavations is underway in order to extract a 40,000-tonne bulk sample and the start-up of production is scheduled for 2010. At its Lac Herbin mine northeast of Val-d'Or, Alexis announced an expansion of its proven and probable reserves, which now stand at 617,374 t at 7.36 g/t Au.
- East of the Kiena mine, **Wesdome Gold Mines** continued its drilling program on the Dubuisson gold zone discovered in 2008.
- In Malartic, the MRNF issued a certificate authorizing **Osisko Mining Corporation** to go ahead with the Canadian Malartic mining project, where reserves are 183.3 Mt at 1.07 g/t Au. The adjacent South Barnat zone contains a resource of 37.1 Mt at 1.71 g/t Au.
- **Northern Star Mining Corporation** continued excavation work to complete its exploration ramp on the Malartic-Midway gold project, as well as definition drilling in the Briar, West Chabella and L zones.

It is also worth mentioning that lithium exploration is generating much interest. Several hundred claims were map-designated in the vicinity of the Preissac-Lacorne Batholith, host of the former Québec Lithium mine, which is currently being reassessed by **Canada Lithium Corporation**.

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Geology of the East Part of the Baie-Comeau Area, NTS Sheet 22G (Cap-Chat), Côte-Nord, Québec

Abdelali Moukhsil, Pierre Lacoste and Fabien Solgadi (MRNF)

The map area covers about 5,000 km² and extends from east of Baie-Comeau to west of Pentecôte. This is a regional mapping project, the objective of which is to acquire new geological and metallogenic knowledge in NTS sheets 22G05, 22G06, 22G11, 22G12, 22G13, 22G14, and 22G15. The map area is located in the Côte-Nord region and is part of the Grenville Province.

Mapping was conducted at a scale of 1/125,000 and resulted in the identification of several lithological units, including paragneisses (with biotite ± garnet ± sillimanite ± clinopyroxene ± graphite ± cordierite), showing a variable degree of migmatization but generally remaining in the metatexite range, migmatites of igneous origin, quartzite beds and minor amounts of diopside-rich calc-silicate rocks. Intrusive rocks such as mangerite, monzonite, monzodiorite, and granite (porphyritic to porphyroclastic), gabbro, gabbro-norite, and pyroxenite were also mapped in association with charnockites. Minor amounts of late granite and syenite also occur within the map area.

Anorthositic suites were mapped in the region. The Vallant anorthositic Suite (1141-1148 Ma) consists of anorthosite, leuconorite, norite, leucotroctolite and minor amounts of troctolite and gabbro-norite with iron and titanium oxides. The plagioclase in this anorthosite is generally recrystallized to varying degrees and consists of andesine or labradorite. The Pentecôte anorthositic Suite (1354 Ma) is composed of anorthosite, leucotroctolite, and leuconorite.

The regional metamorphic grade ranges from the lower amphibolite facies to the granulite facies. Amphibolite-grade rocks are generally the products of retrograde metamorphism that affected rocks previously at the granulite facies.

Two main phases of deformation are observed in the area. Phase of deformation D1 is represented by a gneissosity (G1) or a strong penetrative S1 foliation, that affect most of the lithological assemblages in the area. This fabric was folded by phase of deformation D2, to which an S2 (G2) foliation is locally associated and which gives the region its structural pattern. Many types of folds were observed in the map area. Most of these folds are isoclinal, with an axial plane parallel to the S2 (G2) foliation plane. Faults were mapped mainly along the contacts between the two anorthositic suites and their country rocks.

The area contains exploration targets with good potential for the discovery of various types of mineralization, namely nickel-copper, uranium, iron and titanium, architectural stone, and industrial minerals (silica, sillimanite, garnet).

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Industrial Minerals in Québec: Exploration and Mining Activities

N'golo Togola and Germain Girard (MRNF)

Industrial minerals produced in Québec in 2008 include chrysotile asbestos, ilmenite, graphite, mica, rock salt, brine, silica, limestone, dolomite, marble, shale, and peat.

Chrysotile asbestos is extracted in one mine in the Estrie region. Ilmenite is produced at the Lac Tio mine, north of Havre-Saint-Pierre. Flake graphite is mined at the Stratmin mine in Lac-des-Îles south of Mont-Laurier, and mica at the Lac Letondal mine in Suzor Township, northwest of La Tuque in the Mauricie region. Rock salt is extracted at the Seleine mine in the Îles-de-la-Madeleine, whereas brine is produced from five wells in the Bécancour area. Shales are quarried in the Montréal area and are used to manufacture bricks. The main sources of silica are: quartzite (five quarries), sandstone (four quarries), and natural sand (two operations). Limestone, dolomite and marble are mined for industrial purposes in more than 15 quarries. Peat is harvested from about 40 different sites located in the Bas-Saint-Laurent, Côte-Nord, and Saguenay-Lac-Saint-Jean regions.

Ongoing **exploration work** for industrial minerals is namely focused on diamonds, apatite, lithium, rare earth elements, aluminous clay, and peat. Several exploration projects are in the advanced stages: for diamond in the Otish area, for apatite in the Lac à Paul (Saguenay-Lac-Saint-Jean) and Sept-Îles (Côte-Nord) areas, for lithium in the Baie-James region and near Barraute in the Abitibi, for graphite in the Lac Knife and Lac Guéret areas (Côte-Nord), and for aluminous clay near Grande-Vallée (Gaspésie). Inventory studies are also underway in peat-producing areas.

Geological mapping programs conducted by the MRNF in the Mont-Laurier area from 1996 to 2004 led to the discovery of sillimanite and graphite occurrences associated with paragneiss units, of sillimanite and muscovite occurrences in diatexite, of garnet in amphibolite, and phlogopite and apatite in ultrapotassic alkaline rocks.

Recent geological mapping conducted by the MRNF in the Labrieville, Baie-Comeau and Baie-Trinité areas led to the discovery of apatite, ilmenite, and magnetite showings associated with gabbro-norites, as well as quartzite and sillimanite occurrences associated with paragneiss units.

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Toward New Geological Maps of Surficial Deposits in Québec – Standardization of Legends and Lithofacies Codes

Michel Parent, Serge J. Paradis, Ruth Boivin
and Yves Michaud (GSC-Q)

The acceleration of surficial deposit mapping work triggered by Québec's groundwater knowledge program entails the need to standardize the content, particularly legends, of 1/50,000 scale maps produced within the scope of this program, destined for integration in SIGÉOM. Based on work conducted in the last twenty years in Québec and Eastern Canada, the standardized legend for surficial deposit maps is designed to provide sufficient flexibility for geoscientists to present their stratigraphic and geomorphic interpretations and their underlying observations, while maximizing the usefulness of these maps in regional hydrogeology: hydro-stratigraphic setting, identification of recharge and confined zones, assessment of recharge distribution, assessment of aquifer vulnerability, etc.

Cartographic units are classified and identified using a two-letter code. The first letter (in upper case) refers to the sedimentation setting of units (*i.e.* glacial, fluvioglacial, glaciolacustrine, marine, fluvatile), and the identification of these broad categories of sediments is facilitated by the use of standardized colours. The second letter (in lower case) refers to the mode of emplacement of units, in other words to morpho-sedimentary assemblages (*i.e.* juxtaglacial, deltaic, littoral, outwash); their identification on the map is facilitated by the use of various shades of the standardized colours. To the extent that such information is applicable or useful to users, the legend also contains, for each cartographic unit, information on the origin, grain size, lithological composition, structure, colour, thickness, morphology, and distribution of units. Surficial deposit maps also include a series of symbols and figures used to indicate additional elements (*i.e.* gravel pit, mine, backfill) as well as landforms (*i.e.* esker, kame, beach, channel, levee, etc.) that complete or support information provided in the description of cartographic units. Given the choice which was made to avoid numbered legends and thus make it easier to read maps from different regions or different authors, it is essential that the legend be sequenced according to the stratigraphic succession, since this becomes the main, and ultimately the only means to provide this information, for both unconsolidated deposits and their associated landforms.

This cartographic standardization effort was preceded by an effort to standardize the geological characterization of surficial deposits, namely by developing a lithofacies code for Quaternary deposits; this work was recently published within the scope of a methodology guide by the MDDEP.

<http://www.mddep.gouv.qc.ca/eau/souterraines/aquiferes/index.htm>

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Stratigraphy and Provenance of Tills in the Abitibi – Glacial Dispersion and Mineral Exploration in the Northern Volcanic Zone

Michel Parent (GSC), Pierre Rhéaume (MRNF), Éric Boisvert (GSC),
Hugo Dubé-Loubert (MRNF), François Hardy (Génivar)
and Karine Bédard (INRS-ETE)

The Normétal/Lebel-sur-Quévillon volcano-sedimentary band, located practically in the centre of the Abitibi, is an area where the thick cover of glaciolacustrine sediment hinders mineral exploration. From 2006 to 2008, the MRNF and the GSC led a joint project to generate new exploration targets and establish the stratigraphy and provenance of sub-surface tills using their geochemical (< 0.063 mm fraction), mineralogical (heavy minerals of the 1.0-0.25 mm fraction) and lithological (counts in the 4-8 mm fraction) characteristics. This project is based on a 134-hole drilling campaign, which also resulted in the production of 3D geological models integrating stratigraphic architecture, paleo-glacial dynamics, and clastic and geochemical dispersal patterns. In this region, the relative timing of striated surfaces (Veillette, 1989; Paradis, 2007) was until now the main method used to establish the regional glacial history. Except for very rare indications of an early south-directed ice flow (Selbaie mines), the glacial dynamics of the Wisconsinian may be summarized in three main phases: a final regional movement to the SSW, preceded by a phase of WSW-directed ice flow, itself preceded by an earlier NW-directed glacial movement.

Drill holes completed at a spacing of ± 2 km in the south part of map sheets 32F04 and 32F03 intersected 2,593 m of Quaternary deposits and enabled the recovery of 1,138 m of glacial sediment cores. The average thickness of intersected deposits is about 20 m, peaking at 56 m. This work led to the development of a regional framework for Quaternary stratigraphy, particularly for the stratigraphy of sub-surface tills. Underneath the cover of proglacial and glaciolacustrine sediments emplaced during deglaciation, our work identified a series of at least four layers of till, separated by various units of non-glacial sediments. These stratigraphic sequences with multiple tills are thus fairly common in the area: about 10% of all drill holes contained sequences with three tills, and about 25% of drill holes had two-till sequences.

The lower till, probably Illinoian in age, was intersected in only a dozen or so drill holes, such that its provenance remains uncertain. Along the margins of the Marest Batholith, the lower till also contains various indicators [Au, chalcopyrite (Cpy), arsenopyrite (Apy)] most likely derived from volcano-sedimentary rocks located to the east or southeast. However, the same indicators (Au, Cpy) encountered in a drill hole located on the Bernetz intrusion suggest a N or NE

provenance for the lower till. In fact, this ambiguous provenance is in part compensated by the fact that the sources of geochemical and mineralogical anomalies observed in this till are probably fairly proximal, since this till is in direct contact with the Archean bedrock.

The median till is in direct contact with the bedrock in 14 of the 25 drill holes where it was observed; elsewhere, it overlies Sangamonian sediments or the lower till unit. This till is typically very compact and its dark grey or dark olive grey colour is a good indication of its enrichment in mafic components. The matrix is generally calcareous, given the abundance of calcite veinlets in underlying volcanic rocks, and it is markedly more silty than the upper till. These characteristics, as well as its predominantly mafic composition, indicate that the median till comes from the east. The distribution of Au, Cu, Zn, and indicator mineral anomalies (Cpy, Apy) along the margins of the Marest Batholith may be interpreted in one of two ways: either the source corresponds to the vicinity of the Comtois deposit, located 10 to 30 km away, or it is associated with various local sources peripheral to the Marest Batholith.

The upper till directly overlies the bedrock in all other drill holes. This till is generally less compact, more sandy, and lighter-coloured than the underlying till; its relative enrichment in granitoid clasts indicates it came from the North, in keeping with the orientation of the youngest glacial striations (170-190°). In the west part of the area, the upper till hosts a dispersal train of olivine grains that extends for about 15 km toward the SSE and is sourced from an ultramafic intrusion of the Maizerest Formation located a few kilometres north of the Sleeping Giant mine. Further east, Au anomalies in the upper till are largely concentrated along the margins of the Marest Batholith, as are Cu and Zn, and Cpy and Apy anomalies. A more detailed study of the distribution of these anomalies indicates that some are attributable to reworking of the underlying till unit, whereas others are associated with new bedrock sources. Dispersal trains associated with the upper till therefore have a composite nature (Parent *et al.*, 1996) since they also display a palimpsestic component resulting from the reworking from earlier till units.

Surficial Deposit Mapping Initiative for All of Municipalized Québec: the MRNF-MDDEP Agreement

H. Dubé-Loubert (UQAT), G. Allard (UQAM), J.-Y. Labbé (MRNF), M. Ouellet and C. Lamontagne (MDDEP)

The Ministère du Développement Durable, de l'Environnement et des Parcs (MDDEP) launched, in September 2008, Québec's Groundwater Knowledge Acquisition Program. This program, with Phase 1 lasting 5 years, should in the end help ensure the preservation and sustainability of groundwater resources in southern Québec. Its main long-term objectives are to develop a global picture of groundwater resources for all of municipalized Québec and, indirectly, to improve our understanding of unconsolidated material deposition and to update Quaternary mapping. In this perspective, the MRNF has been mandated, by means of an agreement with the MDDEP, for the supervision, production and publication of surficial deposit maps, within the scope of different projects supported by the program. However, it is important to add that the cartographic goal pursued by the MRNF, within the scope of this agreement, is not only to produce deliverables that meet the needs of hydrogeology users, but also of any other potential user of surficial deposit maps.

This collaborative effort between the MRNF and the MDDEP will result in the delivery and publication of a significant number of surficial deposit maps and consequently, in an updated understanding of southern Québec's Quaternary geology. Concretely, three regional mapping projects started this year and will continue in 2010. The Université du Québec à Montréal has been mandated to conduct mapping in an area corresponding to the Rivière Bécancour watershed (12 NTS sheets at 1/50,000 scale), whereas the Université du Québec à Chicoutimi received the same mandate for part of the Saguenay-Lac-Saint-Jean region (7 NTS sheets at 1/50,000). Finally, a joint project involving the MRNF and the Geological Survey of Canada targets the Richelieu-Yamaska area (10 NTS sheets at 1/50,000). Two other regions, Mauricie and Abitibi-Témiscamingue, are also targeted by the Groundwater Knowledge Acquisition Program.

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Inventory of Aggregate Resources in the Gatineau Area

André Brazeau (MRNF)

During the summer of 2009, an inventory of aggregate resources was conducted in the Gatineau area. This work was carried out at 1/50,000 scale and covered parts or all of NTS sheets 31G05, 31G11, and 31G12. The results of this work will help locate and characterize sources of aggregate in order to assess their importance.

Fieldwork mainly consisted in examining a total of 168 sand and gravel pits, as well as several natural cross-sections and road cuts. Moreover, 26 sand or gravel samples were collected and shipped to the laboratory to determine their physical and mechanical properties.

In terms of geomorphology, the area consists of a plain and a plateau dissected by differential erosion. The plain, where altitudes range from 40 to 130 m above sea level, borders the Ottawa River. It shows little topographic relief and slopes gently toward the Ottawa River. It is generally composed of thick clay deposits left by the Champlain Sea. A few hills of till and rock outcrops are also present. The main topographic feature is the bluff along the Proto-Ottawa terrace, about 25 m high, that separates two levels of clay plains. The plateau on the other hand, has been shaped by erosion to form a hilly landscape, namely in the Gatineau Hills. Altitudes on the plateau rarely exceed 400 m and glacial features are ubiquitous.

The area is largely underlain by Precambrian rocks that form a mixed assemblage of metamorphic, igneous and sedimentary rocks of the geological Grenville Province. These rocks namely include paragneiss, quartzite, crystalline limestone or marble, calc-silicate rocks, orthogneiss, diorite, gabbro, and anorthosite. These lithologies are cut by granitic, pegmatitic, tonalitic, and syenitic intrusions and by late gabbroic plutons and diabase dykes. The south part of the area contains Paleozoic sedimentary rocks of the geological Saint Lawrence Lowlands Province. These rocks, overlying the Precambrian basement along an angular unconformity, include dolomite, limestone, sandstone, siltstone, and shale. Local aggregates accurately reflect the composition of the underlying bedrock and are generally of good quality.

Most sand and gravel deposits were emplaced during the last deglaciation. Many fluvioglacial deposits shape the landscape, in both valley and plateau settings. These deposits are much thicker and abundant in valleys however, where they occur as proglacial outwash and ice contact deposits. The Champlain Sea, which invaded the region after the ice receded, also left numerous deposits.

Sources of aggregate were once abundant in the study area. However, many have been extensively drawn from and are now depleted. They mainly consist of sand of variable grain size. Sources of natural gravel are not nearly as abundant.

The main areas that supply aggregates are: the Sainte-Angélique area, sites 5 to 9 and 24, along the Rivière de la Petite Nation, sites 27 to 31 west of Saint-André-Avellin, sites 32 to 35 along Montée Gore north of Plaisance, sites 41 to 44 north of Thurso, the Lac La Blanche area, along the Rivière du Lièvre valley northwest of Buckingham, as well as areas near Perkins, Cantley, and Wilson's Corner.

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New Lake-Bottom Sediment Geochemistry Data in the Western Grenville Province

Jean-Yves Labbé (MRNF)

In order to improve the regional geological knowledge base in the Grenville Province, Géologie Québec launched in 2007 a project to update the surficial sediment geochemistry coverage in this vast region. In 2008, within the scope of the Grenville West project, an extensive lake-bottom sediment survey was conducted in the Val-d'Or, Chibougamau and La Tuque areas. The study area roughly corresponds to a vast triangular zone bounded to the south by latitude 47° 22' 30"N, to the east by longitude 72° 00' 00"W, and to the northwest by the Grenville Front. A total of 4,357 samples were collected over a surface area of 59,400 km² for a sample density of about one sample per 13 km². The project also involved re-analysis of 2,631 samples collected in 1994 in the Parent area. All these samples were analyzed at AcmeLabs facilities in Vancouver. Concentrations for 53 chemical elements were determined by inductively coupled plasma mass spectrometry (ICP-MS) following *aqua regia* digestion. The data are available in SIGÉOM.

Regional maps showing the distribution of each element were produced using the inverse distance method. This poster shows a few maps that are most likely to be of interest for mineral exploration.

The copper distribution map highlights a few anomalous areas, namely in the south part of the region where three zones are identified. Two large nickel anomalies are defined in the west part of the region, in the Parautochthonous. The uranium distribution map on the other hand, shows many anomalous zones, namely in the westernmost part of the study area. Finally, the map showing combined lanthanum-niobium-yttrium values outlines a few anomalous zones most likely associated with alkaline intrusions.

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Outstanding Geological Sites – Protecting 4 Billion Years of History

Philippe Ferron (MRNF)

Geodiversity, much like biodiversity, is a common heritage that we must preserve and develop. Geodiversity encompasses a wide range of geological phenomena. It includes rocks, fossils, minerals, landscapes, soils, and unconsolidated deposits, as well as many of the natural processes that shape our environment. Québec is particularly well endowed in this regard and hosts many geological sites that contribute to this geodiversity and that should be taken into consideration.

In the fall of 2001, the government of Québec unveiled *Québec's Strategy for Protected Areas* (Ministère de l'Environnement, 1999, 2002). It was then that the foundations of sustainable development were laid and that the proposal to protect 8% of the territory in order to ensure the balance and future of our planet was made. In 2005, Québec added measures to the Mining Act to protect geological sites that are of interest for educational purposes, scientific research or conservation, and that deserve to be protected, either because they are threatened, rare or vulnerable.

Bill no.121 introduced the notion of classifying **outstanding geological sites** where, in accordance with section 30.1 of the Mining Act, mining activities would be prohibited. When a site is classified as an outstanding geological site, other types of activities may also be prohibited in accordance with other legislation, depending on the level of protection deemed adequate and what type of threat it may face. Based on the criteria of the International Union for Conservation of Nature (IUCN), outstanding geological sites may fall in one of six management categories recognized at the MDDEP.

An **outstanding geological site** is "*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*" (Section 1 of the Mining Act).

Conservation of these sites represents a major asset for science, education and public awareness of geodiversity. The geology of Québec has influenced the economic and cultural development of its regions. This is why, in addition to examining the situation at the provincial scale, it is important to consider regional specificity.

Earth is the ultimate support system for life as we know it through its wildlife and vegetation. To protect life's support system means to protect life itself!

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Geological and Metallogenic Setting of Gold Showings on the Poste Lemoyne Extension Property, Map Sheet 33G06, Baie-James

Simon Bourassa (UQAM), Alain Cayer (Virginia Mines), Daniel Bandyayera (MRNF) and Michel Gauthier (UQAM)

The Baie-James region is a popular playground for gold exploration, especially along the contact between the La Grande and Opinaca subprovinces, which has revealed its tremendous potential, namely on the Éléonore property. The study area selected for this Master's project, *i.e.* a portion of map sheet 33G06 covered by claims held by Virginia Mines, includes about a dozen gold zones (clusters of showings), for the most part recently discovered, all aligned parallel to this contact over about 12 km strike length. These gold-bearing zones are hosted in various lithologies, including iron formations, amphibolites, and diorites. It is fair to ask what type of genetic model, or models are involved. However, the geological and metallogenic setting of the area must be better understood before we can answer this question. Is the metamorphic and lithological contrast between the two subprovinces involved in some way? What is the nature of this contact and how does it relate to the mineralization? What are the different phases of deformation observed and how do they relate to gold emplacement? In order to explain the presence of this continuous anomalous corridor, it is easy to come to the conclusion that a large-scale phenomenon must have come into play.

Fieldwork, including targeted traverses and site visits of many occurrences in the study area, enabled us to clarify some of these questions. Specifically, several gold-bearing zones occur within or peripheral to zones that underwent significant retrograde metamorphism at the greenschist facies. Moreover, certain alteration patterns observed in the field, the presence of gold-bearing intermediate intrusions, and the occasional association with molybdenite can also lead to interesting hypotheses.

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Characterization of the Archean Porphyry Mo-Cu ± Au System at Tilly, Baie-James region, Québec

Baptiste Chapon, Michel Jébrak (UQAM), Pierre-Simon Ross (INRS-ETE), Ross Stevenson and André Poirier (GEOTOP-UQAM)

The exclusive occurrence of molybdenum porphyry deposits in Phanerozoic rocks is being called into question following several recent discoveries in Precambrian rocks. In Québec, the Tilly porphyry system was discovered by Sirios Resources based on the results of a regional lake-bottom sediment geochemistry survey. It is located in the La Grande geological Subprovince, within the Archean Superior craton, between reservoirs LG-3 and LG-4.

The geological setting on the Tilly property mainly consists of granitoid intrusions in the centre, with quartz diorites to the north. The granitoids display tonalitic to granodioritic compositions and have geochemical signatures typical of arc settings. Porphyry-textured intrusions were observed on outcrops and in drill holes. They are located mainly in the north-central part of the property, within the granitoids. Volcaniclastic rocks are exposed in the southeast part of the property, and may represent the effusive component and thus the top of the Tilly volcano-plutonic system. East of the property, the Sakami Formation forms a Paleoproterozoic arenitic platform sequence. This unit unconformably overlies the volcaniclastic rocks and the granitoids; it dips at about 25-30°, which indicates tilting after its deposition.

Mineralized zones are exclusively hosted in granitoid rocks. Molybdenite is the main mineral of economic interest; gold is associated with chalcopyrite, which is the dominant copper-bearing mineral phase.

Three styles of molybdenum mineralization were observed: (1) molybdenite in cm-scale pods in the quartz-rich cement of hydrothermal breccias; (2) networks of quartz-molybdenite veins and veinlets in granitoid rocks; and (3) cm-scale pods of molybdenite disseminated throughout the granitoid, associated with quartz pockets and microveinlets.

Hydrothermal breccia zones are 100 m to 1 km in size and crosscut the granitoid rocks. They are aligned along an east-west direction, indicating significant structural control. They show features typical of hydraulic fracturing: angular clasts, hydrothermal cement, and locally *in situ* brecciation textures.

Although the weak development of hydrothermal alteration is atypical, the Mo-Cu ± Au metal association is quite characteristic of recent porphyry systems in magmatic arcs.

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Reconstruction of the Volcanic Architecture in the Matagami Mining Camp: Implications for Mineral Exploration

Julie-Anaïs Debreil, Pierre-Simon Ross (INRS-ETE) and Patrick Mercier-Langevin (GSC-Q)

This study is located within the Matagami mining camp, in the north part of the Abitibi Subprovince. Eighteen volcanogenic massive sulphide (VMS) deposits are currently known in the camp and are concentrated along two felsic lava bands, the North Flank and the South Flank, located on either side of a mafic intrusion. Some undeveloped deposits are also present further west ("West Camp"), but correlations with the main camp remain uncertain at this point.

The objective of the project is to reconstruct the volcanic architecture at the local (orebody) and regional (mining camp) scales to facilitate exploration. This reconstruction is based on the study of vertical and lateral variations in volcanic facies, as well as a chemostratigraphic approach. Hydrothermal fluids responsible for the formation of massive sulphide lenses follow preferential paths in the volcanic stratigraphy. Reconstruction of the architecture of the volcanic system will highlight synvolcanic structures and potentially provide vectors for the investigation of new lenses. Another objective of the project is to better understand the setting and mode of emplacement of VMS lenses in the camp.

Type-sections containing several key drill holes located in priority areas for exploration were examined in detail over the course of two field campaigns (2008-2009). It initially became clear that several deposits (Perseverance, McLeod, etc.) formed along the interface between two rhyolites and not in a bimodal volcanic setting as suggested by previous publications. Moreover, the Watson rhyolite underlying the deposits does not contain obvious volcaniclastic products and appears to have been emplaced in the form of thick flows of fluid lava, which is fairly uncommon for felsic magmas. Systematic sampling was conducted to obtain chemostratigraphic profiles of the various geological units in the camp. These geochemical data will be used to characterize alteration and primary composition of lavas. Moreover, six new U-Pb zircon analyses are currently underway in order to date and constrain the timing of emplacement of the different rhyolites. By combining these methods, it will be possible to compare and correlate rhyolites in the South Flank and the West Camp, a key area for exploration.

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Heterogeneities in an Archean Fault: The Case of the MacCormack Area Along the Destor-Porcupine Fault, Abitibi (Québec)

Raphaël Doutre and Michel Jébrak (UQAM)

Major Archean faults exhibit strong heterogeneities, the origin of which, as well as their metallogenic impacts, remain poorly understood. A study was therefore undertaken along the east extension of the E-W-trending Destor-Porcupine Fault, in the MacCormack area, about 40 km northwest of Val-d'Or in the Abitibi region.

The fault is hosted in ultramafic rocks. Deformation within the fault zone is intense with a strongly penetrative schistosity. Two phases of deformation are recognized: D1 is characterized by an E-W-trending penetrative schistosity, quartz-ankerite veining, and E-W-trending dextral oblique shearing. D2 displays a NE-SW-trending schistosity, quartz $\pm$ ankerite veins, and NNE-SSW-trending sinistral shearing. Lavas underwent strong fuchsite, chlorite, and ankerite hydrothermal alteration during the first phase of deformation. Quartz-ankerite veins related to D1 have low length-to-thickness ratios in the 30-100 range, suggesting strong fluid overpressure. Outside of the fault zone, deformation is very weak, with a weakly penetrative schistosity and non-existent alteration. Quartz veins show high length-to-thickness ratios (400-500), suggesting low fluid overpressure.

Gold-bearing intermediate to felsic intrusions are present in the fault zone. These intrusions were emplaced during the first phase of deformation, taking advantage of local zones of weakness. The MacCormack intrusion was emplaced in the hinge of a km-scale F1 fold. Once they were emplaced, granitic intrusions acted as competent nodules within the fault zone leading to heterogeneous deformation, which may have resulted in the second phase of deformation.

Heterogeneities observed within the Destor-Porcupine Fault therefore have a lithological and structural origin. Lithological heterogeneities are responsible for the main rheological contrasts within the fault zone. They may predate the fault, or have appeared during its active phase such as intrusions in the MacCormack area. Structural heterogeneities are intimately linked to lithological heterogeneities: (a) shears, folds, and veins develop preferentially in rocks with favourable mechanical properties; and (b) the appearance of a new lithological heterogeneity in the fault zone will create a disturbance that may lead to the local expression of a second phase of deformation.

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Existence of Deep-Seated Transverse Discontinuities Involved in the Geodynamic and Metallogenic History of the Southwestern Grenville Province in Québec, Canada

G. Dufréchoy and L.B. Harris (INRS-ETE)

The Grenville Province is an orogenic belt, considered as the deep root of a Himalayan-type collisional orogen. It is composed of two belts: the Parautochthonous Belt composed of reworked Archean rocks, thrust over by the Allochthonous Belt, composed of elements that formed from 1.8 to 1.24 Ga in Andean-type geotectonic settings, associated with accretion of magmatic arcs. In the southwest part of the Grenville in Québec, Parautochthonous crust extends toward the southeast underneath Allochthonous crust, up to the Labelle deformation zone. The crust in this location is 44 km thick on average.

Gravity lineaments in the southwestern Grenville Province in Québec show the existence of deep-seated crustal-scale transverse discontinuities. Upward-continued filters corresponding to Z_0 depths of 5, 25, and 40 km indicate the presence at depth of two transverse lineaments trending N140°.

The Mont-Laurier lineament is visible up to 40 km depth. It marks the boundary of many deformation zones in the Central Metasedimentary Belt and near the Cabonga terrain, where it also marks the limit between Parautochthonous and Allochthonous terrains. This lineament extends into the Superior Province. This major Archean structure thus existed along the margin of the Laurentian craton prior to accretionary events and was presumably later reactivated during the Mesoproterozoic, during the construction of the Grenville Province.

The Portneuf lineament is visible at 25 km depth. It cuts across the Portneuf-Mauricie terrain, in which Ni-Cu and precious metal-rich magmas were emplaced. It is interpreted as the result of a change in the dip of the slab, attributable to collision between the Laurentian continent and an island arc represented by rocks of the Montauban Group at 1.4 Ga. The absence of this discontinuity in the surface geology may be explained by post-accretionary continental arc plutonism that affected the Portneuf-Mauricie terrain and that presumably masked the presence of this discontinuity, much like the suture zone itself. The presence of this type of structure has already been suggested to explain the presence of Ni-Cu $\pm$ PGE mineralization.

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3D stochastic inversion of magnetic data

Pejman Shamsipour, Michel Chouteau and Denis Marcotte (Poly)

One of the physical properties which changes from one rock type to another is susceptibility. The aim of magnetic surveying is to measure variations in the Earth's total magnetic field caused by changes in the susceptibility of subsurface rocks. Magnetic surveys have been used in the investigation of a wide range of scales, such as tectonic studies, mineral exploration, engineering and environmental problems, and oil and gas exploration. In this paper, a stochastic method for inverting surface magnetic data is presented to recover a 3D susceptibility model. Geophysical inversion of potential field is always a challenging job because of the non-unique property of these problems.

In 3D magnetic inversion, there are different ways that the model can be defined. One flexible way is to describe the model by a grid of prismatic cells. The subsurface is divided into prisms of known sizes and positions. The susceptibility contrasts are supposed constant within each cell. The parameters to estimate are the susceptibility of cells. The anomalous magnetic field is the sum of the responses of each cell at the observation location. The result of forward modeling is shown on synthetic data and compared with commercial software (potent). Noted in this algorithm, it is supposed that there is no remanent magnetization and the observation data are produced by induced magnetization only. This is true for the Archean rocks in Québec.

In this paper the inversion method based on a geostatistical approach is presented for three-dimensional inversion of magnetic data. The aim of geostatistics is to provide quantitative descriptions of natural variables distributed in space or in time and space. Cokriging, the method which is used here, is a method of estimation that minimizes the error variance by applying cross-correlation between several variables.

The necessary total field, susceptibility and total field-susceptibility covariance matrices are estimated using the observed data. Then, the susceptibilities are cokriged or simulated using the susceptibility data as the secondary variable. It should be mentioned that in our cokriging system, the primary variable is susceptibility and the secondary variable is total field. The cokriging system used here has the particularity that the estimate is obtained only from the secondary variables.

The proposed method is applied to two different synthetic models. The results show the applicability of the method to 3D inversion of magnetic data. The next step will be to apply it to a real dataset from mineral exploration.

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The Preliminary Results of a Study of the Volcanology and Metallogeny of a Prospective Sector of the Hébécourt Formation, Abitibi Subprovince, Québec

Russell Rogers, Pierre-Simon Ross (INRS-ETE), Jean Goutier (MRNF), Patrick Mercier-Langevin (GSC-Q), Benoit Lafrance (CONSOREM) and Tony Brisson (Cogitore Resources)

The Blake River Group (BRG) is the youngest dominantly volcanic subalkaline package within the Archean Abitibi Greenstone Belt. The overwhelmingly tholeiitic and mafic Hébécourt Formation is located in the northern part of the BRG and is among its oldest stratigraphic units, corresponding approximately to the age of the rocks hosting the world-class Horne volcanogenic massive sulphide (VMS) deposit in the Noranda camp. A collaborative research endeavour is in progress to examine the top part of the Hébécourt Formation on either side of the Ontario-Québec border. This sector was selected because VMS-style mineralization is known from historical and recent drilling, but the area has seen much less exploration than, for example, the central Noranda camp.

The study aims to improve the lithostratigraphy, chemostratigraphy and characterization of the physical volcanology of the units and to understand and exploit the exhalative horizons as tools for mineral exploration. Improved chemostratigraphy will enable the development of vectors from the sulphide and mineral chemistry of the exhalative horizons by firmly establishing their stratigraphic position. Enhanced chemostratigraphy will also improve the positioning of synvolcanic faults of the area. Detailed facies interpretation will indicate the location of volcanic vents, which are often associated with hydrothermal vents.

In the study area, the top part of the Hébécourt Formation is characterized by two progressions from mafic to felsic lavas with an exhalative horizon capping each progression. The first progression consists of a basalt (predominantly pillowed), a rhyolite (informally subdivided into a lower and an upper unit), and an exhalite. Both rhyolitic units are increasingly brecciated up succession from massive intervals with local flow banding. The second progression begins locally with another basalt, followed by a variolitic basaltic andesite (hyaloclastite at the base and pillows with interstitial hyaloclastite at the top) and finally a rhyodacite (that has both massive and lapilli tuff facies), and the second exhalite. Locally there is a second rhyodacite, with a transitional affinity more typical of the overlying volcanic rocks in the BRG. The relationship of this rhyodacite to the other rocks of the Hébécourt Formation is still unclear at present. The exhalative horizons vary in thickness and composition, between horizons and laterally, from very finely laminated pyrite to massive chert with no visible sulphides, to sulphide stringers.

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Geoscience Knowledge Acquisition in Québec – Planning and Consultation

Sylvain Lacroix, Jean-Yves Labbé and Charles Maurice (MRNF)

Québec Exploration is a great venue to present our geoscientific program planned for the coming year, and to collect the comments of stakeholders from the industry, universities and regions. Québec Exploration 2009 is a particularly good opportunity to conduct a geoscientific consultation, since the year 2009 coincides with the end of the Copper Plan (2005-2009), the start of the geoscience component of the Northern Plan, and the start of a program to map surficial geological formations (Quaternary) in partnership with the Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP) under Québec's Groundwater Knowledge Acquisition Program.

This poster aims to illustrate the main geoscience projects conducted in recent years throughout Québec, and those currently planned for the future. Geoscience projects are listed per multi-year geoscience program, per geological region, and per intervention method (geology, geochemistry, geophysics). The initial planning for the 2009-2010 geoscience program will also be presented. We invite all interested stakeholders from the mining industry, universities and regions to provide their feedback using the comment form that will be made available near the poster.

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Imaging structures at different depths through enhancements of aeromagnetic and gravity data in the Chibougamau area, Abitibi Subprovince

Lyal Harris, François Leclerc (INRS-ETE) and Jean Bédard (GSC-Q)

Despite the availability of excellent quality aeromagnetic and gravity data in Canada, data imaging is generally restricted to simple processing of total fields. For example, aeromagnetic imagery is commonly presented as total magnetic intensity, first (and possibly) second vertical derivatives, and directional derivatives or shading. The Bouguer anomaly and vertical derivatives are the most common portrayals of gravity data. Most exploration effort and regional mapping (except by several major global exploration companies) focusses on surface to near-surface geology; even when geophysical data, such as gravity or aeromagnetics, are used in mineral exploration, they are not generally separated into (i) deep crust and mantle, and (ii) upper crustal components. Resulting interpretations commonly miss what may be the most important structures localizing mineralization, *i.e.* those in the deep crust and sub-crustal lithospheric mantle. Also, as the total field is interpreted, upper crustal structures hosting mineralization are not imaged as well as if only the shallow-source component is examined in detail.

The Chibougamau area in the Abitibi Subprovince of the Superior craton, Québec, is used as an example of processing of aeromagnetic data acquired during NRCAN's Targeted Geoscience Initiative 3 Abitibi Project's Megatemp survey and of regional GSC gravity data to highlight structures at different crustal levels. The combination and ternary representation of derivatives of aeromagnetic imagery enhances stratigraphic horizons and upper crustal structures, greatly aiding regional mapping. In the Chibougamau area, for example, ternary images, especially where combined with total field or bandpass-filtered aeromagnetics, highlight early fold closures and detailed structures in regional shear zones. Bandpass filtering of aeromagnetic imagery highlights deep crustal structures. Edges in the horizontal gradient of Bouguer gravity data upwards continued to different levels (*i.e.* "worming") portray the 3D geometry of crustal structures. Structures in the lower crust and possibly sub-crustal lithospheric mantle are imaged in enhanced, bandpass-filtered gravity data. Regional deep structures are identified by combining deep "worms" with such additional treatments of gravity data.

Enhancements of aeromagnetic and gravity data presented for the Chibougamau area illustrate the potential to extract more information from available geophysical data in regional mapping and target generation in mineral exploration.

175A

Recognition of Synvolcanic Structures Fertile for Volcanogenic Massive Sulphide Mineralization (Cu-Zn) in the Blake River Group, Abitibi

Stéphane Faure (CONSOREM)

Spatial relationships were established between synvolcanic structures (known or newly interpreted) and volcanogenic massive sulphide (VMS) mineralization and alteration in the Misema Caldera of the Blake River Group (BRG) in the Abitibi.

Known faults on the Québec side of the BRG were the subject of a comparative analysis with fault networks in the southern Superior Province. Faults belonging to the N050-N090 (Central Camp) and N090-N135 systems were interpreted as synvolcanic structures because they are confined within the walls of the Misema Caldera. Other faults are at higher angles with respect to the Abitibi structural grain and correlate with various brittle tectonic events of Proterozoic age.

A new method of recognizing faults has been developed. The technique is based on disruptions of interpolated surfaces generated from spatially referenced bedding (S0) data. The technique consists of locating sharp breaks in the strike and dip grids. The method revealed 153 new faults or fault extensions, mainly in the western part of the BRG and south of the Misema inner fault. Overall, the strikes of these new faults are very similar to the orientation of the main systems of known faults, indicating that these structures have a real geological significance.

A single database was compiled containing 830 known and interpreted faults, taking into consideration the proximity of these faults to 22 geochemical alteration criteria, normative alteration minerals, and mineralization criteria. Principal components analysis (PCA) was performed on previously known faults affected by at least two types of alteration, to isolate volcanogenic-type fertile lithogeochemical alteration assemblages. These faults are spatially associated with mines and VMS lenses (≤ 400 m), sulphide zones and copper showings, and/or are proximal to mafic dykes (≤ 200 m) and have Ishikawa + pyrophyllite and/or Spitz-Darling types of alteration. The latter types of fertile alteration were subsequently searched for among the rest of the known faults and among the new faults. The map distribution of all fertile faults demonstrates that only hydrothermal systems related to the New Senator and Noranda calderas are fertile. Nevertheless, the most fertile faults are restricted to the Central Camp and are associated with a N070 synvolcanic system and with the Despina and McDougall faults.

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Hydrothermal Footprint in the Hanging Wall of Volcanogenic Massive Sulphides, the Case of the Matagami Camp

Hugues Longuépée (CONSOREM)

Volcanogenic massive sulphide (VMS) deposits are always associated with alteration zones that reflect the circulation of hydrothermal fluids responsible for the leaching, transport, and deposition of various chemical elements. Geochemical tools to establish the presence of hydrothermal alteration are therefore commonly used in mineral exploration. The different models for VMS systems invoke either exhalation of high-temperature fluids and alteration of rocks underlying the deposit (footwall), or replacement underneath an impermeable horizon. In the first case, alteration in the hanging wall cannot be generated (*e.g.*, VMS in the Noranda Camp), and footwall alteration is well defined. In the second case, the impermeable layer also generates alteration concentrated in the footwall. Repeated activity along a synvolcanic fault and circulation of hydrothermal fluids may lead to stacking of ore lenses emplaced at different stratigraphic levels. In this particular case, alteration in the hanging wall of a lens represents the alteration zone in the footwall of the overlying lens. However, there are cases reported in the literature where alteration in the hanging wall of a deposit is suspected, without the presence of this stacking process. The objective of the Consorem project is therefore to recognize and analyze hydrothermal alteration located in the stratigraphic hanging wall of volcanogenic massive sulphide deposits. Since the study area should not be characterized by stacking of ore lenses, the Matagami camp was therefore selected as the ideal study area. With the exception of the Bracemac and Orchan West deposits, massive sulphide lenses are all located along the same stratigraphic layer, and no stacking is recognized.

Three-dimensional modeling of lithogeochemistry data along the South Flank of the Galinée anticline reveals the presence of hydrothermal alteration in the hanging wall of each deposit. This alteration translates into elevated values for the Ishikawa and Hashimoto indices, the chlorite alteration index, and high zirconium values. Na_2O on the other hand shows depleted values relative to regional background levels. These indications suggest a zone of sodium leaching, which extends for about 40 metres above the largest deposits. One possibility to explain these observations is that despite the flow of lavas above ore lenses, hydrothermal activity may have continued over a short time span, thus creating an altered "cap rock" above ore lenses. These elements should be taken into consideration in exploration strategies.

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Digitization of Analogue Radiometric Data from SOQUEM in the Grenville

Sylvain Trépanier (CONSOREM)

The lack of public and regional radiometric data is a major obstacle to exploration in the Grenville Province of Québec. However, analogue data from private radiometric surveys (spectrometer and scintillometer surveys) conducted by SOQUEM in the 1960s and 1970s cover extensive areas across this geological province. These surveys were provided by SOQUEM to the CONSOREM within the scope of a project to assess the mineral potential of the Grenville Province.

In their analogue form (paper), these surveys are very difficult to use within the scope of a regional targeting study. Moreover, no correction of raw radiometric values was available.

A semi-automated digitization method was developed to rapidly and efficiently transform paper profiles into digital data that could be used in modern GIS. Given the considerable amount of survey data and the limited resources available, only regional spectrometer surveys of areas not covered by public surveys were digitized. Various correction factors were then applied to these raw data to obtain better signals.

The 133 digitized surveys mainly cover NTS sheets 22C, 22D, 22E, 22F, 22G, 22I, 22J, 22K, 22N, 22O and 31O. Some of these map sheets are covered 100% whereas others only have partial coverage. The spacing between flight lines was normally 1 km. The area covered by the digitized data represents about 56,000 square kilometres, *i.e.* a little over 12% of the surface area of the Grenville Province in Québec.

Digital survey data in grid format is available to the public in GM-63976. A technical report is also included that specifies the characteristics of the surveys, the digitization procedure, and the various correction factors applied to the data.

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DIVEX: The Network and Current ProjectsCéline Dupuis, Georges Beaudoin (ULAAVAL)
and Michel Malo (INRS-ETE)

DIVEX is a research network focusing on the diversification of mineral exploration in Québec. It brings together geoscientists from all the universities in Québec and researchers from the Ministère des Ressources naturelles du Québec and the Geological Survey of Canada. DIVEX strives to develop new approaches, new methods, or new practical tools for mineral exploration by combining fundamental and applied research. Since 2002, 40 projects have been financed thanks to grants from VRQ, the MDEIE, and the FQRNT. Four main themes are at the heart of the scientific program:

- The potential for discovering new substances in Québec (diamonds and platinum group elements);
- Under-explored geological environments in Québec (sedimentary environments, Archean magmatic systems, and high-grade metamorphic terrains);
- The use of new geological and genetic models to better understand Québec's deposits;
- The use of new tools to improve exploration methods.

Twelve projects are currently financed by the network, the last two of which are in collaboration with Groupe MISA:

SC29 - Applied mineralogy in mineral exploration

SC30 - New VMS exploration concepts: the case of Matagami

SC31 - Characterization of crustal-scale structures interpreted from gravity "worms" and their relationships to hydrothermal alteration and mineralization, Grenville Province, SW Québec

SC32 - Cu-Au-Ag mineralization at Ell Lake: implications for the genesis of the Roberto gold deposit and exploration strategies in the Baie-James region

SC33 - The Misema and New Senator calderas: volcanology, volcano-tectonic structures and VMS mineralization, Blake River Group

SC34 - Granitoids and lode gold deposits, Val-d'Or, Abitibi – Structural synthesis and contribution of $^{40}\text{Ar}/^{39}\text{Ar}$ dating

SC35 - Evaluating the link between gold potential at depth and the permeability along Archean deformation corridors

SC36 - The Tilly molybdenum porphyry system

SC37 - Inter-sector thermometry in pyrite: a new potential tool for metallogenic studies

SC38 - Spatial distribution of orogenic deposits along major Archean faults

SC39 - Metallogenic, metamorphic and morphological description of the magmatic Ni-Cu-Co-Pd Nisk-01 deposit in the Lac des Montagnes band of the Nemiscau belt, Baie-James region

SC40 - Nature of the association between pedogeochemical signatures and high thermal conductivity zones

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Three-Dimensional Hydrothermal System Visualization About the Horne Orebody From Oxygen Isotope Mapping

Bruce Taylor, Eric de Kemp (GSC), Louis Martin (Xstrata Copper Canada), Eric Grunsky (GSC), Jean Goutier (MRNF), Kathleen Lauzière, Benoît Dubé (GSC-Q), Gordon Maxwell (Xstrata Copper Canada) and David Rigg (Alexis Minerals)

The whole-rock oxygen isotope technique provides a robust means of mapping paleo-hydrothermal systems. We combine data from surface (outcrop) and near-surface (drill core) samples in the Rouyn-Noranda area and from underground (drill core) samples in the Horne mine, to present the first 3D visualization of the ore-forming hydrothermal system for this world-class orebody. The isotopic compositions, reported as $\delta^{18}\text{O}_{\text{WR}}$ (V-SMOW), are grouped for graphic representation as follows: $\delta^{18}\text{O}_{\text{WR}} < 6.0\text{‰}$, $6\text{--}9\text{‰}$, and $> 9.0\text{‰}$. Colour grouping (symbols and zone patterns) as red ($< 6.0\text{‰}$) or blue ($> 9.0\text{‰}$) signifies higher-temperature and lower-temperature alteration, respectively, and facilitates ready visualization. The range of $\delta^{18}\text{O}_{\text{WR}}$ for surface samples within about 5 km of the Horne mine comprises values from 2.8 to 12.4, and represents both the eastern portion of the Powell Pluton, as well as rhyolitic and andesitic flows and volcanoclastic rocks inferred to be internal and external to the Noranda cauldron. Samples from the wallrocks of the Horne mine orebodies have a similar range of values. In both cases, the range of compositions is broadly reflective of the rocks' hydrothermal mineral assemblages. Relative to fresh rocks, with $\delta^{18}\text{O}_{\text{WR}} \sim 6.0$ (andesite) to 8.0 (rhyolite), low values of $\delta^{18}\text{O}_{\text{WR}}$ are associated with higher temperature, chlorite-dominant alteration, whereas high values of $\delta^{18}\text{O}_{\text{WR}}$ are associated with lower temperature, quartz-sericite alteration. However, it is the mapped distribution of the $\delta^{18}\text{O}_{\text{WR}}$ values that is of most significance in our study. Contained within the 'mine wedge', bounded by the Horne Creek and Andesite faults, isotopic variations about the Horne mine are isolated from isotopic features of the central camp, in particular, a narrow, discordant, low $\delta^{18}\text{O}$ (high-temperature) zone emanating from the Powell Pluton associated with elevated Cu/(Cu + Zn) ratios and normative corundum, and lowered concentrations of SiO_2 . Many samples from the footwall of the Horne deposit have somewhat elevated values of $\delta^{18}\text{O}$, reflecting lower-temperature silicification prior to the main period of sulphide deposition. The distribution of ^{18}O -enriched samples is somewhat irregular, however. Unlike many other systems, we have yet to find evidence for focused high-temperature up-flow zones in the footwall. Low $\delta^{18}\text{O}_{\text{WR}}$ values indicative of high-temperature fluids are found sporadically in both the (structural and/or stratigraphic) footwall and hangingwall, and likely represent post-main stage fluid flow. This finding is, in part, influenced by our sample distribution and structural considerations, but corresponds to conclusions of others based on the occurrence of selected alteration minerals such as chlorite.

160BC

Geology of the Ell Lake Cu-Au-Ag Showing, Éléonore Property, Baie-James

Valérie Bécu (GSC), Jean-François Ravenelle (INRS-ETE), Benoît Dubé (GSC), Michel Malo (INRS-ETE), Robert Creaser (University of Alberta), Vicki McNicoll (GSC) and Jacques Simoneau (Mines Opinaca)

The Ell Lake Cu-Au-Ag showing shares certain similarities with porphyry-type Cu-Au deposits; it is hosted in a calc-alkaline porphyry intrusion and the mineralization is mainly composed of chalcopyrite and pyrite with minor bornite, magnetite, and molybdenite. Mineralization varies from disseminated to semi-massive from the edges to the core of the main mineralized zone. Bismuth-molybdenum sulphosalts, tellurides and electrum were observed in association with semi-massive chalcopyrite pockets. Potassic alteration of variable intensity and limited extent, and propylitic alteration, outlined by the presence of chlorite-epidote±carbonates, occur in association with the mineralization.

Nonetheless, the spatial distribution of the mineralization as a network of veins or mineralized breccias, as is commonly encountered in magmatic porphyry-type deposits, is not clearly recognized in exposed parts of the Ell Lake showing. Also, there appears to be no zoning of the mineralization nor of hydrothermal alteration zones. Average grades for five grab samples reach 7.05% Cu, 5.6 g/t Au, and 33.1 g/t Ag, which is not typical of the low grades generally associated with magmatic porphyry-type deposits.

Based on observations made during the current study, a relative time line was established that does not support the magmatic porphyry Cu-Au deposit model, where the host intrusion would also have acted as a heat source and/or a source of mineralization. Mineralized zones in the Ell Lake showing are confined within a m-scale corridor trending SSW, *i.e.* at an angle relative to the main foliation S2 that affects the intrusion in the area. Certain disseminated zones are parallel to S2, whereas other zones trend SSW, *i.e.* parallel to the alignment of the broader mineralized corridor. Aplite dykes were mapped in the host diorite, and one of these dykes is boudinaged and cut by the mineralized corridor. A dyke with porphyritic K-feldspar, whose dioritic wallrocks have undergone strong potassic alteration, has also been mapped in the area. These late magmatic phases may have played a key role in the genesis and emplacement of the mineralization.

Based on information collected thus far, it is currently difficult to determine the exact origin of Cu-Au-Ag mineralization at the Ell Lake showing. Results of Re-Os geochronology analyses on molybdenite grains, combined with new U-Pb geochronology data on the Ell Lake intrusion (2705.6 ± 1.9 Ma) will help constrain the age of the mineralization and test the model of a porphyry-type deposit associated with the host intrusion. These new data will document the magmatic history of the Éléonore property and the potential role of magmatism in the genesis of the Ell Lake showing and the Roberto gold deposit.

175BC

Metamorphosed Advanced Argillic Alteration in the Bondy Gneiss Complex, Grenville Province, Québec: Metallotect for Exploration of Metamorphosed Epithermal Systems?

Vladimir Antonoff, Marc Richer-LaFlèche (INRS-ETE), Louise Corriveau (GSC), Grégory Dufréchoy and Lyal B. Harris (INRS-ETE)

The Bondy Gneiss Complex (1.4-1.35 Ga), Grenville Province, is interpreted as the remains of a vast volcano-plutonic complex emplaced in a back-arc setting. The north part of the Bondy Complex hosts an extensive, magnetite-rich hydrothermal system some 12 × 4 km in size, with components identical to those in iron oxide-copper-gold (IOCG) systems, metamorphosed to the granulite facies (~950°C at ~10 kbar) at 1.2 Ga. A new alteration zone, unknown until now, was recently identified within this hydrothermal system.

The alteration zone is represented by anomalous concentrations in aluminosilicates (sillimanite ± kyanite) and sulphides (up to 60% pyrite-pyrrhotite ± cubanite ± chalcopyrite ± molybdenite ± sphalerite). A petrology study of rock samples led to the identification of gneissic bands with aluminosilicates-quartz-sulphides ± K-feldspar, sillimanite layers with or without sulphides, orthopyroxene-biotite ± magnetite nodules, massive sulphide veins, all associated with a series of quartzofeldspathic gneisses ± biotite ± garnet ± sulphides, and silicified gneiss. Despite the fact that the primary mineralogy and textures are not preserved, the geochemical study of aluminosilicate-quartz-sulphide ± K-feldspar gneisses shows strong enrichment in Sr (up to 1854 ppm) and locally in Ba (1227 ppm), associated with strong leaching of CaO, Na₂O, MgO and K₂O, typical of quartz-alunite-clay-barite rocks in the advanced argillic alteration zone associated with high-sulphidation epithermal-type deposits. Local anomalies in W (333 ppm), Cu (4800 ppm), Zn (7000 ppm), Ag (3.5 ppm), and Mo (26 ppm) were discovered in sulphide-bearing sillimanite layers within the alteration zone.

The identification of a new alteration zone showing similarities with advanced argillic alteration zones in high-sulphidation epithermal-type systems and hosting mineral occurrences offers new insight to understand the origin of the hydrothermal system in the Bondy Gneiss Complex. Our results demonstrate the importance of pursuing exploration efforts to discover epithermal-type deposits in the Grenville. At a larger scale, the study outlines the importance of not overlooking high-grade metamorphic terrains in mineral exploration strategies.

Richmond Minerals Ltd holds the mining claims in the Bondy Gneiss Complex and provided the funds for this research project.

176BC

New Stream Sediment Geochemistry Data in North-Central Gaspésie

Ahmed Boulahcen, Michel Malo (INRS), Jean-Yves Labbé (MRNF) and Georges Beaudoin (ULAAVAL)

In an effort to develop the mineral potential of the Gaspésie region, the MRNF has conducted, over the past thirty years, geochemical prospecting campaigns involving systematic sampling of stream sediments. About 70,000 stream sediment samples were thus collected prior to the year 2000.

During the year 2009, the MRNF re-analyzed 7,290 samples in an important area for exploration in north-central Gaspésie, which namely hosts the mine in Murdochville. New analyses using modern analytical methods will be used to upgrade geochemical anomaly maps for the area. This poster shows a few preliminary geochemistry maps as well as the objectives of a Master's project on the regional metallogeny of north-central Gaspésie.

The objectives of this project are to reassess the potential for various types of metallic deposits in the north-central part of the Gaspé Peninsula, to take stock of all mineral occurrences, to define the main metallotects and to define the metallogenic potential of the region, taking into account its regional geological and geophysical characteristics. Exploration guides may then be developed based on geological, geochemical and geophysical data, in order to locate metal concentrations and designate prospective areas for exploration.

Sediment samples were collected at 500-m intervals, in the bed of all streams across the Gaspésie region. The samples were dried in the open, then in an oven, and were subsequently sieved to obtain the appropriate grain size fraction.

Samples were initially analyzed either by:

- Atomic absorption spectrometry, or by
- Visual colorimetry.

In 2009, induced coupled plasma (ICP) mass spectrometry following *aqua regia* digestion was used to analyze samples for 53 chemical elements.

The effectiveness of stream sediment geochemistry as an exploration tool in the Gaspésie region is recognized by all those who have used it in the past. The region has a well-developed drainage network and very little glacial overburden; these two factors explain the success of this method.

Stream sediment analysis successfully outlined variations in the lithogeochemistry of underlying sedimentary sequences. In light of these results, studies directly focused on the lithogeochemistry of these sedimentary sequences and their various facies should be undertaken, the results of which would prove useful for both exploration, and stratigraphic and geological studies.

177BC

Glacial Sediment Prospecting in a Multiple-Flow Zone, Meadowbank Gold Project, Nunavut

Catherine Goulet, Martin Roy (UQAM), Guy Gosselin and Denis Vaillancourt (AEM)

The Meadowbank property is located in an area of the Keewatin that is particularly important relative to the configuration of the Laurentide ice cap, which covered the entire region during the last ice age. The study area lied directly underneath a thick dome of ice, from which ice flowed toward the west and northwest margins of the ice cap. Recent work has shown that this glacial dispersion centre, commonly called the Keewatin dome, was displaced over several hundred kilometres during the glaciation, thereby creating major reorganizations of ice flow patterns. These important variations in the location of the ice divide consequently affected glacial transport and reworked glacial dispersal trains.

Interpretation of geochemical results must address many challenges in this area, due to the following: permafrost-related processes modify till layers through important freeze-thaw cycles that influence sulphide dissolution and rework unconsolidated material; the nature of the gold-bearing host rock plays a role in the distance over which gold may be transported in the secondary environment; local variations in glacial dynamics; analytical issues related to gold (nugget effect); the well-endowed nature of the bedrock that hosts many sources of gold, known and yet unknown; and the occurrence of many ice flow patterns with diverse orientations that complicate the morphology of dispersal trains.

Based on glacial geology mapping, 7 ice flow directions were recognized: W, NW, N, NNW, NNE, WSW and SW. The dominant ice flow direction trends N-NNW and corresponds to the most recent phase of this series of ice flow movements. Geochemical dispersal trains for gold and associated major elements are also dominantly N-NNW, but also show evidence of reworking of earlier dispersal trains. An estimate of transport distances based on a microscope study of gold grains and on till geochemistry patterns suggests that transport distances vary from one area to another. However, most parts of the property are characterized by short transport distances, commonly less than 3 km, except for a narrow corridor which contains landforms indicating rapid ice flow. Petrographic counts of clasts in till will provide a more accurate estimate of glacial transport in the area. The data derived from this project should help locate certain areas with gold potential and thus contribute to mineral exploration in this region.

178BC

Numerical Analysis of Water Flow and Contaminant Transport in Mine Waste Stored in Fractured Rock Masses

Farouk Ben Abdelghani, Richard Simon, Michel Aubertin, John Molson (Poly) and René Therrien (ULaval)

Water flow and transport of contaminants in mine waste that is stored in fractured rock masses are strongly controlled by discontinuities. In this study, many numerical simulations were performed in order to examine the impact of discontinuities on water flow near underground openings. Water flow was simulated in unsaturated and transitory conditions, in both rock masses and in mine waste stored in open pits. The simulations were carried out using HydroGeoSphere 3D code (Therrien *et al.*, 2005). Parametric analysis was performed by simulating many representative situations using the experimental properties of materials and by setting boundary conditions for precipitation flux and initial contaminant concentrations. The influence of the hydraulic properties of materials (water retention curve and hydraulic conductivity curve) and of the characteristics of the network of discontinuities was also examined. Parametric analysis illustrates water flow and migration of contaminants around mine waste storage sites situated in fractured rock masses. The implications on the storage of contaminated mine waste are also discussed.

179BC

The ITRAX Core Scanner™: A Non-destructive Tool for Very High Resolution Radiographic Imaging and Chemical Analysis by X-ray Microfluorescence of Rocks and Sediments

Arnaud De Coninck and Pierre Francus (INRS-ETE)

Traditionally, the acquisition of geochemical data is a rather long and tedious task. The ITRAX Core Scanner™ provides rapid acquisition of high-resolution (100 µm) geochemical data and radiographic images of rocks, sediments and soils without losing or destroying the material to be analyzed.

The operating principle is based on the simultaneous acquisition of micro-variations in density and structure (micro-radiography) and the chemical composition of the sample's surface (X-ray microfluorescence) using two distinct X-ray detection systems. An optical line-scanning camera is incorporated into the system to provide an image of the sample. In addition, a laser measures the topographic profile of the sample, allowing the XRF detector to automatically adjust to variations in the topography of the sample surface. The analysis is therefore performed without touching the sample surface and is completely non-destructive.

The apparatus can analyze samples in the form of half-cores, slabs or U-channels. The maximum measurable length is 1.8 m over a width of 11 cm and a thickness ranging from 2 to 8 cm. Profiles of variations in concentration can be recorded for a wide range of elements, from Si to U, including the majority of major elements, metallic trace elements, rare earth elements, and platinum group elements. A molybdenum X-ray tube allows for a detection limit down to 20 ppm for some elements, depending on the analytical time and the composition of the matrix.

In contrast to traditional geochemical analyses that yield an average concentration of given elements for the whole sample, this technique reveals geochemical variations along the entire length of the sample at the millimetre, even micrometre, scale. Integrated with field and geochronology data, it provides a better understanding of the geochemical evolution (changes in the geochemical phases) of the system in time and space. This technology is applicable to several fields of study, including, for example: sedimentology, paleoclimatology, mineral and petroleum exploration, civil engineering, environmental science, pedology and archaeology.

180BC

Maar-Diatreme Volcanic Systems

Séverine Delpit and Pierre-Simon Ross (INRS-ETE)

A general consensus outlines that monogenetic volcanic systems of maar-diatreme type form as a result of explosive interaction between ascending magma and an external source of water under the pre-eruptive surface. This eruptive process, called phreatomagmatic, leads to the expulsion of wallrocks toward the surface. The maar is an explosion crater situated in the pre-eruptive surface and bordered by a ring, complete or incomplete, of pyroclastic material ejected during the eruptive phase. Its dimensions range from 100 m to about 2-3 km in diameter and from 10 m to about 300 m depth. The diatreme is the internal part of the system and the most elaborate one. It results from the progressively deeper penetration of repeated explosive interactions. It is cone-shaped, its diameter ranges from about 10 m to more than 1500 m, and its root can reach 2000-2500 m depth. The nature of the eruptive process(es) leading to the formation of such volcanic systems remains speculative and is still poorly understood as these processes mostly occur at depth. The shape and geometry of these systems are largely influenced by the structural setting and the type of substrate in which they were emplaced: in "hard rock" settings or in unconsolidated materials. Within the scope of the PASADO project, a Quaternary maar and the surrounding volcanic systems, emplaced in a mixed environment, were studied in Argentina (Pali Aike volcanic field, near the Chilean border), in order to shed new light on eruptions in this little-known environment. A second project is underway to study diatremes (Missouri Breaks, USA) to better constrain the nature of eruptive process(es). The study of this type of volcanism is socially and economically important. Volcanism remains a dangerous and unpredictable phenomenon: for example, Quaternary monogenetic volcanic fields such as the Massif Central in France or the Eifel Field in Germany may reactivate and represent a risk for local populations. The study of these volcanic systems will thus lead to a better understanding of eruptive processes and volcanic risks. Moreover, certain kimberlitic diatremes contain mineable diamond deposits. Improved understanding of these systems will thus also benefit mineral exploration.

181BC

Estimation of Nickel Grades Using Stochastic Seismic Tomography

L. Perozzi, E. Gloaguen, S. Rondenay, G. McDowell, R. Wheeler and A. Leite (INRS-ETE)

In the mining industry, classic methods to build a grade model for ore deposits are based on kriging or cokriging of grades for targeted metals measured in drill core in fertile units. In cases where the geometry becomes difficult to unravel, grade estimation becomes a complex task. As the complexity of the geological geometry increases, so does the complexity of grade estimations. For example, in layered mafic or ultramafic intrusions, it is necessary to know the layering geometry in order to perform kriging of grades in the most fertile zones. Without additional information on structure, the definition of zones enriched in targeted minerals is a low-precision exercise that requires extensive experience and good intuition from the geologist.

Geophysical measurements thus become a very interesting tool to provide additional information on the nature of the deposit.

For example, in lens-shaped deposits, it is necessary to know the shape of ore lenses and to kriging grades within these lenses. It is quite obvious that without additional information, the definition of fertile zones will be a low-precision exercise. Thanks to the development of geophysical and computer tools, processing of seismic imagery data between drill holes has become more and more attractive for various *in situ* applications. This non-intrusive method can be used to image the physical properties of the sub-surface between two or many drill holes. In particular, seismic tomography can be used to extrapolate mechanical properties by analyzing the speed and attenuation of the transmitted wave. Moreover, borehole geophysical surveying can be used to constrain seismic imagery between drill holes. Vale Inco acquired a set of seismic and borehole survey data for one of their mine sites in operation. A geostatistical approach to seismic imaging can produce grade scenarios of targeted minerals measured in drill core and constrained by geophysics. The ultimate goal is to provide grade models between drill holes, constrained by geological and geophysical data.

300

New targets for mineral exploration – 2009

Daniel Lamothe (MRNF)

Stop by Salon Montcalm for a look at the new ArcGIS secondary environment analysis processing module. By incorporating data from multiple sources (lakes, streams, tills, and soil) this Modelbuilder program automates the production of geochemical maps for Québec as a whole. The module is supplied by a geodatabase covering all of Québec. This multisource analytical database incorporates data from the new lake sounding survey in Grenville as well as the recent ICPMS re-analyses of samples from the North Shore of the Labrador Trough (lake bottom) and the center of Gaspésie (streams).

Thirteen multisource raster maps (Geotiff and ArcGIS formats) and a database of geochemical targets (ArcGIS files) will be distributed in EXAMINE (other data) for the following elements: As, Ce, Cr, Co, Cu, La, Li, Mo, Ni, Th, U, W, and Zn. In each case, two types of targets were generated using the weight of evidence method and spatial regression approach developed by CONSOREM.

301

New Targets for Mineral Exploration – 2009 Geoscience Projects

MRNF

Géologie Québec presents all the targets of economic interest uncovered during its 2009 geoscience projects. During their fieldwork, geologists from the Ministère des Ressources naturelles et de la Faune identified areas with a favourable geological setting for mineral exploration. These areas of interest have not been studied in detail but warrant further investigations by exploration companies. Newly acquired data on these areas of interest were processed in a preliminary fashion and will be made public during Québec Exploration 2009.

In this document, a target corresponds to a zone where the geological setting is favourable for mineral exploration and where further exploration work is deemed relevant. Data provided on these targets are essentially derived from field observations. There are three categories of targets: 1- point targets measuring less than 100 metres; 2- local targets ranging from 100 metres to 1 kilometre in size; and 3- regional targets greater than 1 kilometre in size.

**ACRONYMS,
LIST OF EXHIBITORS,
MAPS OF EXHIBIT ROOMS AND
PROJECT LOCATION MAPS**

ACRONYMS

- **ACPE** : Association canadienne des prospecteurs et entrepreneurs
- **AEM** : Agnico-Eagle Mines
- **AEMQ** : Association de l'exploration minière du Québec
- **AMQ** : Association minière du Québec
- **BAPE** : Bureau d'audiences publiques sur l'environnement (Gouvernement du Québec)
- **CERM-UQAC** : Centre d'étude sur les ressources minérales de l'Université du Québec à Chicoutimi
- **CGC** : Commission géologique du Canada
- **CGC-CC** : Commission géologique du Canada - Centre du Canada
- **CGC-O** : Commission géologique du Canada - Ottawa
- **CGC-Q** : Commission géologique du Canada - Québec
- **CGO** : Commission géologique de l'Ontario
- **CNRS** : Centre national de la recherche scientifique
- **CONSOREM** : Consortium de recherche en exploration minérale
- **CRÉ** : Conférence régionale des élus
- **CRPG** : Centre de recherches pétrographiques et géochimiques, France
- **CSM** : Colorado School of Mines
- **CSST** : Commission de la santé et de la sécurité du travail
- **CU** : Carleton University
- **DIVEX** : Diversification de l'exploration minière du Québec (Réseau de recherches géoscientifiques)
- **FQRNT** : Fonds québécois de recherche sur la nature et les technologies
- **GC-DLG** : Géomatique Canada - Division des levés géodésiques
- **GC-GSD** : Geomatic Canada - Geodesic Survey Division
- **GEOTOP UQAM-McGILL** : Centre de recherche en géochimie et en géodynamique de l'Université du Québec à Montréal et de l'Université McGill
- **GSC** : Geological Survey of Canada
- **GSC-O** : Geological Survey of Canada - Ottawa
- **GSC-Q** : Geological Survey of Canada - Quebec
- **IGC-3** : Initiative géoscientifique ciblée (2005-2010) de la CGC
- **INRS** : Institut national de la recherche scientifique
- **INRS-ETE** : Institut national de la recherche scientifique – Centre Eau, Terre et Environnement
- **LU** : Laurentian University
- **McGill** : Université McGill
- **MDDEP** : Ministère du Développement durable, de l'Environnement et des Parcs
- **MDEIE** : Ministère du Développement économique, de l'Innovation et de l'Exportation du Québec
- **MISA** : Mines, innovations, solutions et applications
- **MRNF** : Ministère des Ressources naturelles et de la Faune du Québec
- **MPMPS** : Mineral potential maps production system (MRNF)
- **MTP** : Miller Thomson Pouliot
- **NTS** : National Topographic Series
- **OF** : Open File
- **OGS** : Ontario Geological Survey
- **PDAC** : Prospectors and Developers Association of Canada
- **Poly** : École Polytechnique de Montréal. Département des génies civil, géologique et des mines
- **RSC** : Ressources Strateco
- **SPCPM** : Système de production des cartes de potentiel minéral (MRNF)
- **TGI-3** : Targeted Geoscience Initiative (2005-2010) - GSC
- **U d'O** : Université d'Ottawa
- **U of A** : University of Alberta
- **U of O** : University of Ottawa
- **UL** : Université Laurentienne
- **ULaval** : Université Laval
- **UNB** : University of New Brunswick
- **UQAC** : Université du Québec à Chicoutimi
- **UQAM** : Université du Québec à Montréal (Département des Sciences de la Terre et de l'Atmosphère)
- **UQAT** : Université du Québec en Abitibi-Témiscamingue
- **URSTM-UQAT** : Unité de recherche et de service en technologie minérale de l'Université du Québec en Abitibi-Témiscamingue
- **VRQ** : Valorisation-Recherche Québec : un programme d'investissement du gouvernement du Québec destiné à la recherche universitaire

Salle de Bal

1	Diagnos
2	Ressources Appalaches
3	Géophysique GPR International
4	Tres-Or Resources
5	Exploration Dios
6	Goldbrook Ventures
7	Osisko Exploration
8	Équipement Jexplore
9	IOS services géoscientifiques
10	SGS Géostat
11	Hélicoptères Canadiens
12	IDNR-TV
13	Corporation Minière Niogold
14	Prospectors & Developers Association of Canada
15	New Brunswick Natural Resources
16	Centre géoscientifique de Québec
17	Ressources Cogitore
18	Activation Laboratories
19	Exploration Typhon
20	SRK Consulting
21	Groupe Fordia
22	Stornoway Diamond Corporation
23	Exploration Midland
24	Université du Québec en Abitibi-Témiscamingue
25	Alexis Minerals Corporation
26	New Millennium Capital corp.
27	Fugro Airborne Surveys Corp.
28	Newfoundland and Labrador Dept. of Natural Resources
29	Mira Geoscience
30	Mines Virginia
31	MIR Télédétection
32	Novatem
33	Terraplus
34	Exploration Azimut
35	Quantec Geoscience
36	Société de développement de la Baie-James
37	ALS Chemex
38	Ministère des Ressources naturelles et de la Faune
39	Ministère des Ressources naturelles et de la Faune

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41	Orizon Mobile
42	Association Minéralogique du Canada
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44	RCM Modulaire
45	Northern Superior Resources
46	Biogénie S.R.D.C.
47	Elemental Controls - NITON Analysers
48	Pitney Bowes Business Insight (PBBI)

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64	Aeroquest Surveys
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66	2iC Australia Pty
67	Xstrata Nickel-Zinc-Cuivre
68	Hydro-Québec
69	Association de l'exploration minière du Québec

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109	Heli-Transport
110	Junex
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122	UQAM
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125	MDN
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127	EMpulse Geophysics
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129	Sirius secourisme en régions isolées
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131	Salon des prospecteurs
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Montcalm

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 131-2 Benoît Frigon, prospecteur autonome
 133-3 Centre d'étude appliquée du quaternaire (TJCM)
 133-4 Fonds minier du Saguenay-Lac-St-Jean
 133-5 Association des prospecteurs de la Haute-Côte-Nord
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 137-9 Association des prospecteurs de Manicouagan
 137-10 Gervais Simard Exploration

Carothèque**Mardi 24 novembre**

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 C-2-J1
 C-3-J1
 C-4-J1 Services industriels Best H₂O
 C-5-J1 Western Troy
 C-6-J1 Nyx Dimensions
 C-7-J1 Lithium One
 C-8-J1 Stornoway Diamond Corporation
 C-9-J1 Ressources Abitex
 C-10-J1
 C-11-J1 Detour Gold
 C-12-J1

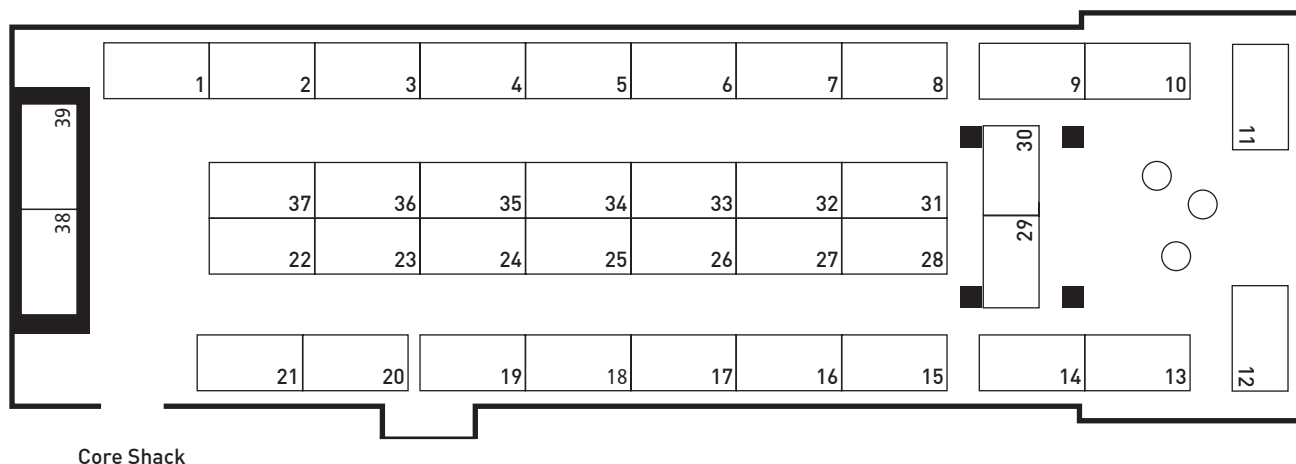
Mercredi 25 novembre

- C-1-J2 Design Shelter
 C-2-J2
 C-3-J2 Relais Expert-Conseil
 C-4-J2 Services industriels Best H₂O
 C-5-J2 Western Troy
 C-6-J2 Nyx Dimensions
 C-7-J2 Lithium One
 C-8-J2 Stornoway Diamond Corporation
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 C-10-J2
 C-11-J2 Detour Gold
 C-12-J2 Ressources Sirois et Exploration Dios

Jeudi 26 novembre

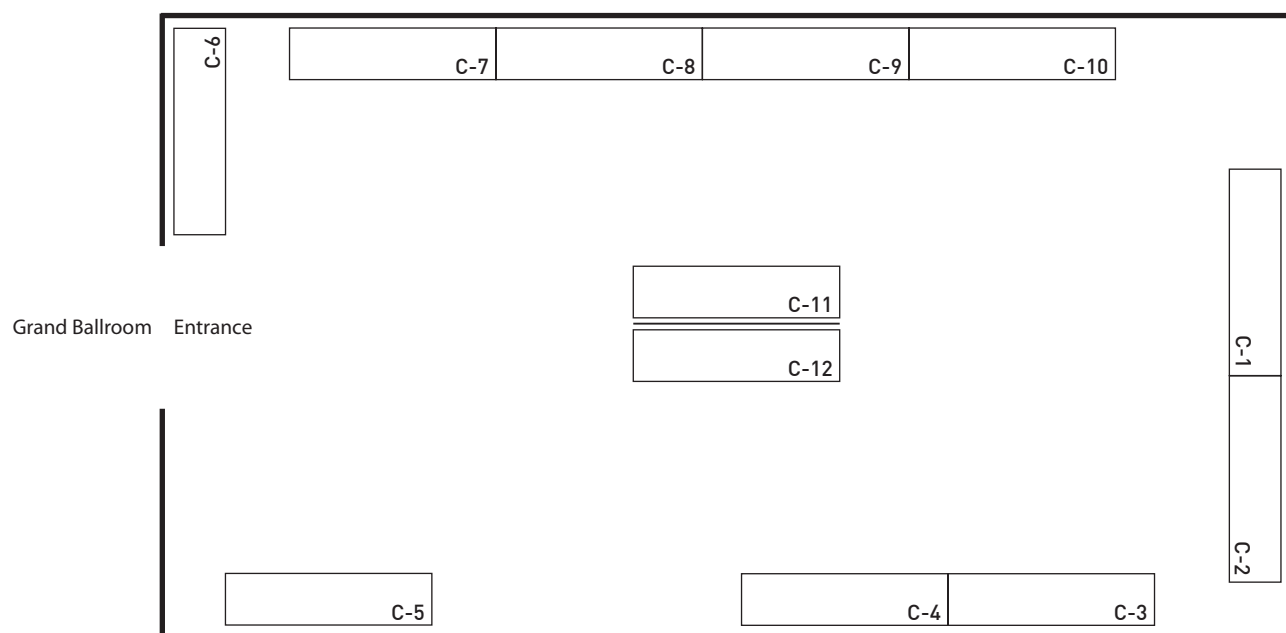
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 C-2-J3
 C-3-J3 Relais Expert-Conseil
 C-4-J3 Services industriels Best H₂O
 C-5-J3 Western Troy
 C-6-J3
 C-7-J3 Lithium One
 C-8-J3 Stornoway Diamond Corporation
 C-9-J3
 C-10-J3
 C-11-J3 Detour Gold
 C-12-J3

Salle de bal
Commercial exhibit



Core Shack

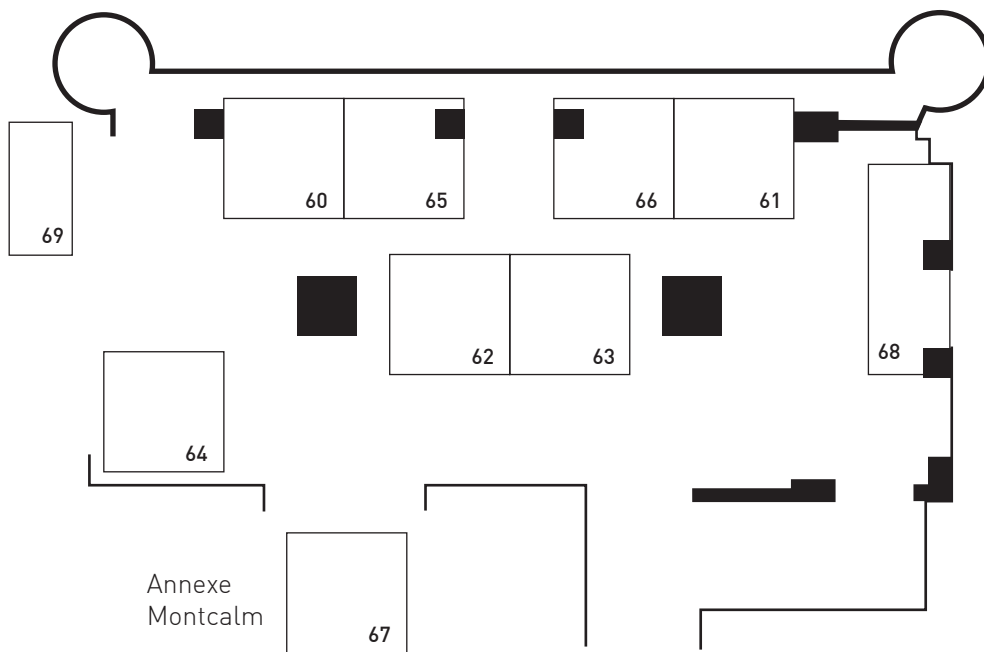
Core Shack



Grand Ballroom Entrance

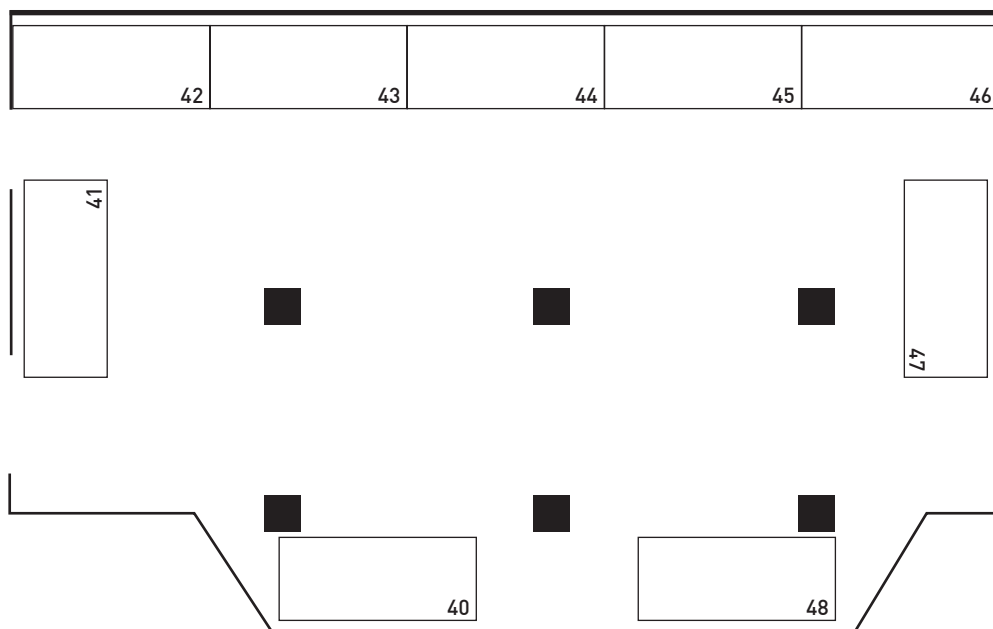
Verchères

Commercial exhibit

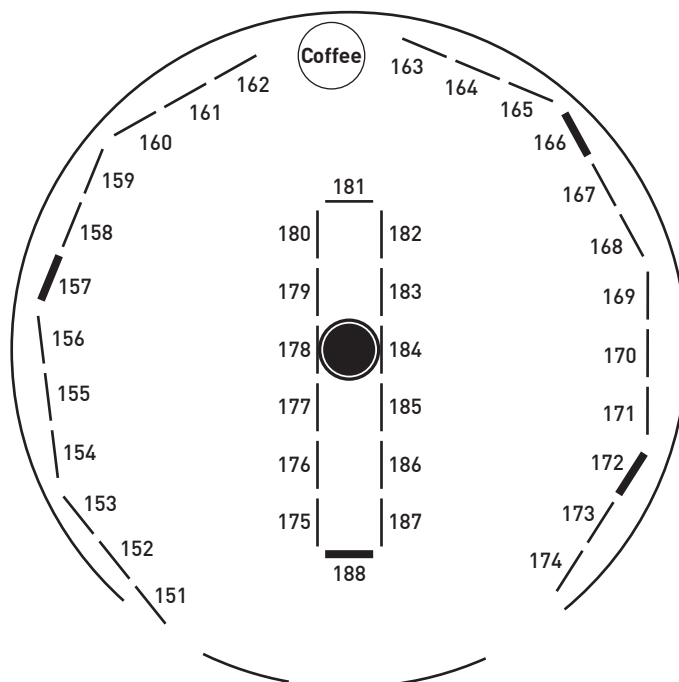


Bellevue

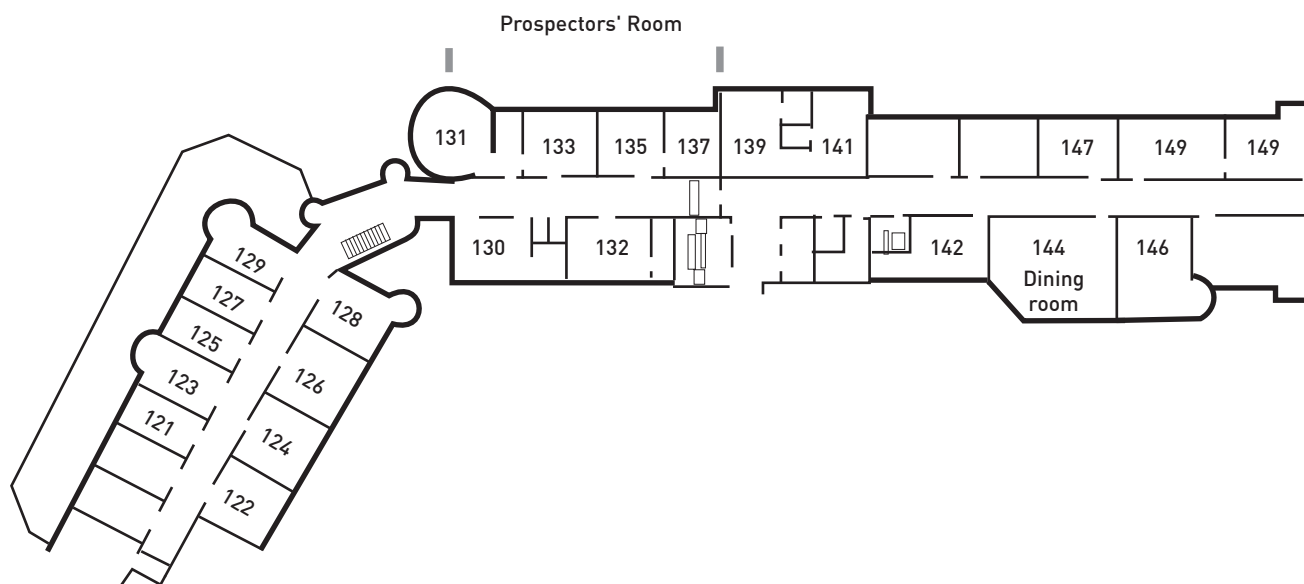
Commercial exhibit



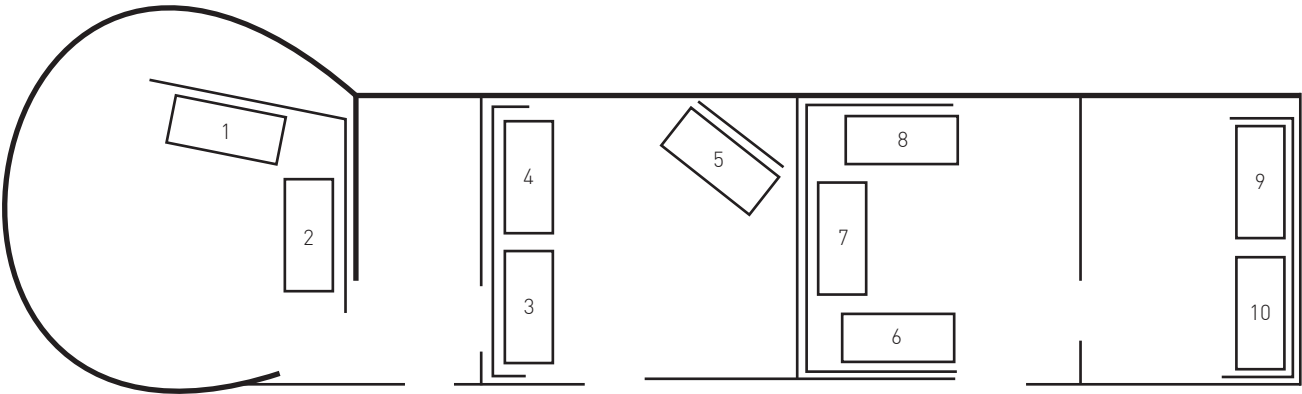
Salon Rose
Geoscience exhibit



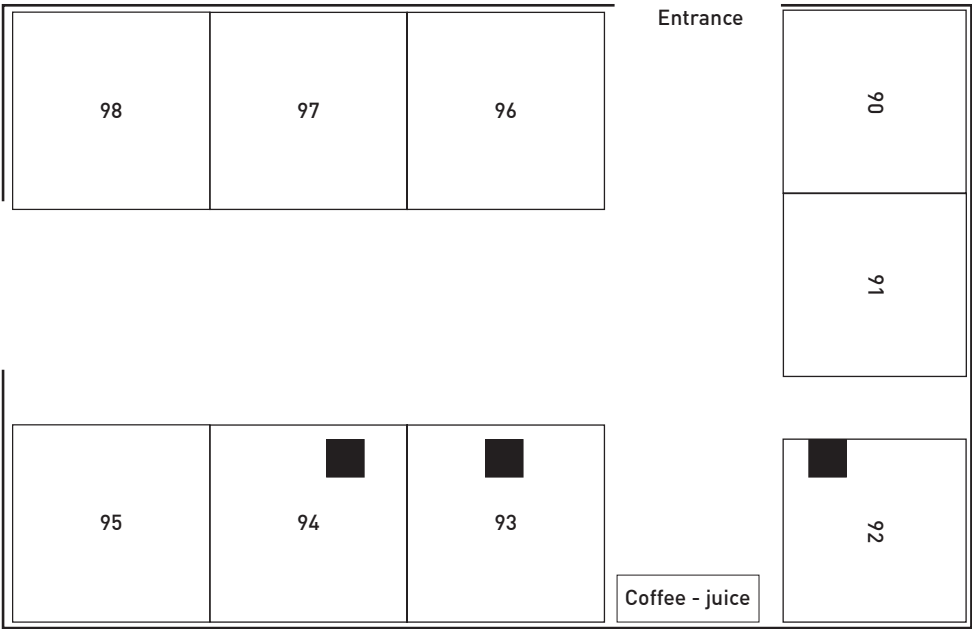
Rooms
Commercial exhibit



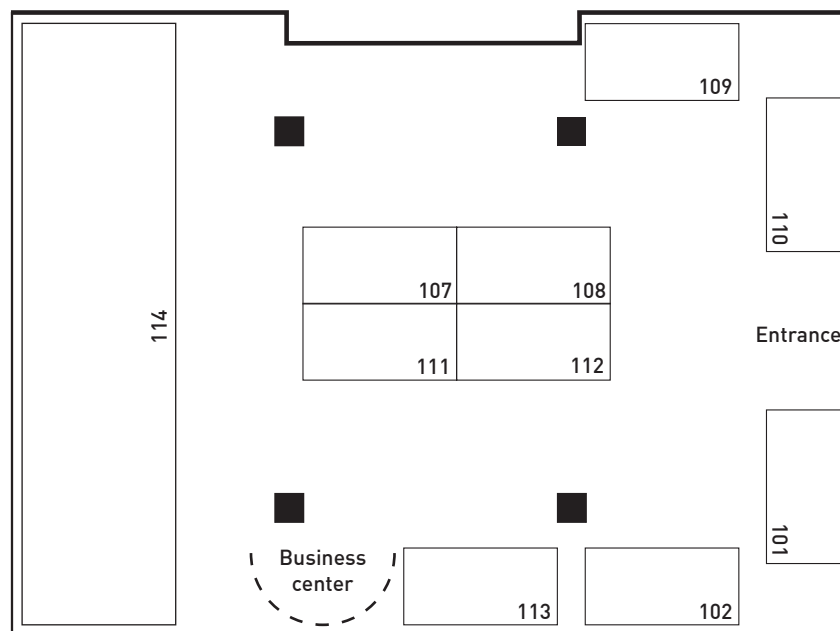
Booths 131, 133, 135 and 137
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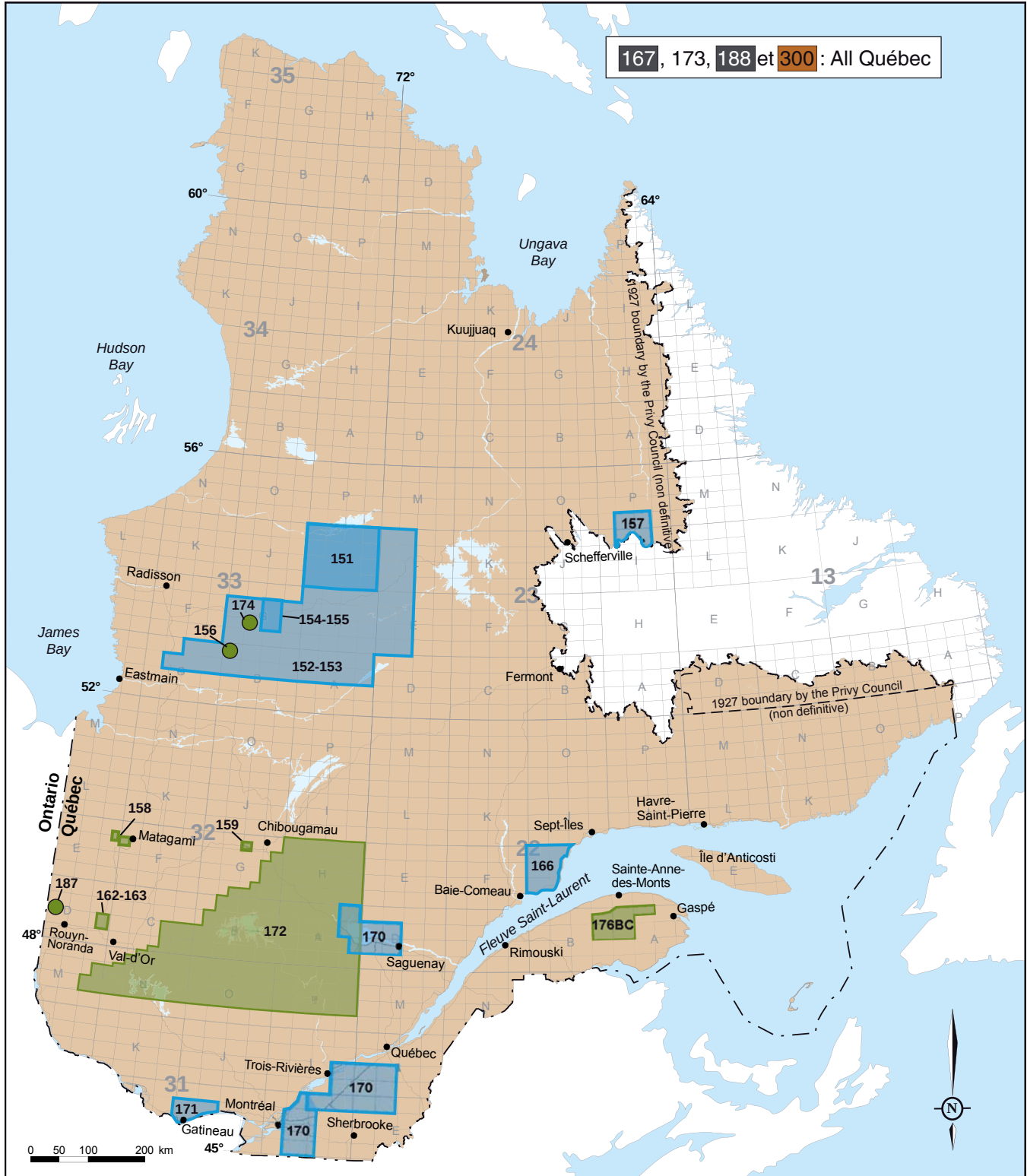


Place d'Armes
Commercial exhibit



Jacques-Cartier
Commercial exhibit





Inventories



Studies



Assessment
of the mineral
potential



Geoscience
program

Québec Exploration 2009 is going green!

In order to reduce the conference's environmental footprint, the organizing committee has developed a number of interactive visibility tools.

Plasma screens, digital displays, USB keys, eco-friendly bags, reusable water bottles...

We're using a host of innovative and reusable tools to provide quality visibility for partners and optimize information about conference activities.

Thanks to all our financial partners who have made the leap to go green!