Québec EXPLORATION

ABSTRACTS OF ORAL PRESENTATIONS AND POSTERS

2011

November 21 to 24, 2011

DV 2011-04

AEMQ
ASSOCIATION DE L'EXPLORATION MINIÈRE DU QUÉBEC

Ressources naturelles et Faune
Québec

Coordinators
- Charlotte Grenier
- Luc Charbonneau

Translation and linguistic version
- Venetia Bodycomb
- Michèle Mainville
- Marie Racine

Editing
- Joanne Nadeau

Drawing
- André Tremblay

Cover page and design
- André Tremblay

Technical supervision
- André Tremblay

DISCLAIMER

This report contains data from various sources. The accuracy and reliability of these data depend entirely on these sources.

Dépôt légal – Bibliothèque et Archives nationales du Québec
ISBN : 978-2-550-63101-9

An Invitation from the Minister for Natural Resources and Wildlife

I am very pleased to invite you to the 2011 Québec Exploration conference. This year's Québec mineral exploration industry "must-attend" gathering, whose theme is "From Knowledge to Discovery," will run November 21 to 24.

The mineral resources sector is booming and the effects are being observed in the field with many projects in Québec and elsewhere. They are also making themselves felt in the Québec government, witness the launch of Québec's Mineral Strategy in 2009 and the recent implementation of the Plan Nord, which places strong emphasis on the sustainable development of our natural resources. Draft legislation on mineral resource development has also been tabled.

Knowledge has become a key factor in this period of transition and growth. Québec has one of the world's most comprehensive geoscientific databases. In creating the Mining Heritage Fund in 2008, the government enabled the yearly acquisition of geoscientific knowledge to be pursued. This knowledge will continue to pave the way for new discoveries in a territory known for its high mineral potential!

Québec Exploration 2011 invites you to get back to basics. Make this conference an opportunity to learn more about Québec's mineral potential, the latest technologies and the best practices. Many discoveries await you!

I wish you an enjoyable, productive conference!

Serge Simard

Minister for Natural Resources and Wildlife

An Invitation from the AEMQ President

The Québec Mineral Exploration Association (AEMQ) is once again pleased to join Québec's Ministère des Ressources Naturelles et de la Faune (MRNF) in presenting this ninth edition of Québec Exploration. This year's theme – From Knowledge to Discovery – underscores the importance of mineral resource-related research and exploration in our industry. It also emphasizes the significant role played by Québec Exploration's two partners in the success of the mining industry. Québec is known to be rich in mineral wealth. However, its exploration and renewal present major challenges for industry, the MRNF and the communities involved.

The year 2011 started on a very positive note and the planets seem aligned for another exceptional year of mineral exploration in Québec. Amid rising metal prices, supported by emerging economies, the keen interest for mineral exploration in Québec reflects the enviable reputation we enjoy for our mineral exploration investment climate, along with the stability of our rules and the vast mineral potential lurking beneath Québec's surface. But our efforts to attract investors must continue, hence the importance of maintaining a favourable business climate.

In this context, we believe that the Plan Nord's implementation will enable Québec to adopt effective tools and gain international recognition through its innovative approach to territorial development. The AEMQ is proud to take part in the Québec government's plan to shape the province's future by developing its vast mineral resources in the North. The Plan Nord is an excellent opportunity for the mining industry to help harness and develop this vast territory, while remaining a world leader in mining exploration. It has become evident in the past few years that the future of mining exploration in Québec is gradually shifting north. Boundaries are being pushed back and mineral potential is high. This potential is already being realized with discoveries of gold, uranium, copper, zinc, rare earths, nickel, lithium and diamonds – characteristic features of this vast landscape. In this context, mineral resource exploration is definitely one of the cornerstones of the Plan Nord strategy. The next chapter of our future is being written, and we're all invited to take part.

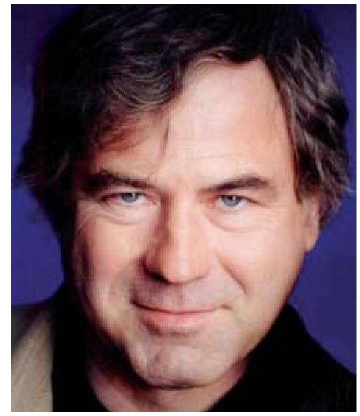
Exploration and development activities underway – in Québec in 2011 bode well for our industry's future and should continue to generate collective long-term wealth for Québécois. We can be very proud of our contribution.

To conclude, I strongly encourage you to take part in the many activities offered during Québec Exploration 2011. I extend a special invitation to all AEMQ members to attend the annual general meeting to be held on Monday, November 21. I hope to see you soon and hear about your 2011 achievements.

Ghislain Poirier

President
Québec Mineral Exploration Association

An Invitation from the Honorary President of Québec Exploration 2011



It is my pleasure as Honorary President of Québec Exploration 2011 to invite you to this event. This important annual activity brings together all those who generate collective wealth for Québec by uncovering what lies subtly hidden within its depths. This represents a huge challenge, since fifteen, twenty even thirty years – if not more – can go by between the early stages of exploration and the first actual mining activities. Contrary to the impression conveyed to the general public, there's many a slip between cup and lip. The current production wave may lead some to think that a mine can be picked like a strawberry in the field, and that any first-comer can stake a claim. This denotes a pernicious lack of knowledge for a resource-rich country.

Behind this long gestation period, from the preliminary stages of exploration to the first ingot, lies considerable financial risk for both government and the private sector. The first step in this long process begins with the acquisition of geoscientific knowledge. It is this valuable information that attracts the world's mine creators. Québec stands out in this regard for the quantity and especially the quality of information stored in its geoscientific database. This enormous undertaking, long promoted by the government, has just shifted into high gear with an extensive survey campaign. It is both a lot and yet too little for such a vast territory. This will be evident during the conference presentations.

This knowledge is critical to identifying viable mineral resources, but it is not enough. A prospector is needed to do the detective work. Marks left by known deposits have to be identified in order to assess a mine's potential. The vast database must be scrutinized to decipher the underlying message. A substantial amount of capital must then be risked – yes, risked – out in the taiga, searching for a small bog under which may lie tons of gold, iron, tungsten and other rare earths.

This conference is for all those with a passion for this quest. My heart goes out to these brave pioneers, whose sustained and patient efforts – over hill and dale, in snow or rain, between clouds of mosquitoes and black flies, smothered in insect-repellent or frozen to the core, in mud-soaked workings and drilling sites – create wealth that all Québécois enjoy, and will continue to enjoy, both in the South and in the North. May this conference serve as a forum for all who rely on their labour, often without knowing it.

Michel Gauthier

Mineral Exploration, Professor Emeritus
Université du Québec à Montréal (UQAM)

ORGANIZERS

Robert Marquis

Directeur général, Géologie Québec
Ministère des Ressources naturelles et de la Faune (MRNF)

Valérie Fillion

Directrice générale, Association de l'exploration minière du Québec (AEMQ)

Luc Charbonneau

Ministère des Ressources naturelles et de la Faune

Pierre Verpaelst

Ministère des Ressources naturelles et de la Faune

Christian Fortin (Coordinator)

Ministère des Ressources naturelles et de la Faune

Marie-Pier Loiselle

Association de l'exploration minière du Québec

Marco Gagnon

Association de l'exploration minière du Québec

Mélissa Desrochers

Association de l'exploration minière du Québec

COMMITTEE SECRETARY

Sylvie Otis (MRNF)

ORAL PRESENTATIONS PROGRAM

Sylvain Lacroix (MRNF)
Michel Allard (Xstrata Zinc, AEMQ)
Jean-Yves Labbé (MRNF)
Martin Demers (Mines Aurizon, AEMQ)

Chairs

1 - François Leclerc (MRNF) **and Martin Demers** (Mines Aurizon)
2 - Louis Doyle (Bourse de croissance TSX) **and Suzanne Durand** (MRNF)
3 - Charles Maurice (MRNF) **and Réal Daignault** (UQAC)
4 - Serge Perreault (SOQUEM) **and Denis Blackburn** (MRNF)
5 - Normand Grégoire (GÉNIVAR) **and Denis Raymond** (MRNF)
6 - Georges Beaudoin (ULaval) **and Jean-Yves Labbé** (MRNF)

EXPLORATION/INVESTISSEMENT FORUM, ORAL PRESENTATIONS AND INVESTOR'S EVENING

Valérie Fillion (AEMQ)
Marie-Pier Loiselle (AEMQ)

MANAGEMENT, REVIEW, PRINTING OF ABSTRACTS AND PROGRAM DOCUMENTS

Charlotte Grenier (MRNF)
Marie-Eve Lagacé (MRNF)
Joanne Nadeau (MRNF)
Marie Racine (Linguistic revision)
Michèle Mainville (traduction)
Venetia Bodycomb (traduction)

VISUAL MANAGEMENT AND PRODUCTION (POSTERS, SPONSORS AND SIGNS)

Charlotte Grenier (MRNF)
Marie-Eve Lagacé (MRNF)
André Tremblay (MRNF)
Sonia Montambault (MRNF)
Diane Devault (MRNF)

FINANCIAL ACCOUNTING

Christian Fortin (MRNF)
Caroline Nadeau (MRNF)

WORKSHOPS, INTERACTIVE SESSIONS AND FIELD TRIP

Valérie Fillion (AEMQ)
Luc Charbonneau (MRNF)

SPOUSE PROGRAM

Gilles Therrien (MRNF)
Gaétan Simard (MRNF)

OPEN HOUSE TO GENERAL PUBLIC AND STUDENTS

Sylvie Otis (MRNF)
Pierre Verpaelst (MRNF)
Marc Émond (MRNF)
Maxime Blanchet (Minalliance)
Charlotte Grenier (MRNF)
Gladys Chamberland (MRNF)
Pascale Côté (RNCan)
Marc Legault (Cégep Abitibi-Témiscamingue)

SPONSORSHIP

Marie-Pier Loiselle (AEMQ)

GALA EVENING

Marie-Pier Loiselle (AEMQ)
Caroline Nadeau (MRNF)

TRADE SHOW, GEOSCIENCE EXHIBITION AND CORE SHACK

Christian Fortin (MRNF)
Marie-Josée Hudon (MRNF)
Marie Dussault (MRNF)

PROMOTION, COMMUNICATION MEDIAS AND WEBSITE

Charlotte Grenier (MRNF)
France Arcand (MRNF)
Sonia Montambault (MRNF)
Gladys Chamberland (MRNF)
Marie Dussault (MRNF)
Marie-Eve Lagacé (MRNF)

SUBCOMMITEE, AD PLACEMENT

Gladys Chamberland (MRNF)
Mélissa Desrochers (AEMQ)
Marie-Pier Loiselle (AEMQ)
Luc Charbonneau (MRNF)
Charlotte Grenier (MRNF)
Anne-Marie Blanchard (MRNF)

REGISTRATION

Caroline Nadeau (MRNF)
Marie-Josée Hudon (MRNF)

CHÂTEAU FRONTENAC MANAGEMENT AND ACCOMODATION

Gaétan Simard (MRNF)

FACILITIES MANAGEMENT, DISPLAY MATERIALS, ROOM ORGANIZATION AND RESERVATION

Christian Fortin (MRNF)
André Cloutier (MRNF)

ROOMS MANAGEMENT

Christian Fortin (MRNF)
Marie Dussault (MRNF)

AUDIOVISUAL LOGISTICS, CONFERENCE AND EXHIBIT ROOMS

Gaétan Simard (MRNF)

SIGNPOSTING, GUIDES AND HOSTESS

Diane Devault (MRNF)
Sylvie Otis (MRNF)

COMPUTER AND NETWORK

Pascal Levasseur (MRNF)
Pierre-Thomas Poulin (MRNF)
Yan Carette (MRNF)
Michel Morais (MRNF)

GENERAL LOGISTICS

Christian Fortin (MRNF)
André Cloutier (MRNF)
Normand Labbé (MRNF)
Robin Bélanger (MRNF)
Charles Blais (MRNF)
Marie Dussault (MRNF)
Gaétan Simard (MRNF)
Frédérick St-Pierre (MRNF)
Guy Lachance (MRNF)
Jonathan Aubin (MRNF)
Stéphane Beauséjour (MRNF)

And many other collaborators.

Abstracts of oral presentations and posters

Tuesday ▪ November 22

8:30 **Official Opening of Québec Exploration 2011**
President of Québec Mineral Exploration Association (AEMQ) and Executive Director of Géologie Québec (MRNF)

SESSION 1

New geological knowledge and mineral potential of the Abitibi geological region

Co-chairs: François Leclerc (MRNF) and Martin Demers (Aurizon Mines)

Partner:

COGITORE RESOURCES INC.

9:00 **Massive volcanogenic sulphide deposit potential in the Abitibi – 2011 update**
Daniel Lamothe (MRNF)

9:20 **Bracemac-McLeod: From exploration to production via research**
Gilles Roy, Michel Dessureault (Xstrata Zinc), Robin Adair (Donner Metals), Julie-Anaïs Debreil (INRS-ETE), Dominique Genna, Damien Gaboury (UQAC), Pierre-Simon Ross (INRS-ETE) and Pierre Pilote (MRNF)

9:40 keynote speaker
Geological revision of the Matagami region
Pierre Pilote (MRNF), Julie-Anaïs Debreil (INRS-ETE), Kenneth Williamson, Olivier Rabeau and Pierre Lacoste (MRNF)

10:10 **Chapais-Chibougamau: Beyond the traditional mining camp**
François Leclerc, Patrick Houle, Patrice Roy (MRNF), Lyal B. Harris (INRS-ETE), Jean H. Bédard (GSC-Q), Vicki McNicoll, Otto van Breemen (GSC-O), Jean David (GÉOTOP) and Normand Goulet (UQAM)

10:30 **Numerical modelling of the Archaean seismic activity along the Cadillac-Larder Lake Fault Zone: inferences on orogenic gold mineralization**
Silvain Rafini, Stéphane Faure (CONSOREM) and Réal Daigneault (CONSOREM-UQAC)

10:50 **Geological model for the Windfall Lake gold project**
Jean-Philippe Desrochers, Darrell Turcotte (Eagle Hill) and Neil W. Richardson (VMS Ventures)

11:00 E **Grade control at the Detour Lake gold deposit, Ontario**
Pat Donovan (Detour Gold)

SESSION 2

Entrepreneurship and public financing: What entrepreneurs and investors think

Co-chairs: Louis Doyle (Venture exchange TSX) and Suzanne Durand (UQAT)

Partner:

DETOUR GOLD

1:30 **Introduction**
Louis Doyle

1:50 **Panel of entrepreneurs**
Simon Britt (Ressources GéoMéga), Philippe Cloutier (Cartier Resources) and Glenn Mullan (Golden Valley Mines)

2:55 **Panel of investors**
Michel Champagne (SIDEX), Jacques Cossette (CIBC Wood Gundy) and Denis Landry (SODEMEX)

E **Conferences will be presented in English**
All talks are available with simultaneous translation.
Place: Salon Frontenac
Reruns: Salon Petit Frontenac

Wednesday ▪ November 23

SESSION 3

Geoscience, exploration and discovery of mineral resources: an inseparable trio

Co-chairs: Charles Maurice (MRNF) and Réal Daigneault (UQAC)

Partner:

QUEST RARE MINERALS LTD.

9:00 keynote speaker
Public Geoscience for Private Exploration
E Murray Duke (Ottawa, Ontario)

9:40 **Geoscience knowledge in Québec: Its value, its impact, and its future**
Sylvain Lacroix, Charles Maurice, Daniel Lamothe and Charles Roy (MRNF)

10:00 **Mineral exploration problems and real solutions: CONSOREM's contributions to applied research**
Stéphane Faure, Réal Daigneault, Benoit Lafrance, Silvain Rafini and Sylvain Trépanier (CONSOREM)

10:20 **Identification of structures in the deep crust to lithospheric mantle transverse to Proterozoic orogens in Quebec and surrounding areas and their role in localizing mineral deposits**
Lyal Harris, Grégory Dufréchou and Camille Armengaud (INRS-ETE)

10:40 **Composition of fluid inclusion volatiles: significance and use in gold exploration in metamorphic environments**
Damien Gaboury (UQAC)

11:00 keynote speaker
Honorary President's Conference - From knowledge to discovery
Michel Gauthier (Emeritus professor, UQAM)

SESSION 4

Iron: From exploration to mining

Co-chairs: Serge Perreault (SOQUEM) and Denis Blackburn (MRNF)

1:30 **The Iron Ore Market in 2011**
Serge Perreault (SOQUEM)

1:40 **Portrait of the iron ore industry in Québec**
Denis Blackburn and Martin Bernatchez (MRNF)

2:00 **The Iron Ranges of Western Labrador - New Developments and Future Potential**
E Andrew Kerr, John Clarke and Phillip Saunders (Department of Natural Resources, Newfoundland)

2:20 keynote speaker
China, a rich country but a poor people: the sustaining power for the global steel industry
Sandy Chim (Century Iron Mines)

3:00 **Building the Next Major Iron Ore Mine in the Labrador Trough**
E Jeff Hussey (Champion Minerals)

3:20 **A New Iron Ore Mine at Schefferville – Rebirth of a Historic Mining Camp**
John Kearney (Labrador Iron Mines)

3:40 **On the path to production**
Dean Journeaux (New Millenium Iron)

E **Conferences will be presented in English**
All talks are available with simultaneous translation.
Place: Salon Frontenac
Reruns: Salon Petit Frontenac

Thursday ▪ November 24

SESSION 5

Critical, strategic and high technology minerals and metals

Co-chairs: Normand Grégoire (GÉNIVAR) and Denis Raymond (MRNF)

9:00 **Critical, strategic and high technology minerals and metals.Offer – Demand – Strategic considerations: alarm signals**
Normand Grégoire (GÉNIVAR)

9:10 keynote speaker
Critical minor metals and minerals: Risks and opportunities
Christian Hocquard (BRGM)

9:50 E **Graphite Exploration and Development in Québec**
Gary Economo (Focus Metals)

10:10 **Quebec as the world's alternative secured source of lithium supply? Sure.Could it be the MAIN one? Certainly!**
Guy Bourassa (Nemaska Exploration)

10:30 E **Geology and Economic Significance of Selected Rare Earth Element Deposit Types**
George J. Simandl (British Columbia Geological Survey)

11:00 **Strategic minerals and metals used in the manufacture of lithium storage cells (accumulators) for electric vehicles**
Daniel Perlstein (Anextase)

11:20 **Ore beneficiation – New challenges and constraints**
Normand Grégoire (GÉNIVAR)

11:30 **Social acceptability and public consultations – New challenges for the industry**
Donald Blanchet (Canada Lithium) and Émilie Bélanger (GÉNIVAR)

SESSION 6

Earth sciences: at a crossroads in knowledge

Co-chairs: Georges Beaudoin (ULaval) and Jean-Yves Labbé (MRNF)

1:30 keynote speaker
The National Institute for Earth Sciences and Astronomy of the CNRS (France): a research institute dedicated to an integrated Earth System approach
Bruno Goffé and Jean-François Stéphan (CNRS-INSU)

2:10 E **The Ocean Networks Canada Observatory – Making the ocean transparent**
Mairi Best, Kim Juniper, Scott McLean, Kate Moran, Martin Taylor and Verena Tunnicliffe (Ocean Networks Canada)

2:30 E **A New View of the Continent beneath Our Feet: Scientific, Economic and Social Benefits of an Earth Sciences Mega-Project**
Ron M. Clowes (UBC-Lithoprobe)

3:10 **Regulating Uranium Mines and Mills in Canada – Applying Science and Research in Regulatory Decision Making**
Jean LeClair and Michael Rinker (CNSC)

3:30 Keynote speaker
Plan Nord presentation
Speaker to be confirmed

4:00 **Closing speech**

E **Conferences will be presented in English**
All talks are available with simultaneous translation.
Place: Salon Frontenac
Reruns: Salon Petit Frontenac

Session 1 ■ 9:00

Massive volcanogenic sulphide deposit potential in the Abitibi – 2011 update

Daniel Lamothe (MRNF)

An update to the mineral potential favourability for volcanogenic massive sulphide (VMS) deposits in the Abitibi was completed in 2011. The work outlined 3,611 high-favourability zones, which contain more than 365 targets that were unstaked as at April 9, 2011. A favourability map was produced at 1:500,000 scale and published on the Ministry's site. The favourability zones were entered into GESTIM.

All VMS data modelling for the 2011 version was done using the ModelBuilder tool in ArcGIS 9.3. The process for calculating the Abitibi's VMS potential is now fully programmed and can be automatically executed in just a few hours. The possibility of quickly testing new parameters or different calibration sets represents a significant improvement to the mineral potential assessment process and will be applicable to all future metallogenic models developed by the MRNF.

The current data analysis uses 22 parameters compared to 26 in 2005. Parameters were weighted using a set of 51 VMS mines, which were themselves weighted as a function of their productivity. Each parameter was weighted using the Weight of Evidence method. Parameters were then combined using a fuzzy logic approach. Twelve mines not involved in the weighting were used to validate the map's predictive ability.

A minimum favourability threshold was established using a quantile-quantile plot based on the calculated favourability for the VMS mines. The threshold, which encompasses 94% of VMS producers, was then used to create high-favourability zones (HFZ). The portions of these zones that remained unstaked as at April 9, 2011 were subsequently designated as targets.

Since the publication of its results in May 2011, more than 153 mining titles had been acquired on the targets as of September 12, 2011.

Session 1 ■ 9:20

Bracemac-McLeod: From exploration to production via research

Gilles Roy, Michel Dessureault (Xstrata Zinc), Robin Adair (Donner Metals), Julie-Anaïs Debreil (INRS-ETE), Dominique Genna, Damien Gaboury (UQAC), Pierre-Simon Ross (INRS-ETE) and Pierre Pilote (MRNF)

Near the northern boundary of the Abitibi Subprovince, the Matagami mining camp has produced, with very few interruptions since 1963, 46.5 Mt of ore at a grade of 9.1% Zn and 0.9% Cu. Ten ore deposits have been mined; the Perseverance mine, discovered in 2000 and inaugurated in 2008, is currently in operation, and construction work at the future Bracemac-McLeod (BRC-McL) mine is progressing on schedule for the opening slated in 2013.

BRC-McL and its seven ore lenses, with 3.6 Mt of measured and indicated resources grading 11.5% Zn and 1.6% Cu and 2.9 Mt of inferred resources @ 7.9% Zn and 1.3% Cu, will be the second largest deposit in the mining camp. Notwithstanding its economic value, this deposit, via the «Matagami Project», is also a great example of sustainable and structuring development.

The «Matagami Project» was implemented in parallel with exploration work undertaken by Xstrata Zinc and its partner Donner Metals, its timing coinciding with the start-up of construction at the Perseverance mine and the discovery of BRC-McL. This ambitious research project had six objectives: 1) to increase applied and pre-competitive research in Matagami; 2) to improve geoscience knowledge; 3) to increase the chances of making economic discoveries; 4) to have privileged access to a diversified research network; 5) to open up projects for explorationists in the Matagami area and elsewhere; and 6) to contribute in training and gain access to qualified personnel. The project encompassed three doctorate research projects, supported by a consortium involving CONSOREM, DIVEX, GSC, MRNF, INRS, UQAC, École polytechnique, Breakwater Resources, Donner Metals, SOQUEM, and Xstrata Zinc Canada. Simultaneously, the MRNF launched a four-year mapping campaign.

Researchers were provided with insider access to all historical and modern data from mining companies, particularly exploration data from the BRC-McL area. Finally, the outcome of these projects has completely refashioned the geological portrait of the mining camp and calls into question even the genesis of these ore deposits: a revision of the geological map, a new metallogenic model, detailed studies on the volcanic pile, the opening, through mapping and age dating, of new territories, and last but not least, the emergence of experts.

The results of this research will soon be published. This very practical and applied work will drive mineral research not only in the Matagami area but, we believe, well beyond the Abitibi.

Session 1 ■ 9:40

Geological revision of the Matagami region

Pierre Pilote (MRNF), Julie-Anaïs Debreil (INRS-ETE), Kenneth Williamson, Olivier Rabeau and Pierre Lacoste (MRNF)

This work, which started in 2008, is part of a multidisciplinary project on the geologic and metallogenic understanding of the Matagami mining camp (1960-2005 production: 4.6 Mt Zn, 0.494 Mt Cu). The mapping component is under the direction of the MRNF. Geological revision work in the summer of 2011, at a scale of 1:20,000, covered the southern half of NTS map sheet 32F13, the northern half of 32F12, and some areas of 32E09 and 32E16, collectively covering the entire mining camp. A 3D geometric model of the region will be generated at the end of the project, with the objective of providing a better understanding of the stratigraphy, structural features, and distribution of VMS-type mineralization. This revision forms an integral part of a larger partnership involving the MRNF, researchers and students from INRS-ETE, UQAC and École Polytechnique de Montréal, and the mining companies Xstrata Zinc, Donner Metals and SOQUEM.

The mapped region mainly belongs to the Abitibi Subprovince (ASP). It is underlain by various volcanic and plutonic rocks, the Rivière Bell Complex (RBC - a vast subconcordant ultramafic to mafic layered intrusion dated at 2724.6 ± 2.5 Ma), and a narrow band of sedimentary rocks (the Matagami Group - MaG, <2700 Ma) in faulted contact with the Opatica Subprovince (OSP) to the north and volcanics to the south. These lithologies are crosscut by Proterozoic gabbro dykes. Two volcanic groups are present: the Lac Watson Group (WatG, 2725 to 2723 ± 2 Ma) and the overlying Wabassee Group (WabG). The WatG consists mainly of rhyolite, rhyodacite and dacite. It is this group that hosts the majority of volcanogenic massive sulphide deposits in the camp. The Key Tuffite, immediately overlying the WatG rhyolites, represents an important marker horizon for VMS mineralization in this mining camp. The WatG is intruded by the CRB. The Wabassee Group is dominated by andesites and pillowed, massive or brecciated basalts. The group includes the Rivière Bell Volcanics (tholeiitic affinity) and the Rivière Allard Volcanics (calc-alkaline to transitional affinity).

Several geographical areas have been defined in the past: the South Flank, the North Flank, the Central Camp, and the West Camp. Our work has led us to propose a new subdivision into North and South domains, with the boundary marked by three shear zones named “Rivière Allard”, “Rivière Waswanipi” and “Lac Matagami”, all oriented 070°. They represent reverse sinistral shears ranging from 50 m to more than 100 m thick, dipping steeply to the north with a stretching lineation plunging steeply to the east. The South Domain will now comprise the historically defined North Flank and South Flank, the Central Camp and the West Camp. Our work demonstrates, just as several researchers have suggested in the past, that the South Flank, Central Camp and West Camp share the same stratigraphy, oriented NW-SE with a gentle to quasi-horizontal dip, developed in a relatively consistent and predictable manner. Mapping also reveals that the South Flank and Central-West camps are affected by a weak S1 cleavage and by three major F1 fold axes (two synclines and one large anticline), also oriented NW-SE. An E- to ESE-oriented S2 schistosity crosscuts S1 cleavage. The resulting geometry of the juxtaposed North and South domains calls into question the existence of the Galinée Anticline and has serious implications for the VMS potential in the areas described above.

As for the North Flank, stratification is oriented 110° with a dip and general polarity to the north. An S2 schistosity oriented 090° to 110° affected the S0 surface and locally generated F2 folds. Shear zones, also oriented 110°, appear to repeat or truncate certain portions of the volcanic pile and the BRC.

Session 1 ■ 10:10

Chapais-Chibougamau: Beyond the traditional mining camp

François Leclerc, Patrick Houle, Patrice Roy (MRNF), Lyal B. Harris (INRS-ETE), Jean H. Bédard (GSC-Q), Vicki McNicoll, Otto van Breemen (GSC-O), Jean David (GÉOTOP) and Normand Goulet (UQAM)

The Chibougamau mining camp (Lac aux Dorés and Lac Chibougamau areas) was active from 1955 to 2008 and during this time produced 1.6 billion pounds of copper and 3.2 million ounces of gold, along with significant amounts of silver and zinc. The Chapais mining camp, active from 1953 to 1991, produced 1.1 billion pounds of copper, 0.8 million ounces of gold, and 8.2 million ounces of silver. Many of the past-producing mines within the two mining camps are located along shear zones that are underexplored beyond 200 m depth. The discovery potential in these so-called "traditional" areas remains very high. Recent exploration and mapping efforts in the Chapais-Chibougamau area demonstrate that the mineral potential extends beyond the traditional mining camps. VMS deposits are known in all three cycles of the Roy Group: a) at the top of the Chrissie Formation south of Chapais (cycle 1); b) at the Lemoine mine, the Scott Lake deposit and the Lac Lempira area in the Waconichi Formation (cycle 2); and c) in exhalites at the Bruneau and Gwillim mines in the Bruneau Formation, and in zone 8-5 in the Blondeau Formation (cycle 3). Major E-W-trending deformation zones in Chapais-Chibougamau constitute high-potential targets for lode gold and copper-gold deposits. South of Chibougamau, the Joe Mann gold mine (4.7 Mt @ 8.26 g/t Au) was in operation from 1956 to 2007 along the Caopatina-Guercheville shear zone. North of the Chapais-Chibougamau mining camps, many E-W-trending deformation zones are now readily accessible and have been traced over strike lengths of more than 100 km. Showings along the Lac France shear zone (Monexco, Westminer, Gwillim, McGold) and the Croteau shear zone (Croteau-Ouest, Croteau-Est, Croteau-Est-II) occur along the contacts of km-scale quartz- and feldspar-phyric felsic sills within mafic volcanic rocks with strong ankerite alteration. Gold showings along the Faribault shear zone (Asselin, Tadd) occur at the contact between basalts of the Bruneau Formation and lapilli tuffs of the Bordeleau Formation. Gold and copper-gold showings along the Palmer-Tippecanoe-Dollier shear zone occur along the contacts of Obatogamau Formation basalts intruded by felsic dykes. The Obatogamau Formation is overlain by the Waconichi Formation (Queylus Member), which contains gold-bearing sulphide horizons (Chevrier deposit).

Session 1 ■ 10:30

Numerical modelling of the Archaean seismic activity along the Cadillac-Larder Lake Fault Zone: inferences on orogenic gold mineralization

Silvain Rafini, Stéphane Faure (CONSOREM) and Réal Daigneault (CONSOREM-UQAC)

This study investigated the Archean seismic activity of the Cadillac-Larder Lake Fault Zone (CLLFZ) to determine its role in orogenic gold deposit genesis. Numerical modeling was carried out using UDEC (*Universal Distinct Elements Code*) to reproduce the earthquakes that induced crustal-scale hydrothermal fluid migration and gold deposit formation. Observations of active faults in modern environments suggest that hydrothermal fluids are drained from deep-level sources during the seismic cycle into 2nd and 3rd order faults located in coseismic damage zones (CDZs) near to the main fault. The structural permeability enhancement sustained in these zones allows the discharge and precipitation of large volumes of mineralizing fluids for several years or decades following the earthquakes. CDZs can be identified spatially using static stress modeling, following *aftershock theory*, a seismological approach initially developed to study active fault seismic hazards. The Coulomb failure stress change is calculated around a ruptured fault. CDZs correspond to positive change areas brought to the critical rupture state and are characterized by increased seismic hazard and triggered earthquakes. This theory has been applied for decades by seismology researchers to active faults; its extension to gold exploration is an innovative approach, which was successfully introduced in the Australian Greenstone Belt. The recognition of late gold mineralization stages in several deposits from Val-d'Or, Malartic and Rouyn-Noranda goldfields is considered to be contemporaneous with the late dextral component of movement along the CLLFZ. Postulating this dextral activity, regional static stress models achieve an excellent correlation between gold deposits and CDZs produced by recurrent earthquakes on E-W fault-segments (magnitude 7-7.5). It can also explain the heterogeneous distribution of world-class deposits around the CLLFZ, forming clusters known as goldfields. During late-orogenic mineralization stages, the CLLFZ seismic dynamics are controlled by a well-marked structural segmentation inherited from prior Archean tectonics. This architecture causes repeated mainshock rupture arrests on few structural points where the fault is folded, bent, offset and/or split, leading to repeated fluid discharge into the recurrent CDZs and permitting the accumulation of overwhelmingly large fluid volumes. This is corroborated by ample field evidence of repeatedly attained high pore fluid pressures (crack-seal veins). The spatial correlation between large deposits and CDZs is confirmed at a district scale in the Val-d'Or goldfield. It is demonstrated that the occurrence of 2nd and 3rd order faults in the vicinity of rupture-arrest structural points, well-oriented with respect to CDZs, is an important gold exploration criterion.

Session 1 ■ 10:50

Geological model for the Windfall Lake gold project

Jean-Philippe Desrochers, Darrell Turcotte (Eagle Hill)
and Neil W. Richardson (VMS Ventures)

The Windfall Lake gold project is located in the heart of the Urban-Barry Greenstone Belt in the Abitibi region. Volcanic units have similar ages to those of the 1st volcanic cycle in the Chibougamau area (2720 to 2730 Ma) and consist of mafic and felsic flows of the Macho Formation. Younger sedimentary rocks are folded and overlie the volcanic pile along an angular unconformity.

On the Windfall Lake property, volcanic units occur in an early thrust zone dipping shallowly to the southeast. The volcanic units dip about 20° to the southeast and stratigraphic younging directions shift from facing up to facing down, indicating the presence of low-angle folds. Intermediate intrusive rocks and rhyolitic porphyry dykes are sub-parallel to the thrust zone and crosscut gold-bearing zones.

Four main phases of deformation affected the volcanic rocks. The first phase developed a north-trending tectonic foliation with dips ranging from 0° to 30° east. The second phase corresponds to the "regional schistosity" (S2) as well as east-northeast-trending shear zones, both steeply dipping to the north or south. The third and fourth phases of deformation respectively produced east/west-trending shear zones and north-northwest-trending brittle faults.

At least two episodes of gold deposition are recognized on the Windfall Lake property. The first episode corresponds to disseminated pyrite forming mineralized halos oriented parallel to the thrust zone. Mafic rocks exhibit biotite-magnetite-rich zones with pyrite, whereas felsic rocks contain silicified and sericitized zones.

The second episode is characterized by extensive zones with disseminated and stringer pyrite and disseminated tourmaline, trending parallel to the S2 tectonic foliation. Gold-bearing shear zones trending east-northeast also developed during this episode of gold deposition.

A mineral resource estimate will be released in the fall of 2011. Given the high potential of increasing the mineral resource, further diamond drilling is also planned in the fall of 2011, to test the extensions of known gold-bearing zones.

Session 2 ■ 11:10

Grade control at the Detour Lake gold deposit, Ontario

Pat Donovan (Detour Gold)

The Detour Lake gold project is located in northeastern Ontario, approximately 300 km northeast of Timmins, within the Abitibi greenstone belt in the northwestern portion of the Archean Superior Province. Discovered in the mid-70s, Detour Lake was in operation from 1983 to 1999, producing approximately 1.8 million ounces of gold mainly from underground methods.

After acquiring the project in January 2007, Detour Gold Corporation initiated a comprehensive drilling program to define the potential for a large, open pitable, low-grade gold deposit. The gold mineralization is found within a 200 to 350 metres wide corridor over a strike length of >3 kilometres within a mafic metavolcanic assemblage, from surface to at least 1,000 metres depth. In 2007, the drilling focused on the eastern portion of the deposit on a 80m x 80m grid pattern. From 2008 to now, the drilling was completed on a 40m x 40m grid to categorize the mineral resources to the measured and indicated resources categories and to estimate mineral reserves. To date, Detour Gold has completed over 500,000 metres of diamond drilling and has defined an open pit mineral reserve of 14.9 million ounces of gold, which is Canada's largest pure gold reserve.

As a grade control exercise to confirm that the 40m x 40m drilling spacing is adequate for mineral reserve estimation, Detour Gold completed a 20m x 20m drilling program in the eastern portion of the deposit. The successful results confirmed that drilling the deposit on a 40m x 40m drill spacing is sufficient for reserve estimates.

In 2010, Detour Gold started a drilling program to establish the appropriate grade control procedures for production. This diamond drilling program consisted of short holes testing the first four benches (approximately 40 metres) of a selected portion of the deposit on a 10m x 10m spacing. The results did confirm the grades and tonnes that were outlined on both the 20m x 20m and the 40m x 40m spacing.

This exercise provided the confidence that a closed-spaced drilling program will allow Detour Gold to manage the gold grade of the deposit during the mine life. The tightly spaced drilling pattern proposed is an accepted grade control practice world-wide for gold deposits of this type.

In the fall of 2011, Detour Gold has started the production grade control program at Detour Lake. Approximately 9,000 metres of reverse circulation (RC) drilling will be completed on a 10m X 10m spacing.

The Detour Lake project is currently under construction. Gold production is expected to commence in the first quarter of 2013.

Session 2 ■ 1:30

Entrepreneurship and public financing: what do entrepreneurs and investors think?

The mineral potential of Québec attracts companies from around the world. The province also boasts one of the most competitive mining regimes. And both the necessary expertise and institutions ready to support mining entrepreneurship are available in the province. Yet despite these comparative advantages, only 6 of the 149 mining sector companies listed on the TSX Venture Exchange in 2010 were from Québec. Why? Entrepreneurs in the mining industry who have successfully taken the plunge will talk about their progress and how they managed a public company, and will offer some sensible advice. A panel of investors will also weigh in on the qualities they look for in a mining entrepreneur and his/her business plan.

Session 2 ■ 1:50

Panel of entrepreneurs

Simon Britt (Ressources Géoméga), Philippe Cloutier (Cartier Resources) and Glenn Mullan (Golden Valley Mines)

Questions for these entrepreneurs will focus on their motivation for turning to public financing, their choice of method, the consequences for their company, the composition of their boards of directors, the roles of their management teams, the challenges they face and what they have learned from their experiences.

Session 2 ■ 2:55

Panel of investors

Michel Champagne (SIDEX), Jacques Cossette (CIBC Wood Gundy) and Denis Landry (SODEMEX)

Questions for these investors will focus on their main investment criteria, and the indicators they use to assess, among other things, a company's management team and the mineral potential of its projects. Also up for discussion is how best to conduct oneself and one's business to earn their confidence.

Session 3 ■ 9:00

Public Geoscience for Private Exploration

Murray Duke (Ottawa, Ontario)

The function of a geological survey is to ensure the availability of the geoscience information that government needs to promote the public interest. This occurs mainly in two contexts. First, surveys provide geoscience to inform government policy decisions. Second, they provide information as a public good to support decision-making by the private sector, civil society, and the general public. Among the most important examples of the latter is the public geoscience used by industry to carry out mineral exploration. This involvement of government in the market is predicated on three considerations: (1) the fact that most mineral resources (in Canada) are public assets, which conveys a duty of stewardship upon government; (2) governments have determined that the responsible development of these resources is in the public interest; and (3) much of the relevant geoscience information has the economic characteristics of a public good, which argues for a government role in providing it.

Public geoscience attracts exploration investment by allowing industry to identify areas of favourable mineral potential. Accordingly, the quality of public geoscience is an important determinant of the climate for exploration investment. It is often said that government's investment in public geoscience stimulates five times as much in private exploration investment. Although this is a reasonable "rule-of-thumb", it is not the most important consideration. The more important impact of public geoscience is in improving the efficiency and effectiveness of private exploration. By reducing exploration costs and risks, public geoscience not only improves returns on private investment but also increases revenues accruing to governments as royalties and taxes.

The long term global trend of increasing discovery costs indicates that mineral exploration in many areas has reached the point of diminishing returns. In other words, exploration is becoming less cost-effective. Public geoscience can mitigate this trend. Going forward, discoveries will of necessity increasingly be made at depth. Geological surveys can help improve the cost effectiveness of deep exploration by putting greater emphasis on mapping the third and fourth dimensions.

Session 3 ■ 9:40

Geoscience knowledge in Québec: Its value, its impact, and its future

Sylvain Lacroix, Charles Maurice, Daniel Lamothe
and Charles Roy (MRNF)

Geoscience knowledge represents a highly valuable social asset to support the sustainable development of our mineral resources and our territory. In Québec, geoscience information gathered during activities carried out by government agencies, mining companies and universities is integrated into the SIGÉOM geomining information system, which represents an information heritage for which the replacement cost is estimated at 3.9 billion dollars. This precious source of information is used to support private decision-makers looking to invest in exploration, but also serves another purpose, within the scope of government planning of various activities related to land use.

Government inventories (geology, geochemistry, geophysics, metallogeny) completed across Québec account for less than 10% of the replacement cost of SIGÉOM, as opposed to more than 90% for work done by mining companies. However, several documented historical examples show that the acquisition, by government, of new geoscience information has resulted in mineral exploration work and ultimately led to the discovery of new mineral resources, especially in poorly-known areas. A comparison of investments in public geoscience and private mineral exploration in areas targeted under the Near North and the Far North programs also illustrates the leverage that new geoscience knowledge represents for exploration investments. More recently, new geoscience knowledge acquisition programs identified numerous direct (based on geological observations) and indirect (geochemical and geophysical anomalies) targets, which upon publication led to the acquisition of new mining titles.

Over the last decade, the development of predictive ore deposit models, GIS tools, and the increasing density of data in SIGÉOM have made it possible to assess the potential for certain metals and minerals in specific areas. Mineral potential assessment studies aim to identify favourable zones for the discovery of mineral resources, but also facilitate the identification of less favourable areas that may be better suited for the creation of protected areas, as well as emphasize gaps in available knowledge and thus orient future geoscience surveys.

The Québec government has recently allocated a ten-year budget for new geoscience knowledge acquisition in order to stimulate, orient and support the search for new mineral resources, namely in lesser-known areas such as Northern Québec. New geoscience knowledge will also increasingly be acquired to help address social and environmental issues related to sustainable development, for example concerning public land use, groundwater protection, global warming, etc.

Session 3 ■ 10:00

Mineral exploration problems and real solutions: CONSOREM's contributions to applied research

Stéphane Faure, Réal Daigneault, Benoit Lafrance, Silvain Rafini
and Sylvain Trépanier (CONSOREM)

The discovery of a deposit is first and foremost the result of a series of ideas and actions led by players in the exploration industry, from the initial selection of regional fertile environments right through to the drilling stage. Science still does not provide an exact blueprint for discovering deposits, but it does indirectly contribute to most steps in the exploration process. As part of this chain of research and innovation, *Consortium de recherche en exploration minérale* (CONSOREM) occupies a specialized and unique niche between university research and companies. The main objective of its mandate is to develop new exploration models and transfer knowledge to the industry. Three examples of research projects are presented to illustrate the role of CONSOREM: 1) A region's fertility for diamond exploration is primarily determined by whether or not the necessary conditions for preserving diamonds were present in the mantle lithosphere after the mineral formed. The morphology of such fertile cratonic roots had not been clearly recognized in North America until our study determined, by seismic tomography, domains of potential diamond preservation around craton roots, between 160 and 200 km deep. Projected to the surface, this fertile zone confirms the diamond potential for some areas and opens up other new regions for exploration. 2) Mineralized zones are generally accompanied by alteration haloes, and it is a nontrivial task to distinguish the least altered samples in these haloes from the most highly altered samples proximal to mineralization. The difficulty lies in recognizing indicators of least alteration for an area, and these must often be qualitatively assessed using thin sections from a small number of samples. To remedy this problem, CONSOREM developed a new mass balance method using precursor modelling that can be applied when processing large amounts of data, for example at the scale of a mining camp. The new method was delivered to the industry as the original *Lithomodeleur* software, which integrated a wide variety of analytical tools for processing lithogeochemical data. 3) Polymetallic iron-oxide (IOCG) deposits are attractive for their gold, copper and uranium contents as well as for their enormous volumes (Gt), even though they have particularly complex exploration models. CONSOREM has proposed a new approach based on the geochemical characterization of plutons genetically associated with IOCG deposits *sensu stricto*. The method has revealed similarities with Cu-Au alkali-calcic porphyries and can be used to identify favourable areas in the Abitibi.

Session 3 ■ 10:20

Identification of structures in the deep crust to lithospheric mantle transverse to Proterozoic orogens in Québec and surrounding areas and their role in localizing mineral deposits

Lyal Harris, Grégory Dufréchou and Camille Armengaud (INRS-ETE)

Deep crustal and sub-crustal lithospheric mantle structures exert primary controls on the localization of many mineralized districts and giant mineral deposits in diverse tectonic settings, e.g. Olympic Dam IOCG-U-Ag in Australia, Au and IOCG deposits in Chile, and epithermal Au in SW Japan, so mapping such structures is important in regional exploration targeting. Upward-continued and long wavelength components of regional gravity and aeromagnetic data across the Grenville Province of Quebec and northern USA and Proterozoic orogens in NE Quebec and Labrador reveal prominent, but previously unmapped, lineaments at a high-angle to the general orogenic trends. Several of these lineaments correspond to prominent features on MIT P-wave seismic tomographic data suggesting they represent lithospheric-scale structures. Enhancement and edge detection (“worming”) of regional Bouguer gravity data defines new terrane boundaries and deep Archaean crustal structures in the North East Superior Province (NESP). The contact between the Rivière Arnaud and Hudson Bay terranes continues E-W across the NESP. Archaean terrane boundaries and structures extend beneath the New Quebec Orogen where they control Palaeoproterozoic granitoid batholith emplacement and U, Cu-Au-U, Co-Cu-Ni, and Fe mineralization and carbonatite intrusion. Changes in deformation style, dip of structures in the New Quebec Orogen, and width of units in the western Core Zone occur across Archaean basement structures. Similarities in tectonic setting and mineralization style to Muruntau (Uzbekistan) are proposed. The Voisey’s Bay Ni-Cu-Co deposit occurs in plutons intruding an E- to ESE- striking fault zone that is an eastwards extension of the same Archaean basement structure that controls U, Au, Cu, and base metal showings and carbonatite intrusion in the New Quebec Orogen and which links to the Garder fault zone in S. Greenland. Transverse structures identified in the Grenville Province represent Palaeoproterozoic faults in Archaean basement reactivated during Grenville Group sedimentation, deformation throughout the Grenvillian orogenic cycle, and younger deformation. Basement structures bound corridors of present-day seismicity, including the Western Quebec Seismic Zone. Reactivation of basement structures, especially during post-orogenic collapse, reorientated early-formed structures and localized megakink zones in uppermost Grenvillian thrust sheets. SEDEX or clastic dominated Zn±Pb±Ag deposits (e.g. in the Balmat-Edwards district, Adirondacks), IOCG, U±REE mineralization, Palaeozoic Cu±U deposits, carbonatites, and Mesozoic kimberlite and lamprophyre intrusions are spatially associated with the newly identified basement structures.

Session 3 ■ 10:40

Composition of fluid inclusion volatiles: significance and use in gold exploration in metamorphic environments

Damien Gaboury (UQAC)

Several recent studies have determined the P-T conditions involved in the formation of gold deposits, as well as the source of the fluids and gold, and the conditions of solubility-precipitation. Fluid inclusions provide the only direct evidence of the fluids involved in metallogenesis. We therefore maintain that the gas composition of such fluids should reveal fundamental processes involved in forming ore deposits. A unique apparatus, developed by the author, can be used to analyze the gas composition of families of fluid inclusions by mass spectrometry. The apparatus generates a spectrum of fluid compositions (CH_4, H_2O, N_2, H_2S, SO_2, CO_2, C_2H_6, Ar, H_2, He) as a function of the decrepitation temperature (Td: 100 to 500°C). To test the validity of the approach, samples of quartz veins from Archean (Abitibi) and Paleoproterozoic (Birimian) deposits were analyzed using the method presented in Gaboury *et al.* (Economic Geology, 2008). Samples from Casa Berardi (n=15) and Joanna (n=13) were taken from mineralization occurring along major faults in a sedimentary context; samples from Beaufor (n=10) were hosted in granodiorite; and those from Mana (Burkina Faso: n=4) and Liberi (Niger: n=4) in deformed volcano-sedimentary rocks.

All the fluids are rich in CO_2 and contain H_2S, in accordance with their respective roles as a pH buffer for maximum gold solubility and as a gold ligand. The barren samples are collectively depleted in CO_2 and H_2S, or have Td temperatures below the gold solubility range of 250-450°C. The mineralized samples collectively show a Td offset for H_2O-CO_2, indicating phase separation, a fundamental mechanism in gold precipitation. Hydrocarbons (CH_4 and C_2H_6) are omnipresent and provide evidence of a contribution from rocks rich in organic matter. Such rocks (shales) are known to be the best source rocks for generating metamorphic fluids and liberating gold from sedimentary pyrites during their conversion to pyrrhotite. Also commonly present was N_2, which is considered a likely indicator of the contribution from shales. Helium, present at Casa Berardi and Joanna, may indicate the presence of a major fault, which is considered an important metallotect. The significance of other gases remains to be determined.

Gas composition thus sheds light on important processes involved in the genesis of orebodies. In exploration, quartz fragments found in tills or at surface in lateritic environments could potentially serve as exploration vectors based on their gas contents.

Session 3 ■ 11:00

From knowledge to discovery

Michel Gauthier (UQAM)

Who is responsible for gathering geoscientific knowledge and how should go about it? What should be the role of governmental geological services and what should be the contribution from mining companies? These stakeholders find themselves taking turns as knowledge generators and users, thereby imposing a close partnership. In Québec, the fiduciary role of the government is particularly important in generating and developing this foundation of data, and geological mapping constitutes its backbone.

How is this knowledge taken in and applied by those who practice exploration? How can we combine conceptual and empirical approaches to achieve prospecting success? What is the best way to combine them? Using examples, we will illustrate how this process has led to discoveries here and elsewhere.

Session 4 ■ 1:40

Portrait of the iron ore industry in Québec

Denis Blackburn and Martin Bernatchez (MRNF)

The *Direction générale du développement de l'industrie minérale* (DGDIM) of the *Ministère des Ressources naturelles et de la Faune* (MRNF) of Québec keeps stock of all mining activities taking place across the province. In recent years, a large number of projects targeting iron ore or related commodities (titanium, vanadium, phosphate) have been added to the list.

Presently, five areas across Québec are more specifically targeted by this renewed interest in iron ore projects: Fermont, Schefferville, Ungava Bay, James Bay, and Chibougamau. Fermont and Schefferville are the most active areas. Existing infrastructure, namely roads, railways, port facilities, power lines, and municipalities have reached in some cases their maximum capacity and new infrastructure is required to meet the needs of future projects. In the James Bay area and along the west coast of Ungava Bay, exploration projects are also underway. The lack of infrastructure may impose a heavy burden on the development of potential mining projects in these regions. Finally, in the Chibougamau-Matagami area and in other areas of interest across Québec, exploration projects targeting vanadium, titanium or phosphate may also supply, as a by-product, iron ore concentrates.

Session 4 ■ 2:00

The Iron Ranges of Western Labrador - New Developments and Future Potential

Andrew Kerr, John Clarke and Phillip Saunders (Department of Natural Resources, Newfoundland)

Newfoundland and Labrador have been major producers of iron ore for over a century, first from the Bell Island deposits near St. John's, and for the last 55 years from the iron ranges of western Labrador. In conjunction with adjacent Québec, this area is one of the world's great iron ore districts, accounting for at least half of Canada's total production, and containing vast resources for future economic development. Iron ore is hosted within sedimentary rocks of the Paleoproterozoic New Québec Orogen (also known as the Labrador Trough) and their metamorphic equivalents in the parautochthon of the Grenville Province. Deposits fall into three main groups, namely "taconites" (primary sedimentary ores), supergene-enriched (direct-shipping) hematite ores, and metamorphic magnetite–hematite ores derived from taconite protoliths. Only the latter two deposit types have seen commercial production, in the Schefferville and Labrador City–Wabush areas, respectively. Two major undeveloped deposits in the Labrador City area are the subjects of advanced exploration programs. The Julienne Lake deposit, originally discovered in the 1950s, is an exempt mineral land (EML) under evaluation by the Department of Natural Resources; historical estimates suggest that it contains > 500 Mt at ~35% Fe. The Alderon Resources Kamistiatusset (Kami) Project is evaluating substantial deposits of similar aspect, and now estimates a total resource exceeding 1 billion tonnes at ~ 30% Fe. Significant undeveloped resources also remain within the Iron Ore Company of Canada mining leases. The largest single iron ore resource in western Labrador remains in the primary taconite deposits near Schefferville, where resource estimates suggest as much as 5 billion tonnes at 29% Fe; these deposits extend into Québec, where a smaller (but still immense) resource is inferred. From a regional perspective, prospective sedimentary rocks of the Kaniapiskau Supergroup occur widely in the more remote parts of western Labrador, and these areas are now seeing early-stage evaluation. Although exploration activity has grown rapidly since the dawn of the new millennium, it remains concentrated in areas of existing infrastructure, and the hinterland awaits systematic evaluation. There has also been recent interest in iron deposits known elsewhere in Labrador, including those in Archean rocks along the north coast.

Session 4 ■ 2:20

China, a rich country but a poor people: the sustaining power for the global steel industry

Sandy Chim (Century Iron Mines)

With over US$5 trillion dollars of GDP, China has been the second largest economy in the world and growing. With annual growth rates of around 8% to 10%, many expect China will be one day, in the not too distant future, the largest economy surpassing the USA. From only US$216 million GDP in 1978 when its economic reform started, China managed to grow spectacularly by 25 times in about three decades. This solid growth over the years has created tremendous wealth for the nation. If we choose to show how well the country has done by just one number, it can be best understood by its foreign exchange reserve of over US$3 trillion today, the largest in the world and in history by far so far.

It has been that economic momentum from just one country (with China's steel production constituting some 45% of total international market) that is propelling this current super cycle of iron ore so much so that even in the face of global financial crisis both the prices and volumes of seaborne iron ore trade broke record a few times. It is indisputable that over the last decade, China contributed much to this cycle. The inevitable question is whether China can still drive the market after already so much growth.

The answer to that question can best be seen by how much the average Chinese can still improve their income and living standard. Even at over US$5 trillion GDP, with a population of 1.3 billion, China is still a relatively poor people at US$4,000 GDP per capita. If the few millionaires are taken out of this average, the number is even lower. The average Chinese income will grow substantially for sure. A good benchmark of US$17,000 GDP per capita of South Korea is a good comparable target of what China can achieve. At the South Korean level, it will take China to growth 8% for about 20 years. The current geo-political system that took it here seems to be stable to provide the condition for it to improve its poor population significantly. In short, the constant strive for better income and living standard of the Chinese population is the engine of the global steel industry and economy at large.

Session 4 ■ 3:00

Building the Next Major Iron Ore Mine in the Labrador Trough

Jeff Hussey (Champion Minerals)

Champion Minerals Inc. ("Champion") is an iron ore Exploration and Development Company publicly traded on the TSX Exchange under the CHM symbol. Projects include the Fermont Holdings comprised of 17 highly prospective and strategically located brown-field projects located southwest of the town of Fermont. The Attikamagen project is located 15 km northeast of Schefferville and covers 310 km^2 over an 80 km property strike length. Champion also has an option agreement on two copper properties in central Newfoundland.

Champion has an 82.5% direct interest in the Fermont Holdings located adjacent to the major Canadian iron ore producers. They are all proximal to hydroelectric-, road-, and rail-networks that connect to port facilities at Sept-Îles and Port-Cartier, on the St. Lawrence Seaway. Currently the focus is on the Fire Lake North feasibility study following Preliminary Economic Assessment studies. Infrastructure planning has been an integral part of all studies and the Fire lake North project is the first phase of a larger centralized concentrator concept fed by several proximal deposits currently being explored.

Exploration started in 2009 and these projects now host over 1.5 billion tonnes @ 25.4% iron (Fe),of NI43-101 compliant inferred mineral resources. Other projects host a combined 613 million tonnes of 31% Iron, considered to be historical and non-NI43-101 compliant. These estimates were based on very limited drilling and rudimentary geophysics and are considered conservative with significant upside exploration potential. Any new deposits outlined in the area will be advanced to pre-feasibility stage to determine how to integrate them into a centralized Fire Lake North concentrator concept fed by conveyors that can reach up to 30km.

Near Schefferville the Attikamagen Project contains multiple repetitions of the Sokoman Middle Iron Formation characterized by massive hematite/magnetite iron formation. Champion's joint-venture partner Century Iron Mines Corporation is drilling to test taconite and DSO target areas. In January 2011, WISCO and Minmetals of China entered into a joint venture agreement with Century Iron Mines Corporation.

Champion has a strong financial position and growth profile. A 60,000 m diamond drill program is being completed in 2011 to increase the quantity and quality of iron ore mineral resources. Champion is on its way to becoming a major, long-life, iron ore producer in Eastern Canada, a politically stable region with existing infrastructure and a rapidly expanding production profile. The ever-increasing value of Champion's asset portfolio is a reflection of its strategic importance within the context of the increasing world demand for iron ore; a trend that is expected to continue.

Session 4 ■ 3:20

A New Iron Ore Mine at Schefferville – Rebirth of a Historic Mining Camp

John Kearney (Labrador Iron Mines)

In 2011 Labrador Iron Mines (LIM) joined the ranks of Canadian companies mining iron ore with the opening of its new James Mine at Schefferville. In early October the first shipment of iron ore sailed from the Port of Sept Iles for China carrying a total of 167,000 tonnes of iron ore.

History was made at the end of June when LIM's first ore train loaded with direct railing ore departed Silver Yards for the Port of Sept-Iles. This train was the first commercial iron ore train from the Schefferville area in almost 30 years.

The Quebec-Labrador iron range has a tradition of mining since the early 1950s. The former direct shipping iron ore operations at Schefferville operated by Iron Ore Company of Canada (IOC) produced in excess of 150 million tons of lump and sinter fine ores over the period 1954-1982. By the time production ceased, a further 250 million tons of iron ore resource had been identified but left unmined in the Schefferville area.

The first to reprise the vision for the Schefferville area iron ore projects was Labrador Iron Mines (LIM). Through its wholly-owned subsidiaries, Labrador Iron Mines Limited and Schefferville Mines Inc., LIM acquired interests in mineral claims and licenses in both Quebec and Labrador containing over 150 million tons of historic iron ore resources.

From the fall of 2005, LIM conducted extensive exploration and development work to advance the projects, and negotiated Impact Benefit Agreements with local aboriginal groups.

Today LIM is at the forefront of Canada's new iron ore producers, its James Mine now in full scale production, the Silver Yards processing plant constructed in late fall 2010 and now running at design throughput and recovery, rail agreements from Silver Yards to the Port of Sept-Iles. An agreement signed with IOC for the sale and shipping of all of LIM's 2011 iron ore production ensures the maximum possible tonnage of LIM's iron ore will be efficiently shipped and sold during the remainder of 2011.

LIM expects to mine about 2,000,000 tonnes of ore at the James Mine and deliver to the Port of Sept-Iles between 500,000 and 700,000 tonnes of direct rail, lump and sinter fines in calendar 2011. Planned processing enhancements will enable production growth of approximately 2.5 million tonnes of iron ore in 2012 and to 5 million tonnes in 2015.

Session 4 ■ 3:40

On the path to production

Dean Journeaux (New Millenium Iron Corp.)

New Millennium Iron Corp. is an exploration and development company solely focused on iron ore. Its properties are located near Schefferville in the Provinces of Québec and Newfoundland & Labrador. NML controls emerging Millennium Iron Range (MIR), a 210 km long taconite belt. In addition, NML owned direct shipping ore (DSO) deposits, which are currently being developed in a joint venture with Tata Steel. Tata Steel is one of the ten largest steelmakers in the world. The Project is expected to be in production during the fourth quarter of 2012, generating cashflow for the company. NML is also conducting, jointly with Tata Steel, a feasibility study for its Taconite project, which consists of KéMag and LabMag deposits, which are amongst the world's largest undeveloped magnetic iron deposits. In addition, NML is also exploring certain magnetic anomalies in order to identify a major project for future development with another strategic partner. The presentation will provide details of NML's development plan to become a significant producer of iron ore in Canada before the end of this decade.

Session 5 ■ 9:10

Critical minor metals and minerals: Risks and opportunities

Christian Hocquard (BRGM)

"Rare metals" or minor metals constitute a pool of about fifty elements from which today's metallurgists are drawing to develop new alloys. This group is characterized by a number of common criteria, as follows:

Quantitative criteria: They are produced in small amounts, from a few tonnes up to 200,000 tonnes per year.

Technical criteria: Occasionally mined as the main product of interest (Li, rare earths, Ti, Sb, W, etc.), they are, by and large, by-products of the mining or metallurgical industry.

Economic criteria: They are quite valuable, even extremely valuable, commonly due to the high level of purity required for certain applications.

Critical criteria: Their "criticalness" is not a function of the low earnings derived from their annual production, but is related to the fact they are indispensable for numerous high-technology products all the while being produced in high-risk countries.

Behaviour criteria: Rare metal prices commonly show long periods of stability interrupted by crises that may even lead to extreme shortages.

All of the innovative industrial sectors are affected, particularly renewable energies (photovoltaic and wind), transportation (electric and hybrid vehicles), energy efficiency (weight reduction in the aeronautics and automobile industries; low-energy LED lighting), LCD and OLED flat screens, etc. Add to these industrial demands recent strategic inventories building up in many industrialized countries, as well as speculative inventories related to exchange-traded funds (ETF).

Serious concerns and restlessness have been growing in recent years concerning rare metal supply in developed countries, ballooning to a remarkable extent recently with the latest "rare earth" crisis, to the point it has become a political issue. Some of these metals are thus moving from the "rare" category to the "critical" list.

In this context, is it possible to secure a timely and uninterrupted supply for manufacturers, at a time when the production of rare metals is becoming more and more restricted and their availability is vulnerable at various levels in the supply chain?

Session 5 ■ 9:50

Graphite Exploration and Development in Québec

Gary Economo (Focus Metals)

As a business innovator, Focus Metals finds itself in the unique and enviable position of developing two technology-based discovery and development properties in Quebec. And having the Quebec government as your operating partner is a bonus.

As a technology solutions supplier, our flagship Lac Knife property holds the best technology-grade graphite in the world and provides the basis for a business model capable of generating high-value production and sustainable, long-term, revenues.

Focus Metals is developing its own new, environmentally-friendly technologies for graphite production and we plan to become the first Canadian mass producer of graphene for industrial applications.

The investments we've made in Quebec leave us well-positioned to become both a Canadian and a global leader in graphite production and processing. And the investment we've made in Grafoid Inc., our graphene development and patenting joint venture builds value upon shareholder value from our graphite.

Graphene is graphite at the atomic structural level. Our Lac Knife graphite happens to be of the highest grading, highest structural purity in the world. And we are capitalizing on it.

Focus Metals is not your typical, traditional mineral explorer. When you own the best quality, lowest-cost-to-produce technology-grade graphite in the world, it made sense to us to become lowest-cost mass producer of industrial graphene in the future.

To us, investing in Quebec is an investment in the future.

Session 5 ■ 10:10

Quebec as the world's alternative secured source of lithium supply? Sure. Could it be the MAIN one? Certainly!

Guy Bourassa (Nemaska Exploration)

Québec has a history of lithium production (Québec Lithium 1955-1965) and currently has 5 projects in development that are ranked among the world's top 10 most advanced lithium projects according to a survey of 42 projects by SignumBox. Of these 42 projects, 10 are in Québec.

The 5 most advanced projects collectively represent 92 Mt of spodumene in the measured and indicated categories, with grades ranging from 1.1% to 1.54% Li_2O.

Australia currently produces the most spodumene, with its two producers Talison Lithium Ltd and, more recently, Galaxy Resources Inc. Talison is the world's biggest supplier of spodumene concentrate, which is mainly destined for processing in China. Galaxy also produces spodumene concentrate, which it ships to its processing plant in China. Talison has announced it intends to build its own processing plant by 2015, which may leave current Chinese processors without a supply of raw material. For strategic reasons, spodumene should be produced in more than one country and Canada is in a good position to fill that role. An in-depth analysis of spodumene projects elsewhere in the world reveals that Canada, and especially Québec, is a step ahead of other countries. The infrastructure, the size of the orebodies, low energy costs, and the political will to develop a lithium industry for batteries, are all positive factors.

If we believe that the growing demand for lithium will be driven by batteries for all types of hybrid and electric vehicles, for a wide variety of equipment and tools, and for storing energy generated by alternative sources like solar and wind, then we must examine the scenario of lithium carbonate and lithium hydroxide production. Producing these materials requires considerable amounts of sulphuric acid and sodium bicarbonate, as well as a great deal of energy during processing. Québec has an advantage when it comes to hydroelectricity and natural gas, and also boasts a number of geographically widespread supplies of sulphuric acid, and a suitable railroad system for transporting sodium bicarbonate and distributing the finished product to the North American market, not to mention access to the Saint-Lawrence seaway for shipment to the European market.

Québec: if it gives itself the means to do, could not only become a reliable alternative source, but could be the world's *leading* supplier.

Session 5 ■ 10:30

Geology and Economic Significance of Selected Rare Earth Element Deposit Types

George J. Simandl (British Columbia Geological Survey)

The term “rare earth elements” (REEs) includes Y, Sc and the lanthanides (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu). REEs are nearly as abundant in the Earth’s upper crust as Cu, Pb, Mo, and Zn but they are generally more dispersed in rock-forming minerals. REEs are concentrated in a variety of settings including carbonatite-related deposits, peralkaline igneous complexes, peraluminous igneous complexes, pegmatites, metasomatic veins, iron oxide Cu-Au (IOCG) deposits, “ion adsorption clays” (weathered crusts overlying granitic rocks), and ocean sediments.

Since 1980’s, China has become the dominant (>95%) producer of REEs. Currently, Bayan Obo (a carbonatite-associated Fe, Nb and REE deposit), together with two carbonatite-hosted deposits in China, supply most of world’s light rare earth elements (LREE). Mountain Pass (USA) is restarting production. China’s adsorption clay deposits provide most of the heavy rare earth elements (HREEs).

To secure REE supply for its expanding economy, over last few years China introduced export taxes/quotas. This started REE price increases and world-scale REEs exploration rush.

Over 400 REE projects are active worldwide. Of these, 237 are grassroots, 135 have limited drilling, 42 are in the advanced exploration stage; 12 are in the pre-feasibility stage, 9 are at or near the feasibility stage and two operations are under construction (Intierra, 2011). The REE market is global. The ideal LREE and HREE development target would be located in a politically stable jurisdiction such as Canada, close to infrastructure and manpower, near surface, have acceptable grade and tonnage characteristics, favourable, or at least permissive, metallurgy and would not be located in an area that is environmentally sensitive or subject to First Nations objections.

Favourable market conditions, grade, and metallurgy permitting, REEs could also be derived as a by-product of phosphate fertilizer production or uranium processing. It is also possible that some REE-bearing fluorspar deposits, Ti-Zr-bearing placers, and Olympic Dam-type (IOCG) deposits could enter into the supply-demand equation.

Discovery and development of a single giant, high-grade LREE deposit, such as Bayan Obo, or development of several typical carbonatite-hosted REE deposits outside of China would invalidate any projected medium- to long-term shortages of LREEs. Similarly successful development of HREE (± Zr, Nb, Ta, Be), peralkaline intrusion-related deposits such as Nechalacho (NWT) or Kipawa (Quebec) would represent significant competition to Chinese ion adsorption clay deposits and would moderate HREE price fluctuations.

Session 5 ■ 11:00

Strategic minerals and metals used in the manufacture of lithium storage cells (accumulators) for electric vehicles

Daniel Perlstein (Anextase)

Even though the NiMH (Nickel Metal Hydride) battery made it possible to launch the first hybrid electric car (the Toyota Prius) in late 1997, automakers currently producing or thinking of producing hybrid and electric cars now appear to have adopted lithium-ion battery technology.

The medium-term demand for the materials needed to manufacture lithium-ion batteries depend on several factors:

- the growth rate for electric vehicle production;
- the growth rate for hybrid vehicle production;
- the types of lithium-ion batteries used, and their cathode active materials in particular (manganese oxides, or nickel-cobalt-manganese oxides, or metallic phosphates, or others).

It will be important to distinguish the future of fully electric vehicles from that of hybrid vehicles, and in the case of the hybrid, it will also be important which type of hybrid becomes predominant since battery size (in kWh) and the amount of active materials can vary considerably. For example, the battery size for the “mild” Toyota Prius hybrid is 1.8 kWh, whereas the battery for the “plug-in” Chevrolet Volt is 16 kWh, and for the fully electric Nissan Leaf it is 24 kWh.

It is also important to link the future of electric vehicle batteries to the outlook for batteries used for storing electrical energy because both sectors use the same battery technology.

The lithium-bearing material needed to manufacture batteries will essentially be lithium carbonate, a material that is already used in a variety of processes to make lithiated metal oxides or lithiated metal phosphates, and sometimes lithium metal anodes.

The base material for the anode will be graphite, but silicon- or tin-based alternatives are beginning to emerge.

The electrode material must be as pure as possible with a composition that does not change over time. Two main types of processes exist for producing cathode materials: thermal solid state and hydrothermal processes. Each has its own advantages and drawbacks due to the size of the particles produced and their properties at the nanometre scale. In the case of lithiated iron phosphate ($LiFePO_4$), Phostech Lithium will use both types of processes in Québec but at two separate production units.

Session 5 ■ 11:20

Ore beneficiation – New challenges and constraints

Normand Grégoire (GÉNIVAR)

The development of new projects emphasizes the importance of ore beneficiation given the following context:

- New "primary" commodities
- New concentration/extraction technologies
- Potential interest in the beneficiation of "secondary" commodities in the initial phases of project development
- Access to specialized laboratories required to develop - validate - optimize processing flowsheets.

Examples of recent projects involving new beneficiation processes:

- Transformation of lithium concentrate into carbonate and other pure compounds via pyrometallurgy and hydrometallurgy
- Co-concentration of tantalum minerals
- Production of pure niobium/tantalum compounds by leaching, solvent extraction, precipitation, etc.
- Production of pure titanium, iron, and vanadium oxides by leaching, solvent extraction, precipitation, etc.
- Production, from a new raw material, of very pure alumina and rare earths by leaching, purification, precipitation, calcination
- Production of rare earths by leaching, purification, and precipitation.

Impacts:

- Availability of laboratories (delays) and relevant expertise (human and technical resources, analytical capabilities)
- Time required to develop an optimized and validated process
- New expertise needed from consultants (feasibility studies and plant engineering)
- New knowledge needed from plant operators (transition from mineral processor to chemist?)
- New knowledge needs to be taught in learning institutions.

Session 5 ■ 11 : 30

Social acceptability and public consultations – New challenges for the industry

Donald Blanchet (Canada Lithium) and Émilie Bélanger (GENIVAR)

Over the past few years, the regulatory framework and increased public awareness have prompted great changes in the way we approach and handle natural resource projects. We will present the case of the Québec-Lithium project and its commitment to an innovative consultation process.

Various levels of government across the country are revising industry regulations to take into account current issues and concerns. Moreover, the general public has become increasingly aware of and involved in environmental issues. To this we can add some recent Supreme Court judgements that concern First Nations.

All of these factors have contributed to changing the process for opening mines in a variety of settings. The industry now has the challenge of informing the general public of its activities and any choices it plans to make when bringing its mining operation into production, and this applies to all regions, not just those covered by agreements (like the James Bay Agreement).

In addition to explaining what steps the company will take, the challenge also lies in working alongside the host environment to define and carry out the project. This process now begins at the exploration phase and continues during the study phase leading up to construction and mining. At that point, follow-up mechanisms must also be put into place to continue the discussions and maximize the benefits for local communities.

During all these steps, consultation meetings provide opportunities for the company to explain its possible options and its arguments in favour of such options. This allows the project to be discussed, the concerns of the various groups noted and documented, and any suggestions analyzed and taken into consideration.

The Québec-Lithium Project provides an example of a consultation program involving target groups (economic, environmental, native, social) during all stages of the project. We will illustrate how the project evolved both physically and logistically in response to the concerns and suggestions from those involved. We will also present the various monitoring committees that were created to make sure the distinctive characteristics of all affected groups were taken into account, and we will illustrate the way in which these organizations functioned.

Session 6 ■ 1:30

The National Institute for Earth Sciences and Astronomy of the CNRS (France): a research institute dedicated to an integrated Earth System approach

Bruno Goffé and Jean-François Stéphan (CNRS-INSU)

The National Institute for Earth Sciences and Astronomy (INSU; www.insu.cnrs.fr/) is one of the ten institutes of the National Committee for Scientific Research in France (CNRS; www.cnrs.fr/).

The mission of CNRS-INSU is to evaluate, carry out, develop and coordinate research at the national and international levels in the fields of Astronomy and the Solid Earth, Ocean and Atmospheric Sciences, through various publicly-funded French research establishments.

INSU has partnered with 38 universities and 7 organizations (BRGM, CEA, CNES, Ifremer, IRD, Météo-France, Cemagref) with which it shares laboratories (known as mixed research units, or UMR for "*Unités Mixtes de Recherche*") and/or joint research programs. And within the CNRS, there has been increased interaction between the institutes (INSHS, INEE and INSU) involved in the Anthroposphere, Ecosphere and Geosphere components of environmental issues.

A specific focus of CNRS-INSU is its role as national coordinator for a network of observatories, known as "Observatories for Science and the Universe" or "OSU", that belong to its partner universities. These OSU have a three-pronged mission: 1) ensure the long-term functioning of INSU-approved observatory services in the fields of both Astronomy and Earth & Environmental Sciences; 2) mutually manage the laboratory equipment and services needed by the institute and its partners; 3) ensure the best connections possible between research, teaching, and knowledge transfer in the field of planetary and environmental sciences. CNRS-INSU has more than 2,500 researchers and technicians in its 104 UMR and 26 OSU, for a total budget in 2011 of 43 million euros (excluding salaries).

The institute finances, or co-finances with its partners, incentive programs that favour emerging interfaces between various players in the public and private research sectors, whether these interactions be intra- or inter-disciplinary.

And as part of CNRS, INSU is the national coordinator for France's Arctic Observatory Project, which is currently being assembled. The Franco-Canadian International Mixed Unit ("*Unité mixte internationale*" or UMI) called Takuvik (http://www.takuvik.ulaval.ca/index.php) connects *Université Laval* to the CNRS and is the first block in the foundation of this multi- and inter-disciplinary cooperative.

Last but not least, in 2012, CNRS-INSU and the Géologie Québec branch of the MRNF intend to advance their jointly conceived observatory project for mines located in fragile environments ("*Observatoire de la Mine en milieu fragile*") that will use arctic and tropical regions with mining potential to conduct investigations.

Session 6 ■ 2:10

The Ocean Networks Canada Observatory – Making the ocean transparent

Mairi Best, Kim Juniper, Scott McLean, Kate Moran, Martin Taylor and Verena Tunnicliffe (Ocean Networks Canada)

The Ocean Networks Canada Observatory, consisting of the VENUS (coastal) and NEPTUNE Canada (regional) networks, supports a new generation of coastal and deep ocean research. With a 25+ year operating life cycle, the ONC Observatory enables transformative ocean research and technology development through an innovative cabled infrastructure that supplies continuous power and Internet connectivity to a broad suite of novel subsea instrumentation in coastal and deep-ocean environments. Three cable arrays, together over 900km in length, host several hundred sensors distributed in, on and above the seabed. They are strategically located to address key scientific and policy issues (subsea earthquakes and tsunamis, ocean acidification, marine biodiversity, etc) within a wide range of environments (fiord, delta, and open coastal settings, continental slope, abyssal plain, and mid-ocean spreading ridge). The networks are available to all online, through venus.uvic.ca and neptunecanada.ca.

The observatory has over 60 scientific, technical and management staff supporting a national and international community of hundreds of researchers and end-users drawn from the academic, government and private sectors. Given the highly specialized nature of the subsea and communications infrastructure, the combined expertise of this group is unique in Canada.

Additional evidence of the scope and scale of the ONC Observatory are the commercial and outreach programs which are separately funded through the ONC Centre of Excellence for Enterprise and Engagement, a federal CECR, one of the few related to environmental science and technology, and the only one focused on ocean research and development.

Ocean Networks Canada (ONC) is a not-for-profit agency responsible for the management of the Ocean Network Canada Observatory on behalf of the University of Victoria, the lead institution for a pan-Canadian consortium of universities, industries and government agencies.

Session 6 ■ 2:30

A New View of the Continent beneath Our Feet: Scientific, Economic and Social Benefits of an Earth Sciences Mega-Project

Ron M. Clowes (UBC-Lithoprobe)

LITHOPROBE is Canada's national, collaborative, multidisciplinary, Earth science research project established to develop a comprehensive understanding of the geological development of northern North America. It is regarded internationally as one of the most successful national geoscience projects ever undertaken. About 1500 scientific publications were generated. As part of a synthesis of the more-than-two decades of coordinated research, a unique lithospheric cross section within a 6000-km-long corridor across southern Canada from the Pacific to the Atlantic oceans and to a depth of 280 km was constructed. The cross section emphasizes lithospheric-scale relationships between the major tectonic domains; plate collisions and accretions have sequentially stacked orogen upon orogen such that the older crust forms basement to the next younger. This large-scale perspective highlights the similarities among crustal structures produced by orogenic processes over a broad range of age from the Mesoarchean [3.2 to 2.8 billion years ago (Ga)] to the present. Heterogeneities in the lithospheric mantle suggest that, in certain situations, relict subducted or delaminated lithosphere can remain intact beneath, and eventually within, very old lithospheric mantle. In particular, data from northern Quebec indicate that plate tectonic processes as known today were active 2.7 Ga.

However, LITHOPROBE's legacy is more than outstanding scientific results; it also includes economic and social benefits. New and improved understanding of Earth history provides petroleum, mining and diamond companies with an enhanced knowledge base. Working with the federal and provincial surveys and major mining companies, LITHOPROBE demonstrated that high resolution seismic reflection studies can provide a valuable tool for interpreting the stratigraphic and structural framework of mineral systems and even direct-detection capabilities for deep ore deposits. Some examples are from the Abitibi region in Quebec. Development of new geophysical instruments [a portable seismic refraction recorder and a long-period magnetotelluric system] led to technology transfer to Canadian companies. Very high resolution seismic reflection studies, applied first by LITHOPROBE, are proving effective for exploration for uranium deposits in Saskatchewan. In the cratonic areas of Canada, LITHOPROBE seismic and magnetotelluric studies have provided significant new information relevant to exploration for diamonds. On the west coast of Canada, LITHOPROBE studies provided data and a framework for better understanding the mega-thrust earthquake hazard in the region. LITHOPROBE established a highly effective public outreach strategy that involved the print and electronic media as well as material for educational purposes. Unequivocally, LITHOPROBE enhanced the already strong reputation of the Earth sciences in Canada.

Session 6 ■ 3:10

Regulating Uranium Mines and Mills in Canada – Applying Science and Research in Regulatory Decision Making

Jean LeClair and Michael Rinker (CNSC)

The Canadian Nuclear Safety Commission (CNSC) regulates the use of nuclear energy and materials to protect the health, safety and security of Canadians and the environment; and to implement Canada's international commitments on the peaceful use of nuclear energy. This includes the regulation of uranium mining and milling.

In fulfilling its responsibilities under the Nuclear Safety and Control Act, the CNSC draws on multidisciplinary groups of scientists and engineers to review license applications, conduct technical assessments and to conduct independent verification of regulated activities. For example, the regulation of uranium mining and milling draws on experts in various fields of knowledge such as civil, chemical and mechanical engineering, geology, hyrdrogeology, surface hydrology, geophysics, wildlife biology, health physics and epidimeology.

In order to support its decision making, the CNSC may require licensees to fund research activities to increase knowledge and understanding in new areas or areas of uncertainties, or to further investigate events and their potential root causes. In addition, the CNSC also funds an extramural research program to obtain knowledge and information needed to support its regulatory mission. The program provides CNSC with access to independent advice, expertise, experience, information and other resources via contracts, grants and contributions placed in the private sector, and with other agencies and organizations in Canada and elsewhere.

For example, as with all mining activities, uranium mining and milling produces waste rock and tailings requiring long term management. A proposed uranium mine and mill in Nunavut presents a unique challenge in long term tailings management. The CNSC has initiated a research project to develop mathematical and numerical models to predict permafrost degradation within continuous permafrost zones, due to mining disturbances in Canadian northern climates. The project is expected to provide the CNSC with adequate and independent knowledge in order to make well-informed recommendations to the Commission Tribunal on the acceptability of uranium mine tailings management facilities built in continuous permafrost zones.

The CNSC will continue to rely on its internal expertise, coupled with licensee or CNSC lead research projects to improve our knowledge in order to support our mandate in regulating Canada's nuclear related activities in order to protect people and the environment.

251

A Quaternary mapping initiative within the scope of the regional characterization of aquifers in the contiguous basins of Rivière Richelieu, Rivière Yamaska and Baie Missisquoi

Hugo Dubé-Loubert, André Brazeau (MRNF)
and Michel Parent (GSC-Q)

On September 4, 2008, the *Ministère du Développement durable, de l'Environnement et des Parcs* (MDDEP) launched the Groundwater Knowledge Acquisition Program to develop a global portrait of groundwater resources in municipalized areas across Southern Québec, with the ultimate goal of protecting and ensuring their sustainability. One of the underlying premises for this type of project is the need to have a good geological understanding of surface deposits. For certain parts of municipalized Québec, mapping of surface deposits is fragmental and thus inadequate to meet the requirements of this type of regional hydrogeology project.

In order to remedy the situation, the first mapping campaign under the Montérégie Est hydrogeology project was completed in the summer of 2010. This project covers the entire jurisdiction of the *Conférence régionale des élus (CRÉ) de Montérégie Est*, as well as the catchment basins of the Richelieu and Yamaska rivers and Baie Missisquoi, for a total surface area of 9,218 km^2. This represents a total mapping coverage of about 10 NTS sheets at 1/50,000 scale.

This first campaign focused on the north part of the basin, where the surface geology is essentially characterized by extensive plains of marine clay and major sandy sequences that were produced when these lands emerged in the Holocene. More than two thousand control points were described in order to refine existing map models. In addition, numerous sections were examined along the main rivers, which resulted in the addition of new lithostratigraphic data to the regional stratigraphic framework. A few organic clasts and other marine shells will be submitted for age dating analyses during the year, to confirm the timing of certain Quaternary geological events in the Saint Lawrence Lowlands.

During the summer of 2011, a second phase of mapping covered the south part of the basin, and the surface geology in NTS sheets 31H01, 31H02, 31H03, 31H06, 31H07, and 31H08 was revisited.

The entire set of maps for this project is expected to become available in March 2012. Compilation of all of this new information, and integration to existing databases will make it possible to consolidate and upgrade several map compilations and to adequately meet the requirements of the Montérégie Est Groundwater Knowledge Acquisition Project.

252

Advanced exploration and mining development highlights for 2011 in the Abitibi-Témiscamingue region

Pierre Doucet and James Moorhead (MRNF)

In Val-d'Or, Agnico-Eagle Mines continued exploration work at the Goldex mine. Excavation of a ramp to access the D zone (inferred resources of 14.4 Mt at 1.62 g/t Au) and an extensive drilling campaign were carried out. Drill hole #76-013 intersected 240.0 m grading 2.47 g/t Au. At the Kiena mine, Wesdome Gold Mines announced on June 14, 2011 that the exploration drift toward the Dubuisson zone had progressed by 150 m. Drill holes were also completed, on Lac De Montigny, to test the Northwest and Martin zones. Osisko Mining Corporation announced on May 19, 2011, the commencement of commercial production at the Canadian Malartic mine. A new reserve and resource estimate was released: for the Canadian Malartic and South Barnat ore deposits, proven and probable reserves now stand at 343.7 Mt at a grade of 0.97 g/t Au (10.71 Moz), whereas indicated resources are estimated at 47.6 Mt at 0.77 g/t Au (1.18 Moz) and inferred resources at 33.9 Mt at 0.78 g/t Au (850,000 ounces).

Canada Lithium completed a new resource calculation for the Québec Lithium deposit. Measured and indicated resources are now estimated at 29.295 Mt grading 1.19% Li_2O, with inferred resources totalling 20.935 Mt at a grade of 1.15% Li_2O. The company is currently working on a new model and mining plan for the deposit, after which a new feasibility study will be completed. On the Fayolle project located northeast of Rouyn-Noranda, partners Typhoon Exploration and Aurizon Mines completed an extensive drilling campaign, magnetic and aeromagnetic surveys, stripping and mapping. East of Rouyn-Noranda, Aurizon Mines released a new resource estimate for its Joanna project. The Hosco deposit contains 54.14 Mt in measured and indicated resources at a grade of 1.29 g/t Au (2.245 Moz) and 7.67 Mt in inferred resources at 1.15 g/t Au (284,000 ounces, based on a cut-off grade of 0.5 g/t Au). In the Témiscamingue area, Matamec Explorations continued work on its Zeus REE project. A resource calculation released in June 2011 yielded the following results: indicated resources stand at 12.472 Mt at 0.512% REE_2O_3 and 0.913% ZrO_2 and inferred resources at 3.842 Mt grading 0.463% REE_2O_3 and 0.912% ZrO_2 (cut-off grade of 0.3% REE_2O_3). Metallurgical tests were also carried out.

253

Geological reconnaissance of the Rivière Octave region (parts of NTS map sheets 32D16, 32E01, 32F04)

Pierre-Luc Deschênes and Guillaume Allard (MRNF)

Method and objectives

A drilling program combining the study of Quaternary deposits with systematic sampling of the underlying bedrock was carried out to better define the geology of an area near the Sleeping Giant mine. The area targeted by the project is about 90 kilometres north of the town of Amos and covers a surface area of about 430 km^2. The program involved **43 rotasonic drill holes**.

The study follows up on a major drilling project jointly undertaken with the Geological Survey of Canada in 2007 and 2008 (GM-64951 – Rhéaume *et al.*, 2010).

The objectives of this new survey are to:

1) document the geology of the band of volcano-sedimentary rocks north of the Bernetz Pluton and distinguish the different phases of the pluton;

2) establish the stratigraphy for the Quaternary sediments in the region and their associated glacier dynamics;

3) evaluate the mineral potential of the area by determining favourable geological contexts for discovering new mineral deposits.

Part 1: Quaternary stratigraphy

The northern Abitibi is characterized by the presence of a thick argillaceous layer associated with ancient Glacial Lake Ojibway. For this reason, there is very little bedrock exposure. The area also contains evidence of multiple advances and retreats of the ice margin in the Labrador part of the Laurentide Ice Sheet (Veillette *et al.,* 1999, Parent *et al.*, 1995). The various movements were characterized by significant changes in ice flow directions that in turn affected glacial dispersal (Parent *et al.*, 1995), resulting in a highly complex stratigraphy and glacial transport. In this context, it is of great importance to review the stratigraphic framework for the northern Abitibi to determine the number of glacial units present and to elucidate the chronological sequence of glacial advances.

More specifically, our project will shed light on the source of the glacial deposits (tills), which will be interpreted based on field observations and laboratory-based sedimentological, mineralogical, petrological and geochemical analyses. A rotasonic drill produces continuous and relatively intact drill core measuring 10 cm in diameter. This method allows for a thorough stratigraphic examination and a satisfactory interpretation of the depositional environment.

Each core sample was thoroughly described, followed by sampling of the till and fluvioglacial sand units. At least one 8 to 10 kg sample (heavy mineral concentrate) and two 1 kg samples (geochemical analyses + witness) were taken from each stratigraphic interval encountered. A total of 218 till samples were collected for analysis. The fine fraction in tills (<63 μm) will be analyzed by neutron activation (INAA) for trace elements and by X-ray fluorescence spectrometry (XRF) for major elements. Heavy mineral concentrates (HMC) will be prepared to determine which indicator minerals and accessory minerals are present.

The results of the drilling program defined 9 different stratigraphic units. In all, 1,020 metres of Quaternary sediments were collected. Depth to the bedrock varied between 4 and 74 metres (average of 24 metres) and the recovery rate ranged from 96% to 100%.

Part 2: Bedrock geology

Except for some Proterozoic dykes, the rocks of the mapped region are Archean in age. The volcanic rocks, mainly basalts and andesites, belong to the Vanier-Dalet-Poirier Group and the Desboues Formation. These volcanic rocks are discordantly overlain by siliciclastic metasedimentary rocks of the Glandelet Formation. The geological units of the study area are cut by numerous deformation zones, probably related to the emplacement of the Bernetz Pluton to the south. They are also cut by several types of intrusions, including gabbros and felsic quartz±feldspar porphyry intrusions. The largest deformation zone in the area lies within the volcano-sedimentary belt (Glandelet and Rivière Octave formations) between the Laflamme-Sud and Laflamme-Nord shear zones. Regional metamorphism reached greenschist facies and locally attained mid-amphibolite facies along the margins of the Bernetz Pluton.

The westward continuity of the volcanic units of the Sleeping Giant mine and Vior deposit, the presence of favourable alteration, and the identification of probable synvolcanic intrusions collectively underscore the potential of the region for deposits associated with volcanic activity. The extension of the two deformation zones in the region, the presence of wide carbonate alteration zones, and the identification of gold-vein showings also indicate a potential for orogenic gold vein deposits in the area.

References

Parent, M., Paradis, S.J., Boivert, E., 1995. Ice-flow patterns and glacial transport in the eastern Hudson Bay region: implication for the late Quaternary dynamics of the Laurentide Ice Sheet. Canadian Journal of Earth Sciences, volume 32, pages 2057-2070.

Rhéaume, P., Maurice, C., Parent, M., McNicoll, V., 2010. Géologie de la région de la rivière Bigniba (parties des SNRC 32F03, 32F04 et 32C13), Ministère des Ressources naturelles et de la Faune du Québec, GM-64951, 46 pages.

Veillette, J.J., Dyke, A.S., Roy, M., 1999. Ice-flow evolution of the Labrador Sector of the Laurentide Ice Sheet: a review, with new evidence from northern Québec: Quaternary Science Reviews, volume 18, pages 993-1019.

254

Potential for rare earth occurrences in Québec

N'golo Togola, Denis Raymond, Charles Maurice
and Daniel Lamothe (MRNF)

There has never been an active rare earth mine in Québec. However, there is significant potential for these metal commodities across the province.

Numerous exploration projects targeting rare earths are currently underway. Many of these were initially launched in the 1970s but were later abandoned.

The main rare earth element (REE) occurrences are found in the Lac Brisson (Strange Lake) and Lac Lemoyne areas in Nunavik (northeastern Québec) and near Kipawa in the Témiscamingue region (southern Québec).

Carbonatite intrusions such as those at the Niocan deposit in Oka or the Niobec mine in Saguenay commonly contain significant REE concentrations. REE-bearing carbonatite intrusions have also been identified elsewhere, namely in the Abitibi and Saguenay regions, and in the Labrador Trough. Iron oxide-copper-gold (IOCG) occurrences enriched in REE, Y, and U are also known in the Côte-Nord region, and REE also occur in pegmatites in the Laurentides region.

The REE encompass 17 chemical elements that are relatively abundant in the Earth's crust: lanthanides (15 elements with atomic numbers from 57 to 71) plus scandium and yttrium. They are subdivided into two groups, namely light rare earths[1], which are more abundant, and heavy rare earths[2], less abundant.

The main rare earth-bearing minerals are: bastnaesite, monazite, xenotime, and parisite. Each of these minerals has a different rare earth element content.

Global demand for rare earth elements continues to grow, particularly due to the increasing diversity of applications in new technologies and their potential use in the automobile industry.

REE applications are commonly very specific. They are namely used in oil refinery and in the production of glass, ceramics, rechargeable batteries, wind turbines, and digital media players. They are also used to manufacture television and computer screens, ultra-efficient light bulbs, radar systems, catalytic converters, superconductors and permanent magnets (mostly for use in electric motors).

1 - Lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium.

2 - Terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium. Yttrium and scandium are also included in this group.

255

Inventory of natural aggregate resources in the Salluit region

André Brazeau and Guillaume Allard (MRNF)

Natural aggregate resources were inventoried for the Salluit region during the summer of 2011. The study area extends 7 km south of the village and covers a surface area of about 20 km^2 in the northern part of NTS map sheet 35J04.

The population of Salluit (about 1,300 inhabitants) and most other northern villages is growing rapidly. Housing and municipal infrastructure needs are consequently very high. The combination of continuous permafrost and a warming climate makes it difficult to build infrastructure. The demand for aggregate for the construction of foundation mats (under buildings and roads) is greater than ever before.

The results of our inventory work led to the identification and characterization of sources of aggregate material and we were able to estimate their volumes.

Field work mainly consisted of using a backhoe to dig numerous pits and visiting natural exposures and some sand pits. Seven samples of sand and gravel were collected and sent to a laboratory to determine their physico-mechanical properties.

The village is situated at the mouth of a deep valley at the end of the narrow Salluit Fjord. The walls (mountainsides) around the valley reach nearly 250 metres above sea level. Surface deposits are confined to the valley; topographic highs are marked by only thin layers of sediment or none at all. The deposits consist essentially of glacial, fluvioglacial, marine, fluvial, gravitational, and organic sediments. Till generally contains abundant blocks and pebbles, with a silt-clay matrix. The fluvioglacial deposits are composed of medium- to coarse-grained sand, gravel and generally rounded pebbles. The marine deposits cover a good part of the valley floor below 150 metres above sea level. They are sometimes covered by more recent deposits, such as colluvium, at the base of slopes and by littoral sands near the shoreline.

The main sources of aggregate material are the contact fluvioglacial deposits and deltaic marine deposits.

The quality of the material in the region is good. Coarse aggregates (>5 mm) consist mainly of granitic or volcanic rock fragments. Fine aggregates (<5 mm) consist of sand derived from granitic rocks (quartz, feldspar, biotite). The sand size is generally medium to coarse. Based on their inherent characteristics, the coarse aggregates meet Category 1 and 2 standards of the Ministry of Transport, and the sand conforms to Category 1 standards.

257

New geophysical data available from SIGÉOM in 2011

Isabelle D'Amours (MRNF), Maurice Coyle and Frank Kiss (GSC)

Once again, it is an outstanding year for acquiring new publicly available geophysical data for Québec. Significant investments have been made in the region covered by the Plan Nord. Géologie Québec completed 384,000 line kilometres of surveys (published) since last year, and Natural Resources Canada has completed a survey of 41,000 line kilometres, half of which falls in Québec. These surveys will surely be of great use in the geological mapping and identification of new, potentially favourable zones for precious and base metals, uranium and diamond exploration.

As part of this work, Géologie Québec has published the following this year:

DP 2011-01: A magnetic and spectrometric survey covering 13 maps sheets at 1:50,000 scale in the south part of the Opinaca Subprovince where it joins the Otish Basin. The survey was performed in the summer of 2010 by the firm Geo Data Solution (GDS);

DP 2011-02: An aeromagnetic survey mainly covering the southeast part of the Nemiscau Subprovince and the north part of Opatica, totalling 46 map sheets at 1:50,000 scale. The survey was completed in the fall and winter of 2010-2011 by the firm Goldak Airborne Surveys;

DP 2011-03: An aeromagnetic survey covering 22 map sheets at 1:50,000 scale in the region underlain by the Nemiscau and Eastmain subprovinces. The survey was completed in the winter of 2010-2011 by the firm Geo Data Solution (GDS);

DP 2011-04: An aeromagnetic survey covering 13 map sheets at 1:50,000 scale in the region underlain by the La Grande and Bienville subprovinces. The survey was completed in the winter of 2010 by the firm Geo Data Solution (GDS).

As part of its Geo-mapping for Energy and Minerals (GEM) program, the Earth Sciences Sector of Natural Resources Canada has completed an aeromagnetic survey over the Lac Shabogamo area, north of Fermont. The survey, which straddles the provinces of Québec and Newfoundland-Labrador, covers 12 map sheets at 1:50,000 scale (including 8 sheets either partly or entirely within Québec) and is published as **DP 2011-05** (MRNF). These data are also available from the Geological Survey of Newfoundland and Labrador and from the Geoscience Data Repository of the Earth Sciences Sector of Natural Resources Canada.

258

Geology of the Wottonville and Scotstown regions, Estrie, NTS topographic map sheets 21E11 and 21E12

Alain Tremblay, Morgann Perrot, Pierre-Étienne Mercier
and Benoit Soucy-de-Jocas (UQAM)

The Wottonville map sheet (21E12) has not been mapped geologically since Cooke (1950). The geological context of this region, particularly the western part, is therefore very poorly known. It is, however, known that the Ordovician rocks of Wottonville generally belong to the St-Daniel Mélange and the Magog Group (Slivitzky and St-Julien, 1987), which were recently reinterpreted as discordant sedimentary units unconformably overlying the Québec ophiolites and as representing the remnants of a transported synorogenic basin (Schroetter *et al.*, 2006). In the Stokes mountains, the work by Mercier and Soucy-de-Jocas (Master's students) also indicates that Magog unconformably overlies the Ascot Complex, a volcano-sedimentary sequence representing the remnants of an Ordovician volcanic arc, and that these two units are in turn affected by an erosional surface at their contact with the Silurian Lac Aylmer Formation. To better document the relationships between these units and to better understand the origin of the associated mineralized showings, we mapped sheet 21E12 (Wottonville) and compiled and interpreted sheet 21E11 (Scotstown). The mafic volcanic rocks of the Asbestos ophiolite crop out in the NW corner of the Wottonville sheet. These basalts are overlain by a sequence of mudslates and sandstones of the St-Daniel Mélange, which is in turn overlain by an assemblage of cherty and/or lithic tuff and greenish sandstones reminiscent of the Frontière and/or Etchemin formations that define the base of the Magog in the Beauce region. The rocks are overlain by blackish sandstones and pyritiferous mudslates (Beauceville Formation), and by mudslate, siltstone and sandstone rhythmites culminating with a conglomerate and lithic sandstone sequence in the core of a regional syncline, all of which belong to the St-Victor Formation. In the east, the Ascot Complex comprises felsic and mafic volcanic rocks injected by a granitic synvolcanic intrusion. We assign the base of the Lac Aylmer Formation to the appearance of the first horizons of polygenic boulder conglomerates in the Lime-Ridge area. The Guadeloupe Fault, a reverse fault with a SE dip, marks the contact between the Ascot, Magog and Lac Aylmer rocks to the northwest and rocks of the St-Francis Group to the southeast. In the Scotstown region, the latter comprise limestones of the Ayers Cliff Formation and the sandstone and mudslates of the Compton Formation, which is divided into two units – the Milan Member at its base and the Lac-Drolet Member at its summit.

References

Cooke, H.C., 1950. GSC, Memoir 257, 142 pages.

Schroetter, J.-M., Tremblay, A., Bédard, J.H., Villeneuve, M., 2006. Syncollisional basin development in the Appalachian orogen: the Saint-Daniel mélange, southern Québec, Canada. Geological Society of America Bulletin, 118 : 109-125.

Slivitzky, A., St-Julien, P., 1987. Compilation géologique de la région de l'Estrie-Beauce, Ministère de l'Énergie, des Mines et des Ressources, Québec; MM 85-04, map 2030, 1:250,000 scale.

259

Compilation and update of metallic ore deposits in Québec

Pierre Lacoste (MRNF), Guillaume Mathieu, Séverine Blouin
and Claire Legouix (URSTM)

The compilation of metallic and non-metallic occurrences has always been an important task for the Ministère des Ressources naturelles et de la Faune du Québec (MRNF). In the 1980s, various reports by Luben Avramtchev were published in a document titled "*Catalogue des gîtes minéraux du Québec*" (catalogue of Québec's mineral deposits).

More recently, the advent of SIGÉOM, Québec's geomining information system, has made it possible to obtain a wide range of geological information including data on metallic and non-metallic deposits. Using field work reports filed by exploration companies and the MRNF, the information on deposits is compiled using a standardized summary format to ensure uniform and complete descriptions for all deposits (location, work history, morphology, lithologies, mineralization, grades, typology, etc).

One of the modules in SIGÉOM (the metallic deposit module) was developed specifically to share information about ore deposits in Québec. Since September 2011, a new module was added to make it easier to create and update these data.

The method we employ to gather data can be guided in such a way that certain areas can be prioritized during the compilation of mineralized showings and deposits. Our approach also assigns priority to work performed by MRNF geologists. For the year underway, the following 5 areas were updated first:

1) the vast Baie-James and northern Abitibi region covered by NTS map sheets 33 A-B-C-D-E-F-G-H and 32 M-N-O-P;

2) the central-east part of the Grenville Province, namely from Havre-Saint-Pierre to the Basse-Côte-Nord and the Saguenay–Lac-Saint-Jean region (NTS map sheets 12 L, 22 D-E-F-G-I-J-K-L-N-O-P, 23 B-C, 32 A and 21 M);

3) the Churchill Province area south of Ungava Bay (NTS map sheets 13 L-M, 23 I-P and 24 A-B-G-H-I-J-K-P-N);

4) an update of deposit data files ("fiches de gîte") for the Labrador Trough area;

5) the area covering NTS map sheets 31 I-J-O and 21 E-L between the city of Québec and Montréal.

The compilation and updating of deposit data files ("fiches de gîte") has proven to be a fundamental tool for examining and assessing areas with the province, for planning various projects, and for developing Québec's mineral potential.

261

Cu-Zn-Co-Ag-Au Besshi-type mineralization potential in the Labrador Trough

Daniel Lamothe (MRNF)

The Labrador Trough contains several major Besshi-type VMS deposits. Formed in a volcano-sedimentary environment, Besshi-type deposits are characterized by grades of about 3-5% Cu + Zn and by tonnages sometimes exceeding 100 Mt (Windy Craggy, Ducktown). The biggest deposits in the study region are Soucy 1 (5.44 Mt at 1.49% Cu, 1.80% Zn, 1.61 g/t Au, 13.7 g/t Ag) and Prud'homme 1 (5.31 Mt at 1.57% Cu, 1.36% Zn, 1.37 g/t Au and 21.9 g/t Ag). These two deposits occur in the northern part of the Trough, but many other deposits can be found in the southern part (Lac Murdoch-Ouest, Lac Frederickson-NW).

The mineral potential assessment project aims to delineate favourable zones for discovering new Besshi-type mineralization in the Labrador Trough. Data processing involves weighting and combining various geological parameters that are relevant to the Besshi model in order to generate a predictive mineral potential map. The weight of each parameter in the model is calculated as a function of its spatial relationship to known Besshi-type deposits, and parameter combinations were performed using the fuzzy logic approach. The creation of favourable zones results from the selection of a significant and predictive threshold among the spectrum of fuzzy values used for the resulting map.

The Besshi data modelling was done using the ModelBuilder tool in ArcGIS 9.3. The process for calculating the potential for this type of mineralization is now fully programmed and can be automatically executed in just a few hours. The possibility of quickly testing new parameters or different calibration sets represents a significant improvement to the mineral potential assessment process. Most of the operations used original, unmodified tables from SIGÉOM as the data source. This approach allows new potential maps to be easily regenerated if any updates to SIGÉOM affect the source data for the model.

The mineral potential map, accompanied by high favourability zones for Besshi-type mineralization, will be published during PDAC 2012.

264

Evolution of trace element concentrations in magnetite from a fractionating magmatic sulfide liquid: application to exploration of Ni-Cu-PGE deposits

Sarah A.S. Dare, Sarah-Jane Barnes (UQAC)
and Georges Beaudoin (ULAVAL)

Magnetite (Fe_3O_4) is a useful indicator mineral in the exploration of ore deposits since its trace element geochemistry discriminates the different ore-forming environments from which magnetite formed. However, in order to develop a robust set of criteria for identifying magnetite from different environments it is necessary to understand the processes that influence the trace element concentrations in those ore-forming environments.

Magnetite is common in Ni-Cu-PGE sulfide deposits such as Sudbury, Ontario, where it crystallized from the sulfide melt at high temperatures (~ 1000°C). The trace element content of magnetite in 23 massive sulfides from Sudbury has been determined using laser ablation ICP-MS at UQAC. The samples represent the crystallization products of a fractionating sulfide liquid and consist of early-forming Fe-rich monosulfide solution (MSS) cumulates and residual Cu-rich intermediate solid solution (ISS). The massive sulfides contain titanomagnetite (~ 2 wt. %Ti) or magnetite in varying amounts (1 to 23 vol. %).

The trace element composition of magnetite changes with fractionation of the sulfide liquid. The lithophile elements (Cr, Ti, V, Al, Mn, Sc, Nb, Ga, Ge, Ta, Hf, W and Zr) are controlled by the crystallization of magnetite since these elements do not partition into sulfide phases. Their concentrations are highest (up to a total of 15 wt. %) in the earliest crystallizing magnetite and systematically decrease during the continued crystallization of magnetite from the fractionating sulfide liquid. The chalcophile elements, on the other hand, are largely controlled by the crystallization of the sulfide minerals. Only Ni, Co, Zn, Mo, Sn and Pb are present above detection limit in magnetite whereas Ag, As, Au, Bi, Cd, Cu, In, Ir, Pd, Pt, Re and Ru are below detection. Nickel, Mo and Co are compatible in MSS and thus the co-crystallizing magnetite is depleted in these elements. In contrast, magnetite that crystallized later from the fractionated liquid with ISS is enriched in these elements together with Sn and Pb which are incompatible in MSS.

Magnetite from magmatic sulfide deposits can be distinguished from magnetite from all other hydrothermal and sedimentary ore deposits by high Ni + Cr concentrations (> 1000 ppm). The inverse behavior of Cr (decreases) and Ni (increases) ensures that magnetite from sulfide deposits can be distinguished from all other deposits by their high Ni + Cr contents.

265

Mineral chemistry of magnetite in Ni-Cu-PGE deposits and application to exploration

Emilie Boutroy (ULAVAL), Sarah Dare (UQAC), Georges Beaudoin (ULAVAL) and Sarah-Jane Barnes (UQAC)

Iron oxides are common minerals, occurring in many types of ore deposits and geological environments. Magnetite and hematite show significant variations in trace element composition that may be linked to the metallogenic setting in which the deposit formed. A study of this characteristic geochemical signature, measured by EMPA and LA-ICP-MS, is a useful indicator for mineral exploration.

A detailed study of the main Ni-Cu ore deposits in the world, representing a variety of ages and magmatic settings, was conducted. A petrographic study of magnetite grains from the Thompson ore deposit in Manitoba reveals the presence of several types: (1) primary magnetite derived from the sulphide melt; (2) secondary magnetite in sulphides; and (3) secondary magnetite that formed during serpentinization of ultramafic host rocks. The vast majority (95%) of primary magnetite grains plot in the field of Ni-Cu deposits, whereas type 2 and type 3 secondary magnetite grains plot outside the field of Ni-Cu deposits, in the field of volcanogenic massive sulphides (VMS). Magnetites plotting in the VMS field may be the result of a replacement process of pyrrhotite in sulphides and ferromagnesian minerals in host rocks. A compositional difference is thus clearly established between ore-related magnetites and other secondary magnetites, depleted in most elements (Ni, Mn, V, Ti, V, Al, Cr) except Si and Mg.

Primary magnetites, grouped by type of magmatic environment associated with deposit formation, show that the compositional variation of magmas, from mafic to ultramafic, is not an important control on the composition of magnetites, except for Ga and Ge.

The chemical composition of primary magnetites can be used to monitor the evolution of the sulphide melt, based on compositional differences between magnetites that formed in the monosulphide solid solution (MSS) and those that formed in the intermediate solid solution (ISS). Magnetites from all ore deposits analyzed by LA-ICP-MS plot along the sulphide melt fractionation trend.

266

Vanadium mineralization in the Archean layered igneous Rivière Bell Complex, Matagami, Québec

Stéphane Roudaut, Michel Jébrak, Normand Goulet (UQAM), Christian Derosier (Apella Resources) and Mehmet F. Taner (Taner & Associates)

The Rivière Bell Complex is a large layered intrusion dated at 2725 Ma, located in the Matagami mining camp in the northern part of the Abitibi Subprovince. The complex consists of anorthosite at its base, overlain by a gabbro zone containing layers with Fe-Ti-V oxides, and topped by a zone of granophyres. The oxides occur in the summital part of the complex.

The gabbro zone containing the oxides displays polarity to the north. It comprises mesogabbros with disseminated titaniferous-vanadiferous magnetite and layers of massive, semi-massive and disseminated titaniferous-vanadiferous magnetite and ilmenite, as well as leucogabbros and anorthosites sometimes injected into the other facies. The oxide zones can be up to 200 m thick and individual layers are centimetric to decametric. Average grades are 27.3% Fe, 39.04% Fe_2O_3, 6.55% TiO_2 and 0.42% V_2O_5. Overall orientation is east-west with a subvertical dip to the north. The oxide zones are cut by thrust faults striking N130° with a variable dip to the north, interpreted as the products of the collision between the Abitibi and Opatica subprovinces, and by a network of conjugate dextral (northwest-southeast) and sinistral (northeast- southwest) strike-slip faults likely related to the Grenville orogen.

Also present are several primary magmatic sequences directly related to fractional crystallization and likely produced by the various magmatic pulses that formed the complex. A late magmatic brecciation phase is present at the summit. Chloritization of the pyroxenes indicates greenschist facies metamorphism.

Magnetites display trellis-type ilmenite exsolutions associated with ulvospinel and hercynite. Vanadium is present in the crystalline structure of magnetite where V^{+3} ions replace Fe^{+3} ions. The origin of the oxide layers and vanadium grades can be explained by fractional crystallization. A saturated Fe-Ti-V liquid phase and an increase in oxygen fugacity at magnetite crystallization temperatures allowed the oxide layers to form. At high $f(O_2)$, vanadium is preferentially incorporated into magnetite instead of being diluted in other mafic minerals. This model is similar to the model for vanadiferous titanomagnetite mineralization in the Bushveld Complex of South Africa.

In the magmatic breccia zone, the matrix consists of magnetite-bearing pegmatites, plagioclases, chloritized pyroxene and quartz. The pegmatites display evidence of heavy mineral density segregation during the multi-phase opening of the breccias, and they are also characterized by pseudospinifex textures in the giant (up to 1 m) pyroxenes, evidence of dendritic crystallization caused by sudden cooling.

267

Controls on the nature and distribution of rare earth and other high field strength minerals in the Nechalacho rare metal deposit, Thor Lake, NWT

Volker Möller and Anthony E. Williams-Jones (McGill)

The Nechalacho rare metal deposit in the Northwest Territories is a world-class resource of rare earth elements (REE) and other rare metals containing indicated resources of 88.13 Mt grading 1.53% total rare earth oxide (TREO, including Y) and inferred resources of 223.57 Mt grading 1.31% TREO. The deposit also has potentially exploitable concentrations of niobium, tantalum, zirconium and gallium. Here, we present preliminary results of a study of the geological processes leading to the concentration of the REE and high field strength elements (HFSE), based on the analysis of bulk-rock geochemical trends, mineral chemistry and textural relationships among minerals within the deposit and the host rocks.

Located 100 km East of Yellowknife on the north shore of Great Slave Lake, the Nechalacho deposit is hosted by a large layered peralkaline igneous suite of Paleoproterozoic age, which intruded the centre of the Blachford Lake Igneous Suite. The Nechalacho layered syenite suite (NLSS) consists of sodalite-, aegirine-, biotite-, feldspar- and nepheline-rich units which contain zircon, eudialyte, allanite, fergusonite, bastnäsite, pyrochlore and britholite. Low-viscosity flow-textures and the presence of villiaumite (NaF) and fluorite as primary magmatic phases provide evidence of an unusually fluorine-rich magma which was capable of dissolving high concentrations of the REE and other HFSE and depositing them in the upper part of the intrusion.

Two mineralogically distinct zones enriched in REE and HFSE are hosted by biotite foyaites in the upper part of the NLSS. The lower, agpaitic ore zone is enriched in heavy REE (0.33% on average) and forms a discrete, laterally continuous layer. The texture is dominated by packed eudialyte cumulates which have been completely replaced by complex intergrowths of zircon, quartz and biotite. Fergusonite, allanite, monazite and the REE-fluorocarbonates bastnäsite and synchisite are important REE-bearing phases in the lower zone. The upper zone is more variable in shape and is distinguished mineralogically by the presence of large euhedral, zoned and REE-enriched zircon, interpreted to be a miaskitic zircon cumulate.

Hydrothermal alteration is most intense in the upper part of the NLSS which hosts the ore zones and includes extensive replacement of aegirine by magnetite and hematite, albitisation of the uppermost units and significant remobilization of REE in the form of secondary bastnäsite, synchisite and allanite. The volatile-rich nature of the magma, the primary magmatic enrichment of the rare metals in cumulus layers, and the intense alteration were all important factors in the formation of the Nechalacho deposit.

268

Lithological and petrographic characterization of the Misery Syenite Intrusion (Québec)

Laura Petrella, Anthony E. Williams-Jones (McGill), Jean Goutier (MRNF) and Pierre Guay (Quest Rare Minerals)

This study presents a lithological and petrographic description of the Misery Syenite Intrusion, dated at 1409.7 ±1.2 Ma (David and Dion, 2011), which hosts rare earth, Zr, and Nb occurrences recently discovered by Quest Rare Minerals Ltd. Located 20 km east of Schefferville, the Misery Intrusion was emplaced within the Mistastin Batholith, which intrudes Paleoproterozoic rocks of the Churchill Province.

The Misery Syenite Intrusion is a circular pluton some 6 km in diameter that is associated with a strong, well-defined ring-shaped magnetic anomaly. Country rocks consist of coarse-grained potassic granite characterized by a rapakivi texture and the presence of fayalite. The dominant lithology in the intrusion is a coarse-grained syenite composed of idiomorphic alkali feldspar with 1 to 10% mafic minerals (fayalite, biotite, aegyrine, amphibole) and accessory minerals (magnetite, allanite, zircon, fluorite). This facies does contain a few grains of magnetite, but not nearly enough to explain the strong magnetic anomaly that characterizes the intrusion. The core of the intrusion is largely covered by Misery Lake. Visible parts of the core consist of medium-grained quartz syenite with a similar mineralogy. This facies also occurs as dykes trending N330° in the coarse-grained syenite. Other facies were observed locally, namely pegmatitic syenite with ferrosyenite enclaves. The ferrosyenite is an iron-rich syenite that contains at least 30% mafic minerals (olivine, aegyrine, amphibole, magnetite). In some locations, it shows a high olivine content and exhibits graded olivine cumulate textures. An apatite- and olivine-bearing syenite facies was also observed as enclaves in the pegmatitic syenite.

The geochemical characteristics of the various lithologies in the Misery Syenite Intrusion suggest these rocks are alkaline and sub-alkaline, with high Fe/(Fe+Mg) ratios (0.8 to 1). The distribution of all sampled lithologies on the TAS diagram indicates the presence of bimodal magmatism, which suggests the intrusion was emplaced in a continental rift setting. Rare earth profiles vary slightly according to lithology, but are generally enriched in light rare earths relative to heavy rare earths. The ferrosyenite appears to be the least evolved facies and the most enriched in rare earth elements.

Over the next few months, our work will consist in identifying the ore-bearing minerals and establishing their paragenesis.

Reference

David and Dion, 2011 – Géochronologie d'échantillons de Géologie Québec, année 2010-2011: Rapport final. Ministère des Ressources naturelles et de la Faune, Québec; GM 65676, 34 pages.

269

Geology and economic potential of the Kuujjuaq area (SE Churchill)

Hanafi Hammouche, Isabelle Lafrance, Martin Simard (MRNF) and Claire Legouix (URSTM)

A geological survey at a scale of 1/250,000 was carried out in the summer of 2011 in the Kuujjuaq area, covering map sheets 24J and 24K. The map area is mainly underlain by rocks of the Core Zone in the Churchill Province, but also includes part of the Rachel Zone in the New Québec Orogen.

The Core Zone is composed of complex assemblages of Archean to Paleoproterozoic banded and commonly migmatitic gneisses. Multi-kilometre-scale bands of paragneiss and amphibolite are intercalated with the gneisses. Abundant syn- to late-tectonic Proterozoic intrusions of granodiorite, granite, and pegmatite cross-cut earlier rocks. The Rachel Zone largely consists of schistose metasedimentary rocks and mafic metavolcanic rocks, with decimetre-scale layers of marble and calc-silicate rocks. The regional structural fabric trends NW-SE and is overturned to the west, as evidenced by a sub-horizontal foliation, recumbent or overturned folding, and thrust faults. These faults are more abundant near the contact between the Core Zone and the Rachel Zone. Rocks in the map area are also cut by mylonite zones associated with major ductile deformation corridors, the most significant being the Rivière Georges zone.

Several sulphide zones from one to ten metres in size were uncovered in the metavolcanic and metasedimentary rocks of the Rachel Zone. Mineralized zones typically consist of finely disseminated and stringer sulphides, commonly associated with quartz ± carbonate veinlets. Semi-massive sulphide zones with brecciated textures were locally observed. Sites of economic interest in the Rachel Zone are particularly attractive as they seem to correspond, based on their similar settings, to numerous showings located a few kilometres further west in the weakly metamorphosed volcano-sedimentary sequences of the New Québec Orogen. Rusty, sulphide-rich zones were also observed in the Core Zone, hosted in mafic and ultramafic intrusions or in metamorphosed volcano-sedimentary remnants. Most of these zones are associated with major shear zones broadly trending NW-SE. The latter namely host several rusty, highly graphitic horizons several tens of metres thick, for which the potential remains to be determined. A new uranium occurrence was also discovered in coarse-grained whitish granite cross-cutting migmatitic paragneisses. Background values are typically high, and spectrometer readings up to 22,000 counts per second were obtained.

270

Correlation of volcano-sedimentary basins in northeastern La Grande Subprovince (Baie-James) using lithological and mineral geochemistry

Quentin Duparc, Pierre Cousineau (UQAC)
and Daniel Bandyayera (MRNF)

As part of this Master's project, the BEGQ established a collaboration with UQAC to study sedimentary formations in the Baie-James region, specifically in a part of the northeastern Superior Province (33H13, 33H12, 33H08 and 33G05) that had been mapped at 1:50,000 scale. The study focuses on the geochemical and petrological comparison of conglomerate- and wacke-dominated clastic rock sequences belonging to the Magin and Brune formations, as well as a new formation southwest of the La Grande 4 Reservoir. The goal is to test the use of lithological and mineral geochemistry in correlating distal sedimentary units affected by different metamorphic grades and subjected to different degrees of deformation. We studied the least deformed parts of the formations to facilitate both the petrographic study and the interpretation of the depositional environment based on observed sedimentary textures and structures.

The first task in the field was to identify representative sites for each formation, and then strip the outcrops to establish a continuous to semi-continuous stratigraphic column. Researchers performed bed-by-bed surveys of sedimentary structures, and the work included paleocurrent determinations and recording the nature of vertical and lateral contacts to document facies changes. Clast size, degree of rounding, and composition were also noted for the conglomerates. All data will be presented as stratigraphic columns. A petrographic study of the wackes and the conglomerate pebbles is planned for later this year.

Complete geochemical analyses will be run on the collected samples. Particular attention will be given to recognizing carriers of certain chemical elements. Heavy mineral suite analysis represents an interesting correlation tool that has seen little use in tracing Archean greenstones to their source. We will therefore extract heavy minerals from a number of wacke samples. Heavy minerals are known carriers of several characteristic chemical elements (for example, Zr and Hf in zircons). A statistical analysis will establish families of elements that can serve as a correlation tool. Several methods, such as heavy liquids and a magnetic separator, will be used. A more specialized petrographic study will also be performed (for example, microfluorescence).

271

Geology of the Lac Nochet area (NTS 33G08, 33H05, 33H12 and 33H13): New volcanic and sedimentary belts

Jean Goutier, Daniel Bandyayera, Pénélope Burniaux, Claude Dion (MRNF), Guillaume Mathieu (UQAT) and Quentin Duparc (UQAC)

The Lac Nochet area is located in the Baie-James region, between reservoirs LG3 and LG4. It lies in the northeastern Superior Province and covers parts of the La Grande and Opinaca subprovinces. It is underlain by Archean rocks, Paleoproterozoic basins with arenites and conglomerates (Sakami Formation), and Archean (Mistassini) and Proterozoic (Senneterre) gabbro dyke swarms.

New geological and geophysical surveys carried out in the Lac Nochet area namely resulted in:

- A modification of the boundary between the La Grande and Opinaca subprovinces;
- An extension toward the northeast of volcanic rocks of the Guyer Group;
- The identification of a new volcanic belt south of the Guyer Group;
- The identification and characterization of a sedimentary basin comprising polygenic conglomerates, wackes, sillimanite-rich paragneisses, and silicate- and magnetite-facies iron formations.

The new volcanic belt is dismembered and forms a series of remnants. It is composed of amphibolites (derived from basalts), altered intermediate and felsic volcanic and volcaniclastic rocks, iron formations, and centimetre- to metre-scale bands of semi-massive to massive sulphides (PY, PO).

Geochronology and sedimentology studies are underway to better define the new belts and compare them with those located further west. These new belts may prove to be younger than volcanic rocks of the Guyer (2820 to 2806 Ma) and Yasinski (2751 to 2732 Ma) groups, since detrital zircons analyzed in 2009 and 2010 indicate the presence of sources as young as 2720 Ma and 2702 Ma.

The combined results of this work should make it possible to define prospective trends for gold mineralization, sulphide-rich volcanogenic occurrences, and aluminosilicate-rich sedimentary rocks for industrial applications.

273

Outstanding geological sites

Dominique Richard (MRNF)

The outstanding geological sites (OGS) of the *Ministère des Ressources naturelles et de la Faune* (MRNF) will be presented using the following media: the MRNF website and the poster titled "*Sites géologiques exceptionnels*".

The MRNF **website** has been modified to make it easier to learn about and view images of several geosites that have been proposed for OGS status and entered into the OGS classification process. This geosite database will, of course, be augmented and improved over time.

The poster "*Sites géologiques exceptionnels*" shows the location of 63 geosites from all corners of the province of Québec that have been proposed for OGS status and submitted to the first steps in the OGS classification process. These steps are described in the document "Guidelines for Managing Outstanding Geological Sites" available from the MRNF website.

These two media provide answers to the following questions:

- What is an OGS?
- What are the origins of OGS?
- Why does the MRNF want to protect OGS?
- What protective status is granted to OGS?
- What is an OGS called before it is classified?
- Is the term geosite used outside of Québec?
- Is Québec the only place to protect OGS?
- How many geosites have been proposed thus far?
- How many OGS have been classified?
- What are the steps leading up to the classification of an OGS?
- What are the main constraints during the steps towards OGS classification?
- Who can propose a geosite?
- How does one go about proposing a geosite?
- Is there a link between OGS and protected areas?
- What is the difference between OGS and protected areas?
- What is a geopark?
- Do geoparks exist in Québec or elsewhere in Canada?
- Are there places in Québec that could ***not*** be included in a geopark project?

The unveiling of OGS during the Québec Exploration convention will help bring public and industry awareness to the protection of geodiversity. An OGS is often small in size but enormous in terms of the geological history it represents.

276

Geological revision of the Matagami region

Pierre Pilote (MRNF), Julie-Anaïs Debreil (MRNF - INRS-ETE), Kenneth Williamson, Olivier Rabeau and Pierre Lacoste (MRNF)

This work, which started in 2008, is part of a multidisciplinary project on the geologic and metallogenic understanding of the Matagami mining camp (1960-2005 production: 4.6 Mt Zn, 0.494 Mt Cu). The mapping component is under the direction of the MRNF. Geological revision work in the summer of 2011, at a scale of 1:20,000, covered the southern half of NTS map sheet 32F13, the northern half of 32F12, and some areas of 32E09 and 32E16, collectively covering the entire mining camp. A 3D geometric model of the region will be generated at the end of the project, with the objective of providing a better understanding of the stratigraphy, structural features, and distribution of VMS-type mineralization. This revision forms an integral part of a larger partnership involving the MRNF, researchers and students from INRS-ETE, UQAC and École Polytechnique de Montréal, and the mining companies Xstrata Zinc, Donner Metals and SOQUEM.

The mapped region mainly belongs to the Abitibi Subprovince (ASP). It is underlain by various volcanic and plutonic rocks, the Rivière Bell Complex (RBC - a vast subconcordant ultramafic to mafic layered intrusion dated at 2724.6 ± 2.5 Ma), and a narrow band of sedimentary rocks (the Matagami Group - MaG, <2700 Ma) in faulted contact with the Opatica Subprovince (OSP) to the north and volcanics to the south. These lithologies are crosscut by Proterozoic gabbro dykes. Two volcanic groups are present: the Lac Watson Group (WatG, 2725-2723 ± 2 Ma) and the overlying Wabassee Group (WabG). The WatG consists mainly of rhyolite, rhyodacite and dacite. It is this group that hosts the majority of volcanogenic massive sulphide deposits in the camp. The Key Tuffite, immediately overlying the WatG rhyolites, represents an important marker horizon for VMS mineralization in this mining camp. The WatG is intruded by the CRB. The Wabassee Group is dominated by andesites and by pillowed, massive and/or brecciated basalts. The group includes the Rivière Bell Volcanics (tholeiitic affinity) and the Rivière Allard Volcanics (calc-alkaline to transitional affinity).

Several geographical areas have been defined in the past: the South Flank, the North Flank, the Central Camp, and the West Camp. Our work has led us to propose a new subdivision into North and South domains, with the boundary marked by three shear zones named "Rivière Allard", "Rivière Waswanipi" and "Lac Matagami", all oriented 070°. They represent reverse sinistral shears ranging from 50 m to more than 100 m thick, dipping steeply to the north with a stretching lineation plunging steeply to the east. The South Domain will now comprise the historically defined North Flank and South Flank, the Central Camp and the West Camp. Our work demonstrates, just as several researchers have suggested in the past, that the South Flank, Central Camp and West Camp share the same stratigraphy, oriented NW-SE with a gentle to quasi-horizontal dip, developed in a relatively consistent and predictable manner. Mapping also reveals that the South Flank and Central-West camps are affected by a weak S1 cleavage and by three major F1 fold axes (two synclines and one large anticline), also oriented NW-SE. An E- to ESE-oriented S2 schistosity crosscuts S1 cleavage. As for the North Flank, stratification is oriented 110° with a dip and general polarity to the north. An S2 schistosity oriented 090° to 110° affected the S0 surface and locally generated F2 folds. Shear zones, also oriented 110°, appear to repeat or truncate certain portions of the volcanic pile and the BRC.

The resulting geometry of the juxtaposed North and South domains calls into question the existence of the Galinée Anticline and has serious implications for the VMS potential in the areas described above.

277

Geology of the Warrenmac gold-rich polymetallic massive sulphide lens, Westwood deposit, Abitibi, Québec

David Yergeau (INRS-ETE), Patrick Mercier-Langevin (GSC-Québec), Michel Malo (INRS-ETE), Benoît Dubé (GSC-Québec), Claude Bernier, Armand Savoie, Nicole Houle and Patrice Savard (IAMGOLD Corporation)

The Westwood deposit, located 35 km east of Rouyn-Noranda in the Abitibi Subprovince, is one of the recent major discoveries in Canada, with 3.43 million ounces of gold resources. The ore deposit is located in the Doyon-Bousquet-LaRonde mining camp, in the eastern part of the Blake River Group. More specifically, mineralized zones are hosted in volcanic rocks of the Bousquet Formation, which forms a thin homoclinal sub-vertical sequence trending east/west and facing south that possibly represents the remains of a stratovolcano. The Bousquet Formation is divided into a lower member composed of tholeiitic to transitional mafic to felsic volcanic rocks, and an upper member composed of transitional to calc-alkaline intermediate to felsic volcanic rocks. The study area is strongly deformed and metamorphosed to the upper greenschist facies.

The ore deposit consists of three distinct mineralized envelopes that are, from north to south: Zone 2 Extension, the North Corridor and the Westwood Corridor. Zone 2 Extension is characterized by centimetre- to decimetre-scale pyrite-rich gold-bearing quartz veins. The North Corridor on the other hand, consists of centimetre- to decimetre-scale sulphide-rich gold-bearing quartz veins, with semi-massive to massive sulphide veins. Both of these mineralized envelopes are slightly discordant. Finally, the Westwood Corridor is composed of conformable gold-bearing massive to semi-massive sulphide lenses.

The Warrenmac lens, characterized by massive sulphides consisting of pyrite and sphalerite with minor amounts of chalcopyrite and galena overlain by a strongly transposed stringer zone, is a good example of the mineralized lenses in the Westwood Corridor. The footwall of the ore lens consists of fragmental dacite overlain by massive andesite, whereas the hanging wall shows a variable composition. The main alteration minerals associated with this lens are Mn-rich garnet, Mg-rich chlorite, and sericite.

The main objective of this study is to characterize the formation and document the potential link between gold-rich volcanogenic massive sulphides lenses (*e.g.*, Westwood Corridor) and mineralized zones occurring in the form of quartz and sulphide veins (*e.g.*, Zone 2 Extension, North Corridor), based on a study of the Westwood deposit. This area also provides an opportunity to study Archean magmatic-hydrothermal systems. Knowledge derived from this study may contribute in developing better exploration vectors for this type of deposit in the Abitibi and elsewhere, in other ancient greenstone belts.

278

Geology of the Daniel-Johnson Dam (Manic 5) area, Côte-Nord region (NTS 22K14, 22K15, 22K16, 22N03 and 22N02)

Abdelali Moukhsil, Fabien Solgadi (MRNF), Thomas Clark (UQAT-URSTM), Aphrodite Indares (Memorial University of Newfoundland) and Séverine Blouin (MRNF)

Mapping in this area constitutes Phase 1 of a regional mapping project, the purpose of which is to acquire new geological and metallogenic knowledge in NTS sheet 22K and the south part of sheet 22N. The study area is located in the Côte-Nord region, in the Daniel-Johnson Dam area and is part of the central Grenville geological Province.

Mapping conducted at a scale of 1/125,000 led to the identification of several lithological units. Archean gneissic tonalites and granitic gneisses make up the bedrock in the north part of the map area. Abundant iron formations (silicate [± sulphide] and oxide facies) are intercalated with the latter. Boudins and layers of mafic to ultramafic igneous rocks, as well as rusty paragneiss bands (with pyrite, graphite, sillimanite, and locally kyanite) are associated with the Archean gneisses. The area also contains a younger sequence composed of dolomitic to calcitic marble with intercalated quartz-rich layers (metachert?), metre-scale quartzite beds (with clinopyroxene and garnet), and oxide- and silicate (± sulphide)-facies iron formations. This rock assemblage is part of the Gagnon Group, which is the equivalent of Paleoproterozoic rocks in the Labrador Trough. A suite of Labradorian rocks of sedimentary origin (paragneiss, migmatitic paragneiss, quartzite bands, marble, calc-silicate rocks) was also mapped in the area. Mesoproterozoic intrusive rocks composed of mangerite, granite and monzonite, are also present, associated with rare charnockite. Metavolcanic units were identified, some of which show ages comparable to that of the Montauban Group (1.45 Ga), although most of these units probably formed between 1300 and 1240 Ma.

Two anorthositic intrusions are distinguished: the Berté Anorthosite and the Tétépisca Anorthosite. The first mainly consists of pink anorthosite visually similar to the Labrieville Anorthosite (1010 to 1008 Ma), whereas the second is composed of leuconorite, anorthosite, with rare leucotroctolite.

The mineral potential of the map area is largely based on graphite and iron ore. Several mineral exploration targets are attracting attention, including zones with silicate- and oxide-facies iron formations. A few Ni-Cu mineral occurrences in mafic to ultramafic rocks were also inventoried in the area.

279

Gold mineralization in the Beattie Syenite at Duparquet, Québec: orogenic or magmatic?

Ludovic Bigot and Michel Jébrak (UQAM)

Some examples of end-Archean gold mineralization are disseminated and associated with alkaline intrusions and thus differ from the standard “orogenic gold” model. The Beattie Syenite is an Archean porphyry intrusion emplaced near the major Porcupine-Destor Fault in the Abitibi. It was mined from 1933 to 1956, with a total production of about 33 tonnes of gold in 9.2 Mt of ore. The syenite is aligned along an east-west axis; it is hosted by mafic and intermediate volcanic rocks of the Kinojevis Group and is penecontemporaneous with the Timiskaming sedimentary rock sequence, the latter occurring in discordant contact with underlying units.

The structural evolution consists of an early ductile-brittle flattening phase, followed by two more shallow episodes marked by two stress systems, one north-south, with reverse faults oriented east-west, and the other a more extensional setting. A regional tilting event is suggested by the obliquity of the first stress tensor and the regional distribution of mineralization.

Gold mineralization is present in disseminated form within the intrusion, controlled by shear zones in its core or along its contact with the volcanic country rocks. Gold is hosted by arsenopyrite and arseniferous pyrite. The gold grains are fine, less than micron-sized or “invisible”. The association with arseniferous minerals and the very small size suggests that the gold was incorporated into the crystalline structure of arsenopyrite and arseniferous pyrite in solid solution (Au^{1+}) or as nanoparticles (Au^{0}).

The metallic assemblage at Beattie is polyphased: a primary phase enriched in iron-titanium appears to have produced martite in a more oxidizing environment; several subsequent sulphidization phases were marked by the presence of pyrites and arsenopyrites, some rich in gold, suggesting crystallization under more reducing conditions and at lower temperatures. Three generations of pyrite were identified. The first generation is arseniferous and gold-bearing, whereas the second and third are arsenic-poor and devoid of gold. A late silica-enriched hydrothermal phase remobilized the gold and caused cataclasis. Gold migrated into the fractures developed in the cataclized pyrite, where it recrystallized with silver in the form of electrum.

Beattie gold mineralization thus displays both notable similarities and contrasts when compared to the standard orogenic model.

280

Transpressional dynamics and the role of crustal heterogeneities in the localization of the Desmaraisville basin (Abitibi): geophysical study and analogue modelling

Noémie Fayol (UQAM), Lyal B. Harris (INRS-ETE)
and Michel Jébrak (UQAM)

The Abitibi Subprovince contains many late Archean sedimentary basins, dating between 2685 and 2670 Ma in the southern Abitibi, that are host to some major gold deposits. Their association with terminations or flexures in regional E-W faults, such as the Destor-Porcupine and Larder Lake–Cadillac faults, as well as their pronounced subsidence and molassic infilling, abrupt facies changes, and the asymmetry of their Timiskaming-type basins collectively evoke comparisons to more recent transtensional basins.

The Desmaraisville basin, situated in the Abitibi Greenstone Belt about 120 km west-southwest of Chapais, is characterized by a volcano-sedimentary assemblage, mafic and felsic intrusions, and regional NE-SW faults. The Auger and Lac Bachelor sedimentary sequences respectively occur southeast of the Coniagas mine and northwest of the Bachelor mine (Métanor Resources Inc). The sedimentary rocks of Lac Bachelor belong to the Hauy Formation which has been dated at 2692 ± 3Ma in the Chapais region and represent the northern Abitibi equivalent to the Timiskaming Group. The Desmaraisville basin could therefore be included as a Timiskaming-type basin, but differs in its position within a NE-SW deformation zone. Enhanced aeromagnetic images (data from the TGI-3 Abitibi Project) do not reveal any relay faults that could have formed a transtensional basin. The σ schistosity around a pluton indicates a dextral movement along an E-W zone; *en échelon* NW-SE faults with apparently dextral movement are consistent with a transpressional Riedel system with a σ_1 component oriented N-S. The gravimetric data demonstrate the presence of a denser block to the west of Desmaraisville and a less dense domain east of the town. The “stair-step” shape of the block suggests the presence of E-W dextral shear zones, one of which passes through Desmaraisville.

Analogue models of shortening that integrate the crustal heterogeneities identified from gravimetric data produce a basin located exactly in the Desmaraisville area.

The formation of the Desmaraisville basin does not fit the currently accepted model for “transtensional Timiskaming-type” basins, but it could have developed at the interface between crustal heterogeneities during a late N-S shortening phase in the Abitibi. Upcoming studies will analyze the relationships between transpressional dynamics and gold mineralization in this basin.

281

Geochemical recognition of protoliths in high-grade metamorphic domains

Sylvain Trépanier and Stéphane Faure (CONSOREM)

Strongly metamorphosed rock domains pose serious challenges for exploration. For example, it is often quite difficult to correctly identify the protoliths of strongly metamorphosed rocks (sedimentary vs. igneous). Protolith identification is crucial however to develop appropriate exploration models in these areas. An automated geochemical protolith discrimination method is proposed herein, which may be applicable for the entire spectrum from weakly metamorphosed to high-grade metamorphic rocks (granulites).

A database encompassing a wide range of non- (or weakly) metamorphosed sedimentary and igneous rocks was built and used as a reference for automatic protolith recognition. Support vector machines were used as learning algorithm models. Two models were constructed: one model that uses only major elements, and a second model using major elements plus Cr, Ni, Sr, Rb, Zr and Ba.

Reclassification results using this method rated about 87% for the model that uses only major elements, and 92% for the model using major elements and Cr, Ni, Sr, Rb, Zr and Ba. The reclassification rates vary however according to the rock type and alteration. Results are excellent for weakly altered igneous rocks, fine-grained detrital sedimentary rocks (mudstones) and chemical sedimentary rocks (limestone, dolomite, etc.). Lower percentages are obtained for altered felsic and intermediate igneous rocks and for sandstones.

The protolith recognition method was tested on metamorphosed rocks from different case studies, in mineralized and non-mineralized settings. Tests at Winston Lake and Montauban indicate that potassic or aluminous alteration of igneous rocks yields a signature similar to a sedimentary protolith. Upon closer examination however, several samples of altered igneous rocks appear to be scattered between the igneous and sedimentary responses, which is quite different from the very distinctive response obtained for known sedimentary rocks. Other case studies from high-grade metamorphic domains confirm the method is useful, even in migmatitic and granulitic domains.

282

Plutonic suites as an exploration tool for IOCG: application in the Abitibi

Benoit Lafrance (CONSOREM)

This CONSOREM project aims to develop an exploration methodology for polymetallic iron-oxide (IOCG) deposits in Québec. The focus is on the elaboration of a regional-scale exploration guide using the geochemical characterization of plutons genetically related to such deposits. The most recent classifications distinguish IOCG mineralization *stricto sensu* (ex. Olympic Dam and Cloncurry in Australia, Carajas in Brazil and those of Chile) from other iron-oxide mineralizations. This more restrictive classification reveals that the IOCG deposits are associated with a particular intrusive suite in every case.

Plutons belonging to the intrusive "monzodiorite – quartz monzodiorite – quartz monzonite – granite" suite are considered a favourability criterion for IOCGs, *stricto sensu*, at the regional scale. These rocks are potassic and calc-alkaline (K-CA) or shoshonitic, depending on their potassium content (K_2O *vs* SiO_2), and alkaline-calcic or slightly alkaline, depending on their $K_2O + Na_2O$-CaO *vs* SiO_2 content.

A review of the literature during the course of this project also yielded a comparison of IOCG characteristics to those of Cu-Au porphyries – a related deposit type often confused with IOCGs. Geochemically, results suggest that plutons associated with IOCGs are the same as those associated with potassic and alkali-calcic or slightly alkaline Cu-Au porphyry deposits. However, other criteria make possible the distinction between these two types of mineralization, notably the depth of intrusion emplacement and the typology of the mineralization and alteration.

This new exploration guide based on pluton geochemistry was used to locate favourable areas in the Abitibi. Favourable intrusions were isolated by applying a data processing method to CONSOREM's lithogeochemical database for the Abitibi (data obtained from partners and SIGÉOM) using CONSOREM's software tool *Lithomodeleur*. A total of 882 lithogeochemical analyses were identified. These analyses were then spatially correlated to a set of key criteria associated with IOCGs: Abitibi geology, magnetics map, faults, the presence of magnetite or hematite, mass gains in sodium and potassium in volcanics, and the presence of Cu-Au deposits or showings. Our analysis identified 33 plutons or parts of plutons that are favourable for IOCG mineralization *stricto sensu* or for Cu-Au potassic and alkali-calcic or slightly alkaline porphyry mineralization in the Abitibi.

283

A new diamondiferous kimberlite field in Québec?

Stéphane Faure (CONSOREM)

The interpretation of the MRNF's 2009 airborne magnetic surveys over Archean metamorphic terrains of Québec's mid-north ("Moyen Nord") (LG-4) revealed 33 circular magnetic anomalies with a signature typical of kimberlitic intrusions like those documented in the Slave Province. The magnetic anomalies have diameters ranging from 250 to 700 m, with an average of 425 m. The majority of the anomalies display strong magnetic contrasts (up to 2,000 nT) between the surrounding gneissic rocks, generally granulitic and strongly magnetic, and the weakly magnetic cores (negative anomalies) characteristic of kimberlitic material. Also uncovered were four positive anomalies located along the margins of magnetic Proterozoic diabase dykes, in weakly magnetic metasediments. The association of diabase dykes and kimberlites is a traditionally recognized and sought after exploration guide.

At the regional scale, the kimberlite targets appear related to a magnetic NNW-trending arcuate structure measuring several hundreds of kilometres, extending from the northern limit of the James Bay territory (55th parallel), and to the south, the future Renard diamond mine. This crustal structure marks the edge of a strongly magnetic domain to the east, composed of diatexites, metatexites and migmatites (Ashuanipi Subprovince), and a weaker magnetic domain to the west, composed of plutonic rocks. This structure also displays a gravimetric signature. The majority of targets are located around and within a zone of strong isostatic residual gravity anomalies. The horst-forming ENE-trending Vaujours and La Grande fault systems also appear to control the spatial distribution of the circular anomalies. At the more local scale, several of the anomalies are located along secant and topographic NW-SE magnetic lineaments.

The group of circular and magnetic anomalies may represent a kimberlite field comparable in size to the Lac de Gras kimberlite field in the Slave Province, ranked third in the world among diamond producing districts. In the James Bay region, the diamond potential is considered excellent because the group of targets occurs along one of two cratonic roots of the Superior Province with a depth of 180 to 200 km, the depth interval corresponding to the diamond stability field for depleted Archean lithosphere. These targets were staked by a consortium of companies (Virginia Mines, Aurizon Mines, SOQUEM and Stornoway) based on the results of this study.

284

The surface geochemical cycle of metals during mining operations: An example from lake sediments in the Schefferville district, Québec

Stéphane Aebischer, Jean Carignan (ULAVAL), Charles Maurice (MRNF) and Reinhard Pienitz (ULAVAL)

The surface geochemical cycle of metals is disturbed during mining operations. Occupancy, extraction, anthropogenic waste, and changes in the trophic conditions of aquatic systems all contribute to disturbances in the surface geochemical cycle. A preliminary study by Laperrière *et al.* (2009) describes the relationship between mining operations in the Schefferville area and the metal content of sediments in Lac Dauriat, on the outskirts of town.

Our project involves two components: 1) a regional study via processing of lake sediment geochemistry data in the southern Labrador Trough geological zone; and 2) a more detailed study of lake sediment cores, which provide a record covering the last 150 to 200 years. Two cores, taken at different distances from mining sites, were available and were used for the study (Dauriat and Oksana, 2 km SE of town). The following questions will be addressed: 1) what are the sources of metals in lake sediments?; 2) in what chemical form do the metals occur?; 3) how does the transition between pre-mine/mine and mine/post-mine regimes take place?; 4) why has the stationary pre-industrial regime still hasn't been reached some 30 years after the end of mining operations?; and 5) is it possible to accelerate the return to natural equilibrium?

The regional study (Figure 1) demonstrated: 1) a variation in the nature of detrital sources in the different drainage basins; 2) possible dilution of the detrital fraction by organic matter deposited on the lake bottom; and 3) high Fe, Zn, and Pb contents at a given Al content (above the background value), indicating the proximity of a mineralized zone or a contribution of anthropogenic aerosols for certain samples. Analyses of sediment cores reveal that grades for several metals are elevated during the active mining period (1939-1977), with values sometimes far greater than the regional background (*e.g.*, Pb; Figure 1). In addition, the two lakes are not affected by the exact same anthropogenic disturbances, even if they are only a few kilometres apart. It will be possible to discriminate, by comparison, mining sources from "urban" and long-distance atmospheric sources. Selective leaching (speciation) tests and isotopic analyses (Pb, Zn, Fe) may also lead to a better understanding of anthropogenic impacts related to a mining operation in a sensitive sub-arctic environment.

Reference

Laperrière, L., Pienitz, R., Fallu, M.-A., Hausmann, S. and Muir, D., 2009. Impacts de l'activité minière et des eaux usées sur la santé du lac Dauriat à Schefferville : données paléolimnologiques. Naturaliste Canadien, 133(2) : 83-95.

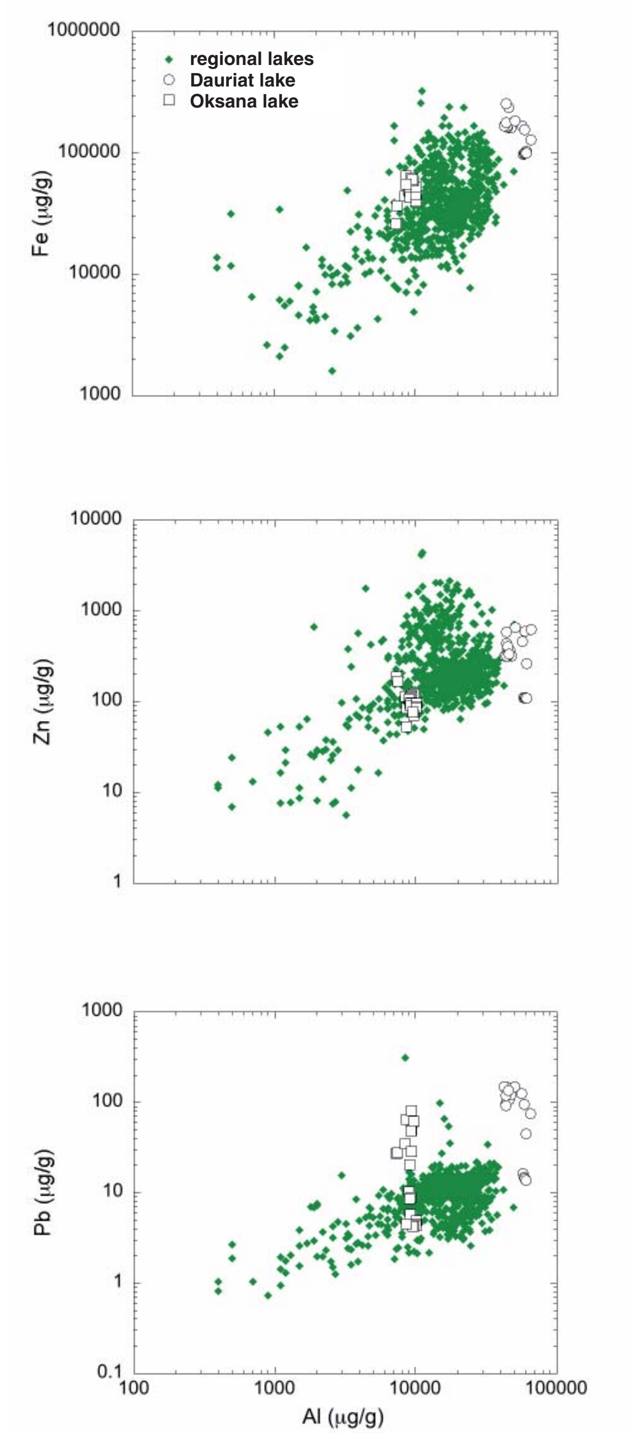


Figure 1. Relationship between Fe, Zn, Pb, and Al in lake sediments from Dauriat lake and Oksana lake, spanning about 150-200 years of sedimentation. The composition of more than 800 lake sediment samples within a 50 km radius of Schefferville provides a portrait of the regional variability.

285-286-287

The DIVEX network: Horizon 2014

Georges Beaudoin and Michel Malo (DIVEX)

Since its foundation in 2002, the DIVEX network has supported 42 research projects involving 51 graduate students and post-doctoral fellows. Scientists and students from 7 universities across Québec (INRS-ETE, Laval, Polytechnique, UQAC, UQAM, UQAT and McGill) and the provincial and federal geological surveys are part of the DIVEX network. About 74% of our projects required the cooperation of scientists from various academic and government establishments, and 78% involved industrial partners. *Valorisation-Recherche Québec* and the *Fond québécois de recherche sur la nature et les technologies* (FQRNT) supported the DIVEX network with grants totalling $2.5M in the 2002-2010 period. From 2008 to 2010, DIVEX generated a leverage of 4.5 times the amount of its grant.

The DIVEX network is now an innovation network supported by the FQRNT until 2014. The objectives of DIVEX are: 1) to contribute to the creation of innovative exploration tools; 2) to contribute to the training of highly qualified personnel by offering student scholarships; 3) to support projects in both fundamental research and applied research; 4) to organize short courses; and 5) to promote technological transfer to industry (annual meeting, CONSOREM-DIVEX technology forum, technology watch).

288

The Behaviour of Base Metals in Arc-Type Magmatic-Hydrothermal Systems – Insights from Merapi Volcano, Indonesia

Olivier Nadeau, Anthony E. Williams-Jones and John Stix (McGill)

Porphyry and epithermal systems are genetically associated with subduction zone volcanism, with volcanic rocks commonly exposed in proximity to ore deposits. Stratovolcanoes thus provide important windows into active hydrothermal processes. Here we describe the hydrothermal environment that resides beneath Merapi volcano, Indonesia. The research involved sampling and analysis of silicate and sulfide melt inclusions and fumarolic gases from Merapi volcano during times of quiescence and eruptive activity, well as a synthesis of data for fluid inclusions from porphyry copper ore deposits. At Merapi, injection of sulfide-saturated mafic magma into shallower, evolved and oxidized resident magma induced exsolution of a hydrothermal fluid from the mafic magma. The fluid dissolved the sulfide melt and was enriched in chalcophile metals. These events may have contributed to triggering the explosive eruption at Merapi volcano in 2006. The melt inclusion data show that both magmas mixed poorly, with the fluid transferring mobile base metals to the shallow resident magma. Fluid inclusion and volcanic gas data are used to link mechanisms of ore formation to those operating during eruptive cycles of volcanoes. We integrate these findings into a model that provides new insights into the formation of porphyry copper ore deposits beneath stratovolcanoes.

290

Reassessment of the mineral potential at the former St-Robert Bellarmin mine, Beauce, Québec

Charlotte Athurion, Marc Richer-Laflèche, Mohamed Koita and Vladimir Antonoff (INRS-ETE)

The St-Robert Bellarmin mine, located 40 kilometres south of St-Georges de Beauce (Québec), produced gold, silver and tungsten over a very short period in 1958, then was again the focus of work in the 1980s but was subsequently abandoned. Rising metal prices and the advent of new previously unavailable geophysical systems led the titleholder, J.A.G. Mines Ltd, to call for a reassessment of the property's mineral potential.

This polymetallic deposit, a fairly rare occurrence in the Appalachians, consists of a series of W, Ag, Pb, Bi, and possibly gold occurrences, in the form of decimetre-scale quartz veins with pyrite, galena, scheelite, cosalite, and sphalerite mineralization, associated with granodiorite dykes intruding Devonian sedimentary rocks of the Frontenac Formation, which is interpreted as a turbiditic clastic sequence composed of sandstone, clayey schist and slate.

A compilation of geophysical and geochemical data derived from previous work carried out from 1951 to 1986 was completed using GIS tools (ArcGIS, Surfer and Oasis Montaj) in order to determine the most promising targets. The geophysical data confirmed the presence of a porphyry intrusion in the northeast part of the property, from which the quartz veins and dykes most likely originated. Soil geochemistry data indicate the presence of a Pb, Ag, and Mo-rich zone about 500 metres in length, west of the Lacombe tunnel.

A new field campaign was carried out in the spring and summer of 2011, to prepare a new geological map of the property, to collect samples of sedimentary and igneous country rocks hosting mineralized veins, to conduct magnetic, electromagnetic, and gravity surveys on the property, and to channel sample quartz veins in the various mineralized zones. Assays and data processing are underway.

291

Multi-parameter measurements on drill core from the Matagami area in a mobile laboratory: Part 1, background and methodology

Alexandre Bourke, Pierre-Simon Ross and Bastien Fresia (INRS-ETE)

Measurements of physical, geochemical, and mineralogical properties on exploration drill core can be used for various geoscientific applications, namely in 3D geological modelling, to improve geophysical models, to characterize hydrothermal alteration, for mineral resource calculations, or chemical stratigraphy. Traditionally, these measurements were taken one at a time, commonly using destructive methods. Consequently, few mining camps across Québec have access to extensive public databases of physical properties, and high-resolution geochemical or mineralogical measurements are generally not available. The INRS LAMROC mobile laboratory for the physical, mineralogical, and chemical characterization of rocks makes it possible to measure on drill core, almost simultaneously and in a non-destructive manner, density based on gamma-ray attenuation, magnetic susceptibility, up to 25 chemical elements by XRF, as well as infrared spectrometry for alteration minerals. The system also acquires a continuous image of the drill core, making it possible to compare measurements with the visual appearance of the rock in order to better understand variations in the different parameters, and to build a complete digital archive of the drill hole.

The MRNF commissioned the INRS to conduct high-resolution multi-parameter analyses of drill core in the Matagami area in the 2010 to 2012 period. This project benefits from the logistical support of Xstrata Zinc and the collaboration of Breakwater Resources, Donner Metals, and SOQUEM. The Matagami mining camp, in the Abitibi Subprovince, hosts numerous Archean zinc-rich volcanogenic massive sulphide deposits and shows good potential for new discoveries. Ore deposits are clustered in three areas: the North Flank, the South Flank, and the West Camp. Drill holes characterized by the LAMROC are located in the three areas. The results of the first year of work were published in the form of two reports (GM 65521 and 65522) and an Access database. LAMROC measurements will namely be useful for university research projects currently underway in the Matagami area (volcanology, geochemistry, metallogeny, geophysics), for 2D and 3D geological mapping, and for mineral exploration. Part 2 of this poster illustrates some of the results of the project.

292

Multi-parameter measurements on drill core from the Matagami area in a mobile laboratory: Part 2, preliminary results

Bastien Fresia, Alexandre Bourke, Pierre-Simon Ross and Erwan Gloaguen (INRS-ETE)

The *Ministère des Ressources naturelles et de la Faune du Québec* (MRNF) commissioned the INRS to conduct high-resolution multi-parameter analyses of drill core from the Matagami area in the 2010 to 2012 period. Two data acquisition sessions resulted in the collection of more than 30,000 measurement points distributed over about 7,000 metres of drill core, at a sample spacing of 20-30 cm. Part 1 of this poster focuses on the background and methodology of the study, whereas the preliminary results are discussed in this part 2.

For illustrative purposes, the poster shows the analytical results for drill hole BRC-08-72 (660 m), which intersects most of the lithological facies in the Bracemac-McLeod area, located along the South Flank of the Matagami mining camp, as well as two mineralized zones. Physical and chemical data were processed to correspond to values obtained through conventional methods.

The vast amount of data and the diversity of measured parameters namely make it possible to use various approaches to analyze and interpret the data:

Geochemistry: Measurements made with the portable XRF analyzer, once corrected, are plotted with conventional geochemical analyses on a TiO_2 vs Zr diagram and facilitate protolith identification. Certain families of intrusions may also be distinguished from one another using their Ti/Zr ratio or their iron or titanium content.

Mineralogy: Hydrothermal alteration minerals are increasingly used as a guide to delineate exploration targets. However, it may be quite difficult to correctly identify them in hand sample, and a thin section study encompassing such vast amounts of data is simply not possible. Infrared spectroscopy thus makes it easier to characterize these minerals.

Multivariate statistics: Multivariate statistical analysis techniques may be used to group data and/or measurement points based on responses for each parameter. This analysis depends on the initial processing done on the raw data, which is linked to the approaches discussed above and, like any other interpretation, on the user's assumptions.

We hope, by combining these various approaches, to use the data acquired with the LAMROC to achieve a fairly detailed resolution in the spatial discrimination of lithologies and alteration related to the emplacement of ore deposits.

293

Overview of Targeted Geoscience Initiative 4 (TGI-4) Ore System Projects: A National, Thematic Program to Enhance Effectiveness of Deep Exploration

Mike Villeneuve, Christine Hutton (GSC-O), Serge J. Paradis (GSC-Q) and Cathryn Bjerkelund (GSC-O)

Between 1980 to 2008, Canada's reserves of metals experienced a continuous decline, resulting in levels today that are less than half of those reported at the end of 1980. A key aspect contributing to this decline is the increasing rarity of surface discoveries in Canada forcing the exploration industry to explore even deeper for new resources. Even in established mining districts, there has not been substantive exploration below 300 m from surface due to limitations in geoscience knowledge of ore deposit and geochemical and geophysical methods. In light of this, NRCan renewed the Targeted Geoscience Initiative (TGI4) in 2010 for 5 years with a budget of $25M. The program focuses on providing industry with the next generation of innovative geoscience knowledge and analytical techniques that will result in more effective targeting of buried mineral deposits, thereby increasing discovery rates.

The first steps of TGI4 developed underpinning scientific hypotheses that define the critical knowledge gaps within ore systems of interest. These hypotheses, in turn, focus the collaborative efforts of geoscientists from the Geological Survey of Canada, provincial and territorial government surveys, industry and academia. In the summer of 2011, TGI4 launched its thematic, knowledge-driven projects that are based around the following ore systems: 1) Lode Gold, 2) Nickel-Copper-PGE-Chrome, 3) Intrusion Related systems (e.g. porphyry), 4) SEDEX, 5) Volcanogenic Massive Sulphide systems, 6) Uranium and 7) Specialty Metals (e.g. Nb, REE). In addition, scientific studies within the fields of geophysics, geochronology and analytical geochemistry are being used to advance methodological development.

Unlike previous incarnations of TGI, the thematic nature of TGI4 means that individual projects are not centred on a geographic region, but instead integrate data and knowledge from multiple mining camps across Canada. In this way, the optimum deposits are used to support studies within a single ore system, in order to best achieve the program objectives.

ACRONYMS, LIST OF EXHIBITORS, MAPS OF EXIBIT 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)
- CCSN : The Canadian Nuclear Safety Commission
- 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
- CMIC : Conseil canadien de l'industrie minière
- CNRS : Centre national de la recherche scientifique
- CONSOREM : Consortium de recherche en exploration minérale
- CRÉ : Conférence régionale des élus
- CRÉBJ : Conférence régionale des élus de la Baie-James
- CRPG : Centre de recherches pétrographiques et géochimiques, France
- CRRNTBJ : Commission régionale sur les ressources naturelles et le territoire de la Baie-James
- CRSNG (RDC) Conseil de recherches en sciences naturelles et en génie du Canada (subventions de recherche et développement coopérative)
- CSST : Commission de la santé et de la sécurité du travail
- CU : Carleton University
- DIVEX : Diversification de l'exploration minérale du Québec (Réseau de recherches géoscientifiques)
- ENSG/CRPG : Nancy Université, École nationale supérieure de Géologie / Centre de recherche de pétrographique et géochimique
- 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 et de l'Université McGill
- GSC : Geological Survey of Canada
- GSC-O : Geological Survey of Canada - Ottawa
- GSC-Q : Geological Survey of Canada - Québec
- 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
- INSU : Institut national des Sciences de l'Univers
- 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
- OGS : Ontario Geological Survey
- PDAC : Prospectors and Developers Association of Canada
- Poly : École Polytechnique de Montréal. Département des génies civil, géologique et des mines, Montréal
- RNCREQ : Regroupement national des conseils régionaux de l'environnement du Québec
- RSC : Ressources Strateco
- SPCPM : Système de production des cartes de potentiel minéral (MRNF)
- TGI-3 : Targeted Geoscience Initiative (2005-2010) – GSC
- UBC : University of British Columbia
- 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 (SCTA) : 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

Grand Ballroom

1	Diagnos
2	Ressources Appalaches
3	Geophysics GPR International
4	Tres-Or Resources
5	Dios Exploration Sirios
6	Goldbrook Ventures
7	Osisko Mining Corporation
8	Equipement Jexplore
9	IOS services géoscientifiques
10	SGS Canada
11	Canadian Helicopters
12	IDNR-TV
13	Niogold Mining
14	Prospectors and Developers Association of Canada (PDAC)
15	New Brunswick department of Natural Resources
16	Quebec Geoscience Centre
17	Cogitore Resources
18	Activation Laboratories (Actlabs)
19	Exploration Typhon
20	SRK Consulting
21	Fordia
22	Stornoway Diamond
23	Midland Exploration
24	Abitibi Geophysics
25	Alexis Minerals
26	New Millennium Capital
27	Fugro Airborne Surveys
28	Newfoundland and Labrador — Dept. of Natural Resources
29	Mira Geoscience
30	Virginia Mines
31	VIASAT GeoTechnologies
32	Novatem
33	Terraplus
34	Azimut Exploration
35	MDN
36	Société de développement de la Baie-James
37	ALS Minerals
38	Héli-Transport
39	Habitaflex Concept

Salon Bellevue

40	Institut de la statistique du Québec (ISQ)
41	Gestion des titres miniers (GESTIM)
42	Système d'information géominière (SIGEOM)
43	Direction générale de la gestion du milieu minier (DGGMM)
44	Direction générale du développement de l'industrie minérale (DGDIM)
45	Direction générale adjointe de l'information géographique (DGAIG)
46	Secteur des Opérations régionales (SOR)
47	Ministère du Développement durable, de l'Environnement et des Parcs (MDDEP)

Salon Verchères

60	Golden Valley Mines
61	Goldcorp
62	2iC Australia Pty
63	Instrumentation GDD
64	Agnico-Eagle Mines
65	Geotech
66	Aeroquest Airborne
67	Xstrata Canada
68	Donner Metals
69	Discovery Air Innovations

Salon Place d'Armes

89	Association de l'exploration minière du Québec (AEMQ)
90	Focus Metals / Adventure Gold
91	GÉNIVAR
92	Royal Nickel
93	Groupe Système Forêt
94	NJ Albert Télécommunications
95	Scintrex
96	Géotic
97	Alexandria Minerals
98	ESRI Canada

Salon Jacques-Cartier

101	Cabo Drilling
102	Gemcom Software
103	Reflex
104	PetroValue Produits Canada
105	Eastmain Resources
106	Commerce Resources
107	CONSOREM
108	Les Ressources d'Arianne
109	Crone Geophysics and Exploration
110	Mineralogical Association of Canada
111	AGAT Laboratories
112	Roche, Consulting Group

Rooms (booths 121 to 135)

121	MBI Drilling Products
122	Université du Québec à Montréal (UQAM)
123	IME
124	Clubs de minéralogie et de paléontologie du Québec
125	Oceanic Iron Ore

126 Atlas Copco Exploration Products
127 Richmont Mines
128 Wesdome Gold Mines
129 Sirius Wilderness Medicine
130 Sécuri-soins
131 Prospector's room
132 Placements B. Allard
133 Prospector's room
135 Prospector's room

Propectors' Room

131-1 Frédéric Bergeron, Joaillier
131-2 Corporation de promotion du développement minéral de la Côte-Nord
131-3 Association des prospecteurs amateurs de la Haute-Côte-Nord
133-4 Jean-Louis Tremblay et Benoît Frigon, prospecteurs autonomes
133-5 Mario et Gilles Bouchard, prospecteurs autonomes
133-6 Association des prospecteurs de la Manicouagan
135-7 Conseil Cri de l'exploration minérale
135-8 Fonds d'exploration minière du Nunavik
135-9 Michel Desbiens et Léopold Tremblay, Association des prospecteurs du Saguenay—Lac-Saint-Jean

Salon Le Champlain

150 RCM Modular
151 Accurassay Laboratories
152 BBA
153 Xmet
154 Century Mining
155 Nemaska Exploration
156 Adriana Resources
157 Detour Gold
158 Veolia Water Solutions & Technologies Canada
159 Photonic Knowledge
160 Korem
161 Clearview Geophysics
162 Elemental Controls
163 EON Geosciences
164 CK Logistics

Salon Bellevue

250 Bureau de l'exploration géologique du Québec – 2010-2011 Activities
251 A Quaternary mapping initiative within the scope of the regional characterization of aquifers in the contiguous basins of Rivière Richelieu, Rivière Yamaska and Baie Missisquoi
252 Advanced exploration and mining development highlights for 2011 in the Abitibi-Témiscamingue region
253 Geological reconnaissance of the Rivière Octave region (parts of NTS map sheets 32D16, 32E01, 32F04)
254 Potential for rare earth occurrences in Québec
255 Inventory of natural aggregate resources in the Salluit region
257 New geophysical data available from SIGÉOM in 2011
258 Geology of the Wottonville and Scotstown regions, Estrie, NTS topographic map sheets 21E11 and 21E12
259 Compilation and update of metallic ore deposits in Québec
260 Field School
261 Cu-Zn-Co-Ag-Au Besshi-type mineralization potential in the Labrador Trough
262 Chair in mining entrepreneurship UQAT-UQAM

Salon Rose

263 Bureau de l'exploration géologique du Québec – 2010-2011 Activities
264 Evolution of trace element concentrations in magnetite from a fractionating magmatic sulfide liquid: application to exploration of Ni-Cu-PGE deposits
265 Mineral chemistry of magnetite in Ni-Cu-PGE deposits and application to exploration
266 Vanadium mineralization in the Archean layered igneous Rivière Bell Complex, Matagami, Québec
267 Controls on the nature and distribution of rare earth and other high field strength minerals in the Nechalacho rare metal deposit, Thor Lake, NWT
268 Lithological and petrographic characterization of the Misery Syenite Intrusion (Québec)
269 Geology and economic potential of the Kuujjuaq area (SE Churchill)
270 Correlation of volcano-sedimentary basins in northeastern La Grande Subprovince (Baie-James) using lithological and mineral geochemistry
271 Geology of the Lac Nochet area (NTS 33G08, 33H05, 33H12 and 33H13): New volcanic and sedimentary belts
272 GT 2011-04 - Les tourbières pennées de la baie de Rupert
273 Outstanding geological sites
274 GT 2011-03 - Le volcanisme et ses vestiges au Québec
275 GT 2008-01 - Les événements géologiques importants au Québec
276 Geological revision of the Matagami region
277 Geology of the Warrenmac gold-rich polymetallic massive sulphide lens, Westwood deposit, Abitibi, Québec
278 Geology of the Daniel-Johnson Dam (Manic 5) area, Côte-Nord region (NTS 22K14, 22K15, 22K16, 22N03 and 22N02)

279 Gold mineralization in the Beattie Syenite at Duparquet, Québec: orogenic or magmatic?

280 Transpressional dynamics and the role of crustal heterogeneities in the localization of the Desmaraisville basin (Abitibi): geophysical study and analogue modelling

281 Geochemical recognition of protoliths in high-grade metamorphic domains

282 Plutonic suites as an exploration tool for IOCG: application in the Abitibi

283 A new diamondiferous kimberlite field in Québec?

284 The surface geochemical cycle of metals during mining operations: An example from lake sediments in the Schefferville district, Québec

285 The DIVEX network: Horizon 2014

286 The DIVEX network: Horizon 2014

287 The DIVEX network: Horizon 2014

288 The Behaviour of Base Metals in Arc-Type Magmatic-Hydrothermal Systems – Insights from Merapi Volcano, Indonesia

290 Reassessment of the mineral potential at the former St-Robert Bellarmin mine, Beauce, Québec

291 Multi-parameter measurements on drill core from the Matagami area in a mobile laboratory: Part 1, background and methodology

292 Mesures multiparamétriques sur des carottes de forage de la région de Matagami grâce à un laboratoire mobile: partie 2, résultats préliminaires

293 Overview of Targeted Geoscience Initiative 4 (TGI-4) Ore System Projects: A National, Thematic Program to Enhance Effectiveness of Deep Exploration

294 Marteau d'or

Core Shack

Thuesday, November 22

C-1 Ressources GéoMégA

C-2 Western Troy Capital Resources

C-3

C-4 Bonterra Resources

C-5 Rockland Minerals

C-6 Design Shelter

C-7 Eagle Hill Exploration

C-8 Eagle Hill Exploration

C-9 Quest Rare Minerals

C-10 Northern Gold Mining

C-11 Zone Resources

C-12 Ex-In - Explorateurs-Innovateurs de Québec

Wednesday, November 23

C-1 Ressources GéoMégA

C-2 Western Troy Capital Resources

C-3

C-4 Bonterra Resources

C-5 Rockland Minerals

C-6 Design Shelter

C-7 Eagle Hill Exploration

C-8 Eagle Hill Exploration

C-9 Quest Rare Minerals

C-10 Northern Gold Mining

C-11 Zone Resources

C-12 Ex-In - Explorateurs-Innovateurs de Québec

Thursday, November 24

C-1 Ressources GéoMégA

C-2 Western Troy Capital Resources

C-3

C-4 Bonterra Resources

C-5 Rockland Minerals

C-6 Design Shelter

C-7 Eagle Hill Exploration

C-8 Eagle Hill Exploration

C-9 Quest Rare Minerals

C-10 Northern Gold Mining

C-11 Zone Resources

C-12

Central Hallway

200 CÉGEP de Sept-Îles

201 Commission géologique du Canada

202 Institut Hubert-Reeves

203 Corporation d'astronomie de Val-Bélair

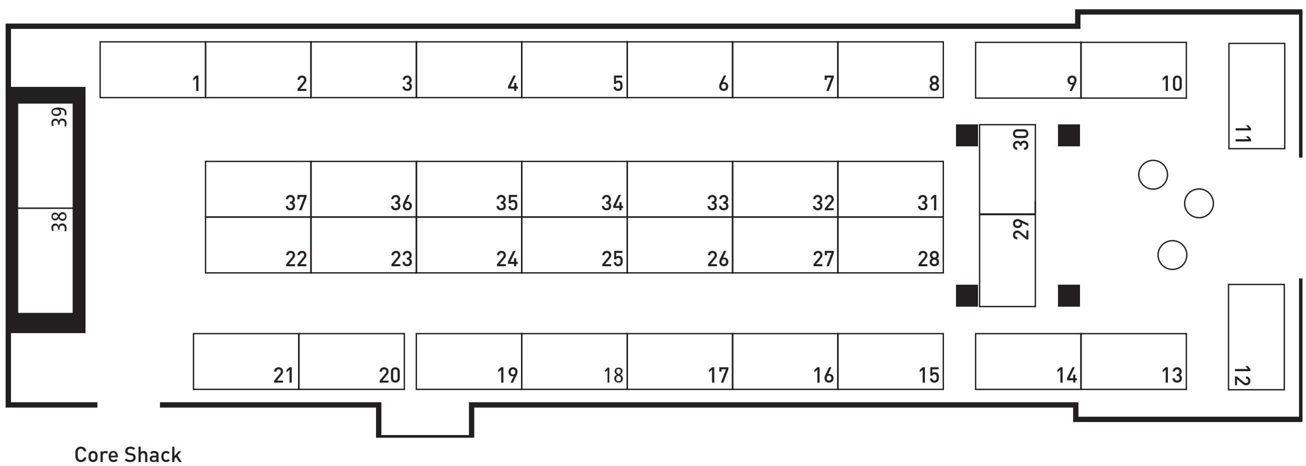
204 CÉGEP de Thetford Mines

205 CÉGEP de l'Abitibi-Témiscamingue

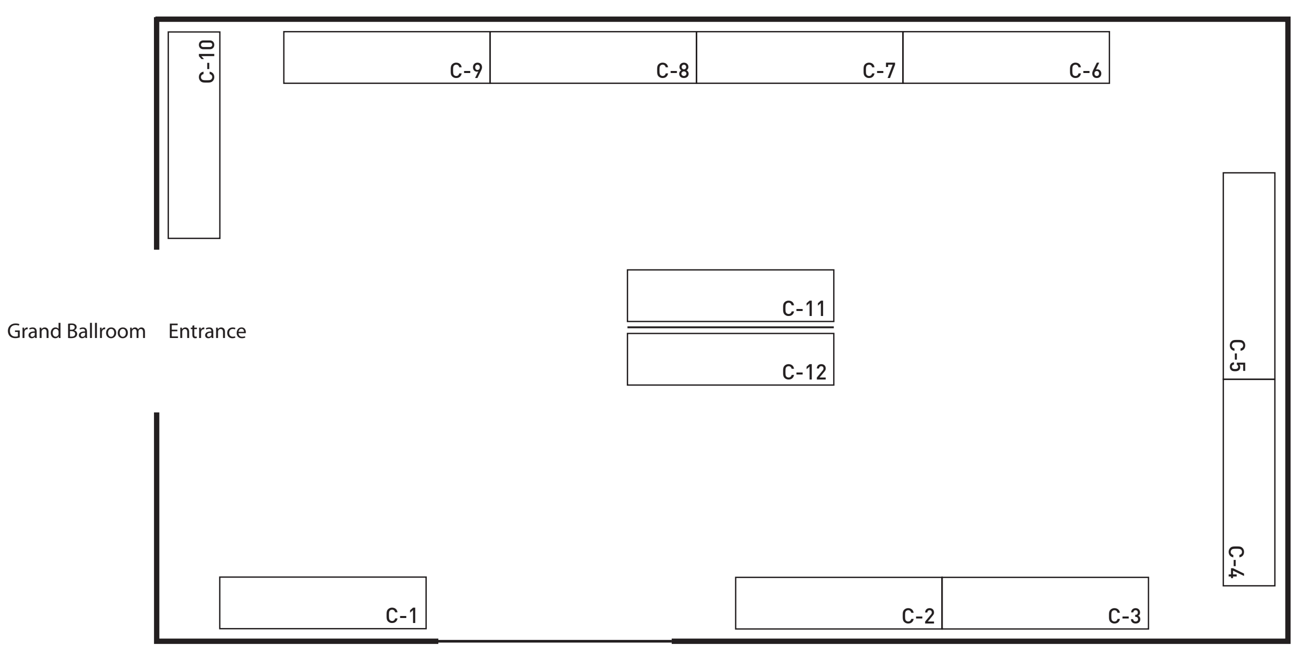
206 Collection de minéraux

207 Plein de ressources (MRNF)

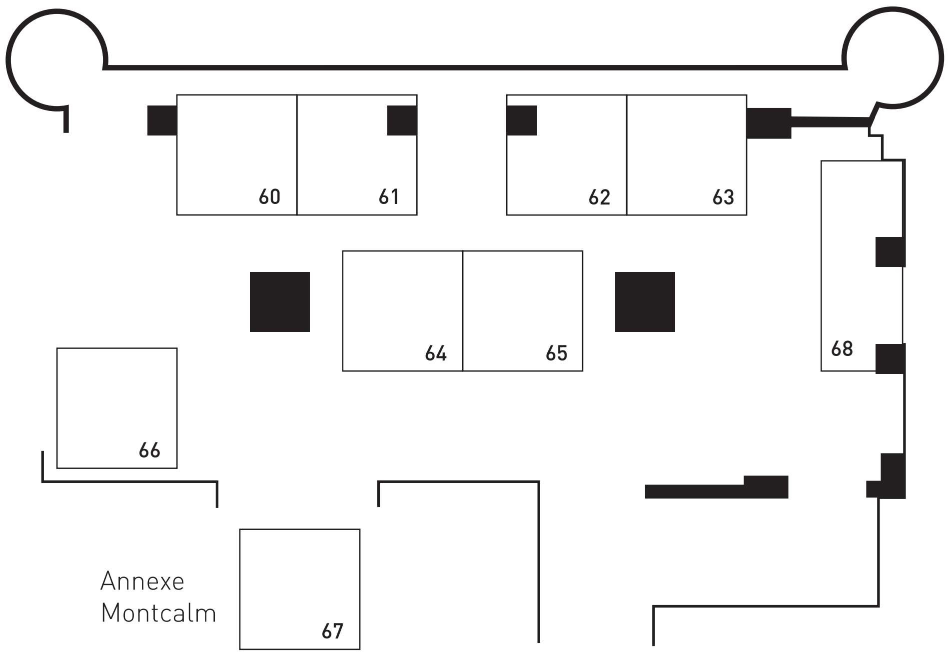
Grand Ballroom
Commercial exhibit



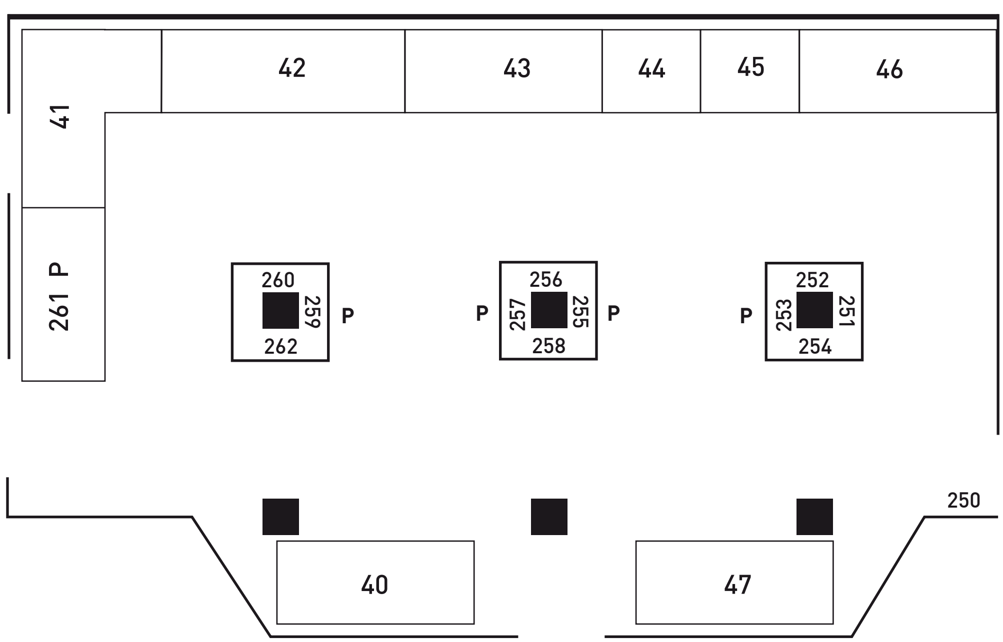
Core Shack



Salon Verchères
Commercial exhibit

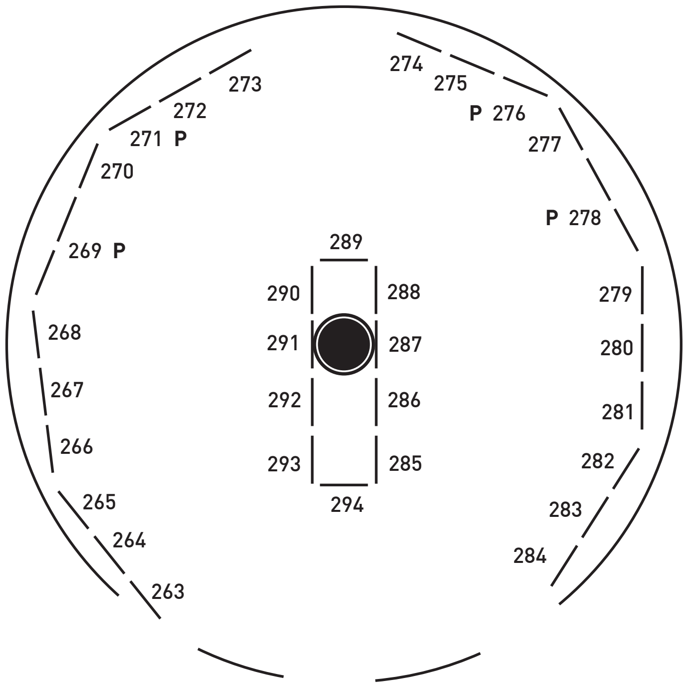


Salon Bellevue
Geoscience and Government Exhibit



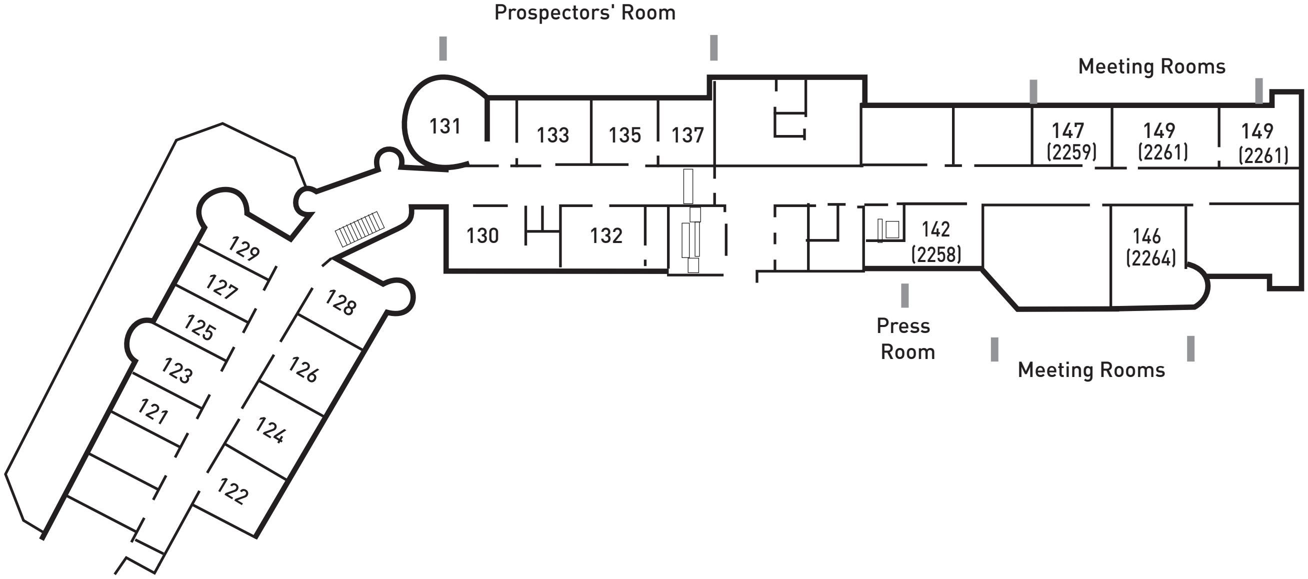
P: Plasma

Salon Rose
Geoscience exhibit

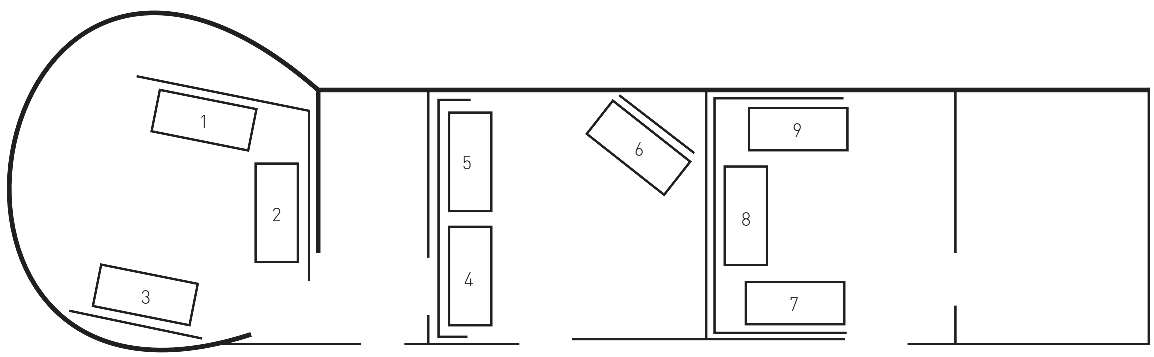


P: Plasma

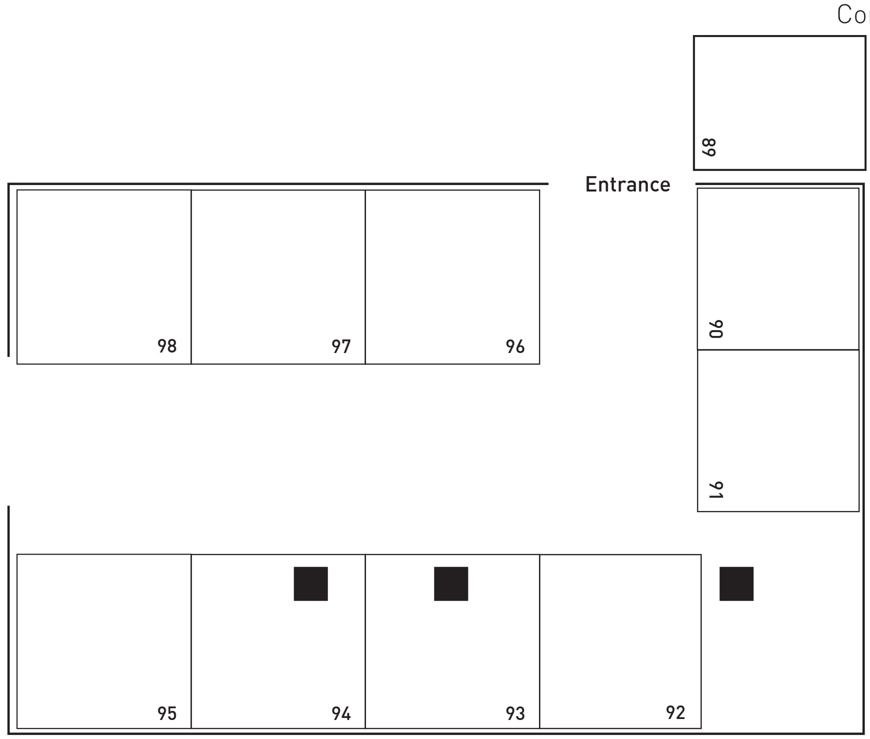
Rooms (booths 121 to 135)
Commercial exhibit



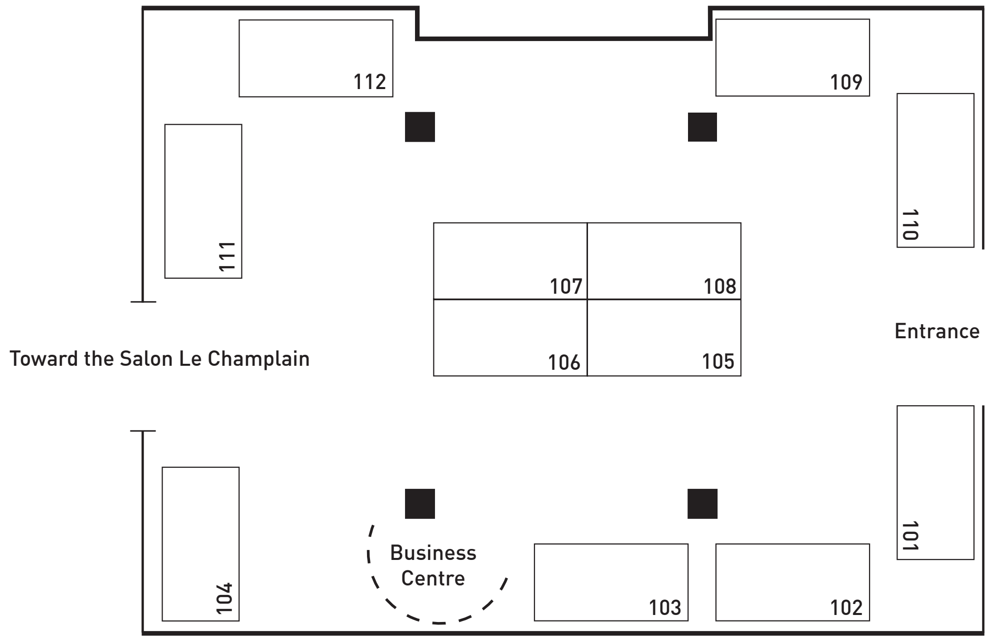
Booths 131, 133 and 135
Prospectors' Room



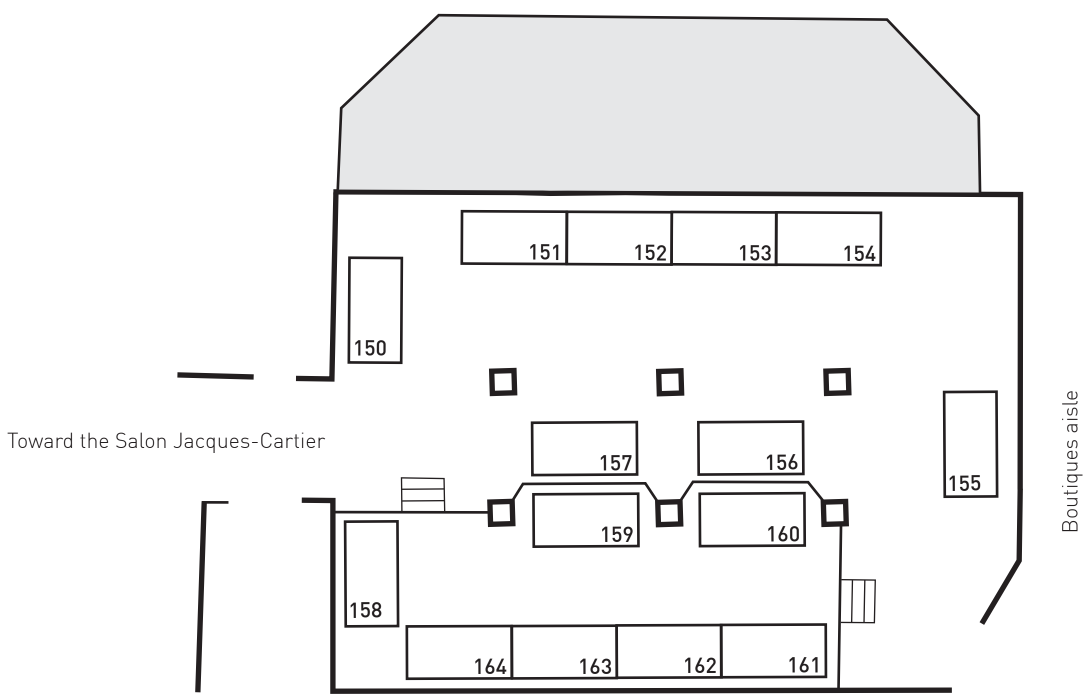
Salon Place d'Armes
Commercial exhibit



Salon Jacques-Cartier
Commercial exhibit

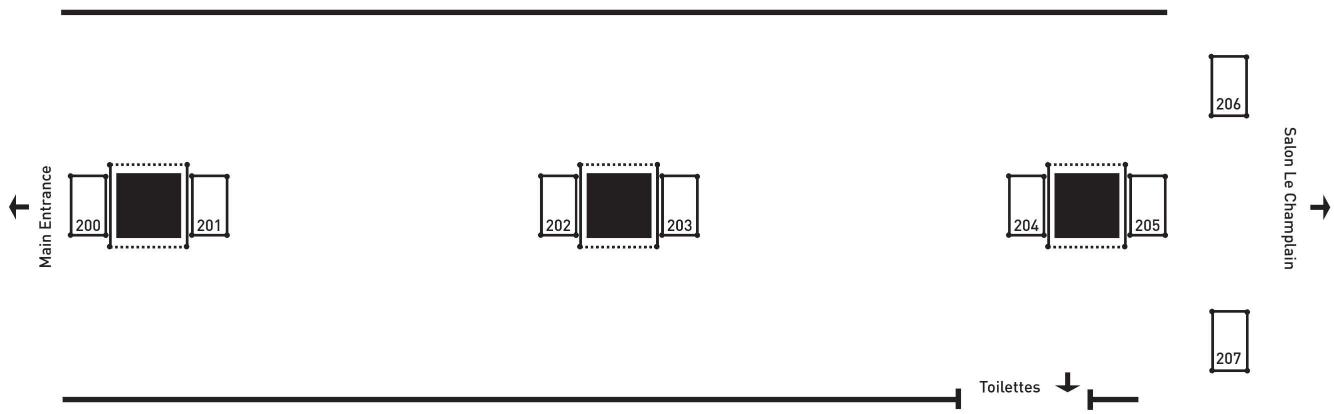


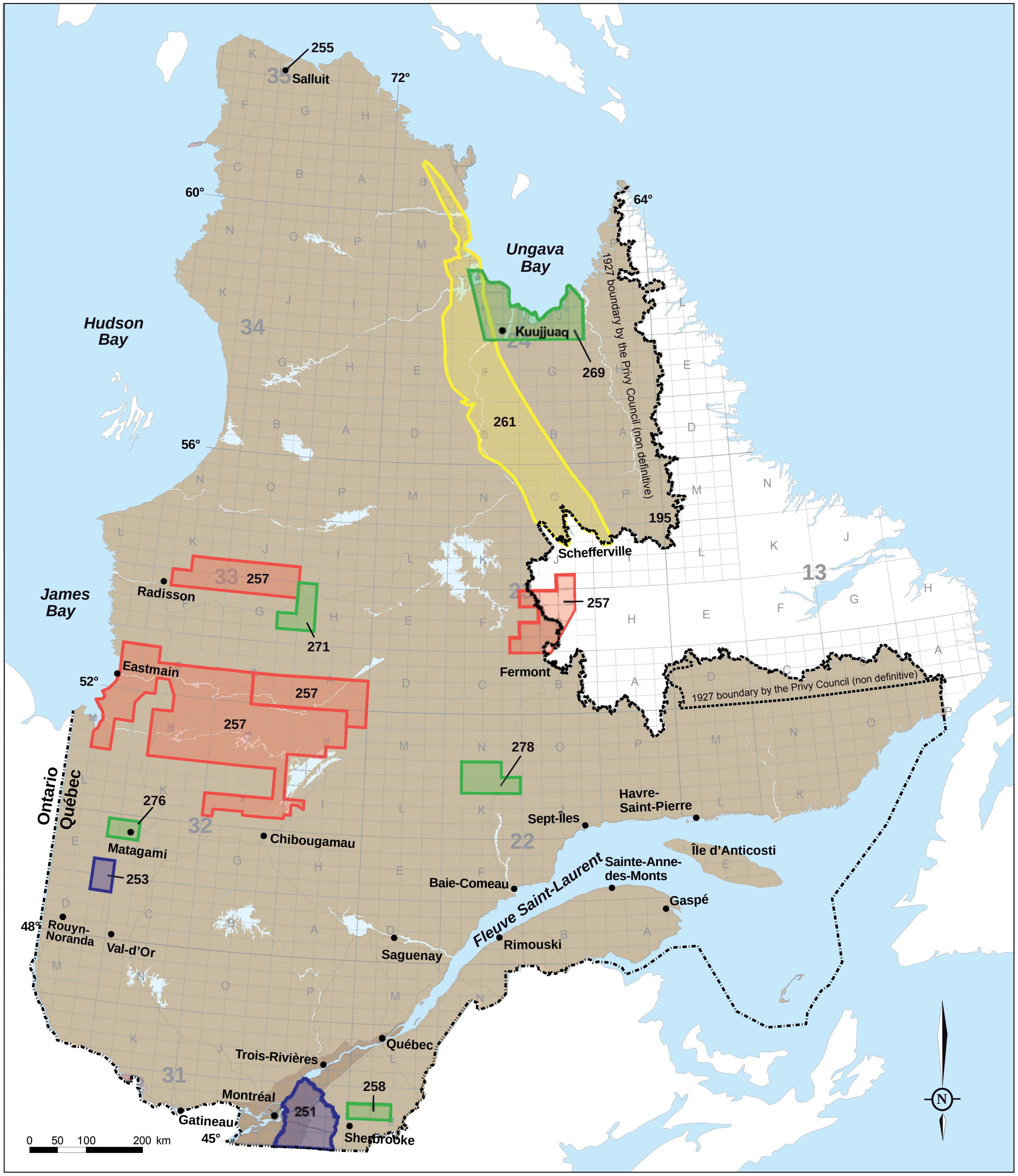
Salon Le Champlain
Commercial exhibit



Central Hallway

Educational exhibit





Geological surveys

Geophysical surveys

Quaternary studies

Mineral potential assessment