DV 2005-04

ABSTRACTS OF ORAL PRESENTATIONS AND POSTERS, QUEBEC EXPLORATION 2005

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Énergie et Ressources naturelles
Québec

QUÉBEC EXPLORATION 2005

November 21 to 24, 2005
Château Frontenac, Québec

Abstracts of oral presentations and posters

DV 2005-04

Québec

QUÉBEC

EXPLORATION

2005

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Summary

List of organizers and their aids 6
Abstract of oral presentations 7
Abstract of posters 29
Abstract of Interactive sessions 47
Acronyms 52
List of Exhibitors 53
Maps of exhibit rooms 56
Projets location 60
Promotional presentations 61



Message from the Minister of Natural Resources and Wildlife

Québec has an exceptional mineral potential and we must seize the opportunity to develop it. Fortunately, in the past few years, exploration has reached new heights in our territory, which is good news for us all!

Indeed, our recent efforts are producing results: "Éléonore", the new gold discovery at James Bay, the discovery of base metals by Falconbridge in the Noranda mining camp or the nickel discoveries in the Cape Smith Belt in the Far North, to mention just a few.

In this context, an event like Québec Exploration 2005 is particularly important because it gives various mineral industry players the opportunity to establish solid business partnerships for the development of this key sector of our economy. It also gives them access to new geological information, adding to their assets and increasing their effectiveness.

To this end, the 2005 edition of Québec Exploration has many surprises in store for you! It not only features sessions and activities around the usual themes of precious and base metals, but includes more unusual topics, such as oil and gas exploration, architectural stone, and uranium, as well.

I am therefore proud and delighted to invite you to be "On Target" and to discover all the advantages of mineral exploration in Québec, which make our vast territory one of the most sought after in the world. May your discussions be rewarding and your stay in our capital enjoyable!

Pierre Corbeil

Minister of Natural Resources and Wildlife

Message from the Chairman of the Québec Mineral Exploration Association



The Québec Mineral Exploration Association and the *Ministère des Ressources naturelles et de la Faune* are joining forces for a third year to present Québec Exploration 2005. As President of the Association, I am very pleased to invite you to attend this event, a gathering of the entire mineral exploration industry, to discuss the latest discoveries and get an update on research and mineral development in Québec.

The Organizing Committee has developed a complete program of talks around this year's theme, "On Target", that will show you why Québec is one of the most attractive jurisdictions in the world in terms of exploration, as confirmed by the latest discoveries, in fact. We have added activities to increase the participation of financial industry stakeholders. 2005 is turning out to be one of Québec's best years in terms of mineral exploration. There is no doubt that, if we stay on target, other world-class deposits will soon be discovered, enhancing Québec's heritage and contributing to the economic development of the regions.

I would be remiss if I did not mention the 30th anniversary of the QMEA. I would like to cordially invite you to attend the Association's Annual General Meeting, which will be held on November 23rd, during which we will celebrate the occasion. Several directors' positions will be available and I suggest that you get more involved in the industry by running for election. And, since Québec Exploration 2005 is being held in historic Old Québec, why not take advantage of the many social activities on the program and even extend your stay.

Gérald Riverin

Chair, Québec Mineral Exploration Association



Message from the Honorary Chairman of Québec Exploration 2005

As CEO of Agnico-Eagle Mines Limited and Contact Diamond Corporation, I am honoured and proud to serve as Honorary Chairman of Québec Exploration 2005. Our companies have been active in Québec for almost 40 years and we have enjoyed tremendous success here discovering and building gold mines. Our LaRonde Mine, in Bousquet and Cadillac Townships is Canada's largest gold deposit and it is the foundation of our company.

Québec remains one of the most attractive mining jurisdictions in the world based on mineral policy and mineral potential. And although, we have begun to pursue growth internationally in other pro-mining regions, we continue to build new gold mines here in Québec. We believe there are more gold mines yet to be discovered in Québec and we are actively exploring our extensive Québec property holdings.

Québec Exploration 2005 is the ideal venue for exchanging information, creating new alliances and establishing partnerships that are productive for both the mining industry and Québec. I look forward to sharing ideas and getting caught up on the latest exploration news and innovations in the mineral exploration sector.

Sean Boyd

President and Chief Executive Officer, Agnico-Eagle Mines Limited
Honorary Chairman of Québec Exploration 2005

List of organizers and their aids

Organizers

Alain Simard
Directeur, Géologie Québec
Ministère des Ressources naturelles et de la Faune

Jean-Pierre Thomassin
Directeur général, Association de l'exploration minière du Québec

Luc Charbonneau
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Ministère des Ressources naturelles et de la Faune

Georges Beaudoin
Université Laval
Département de géologie et de génie géologique

Kamil Khobzi
Mines Cancor, Association de l'exploration minière du Québec

Speakers Program

Georges Beaudoin
Université Laval
Département de géologie et de génie géologique

Pierre Verpaelst
Ministère des Ressources naturelles et de la Faune

Présidents de session

Marco Gagnon (Vior inc.)
Jean-Pierre Thomassin (AEMQ)
Damien Gaboury (UQAC-CERM-CONSOREM)
Michel Malo (INRS-ETE)
Pierre Verpaelst (MRNF)
Serge Perreault (MRNF)
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Workshops and Short Courses

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Serge Perreault
Ministère des Ressources naturelles et de la Faune

Field Trips and Industrial Tours

Yves Bellemare
Ministère des Ressources naturelles et de la Faune

Denis Raymond
Consultant

Investors Night

Dominique Doucet
Ressources Sirios inc.

Accompanying Guest Program

Richard Laverdière
Ministère des Ressources naturelles et de la Faune

Partners

Julie Charrette
Association de l'exploration minière du Québec

Michel Champagne
SIDEX s.e.c.

Gala Evening

Marlène Bergeron
Gilles Therrien
Ministère des Ressources naturelles et de la Faune

Trade Show

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Abstracts of oral presentations, posters and interactive sessions

Oral Presentations

Tuesday, November 22

8:15 **Welcoming address**

A. Simard, Director of Géologie Québec
and G. Riverin, Chair of the Québec Mineral Exploration Association

Session 1 - New Discoveries and Advanced Projects

Chair: **Marco Gagnon** (Vior inc.)

8:30 **Gold Metallogeny of the Superior (Canada) and Yilgarn (Australia) Cratons and Implications for Exploration**

François Robert (Barrick Gold)

9:20 **History and Geology of the Roberto Gold System, Eleonore Project, Québec**

Paul Archer (Virginia Gold Mines Inc.)

9:40 **Recent Exploration Success Stories in the Noranda Mining Camp**

Mario Masson (Falconbridge Ltd)

10:00 **A New Look at the Destor-Porcupine Fault, Abitibi Subprovince**

Marc Legault, Jean Goutier (MRNF), and Francine Fallara (URSTM-UQAT)

10:20 **Potential of the Western Part of the Cape Smith Belt**

Richard Dufresne, Gary De Schutter, Maria Gabriel and Clément Dombrowski (AAEC)

10:40 **Geological and Geochemical Evidence for Carlin-Type Gold Mineralization in the Gaspésie Region**

Virginie Garnier, Michel Malo, (INRS-ETE), Benoît Dubé (GSC-Q), André Chagnon (INRS-ETE) and Georges Beaudoin (Université Laval)

11:00 ★ **New Approaches for Discovery - An Economic Look at the Impact of New Technology Applied to Wealth Creation in Exploration**

Rob Gordon (Quantec Geoscience)

Session 2 - Managing and Exploring, an Achievable Goal?

Chair: **Jean-Pierre Thomassin** (QMEA)

1:30 **Be on Target with Properly Conducted and Transparent Lobbying Activities**

André C. Côté (Québec Lobbyists Commissioner)

2:20 **Impacts of New Regulations on Mining Companies**

Josée Deslauriers (Autorité des marchés financiers)

2:40 **Global Leaders in Mining**

Louis Doyle (TSX Venture Exchange)

3:00 **How to Optimize Financing for Exploration Work in Québec**

Michel Champagne and Isabelle Cadieux (SIDEX)

3:20 **The Nuclear Renaissance and its Implications for Uranium**

Pierre Heeroma and Tim Gitzel (AREVA Mining Business Unit)

3:40 **The Importance of Communicating with Investment Advisors**

Sylvain Laberge (Renmark Financial Communications Inc.)

Wednesday, November 23

Honorary Chairman speech

8:30 ★ **Building a Multi-Mine Quebec-Based Gold Company**

Mr. Sean Boyd, President and Chief Executive officer, Agnico-Eagle Mines Ltd, Honorary Chairman of Quebec Exploration 2005

Session 3 - New Exploration Technologies

Chair: **Damien Gaboury** (UQAC-CERM-CONSOREM)

9:00 **Using Major Elements to Evaluate the Metamorphism, Physical Properties, and Alteration of Rocks**

Mathieu Piché (Alexis Minerals Corporation)

9:20 **3D Architecture of the North American Lithosphere by Seismic Tomography: Implications for Regional Diamond Exploration**

Stéphane Faure (CONSOREM-UQAC), Francine Fallara (URSTM) and Stéphanie Godey (European-Mediterranean Seismology Centre)

9:40 **Lake Sediment Geochemistry Survey in the Manicouagan Area: More Than a Prospecting Tool**

M. Beaumier (MRNF)

10:00 **Artificial Neural Networks: Examples of Geoscience Applications**

Sylvain Trépanier (CONSOREM)

Session 4 - Government Support for Oil and Gas Exploration

Chair: **Michel Malo** (INRS-ETE)

10:20 **Hydrocarbon Exploration in the Gaspésie Region: Contribution of RADARSAT Images Combined with Geoscience Data**

Michel Rheault, Adeline Kilicaslan (MIR), Daniel Brisebois (MRNF), Nicolas Pinet (GSC), Michel Malo (INRS-ETE), Robert Thériault and Jean-Yves Laliberté (MRNF)

10:40 **Imprints of the Ottawa-Bonnechère and Saguenay Grabens in the St. Lawrence Lowlands and the Appalachians: Targets for Hydrocarbon Exploration**

Robert Thériault, Jean-Yves Laliberté and Daniel Brisebois (MRNF)

11:00 **Contribution of Recent Geophysical Data to the Understanding of Sedimentary Basins in the Gaspésie Region – Implications for Oil & Gas Exploration**

Nicolas Pinet, Denis Lavoie (GSC), Denis-Jacques Dion (MRNF), Pierre Keating, Jim Dietrich, Pierre Brouillette (GSC), Daniel Brisebois (MRNF), Michel Malo (INRS-ETE) and Sébastien Castonguay (GSC)

11:20 **Introduction to the Canadian Energy Supply Security Program of the Earth Sciences Sector, Natural Resources Canada**

Martin Fowler (GSC-C) and Denis Lavoie (GSC-Q)

2:00 **Special conference**
Copper in Québec and elsewhere in Canada: the contribution of the Targeted Geoscience Initiative

Simon Hanmer, Interim Program Manager TGI3, Central Canada division, Geological Survey of Canada
Room: Suite des Gouverneurs

4:00 **Reconnaissance awards (Salle Frontenac)**

5:00 **Cocktail**

6:00 **Gala Evening**

Keynote speaker

Sessions marked with an ★ will be presented in English.

All sessions will be offred with simultaneous translation.

Oral Presentations

Thursday, November 24

Session 5 - Architectural Stone in Québec

Chair: **Pierre Verpaelst** (MRNF)

8:30 **Profile of the Architectural Stone Industry in Québec**

Yves Bellemare (MRNF)

8:40 **Stone Extraction Techniques**

Reggie Zanchetti (NOVAMAC Industries Inc.)

9:10 **Evolution of Granite Processing Techniques in the Last Thirty Years**

Frédéric Lacroix (A. Lacroix et Fils Granit Ltée)

9:30 **Uses of Architectural Stone**

Alain Prince (Technipierre-Héritage)

Session 6 - Uranium Deposits: from Source to Deposit

Chair: **Serge Perreault** (MRNF)

9:50 **Is a Uranium-Rich Source an Essential Requirement for the Genesis of Major Uranium Deposits?**

Michel Cuney (CNRS, CREGU)

10:40 **Exploration Guides in the Athabasca Basin 20 Years After the Discovery of Cigar Lake**

Philippe PORTELLA and Claude CAILLAT (COGEMA Resources Inc., AREVA Group)

11:00 **The Otish Basin: Uranium Potential and Correlations with Proterozoic Analogs in Eastern Canada**

Serge Genest (URANOR Inc.)

Session 7 - Volcanogenic Massive Sulphides

Chair: **Georges Beaudoin** (Université Laval)

1:30 ★ **Abitibi Volcanogenic Massive Sulphide Deposits: the spectrum of environments, modern analogs and implications for exploration**

Harold Gibson (MERC-DES), James Franklin (FGL, MERC), Mark Hannington (DESUO, MERC) and Stephen Piercey (MERC-DES)

2:20 **Economic Models for VMS and Implications for Exploration Strategies**

Gérald Riverin (Cogitore Resources, Woodruff Capital Management Inc.)

2:40 **Structure and Stratigraphy of the Urban-Barry Belt: New Tectonostratigraphic Vision and Implications for Volcanogenic Occurrences**

Pierre Rhéaume, Daniel Bandyayera (MRNF) and D. W. Davis (University of Toronto)

3:00 **Geochemical Signature of Rhyolites and Volcanogenic Deposits Fertility: Myth or Reality**

Damien Gaboury (UQAC-CERM-CONSOREM) and Vital Pearson (CONSOREM)

3:20 **GIS Data Integration as an Exploration Tool: Potential Assessment for VMS in the Abitibi as an Example**

Daniel Lamothe (MRNF) and Jeff R. Harris (GSC)

3:40 **Towards New Discoveries thanks to the Application of 3D Modeling in the Noranda Camp**

Louis Martin and Mario Masson (Falconbridge Ltd)

Session 1 8:30

Gold Metallogeny of the Superior (Canada) and Yilgarn (Australia) Cratons and Implications for Exploration

François Robert (Barrick Gold)

The Superior and Yilgarn cratons respectively contain >8500 and >9200 tonnes of gold, essentially concentrated in greenstone belts. Their geological history dates back to the Mesoarchean and shows strong similarities during the Neoarchean. In both cases, the orogenic phase is defined by a shift from predominant volcanism to predominant clastic sedimentation, followed by granitic plutonism, progressive deformation, and metamorphism.

Gold deposits in both cratons show nearly identical tonnage-grade distributions, with ~80% of the gold concentrated in ~20% of deposits. Most of the major deposits (>100 t Au) are concentrated within a few very gold-rich corridors along which deposits are generally clustered in well-defined camps typically spaced 30 to 50 km apart. Gold deposits in both cratons show the same diversity of styles of mineralization, namely quartz-carbonate veins, including a sub-group with crustiform-colloform textures, sulphide-rich quartz veins, disseminated sulphide zones, and massive sulphide zones. Three lithological associations are particularly favourable to the development of major deposits: iron-rich mafic igneous rocks, iron formations, and intermediate to felsic porphyry dykes and stocks. Geological relationships and timing constraints clearly define several distinct episodes of gold mineralization during the 30 to 50-million-year orogenic phase in each craton. Existing constraints require a number of different genetic models.

The richest gold camps (Timmins, Red Lake, Kalgoorlie) are characterized by an anticlinal structure cored by komatiitic and basaltic rocks, by conglomerate and arenite units unconformably overlying volcanic units, by the presence of regional fault zones, and by gold deposits of various styles and ages. The most prolific corridors (Timmins–Val-d'Or, Wiluna–Norseman) are characterized by a significant volume of komatiites and by the high degree of preservation of supracrustal sequences, namely reflected by the presence of the youngest volcanic and sedimentary rocks in each craton and of prehnite-pumpellyite-grade metamorphism. These corridors generally overlap regional structures that remained active throughout the geological evolution, that served as crustal conduits for magmas and hydrothermal fluids, and that influenced clastic sedimentation. The heterogeneous distribution of gold deposits in each craton also calls for a prerequisite heterogeneous distribution of gold in source regions.

Session 1 9:20

History and Geology of the Roberto Gold System, Éleonore Project, Québec

Paul Archer (Virginia Gold Mines Inc.)

The Éleonore project, wholly owned by Virginia Gold Mines, is located in the northeastern part of Opinaca Reservoir, in the James Bay region of Québec. The area is part of the Superior Province of the Canadian Shield. The regional geology is dominated by a vast batholithic complex composed of synvolcanic (2747-2710 Ma) to syntectonic (2710-2697 Ma) intrusions, indicating voluminous and long-lived magmatic activity spanning a period of 50 Ma. The area also includes greenstone and sedimentary assemblages of the LaGrande Subprovince as well as paragneisses of the Opinaca Subprovince. Late to post-tectonic (2697-2618 Ma) intrusions of granodiorite and pegmatitic granite are also present. Metamorphic conditions range from the upper greenschist to the middle amphibolite facies in greenstone assemblages, but reach the granulite facies in the Opinaca Subprovince. The Eleonore property is centered on the Ell Lake intrusion, a small diorite stock bordering the batholithic complex, along the contact zone between the LaGrande and Opinaca subprovinces.

Regional reconnaissance work conducted by Virginia since 1996 led to the discovery in 2001 of Au-Cu-Ag showings within the Ell Lake diorite in the Opinaca Reservoir area. Subsequent exploration campaigns identified several new Au-Cu-Ag showings in the diorite intrusion, and also uncovered a few Au-As-(Sb) showings in sediments to the north, culminating with the discovery of the Roberto zone in the summer 2004.

Typical Roberto ore consists of a hydrothermal replacement zone and a quartz stockwork, hosted in wackes and siltstones. The high-grade replacement zone is pinkish and composed of quartz, microcline and tourmaline with 5% disseminated arsenopyrite and pyrrhotite. The main ore zone is located in a fold hinge and is deformed. The Roberto zone yielded impressive results both on surface (up to 18.5 g/t Au over 11 metres in trenches) and in drillhole (up to 18.85 g/t Au over 16 metres). Other subsidiary zones parallel to the main zone were subsequently discovered and in late August 2005, the Roberto gold system had been traced by drilling over a lateral distance of over 1.3 kilometres to a vertical depth of 620 metres. The system remains open in all directions.

Oral Presentations

Session 1 9:40

Recent Exploration Success Stories in the Noranda Mining Camp

Mario Masson (Falconbridge Ltd)

In June 2004, Falconbridge Limited signed a joint venture agreement with junior company Alexis Minerals Corporation, to conduct an extensive exploration program in the Noranda camp. The exploration strategy adopted in August 2002 to reboot exploration in the Noranda mining camp was based on the application of new technologies such as MegaTEM, Gocad and Titan-24.

From the MegaTEM survey to the Lac Montbray discovery

In November 2004, Falconbridge and Alexis discovered a new massive sulphide zone in Montbray Township. Drillhole MON-04-09 encountered a 5.16-m interval at 5.61% Cu and 1.70% Zn. Subsequent drillholes did not intersect any significant mineralization, however this new gently dipping favourable horizon was traced to a vertical depth of about 400 metres and remains unexplored beyond this depth. This success clearly demonstrates how using this new technology can bring new discoveries to light in so-called mature mining camps.

From the 3D model (Gocad) to the West Ansil discovery

In March 2005, a new massive sulphide zone grading 1.07% Cu over 18.75 m, followed by a stringer zone grading 1.80% Cu and 0.70% Zn over 7.40 m were intersected in drillhole AN-05-03 in the Rusty Ridge Formation. This new discovery lies a mere 1.8 km southwest of the former Ansil mine. Subsequently, several other significant intervals were intersected on West Ansil, namely 45.70 m at 3.35% Cu, 1.30% Zn, 1.86 g/t Au and 12.3 g/t Ag in drillhole WAN-05-04, and 6.30 m at 14.34% Cu in drillhole WAN-05-10. To date, three mineralized lenses have been identified within the basaltic-andesitic sequence of the Rusty Ridge Formation, between horizons hosting the Ansil mine (Lewis Horizon) and the Beecham Breccia, at a vertical depth between 175 and 550 m. This new discovery is a direct result of drill-testing a target generated with Gocad.

From the Titan-24 survey to the next discovery!

During the summer 2004, an important Titan-24 survey was conducted along the northwestern extension of the Central Camp. This survey covered roughly 135 line kilometres along flight lines spaced 400 m apart. Several MT and IP anomalies were detected at different depths, in areas with little or no previous exploration.

Session 1 10:00

A New Look at the Destor-Porcupine Fault, Abitibi Subprovince

Marc Legault, Jean Goutier (MRNF) and Francine Fallara (URSTM-UQAT)

The Destor-Porcupine Fault (DPF) constitutes one of the most important gold metallotects in the Abitibi Subprovince. However, very little gold has come out of the Québec side of the fault (~46 t Au) compared to the Ontario side (~2400 t Au). The MRNF, in an effort to attract attention to the DPF, has developed new tools for gold exploration by producing a regional metallogenic synthesis and 3D model. The metallogenic synthesis reveals the presence of seven types of gold mineralization, each with specific characteristics. The vast majority (~80%) of gold occurrences along the DPF consist of orogenic deposits associated with quartz-carbonate veins in deformation zones or with quartz-carbonate stockworks spatially associated with felsic porphyry intrusions. However, most of the gold extracted on the Québec side of the fault (89%) comes from syenite-related deposits. This type of mineralization is associated with pyrite-arsenopyrite-rich silicified zones surrounded by a sericite-carbonate alteration halo. This type of mineralization remains underexplored considering its potential. Epithermal veins constitute a new type of mineralization, relatively uncommon in the Abitibi Subprovince. These veins show open-space filling textures as well as anomalous Zn, Pb and Hg concentrations typical of neutral epithermal deposits. These veins occur in areas bordering the Duparquet basin, and appear to be associated with faults related to basin formation. However, these faults remain underexplored (especially in the northern part), despite the fact they are associated with important alteration zones. Thus, characterization of the various types of gold mineralization can help exploration efforts in the area zero in on targets more effectively, especially with the 3D model built along a strategic segment of the DPF. The model not only shows the 3D geology and gold distribution, it can also be queried using specific geological criteria typical of the various types of mineralization, to target high-potential areas for new gold-bearing zones. The DPF study outlines the presence of several areas with little or no previous exploration, and suggests the Duparquet basin area shows a shallower level of erosion, thus suggesting gold potential at depth.

Session 1 10:20

Potential of the Western Part of the Cape Smith Belt

Richard Dufresne, Gary De Schutter, Maria Gabriel and Clément Dombrowski (AAEC)

In 2001, Anglo American Exploration Canada Ltd. (AAEC) completed a compilation/interpretation project which recognized the Ni-Cu-PGE potential of the western half of the Cape Smith Belt. This led to the map designation of 1,646 claims in 2002. Subsequently, AAEC acquired more ground through map designation and joint venture bringing its potential holdings to more than 4,907 claims (>192,000 ha). In March 2003, AAEC signed an option/joint venture agreement with Knight Resources Ltd. for the West Raglan project and in 2005 entered into an option/joint venture agreement with Goldbrook Ventures Inc. for the Belanger and Nuvilik properties.

The "Raglan Horizon" (Chukotat Group) and the "Delta Horizon" (Povungnituq Group) are both present within the boundaries of AAEC properties. From 2003 to 2005, important new Ni-Cu-PGE mineralized zones were discovered on the West Raglan, Belanger and Nuvilik properties.

Since 2002, exploration by AAEC and its partners in the western part of the Cape Smith Belt has been successful in discovering several new Ni-sulphide-rich areas that may lead to the discovery of major deposits.

Session 1 10:40

Geological and Geochemical Evidence for Carlin-Type Gold Mineralization in the Gaspésie Region

Virginie Garnier, Michel Malo (INRS-ETE), Benoit Dubé (GSC-Q), André Chagnon (INRS-ETE) and Georges Beaudoin (Université Laval)

Paleozoic rocks in the southern Gaspésie region host abundant mineral occurrences, mainly polymetallic skarns and gold showings. Our recent study aims to assess the potential for Carlin-type deposits in gold showings hosted in Silurian limestones. Most of the features typical of Carlin-type deposits are also observed in Gaspésie, at the scale of the region, the district and the deposit. The Saint-André-de-Ristigouche showing shares many characteristics with Carlin-type deposits in Nevada, namely: 1) carbonate host rocks (White Head Formation), 2) gold-bearing quartz-stibnite veins, often brecciated, 3) Au-Sb-As-Hg metal signature with no base metals or silver, 4) spatial association with a major subvertical fault (Ristigouche fault), 5) hydrothermal alteration characterized by silicification proximal to mineralized veins and the presence of kaolinite in argillic alteration halos, 6) abundant felsic dykes, 7) microscopic gold, and 8) hydrothermal fluid dominated by meteoric water.

The microscopic gold is found in arsenic-rich pyrite rims, which contain up to 2280 ppm Au, 15 wt% As and 2850 ppm Sb, occurring as overgrowths on pre-mineralization pyrite cores with no Au and very low As and Sb contents. Mineralized pyrite occurs in the silicified wall rocks bordering quartz-stibnite veins. Gold also occurs in arsenopyrite within the veins themselves. Silicification of carbonate rocks, comparable to jasperoid alteration zones, is associated with a low-salinity aqueous hydrothermal fluid (6.6 ± 0.5 wt% NaCl equiv.) at moderate temperatures (Th liquid = 172 ± 16°C). The oxygen isotope composition of quartz in gold-bearing veins and the carbon and oxygen isotope composition of mineralized carbonate rocks and unaltered carbonate rocks suggest the fluid is derived from meteoric waters with no magmatic component. The mineralizing fluid is also partly responsible for alteration halos defined by five different assemblages of clay phyllosilicates – chlorite, smectite, smectite + kaolinite, kaolinite, illite. The chlorite assemblage is inferred to be early and is associated with Cu-Ag skarns. Au mineralization is associated with the kaolinite assemblage. Smectite, kaolinite and illite assemblages probably formed as a result of the hydrothermal fluid reacting with chlorite, and thus postdate skarn deposits. Mineral occurrences in the area always occur in argillic alteration halos. The latter therefore represent a good exploration tool.

Oral Presentations

Session 1 11:00

New Approaches for Discovery - An Economic Look at the Impact of New Technology Applied to Wealth Creation in Exploration

Rob Gordon (Quantec Geoscience)

Mining and exploration companies wishing to capitalize on the current up-turn in the gold price and other commodity sectors must overcome the difficult task of making new discoveries. Advanced technology can provide a significant edge, for both scientific discovery and increased confidence in deeper drilling, thereby significantly reducing the risk exposure in these exploration environments.

Making a discovery is difficult and is arguably more difficult as undiscovered deposits today are more likely found at greater depths. The financial risk with deep drilling is hindering deep exploration. However, deeper drilling will be required to achieve more discoveries. In addition, the value of exploration is difficult to quantify.

Advanced exploration technology and processes are available today that can assist the mining and exploration community with their efforts to yield discovery in a timelier manner. However, the mining industry has been traditionally slow to embrace new technologies particularly if they are not easily understood or when the cost paradigm is out of sync with traditional spending habits regarding drilling versus other technologies. Recent advances in digital signal processing, and faster computers, coupled with the ability to collect very high resolution and deep geophysical data provides new opportunity to further geoscientific investigation at greater depths prior to drilling. Drill targeting can be then more focused thereby providing better returns per metre drilled. In essence, high potential ground may not be under-explored. Economists have often said a critical failure in exploration is the inefficiencies of exploration while exploring highly prospective regions on one hand and the inability to reach abandonment decisions faster on the other hand. Today, images to depths of over 1500 metres for key targeting parameters can assist with required deeper exploration within favourable land packages. Moreover, technology can now provide a means to revitalize exploration in mature mining camps. This paper discusses a new approach of "bottom-up" vs "top-down" exploration and demonstrates application of these deep looking technologies and how they can be scientifically applied to address economic concerns that face the industry such as drilling risk and discovery rates and property abandonment decisions.

Session 2 1:30

Be on Target with Properly Conducted and Transparent Lobbying Activities

André C. Côté (Québec Lobbyists Commissioner)

Given the nature of their activities and how they affect the land, communications between geologists, prospectors and mining industry stakeholders on the one hand and public office holders of the Ministère des Ressources naturelles et de la Faune, municipalities and other public institutions on the other hand, are frequent and often institutionalized.

Some of these communications are sometimes designed to influence the decisions of an elected official or a public servant. These may in fact be considered as lobbying activities, subject to the *Lobbying Transparency and Ethics Act*. As such, a legal framework regulates and ensures the transparency and proper conduct of these activities.

The Act itself and the *Code of Conduct for Lobbyists* raise many questions:

- How does this Act, unanimously adopted by the members of the National Assembly on June 13, 2002, affect me directly?
- To which political and administrative arenas does this Act apply?
- Does influencing the decision-making process of an elected official or a public servant with regards to subsidy grants to companies constitute a lobbying activity?
- Are exchanges with public office holders concerning for example a tax or financial incentive with regards to a mining project governed by the Act?
- Are calls made to the staff of a state-owned corporation, in order to accelerate the issue of a land access authorization certificate considered as lobbying activities?

To provide answers to these questions and many others, and to help you understand the obligations and requirements governed by the *Lobbying Transparency and Ethics Act* and the *Code of Conduct for Lobbyists*, the Lobbyists Commissioner will discuss the objectives of the Act, its context, and the main conditions of its application. Rules of conduct detailed in the Code of Conduct will also be briefly reviewed.

Session 2 2:20

Impacts of New Regulations on Mining Companies

Josée Deslauriers (Autorité des marchés financiers)

Throughout the past year, the *Autorité des marchés financiers*, in conjunction with its provincial counterparts, pursued its efforts to harmonize securities regulations.

All these efforts led to the adoption of several new regulations designed to make it simpler and easier for issuers to gain access to financial markets. Among these, *Regulation 11-101 respecting Principal Regulator System*, in effect since September 19, 2005, allows Québec issuers to report exclusively to the *Autorité des marchés financiers*.

Regulation 45-106 respecting Prospectus and Registration Exemptions, in effect since September 14, 2005, consolidates and harmonizes prospectus and registration exemptions in effect throughout Canada.

Several other regulations were also adopted or are currently in development. For more information on these regulations, please consult the website of the *Autorité des marchés financiers* at: **www.lautorite.qc.ca.**

Session 2 2:40

Global Leaders in Mining

Louis Doyle (TSX Venture Exchange)

Toronto Stock Exchange (TSX) and TSX Venture Exchange are leaders in the mining sector. More mining companies are listed on Toronto Stock Exchange and TSX Venture Exchange than any other exchange in the world. As a result, we uniquely offer mining companies membership in the largest peer group of mining companies anywhere, providing the benefits of premium valuations, visibility for transactions, analyst coverage, specialized indices, liquidity and specifically tailored listing requirements.

Toronto Stock Exchange provides superior access to equity capital, essential for growth-oriented mining companies—anywhere in the world. Combined, Toronto Stock Exchange and TSX Venture Exchange have a vibrant group of over 1100 mining companies from grassroots explorers to world-class producers, valued at over $143 billion.

Toronto Stock Exchange mining companies raised an impressive $4.1 billion in 2004—the largest amount raised compared with any other Exchange in the world. North America's strong retail and institutional investors provided excellent liquidity in the secondary market for our mining companies, with Toronto Stock Exchange mining companies trading over 18 billion shares valued at CDN$140.7 billion in 2004. TSX Venture Exchange nurtures early stage exploration companies—an impressive $2 billion was raised by TSX Venture mining companies in 2004.

TSX and TSX Venture Exchange are the destination markets for mining companies.

Oral Presentations

Session 2 3:00

How to Optimize Financing for Exploration Work in Québec

Michel Champagne and Isabelle Cadieux (SIDEX)

Worldwide exploration budgets for mining companies have consistently increased since 2002 and forecasted expenditures should exceed 3.8 billion dollars. Québec fares quite well with more than 200 million dollars in exploration expenditures incurred within its borders, for the following reasons:

- **Mineral potential**: the Eleonore gold deposit recently discovered by Virginia Gold Mines in the James Bay region is looking more and more like a world-class deposit, which demonstrates the potential of finding new mining camps in Québec.
- **Support of financial institutions**
- **Applied research**
- **Agreements with First Nations**

The most obvious reason remains the very attractive tax system for companies exploring in Québec, which namely includes:

1. **Flow-through shares**: They have been around for many years throughout Canada and are most attractive in Québec. For the 2004 fiscal year, the net after-tax cost of a $1,000 investment in flow-through shares amounted to $284 for an investor in the highest marginal tax bracket. **However, the resource company must forego deductions for exploration expenditures in favour of the investor.**
2. **Tax credits**: 35% for exploration companies and 15% for producers (an additional 30% deduction is available for producers under certain conditions), refundable by the Ministère du Revenu du Québec for exploration expenditures incurred in Québec **provided the funds used were not raised as flow-through funds in Québec**. These tax credits are increased by 3.75% in the Near North and the Far North. Furthermore, additional refunds may be claimed through the:

   Credit on mining duties: 12% of the lesser of the annual loss or the total amount of incurred exploration, deposit appraisal and mine development expenditures, claimed to the Ministère des Ressources naturelles et de la Faune du Québec.

   These measures bring to 47% or 50.75% (40% or 42% net) the refund on exploration expenditures incurred in Québec which may be claimed by an exploration company. **Just imagine: if your company conducts an exploration program of one million dollars in Québec, it can expect to receive a check in the amount of $400,000 (net), without even losing its deduction for exploration expenditures!** These very generous credits are unique worldwide.

Exploration companies can combine various attractive financing alternatives.

All these reasons continue to make Québec a great market for mineral exploration companies, and will ultimately lead to the discovery of new ore deposits.

Session 2 3:20

The Nuclear Renaissance and its Implications for Uranium

Pierre Heeroma and Tim Gitzel (AREVA Mining Business Unit)

Following two decades of depressed market conditions, the revival of the uranium industry is getting stronger with each passing month. The need for nuclear power as a crucial energy source for the future is regaining acceptance throughout the world where sustainable development is becoming a major focus among the world politicians and public.

An increased uranium price has triggered a worldwide boom for exploration with major companies deploying and intensifying their exploration efforts. In addition, many junior companies have entered the game due to the opportunity to easily finance their exploration programs through the stock market. The most spectacular example of this is found in the Athabasca Basin in Saskatchewan where only four companies were exploring in 2003, and where over 50 are exploring today.

This renaissance for uranium exploration is welcome and necessary. World production has been stable or declining for many years. In fact, many of today's supply sources will come to an end or continue to decline between 2015 and 2030. They need to be replaced and new resources will have to be brought into production to meet the forecasted demand increase for nuclear energy.

After 20 years of recession and low budget exploration and mining activities, the uranium industry finds itself with an ageing workforce and loss of expertise, manpower and know-how. Meanwhile, competition for recruitment and retention of qualified personnel is increasing because other sectors, (oil and gas, base metals, precious metals, etc.) are experiencing the same boom and related challenges.

Many opportunities and challenges await potential players. This paper will examine those opportunities and challenges from the perspective of a long-term player, who has lived through both good times and bad.

Session 2 3:40

The Importance of Communicating with Investment Advisors

Sylvain Laberge (Renmark Financial Communications Inc.)

This presentation will discuss 6 items: the competitive nature of the mineral exploration industry and the need for adequate communications; the difference between financial communications and investor relations; the advantages of investor relations (pro-active, effectiveness, follow-up); the retail market and the target market for mineral exploration companies; the main tools used for investor relations; the basics of investor relations for small caps.

Session 3 8:30

Building a Multi-Mine Québec-Based Gold Company

Mr. Sean Boyd, President and Chief Executive Officer, Agnico-Eagle Mines Ltd, Honorary Chairman of Québec Exploration 2005

Agnico-Eagle's success at its LaRonde Mine in Northwestern Québec has enabled it to develop the technical skills and the financial resources to embark on a multi-mine growth strategy based in Quebec. As others close mines and leave the Abitibi area, Agnico-Eagle continues a very active and aggressive exploration program and has begun the process of building new gold mines.

Oral Presentations

Session 3 9:00

Using Major Elements to Evaluate the Metamorphism, Physical Properties, and Alteration of Rocks

Mathieu Piché (Alexis Minerals Corporation)

Translating chemical data into mineralogical data is useful to estimate several physical properties of rocks such as gravity, magnetic susceptibility, and to a certain extent, resistivity. The math used to perform this hyperspatial data transfer requires matrix computations, complex numbers as well as certain topological tools such as Delaunay triangulation. These tools make it possible to map the chemical compositional space of rocks using mineralogical coordinate systems.

It thus becomes possible to automatically determine metamorphic assemblages by triangulating chemical compositions and thermodynamic variables of a group of minerals. It is also possible to calculate the normative mineralogy at different metamorphic facies. The metamorphic facies of a sample may then be estimated by finding the normative facies for which the calculated loss on ignition is closest to the measured value. This approach could be used to map metamorphism on a regional scale, using existing lithogeochemistry data. Such maps could then be used to identify potential major lithospheric structures and by extension, ore deposits generally associated with the latter.

Mapping compositional space also makes it possible to calculate gains and losses using only major elements. This calculation requires a selection of fresh representative protoliths for the sample population under investigation. An algorithm is used to determine the most compatible protolith for each sample. The appropriate protolith composition is then used rather than the sample composition, thereby eliminating compositional variations due to alteration. This improves the precision of lithogeochemistry-based mapping and lithostratigraphic characterization.

The following are freeware available on the Internet, which can provide more background information on the geochemical tools discussed in this presentation:

CSpace: Rafael L. Torres-Roldán, Antonio García-Casco, Pedro A. García-Sanchez. Universidad de Granada, España.

QHull: C. B. Barber, D. P. Dobkin, and H. Huhdanpaa, University of Minnesota.

Perplex: Connolly JAD, Petrini K. Institut Féderal de Technologie Suisse (ETHZ).

Thermocalc: Roger Powell[1] and Tim Holland[2]. [1]University of Melbourne. [2]University of Cambridge.

Session 3 9:20

3D Architecture of the North American Lithosphere by Seismic Tomography: Implications for Regional Diamond Exploration

Stéphane Faure (CONSOREM-UQAC), Francine Fallara (URSTM) and Stéphanie Godey (European-Mediterranean Seismology Centre)

The diamond potential on surface depends first and foremost on favourable pressure and temperature conditions fossilized at more than 150 km below the surface, in the underlying lithospheric mantle. Colder and geochemically depleted areas of the upper mantle generally correspond to cratonic roots. These tectonically stable areas are particularly fertile, since diamond reservoirs may have been preserved since the Archean and subsequently tapped by kimberlitic magmas then uplifted to the surface. Understanding the geometry and depth of cratonic roots thus becomes an essential tool for regional-scale exploration.

Seismic tomography is a deep-penetrating geophysical tool which makes it possible to illustrate in three dimensions and as a continuum, spatial variations in seismic wave velocities. Calculated models are interpreted from variations in seismic wave velocities, which essentially depend on the temperature and composition of the mantle. Thus, higher velocities indicate the presence of iron-depleted and colder mantle compared to the global average. The principles of this new approach in exploration will be presented, and a few examples of global and regional models will be illustrated in 3D using Gocad technology.

The only regional tomographic model that covers both Canada and the United States will be discussed along with spatial correlations with known kimberlite fields in the North American continent. This tomographic model, to 250 km depth, shows that Archean cratons in Canada are agglomerated to a depth of 100 to 200 km. Lithospheric roots underneath cratons single out at about 200 km depth, and reach a maximum of 250 km under the Slave craton. Tomography reveals the extent of cratonic roots underneath certain Proterozoic belts, platforms or cover rocks, which leads us to propose new prospective areas for exploration in Canada and Québec. Seismic signatures also show that certain parts of the mantle underneath Archean cratons, namely the Lake Superior craton, were affected by recent (< 200 Ma) tectonothermal events. These permanent scars may have affected the diamond stability field. Most kimberlites are found along the edge of lithospheric roots and are vertically correlated with the steepest slopes at depths between 160 and 190 km.

Session 3 9:40

Lake Sediment Geochemistry Survey in the Manicouagan Area: More Than a Prospecting Tool

M. Beaumier (MRNF)

In 2003, the MRNFQ conducted a lake sediment geochemistry survey in the Manicouagan MRC, which yielded a great number of targets for mineral exploration.

The survey also provided information on naturally occurring heavy metal contents in various areas, providing a better framework in which to apply the *Soil Protection and Rehabilitation of Contaminated Sites Policy.*

Furthermore, a comparison of these data with previous data collected in 1976 (Choinière, 1986) or with future data, constitutes a means to monitor the evolution of anthropogenic changes in the area.

The absorption of high doses of: a) lead causes cardiovascular, kidney and neurological disorders, b) cadmium causes heart disease and high blood pressure, c) mercury causes neurological disorders, d) arsenic causes cancer, e) aluminium causes Alzheimer's disease, f) vanadium causes respiratory disorders, g) manganese leads to brain dysfunctions. The effects on any living organism absorbing these substances are tripled by a simple reduction of the pH level from 7.5 to 6.0. Based on uranium data, we can bring attention on areas of higher risk to radon gas emissions and respiratory disorders that result from its assimilation.

The identification of areas strongly depleted in magnesium, potassium, and phosphorus, all essential to the regeneration of logged forests, or their relative proportions (Marquis and Paré, 2005), can signal a slower vegetative regrowth, and therefore reduced long-term productivity of the timber resource in certain areas.

The pH level of lakes is a crucial piece of information for the management and stocking of fish fry in lakes. Fish populations in acidic environments (pH from 4.9 to 5.3) have a very low survival rate (Lachance *et al.*, 2000). Add to this the cumulative effect of certain metals (*e.g.*, fish die in waters with an Fe content > 9000 ppm and a pH level of 5.5.)

In short, the lake sediment geochemistry survey constitutes a land management tool, the usefulness of which extends well beyond the field of mineral exploration.

References

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CHOINIÈRE, J., 1988 - Géochimie des sédiments de lacs, région de Manicouagan. Ministère des Ressources naturelles, Québec; DP 86-18.

LACHANCE, S. - BERUBÉ, P. - LEMIEUX, M., 2000 - In situ survival and growth of three brook trout (*Salvelinus fontinalis*) strains subjected to acid conditions of anthropogenic origin at the egg and fingerling stages. Canadian Journal of Fishery and Aquatic Sciences; volume 57, pages 1562-1573.

Session 3 10:00

Artificial Neural Networks: Examples of Geoscience Applications

Sylvain Trépanier (CONSOREM)

Artificial neural networks attempt to reproduce the structure and operation of biological neural networks to solve highly complex and diverse problems.

The principle behind problem solving using neural networks is to supply a series of "real cases" of the problem to the network. Each case may contain a certain number of numeric or category variables as input. Depending on the context, these cases may use different types of input: individuals in a population, geochemistry samples, pixels on a remote sensing image, etc. These cases may even represent different measurements of a certain property through time (time series). Based on these real cases, the artificial neural network completes its training which consists in finding a solution to the problem.

Based on the training technique, two types of neural networks may be distinguished. "Supervised" learning consists in giving the right answer or answers to the network, to solve the problem for each case. Based on these known cases, the network will be able to determine the non-linear combination of the different input variables that best explains the output value or values. This training can then be applied to cases where the result is not known. Supervised training is most common, and may be used for example to analyze complex functions, for classification purposes or to process time series. Unsupervised training refers to cases where the answers are not known. In these cases, the unsupervised network is asked to classify the different cases into categories based on input variables. The latter approach may be related to cluster analysis methods used in statistical analysis.

Neural networks have a multitude of potential applications in Earth Sciences. They can for example be used to recognize very precisely all the different lithofacies in oil wells, to model reservoir fracture patterns, to determine the provenance of building stones in archaeology, etc. Three examples of applications will be briefly reviewed: a mineral potential assessment study of a fictitious area using various layers of geoscience data, supervised identification of lithologies on a multiband remote sensing image of the Cape Smith Belt, and identification of the tectonic setting of recent mafic volcanic rocks based on chemical analyses.

Oral Presentations

Session 4 10:20

Hydrocarbon Exploration in the Gaspésie Region: Contribution of RADARSAT Images Combined with Geoscience Data

Michel Rheault, Adeline Kilicaslan (MIR), Daniel Brisebois (MRNF), Nicolas Pinet (GSC), Michel Malo (INRS-ETE), Robert Thériault and Jean-Yves Laliberté (MRNF)

Within the scope of the Canada-Québec Agreement on the Development and Use of RADARSAT Data, RADARSAT-1 data was used along with topographic, geochemical, aeromagnetic, gravity and seismic data to generate new products to support hydrocarbon potential assessment studies in the Gaspésie region. More than twenty RADARSAT-1 images acquired in ascending and descending orbit were orthorectified and assembled into two mosaics. New high-resolution aeromagnetic and gravity data as well as geochemistry data were integrated and merged with RADARSAT mosaics.

Generated products are used to support regional-scale structural geology studies. The first step consists in analyzing lineaments within previously established structural domains. Overall, rose graphs of lineament orientations show a dominant system parallel to the structural fabric, which shifts from ENE in the western part to ESE in the eastern part. Other subsidiary systems are associated with this main system, forming angles ranging from 20° to 30° relative to the main system. Other sets of lineaments roughly perpendicular to the regional structural trend are also observed.

When compared with mapped fault networks, several interpreted lineaments show a direct correlation with the geological map. However, when analyzed in conjunction with the new high-resolution magnetic and gravity data, they locally suggest a higher degree of complexity than the current geological interpretation. For example, the Causapscal Fault, which appears to branch out into several splays near the Monts Berry syncline, or observed ENE regional discontinuities which remain unexplained within the Fortin Group, or the Ristigouche and Grand Pabos fault zone which appears to be characterized by three segments of discontinuous faults. Note also that regional sets of WNW lineaments observed in the western part remain unexplained for the moment, although they correspond to the orientation of mapped faults in the eastern part.

In the Gaspésie region, two major episodes of deformation (Taconian and Acadian) are well defined. However, the overall architecture may have been modified by late movements that enhanced the expression of these regional lineaments. The results of this study provide a better understanding of the surface architecture, which can help in deciphering its expression at depth. When analyzed in conjunction with seismic data and other field data, they contribute to a better assessment of the hydrocarbon potential of the area.

Session 4 10:40

Imprints of the Ottawa-Bonnechère and Saguenay Grabens in the St. Lawrence Lowlands and the Appalachians: Targets for Hydrocarbon Exploration

Robert Thériault, Jean-Yves Laliberté, and Daniel Brisebois (MRNF)

The Ottawa-Bonnechère and Saguenay grabens formed during a major episode of rifting in the Cambrian, associated with the opening of the Iapetus Ocean along the eastern margin of the North American continent. Although the westward extension of these two grabens within Proterozoic rocks of the Grenville Province are clearly visible (*i.e.*, Ottawa River valley and Saguenay fjord), their possible eastward extension is masked by the presence of Cambrian-Ordovician rocks of the St. Lawrence Platform and by thrust sheets emplaced during the Appalachian orogeny. However, certain clues suggesting the existence of deep crustal faults appear along the eastward extension of these two structural corridors, namely: 1) the presence of major lineaments, generally oriented east-west and visible on RADARSAT and remote-sensing images, 2) the emplacement of numerous mantle-derived intrusive rocks typically associated with an intracratonic rift setting (*i.e.*, alkaline and tholeiitic intrusions, lamprophyres, diatremes, carbonatites), 3) clusters of earthquakes, and 4) an important number of Pb-Zn-Ba mineral occurrences of hydrothermal origin, including Mississipi Valley-type (MVT) occurrences, as well as high Pb, Zn and Ba contents in stream sediments and groundwater. In the latter case, the migration of hydrothermal fluids along deep crustal faults may have served not only to concentrate metals, but also to dolomitize limestones occurring in these regions (*cf.* hydrothermal dolomite model), thereby considerably increasing their porosity and consequently their potential to serve as reservoir rocks for hydrocarbons.

Cambrian-age grabens or aulacogens associated with the opening of the Iapetus Ocean, such as the Ottawa-Bonnechère and Saguenay grabens, represent prime target structures for hydrocarbon exploration. Several major deposits were recently discovered in the United States and Ontario along similar structures, and specifically in areas where reservoir rocks consist of hydrothermal dolomite (*i.e.*, Trenton, Black River or Beekmantown groups). However, although the same lower to middle Ordovician sedimentary sequences are present in Québec, and in fact cover the entire St. Lawrence Platform, the hydrothermal dolomite model has practically never been tested.

Session 4 11:00

Contribution of Recent Geophysical Data to the Understanding of Sedimentary Basins in the Gaspésie Region – Implications for Oil & Gas Exploration

Nicolas Pinet, Denis Lavoie (GSC), Denis-Jacques Dion (MRNF), Pierre Keating, Jim Dietrich, Pierre Brouillette (GSC), Daniel Brisebois (MRNF), Michel Malo (INRS-ETE) and Sébastien Castonguay (GSC)

Characterizing the architecture of an orogen is an important step to assess the oil & gas potential of an area. It is necessary to identify potential traps, but also to develop new plays. In the Gaspésie and Bas-Saint-Laurent regions, the appearance of new geological concepts applied to hydrocarbon exploration is directly related to the integration of data other than field data, and particularly geophysical data. This integration was the prime objective of a recent geoscience initiative led by the Geological Survey of Canada and the Ministère des Ressources Naturelles et de la Faune, in conjunction with various partners.

Among the tools used to better understand the architecture of sedimentary basins, seismic reflection data are typically the first choice in hydrocarbon exploration. Within the scope of this project, a reinterpretation of certain seismic lines, based both on the original processing and a recent reprocessing, suggests that part of the geometric complexity may be explained by the internal architecture of sedimentary bodies.

In the case of underexplored areas (frontier basins), potential field data (gravity and aeromagnetic) are particularly useful since they provide a continuous grid of information which complements isolated blocks of data collected in seismic surveys or by surface mapping. The entire Gaspé Peninsula has now been covered by recent gravity surveys. Furthermore, new high-resolution aeromagnetic data, covering the equivalent of 24 map sheets at 1:50,000 scale, were acquired within the scope of this project.

A qualitative study of Bouguer anomaly maps and total magnetic field maps, as well as various filtered maps, provides a cartographic analysis. This interpretation highlights oblique structures relative to the regional structural trend and outlines the importance of a NE-SW geophysical and structural corridor that cuts the entire Gaspé Belt (late Ordovician – middle Devonian).

Potential field data may also be used to produce direct models of regional transects. Geological cross-sections were used to define the initial geometry of models, which was subsequently modified by successive iterations until the correlation between measured and calculated profiles was deemed satisfactory. Although these models are not unique, they display a regional coherence and help improve our global understanding of the Appalachian Orogen.

Session 4 11:20

Introduction to the Canadian Energy Supply Security Program of the Earth Sciences Sector, Natural Resources Canada

Martin Fowler (GSC-C) and Denis Lavoie (GSC-Q)

In light of the current global increase in energy demand and prices, and concerns on supply and environmental issues, the Earth Sciences Sector of Natural Resources Canada has implemented the Canadian Energy Supply Security Program. The ultimate goal of this program, launched in 2005 for a 5-year term, is to maintain a safe and adequate supply of appropriate energy, to be produced in a safe and environmentally responsible manner.

To ensure the sustainability and durability of Canada's energy supply, the program has many objectives: to increase supply in conventional fossil fuels, to promote new sources of energy, to increase (relatively) supply by reducing demand, and to increase the recovery of fossil fuels in mature oil fields.

Four projects are planned for the first year of the program (2005-2006): i) Mesozoic basins of the Atlantic margin, ii) Paleozoic basins of Eastern Canada, iii) basins of the Canadian Arctic, and iv) the gas potential of Canadian coal fields. The operating budget for these activities amounts to nearly $800,000. The final product to come from these projects will consist of a comprehensive synthesis of the hydrocarbon potential of study areas and/or themes. Other research projects will be added to the program portfolio in coming years.

The project on Paleozoic basins of Eastern Canada is based on the promising results of projects conducted under the Targeted Geoscience Initiative (Appalachian Energy, 2003-2005) and the Appalachian Foreland and Platform NATMAP project (1999-2004). These multidisciplinary and multi-agency projects generated a variety of promising data on hydrocarbon systems. This new project aims to fill certain knowledge gaps, to synthesize data on the various potential systems and assess their eventual resources. Activities planned for 2005-2006 cover land-based and marine Paleozoic domains, including the St. Lawrence Platform, the Appalachian Humber Zone, the Gaspé Belt, and the Maritime Basin. Ongoing activities include: reprocessing of seismic data and modest acquisitions of new land-based data, a study of the petrophysical parameters of potential reservoir rocks, the definition of new hydrothermal dolomite targets, litho-, bio- and magneto-stratigraphic syntheses, absolute dating of hydrocarbon emplacement ages, a study on the maturation of organic matter in poorly known areas, and a teleseismic evaluation of the architecture of the Gulf of St. Lawrence.

Oral Presentations

Session 5 8:30

Profile of the Architectural Stone Industry in Québec

Pierre Verpaelst (MRNF)

In 2003, the Direction de Géologie Québec tabled an action plan for architectural stone in Québec. The objectives of this action plan are to improve industry efficiency by providing easier access to geoscience data released by the Ministère des Ressources naturelles et de la Faune, to help the industry take advantage of the growing demand for stone in Québec, Canada and the United States, and to foster its development. This action plan lists a series of measures, several of which have already been implemented: more effective distribution of information on architectural stone, establishment of a committee representing all industry sectors, development of consultation services. Other measures are currently under way: increasing the geoscience knowledge base, promotion of the stone quarrying potential in Québec, inventory of processing plants, review of customer service. Finally, a few measures are still to come: development of a commercial watch, technological upgrade of processing plants in Québec.

In 2004, the Department launched a website, in French and English, to promote architectural stone in Québec. Efforts in 2005 mainly focused on drawing up a profile of the stone industry in Québec and identifying its strengths and weaknesses. Among its strengths, we can mention the amount of expertise developed in Québec and innovations in quarrying and processing technologies. Its weaknesses lie mainly in the promotion and marketing of Québec products in light of international competition. The advisory committee on architectural stone, with the cooperation of the Canadian Stone Association, intends to establish a list of actions that need to be taken to capitalize on its strengths, and find solutions to improve its competitiveness on world markets.

Session 5 8:40

Stone Extraction Techniques

Reggie Zanchetti (NOVAMAC Industries Inc.)

Architectural stone extraction methods have evolved tremendously over the past twenty years. This presentation will discuss the different quarrying techniques for architectural stone. Old and new technologies used to extract blocks will be compared. These new technologies not only reduce operating costs, they can also help increase the stone recovery rate and make it possible to mine at a profit new stone varieties that previously could not be commercially extracted.

Session 5 9:10

Evolution of Granite Processing Techniques in the Last Thirty Years

Frédéric Lacroix (A. Lacroix et Fils Granit Ltée)

From the very beginnings of humanity, Man has carved stone with whatever means at his disposal. A few thousand years B.C., the Egyptians built the Pyramids and the Sphinx. In short, humans have shaped granite and marble since the very beginning of their existence, often with very basic means and the simplest of tools. Strangely enough, stone working techniques have remained very traditional until just a short time ago. Only in the last thirty years or so have granite processing and manufacturing techniques been developed, to come out of the traditional age into a modern production era.

What is the driving force behind this technological development? This is the main topic of my presentation. I will also show how processes have evolved, by analyzing methods and tools from 20 years ago for a given product, then analyzing current processes for the same product, using today's tools and methods.

Here are the different production sectors we will address:

Sawing of Rough Blocks

The use of diamond wires has revolutionized rough block production methods:

- Abrasive wire saws vs diamond wire saws (evolution of steel wires embedded with abrasives vs diamond wires).
- Gangsaw vs multiwire saw.
- Large diameter disc saw vs automatic 5-strand diamond wire saw (with photos and examples).

Cutting and Processing

Digital controls and electroplated tools have revolutionized traditional granite processing and shaping methods.

- Manual blade saw vs digital control (emphasis on manufacturing processes of a typical product, with former and current techniques).

Surface Finish

- Evolution of polishing methods (with photos and examples).
- Handcrafted finish vs automated process.
- Dramatic evolution of tools and elimination of dust.

The Power of Water

The use of high-pressure water has revolutionized the granite industry. Traditional cutting and surface finishing methods have changed dramatically with the arrival of waterjet machines (with photos and examples).

Conclusion

Session 5 9:30

Uses of Architectural Stone

Alain Prince (Technipierre-Héritage)

Stone construction in Québec dates back to early colonial times. In the 17th century, fieldstones were used in rural areas, whereas rough cobblestone and freestone were used in urban settings. In the second half of the 19th century, developing technologies and the birth of new architectural styles led to the use of new materials.

Today, many quarries extracting stone for construction purposes are in operation and new technologies have brought stone to the same competitive level as other modern materials. Stone, from the time it is extracted to the time it arrives on a building site, may be sawn, squared, tooled, textured or sculpted. It may be used in a variety of shapes and sizes, as cut-to-size panels used as cladding on modern buildings, for funeral monuments, as cut ashlar used to restore heritage buildings. Crude or roughly trimmed stone is used as cobblestone to build or restore walls, paving and flagstone. Granite, limestone, marble, sandstone and slate are most commonly used in Québec. Granite varieties alone provide an impressive range of colours, often enhanced by a variety of subtle hues due to each stone's specific geological composition.

Despite the significant amount of stone available, the latter remains under-used and poorly known in Québec by professionals in the construction industry. Since the era of major stone works in Québec, knowledge on stone working techniques and tools has practically disappeared. To ensure the secrets of the trade are passed on and to meet the needs of craftsmen and industries, the Ministère de l'Éducation du Québec has launched a co-op training program. In recent years, specific markets such as landscaping and heritage restoration have grown. Since the Trélazé schist deposit in France is now depleted, Québec slate has been selected to meet demands in the important market for roof repairs and restoration.

Stone is not only a noble material; it is also ecological and may be recycled. By developing skills at all levels of the stone processing industry, by training and informing those who make it possible, stone products from Québec can have a bright future and contribute to the beauty of our environment.

Oral Presentations

Session 6 9:50

Is a Uranium-Rich Source an Essential Requirement for the Genesis of Major Uranium Deposits?

Michel Cuney (CNRS, CREGU)

Whether an enriched metal source with concentrations higher than Clarke values, in a relatively proximal environment is necessary or not for the genesis of major uranium deposits is a fundamental question, both for metallogenic models and for exploration. This question is relatively easier to solve for uranium compared to other metals given its radioactivity, which makes it easier to detect and measure its abundance, from the micrometer scale (fission tracks) to that of a crustal segment (airborne gamma-ray spectrometry and heat flow measurements).

Hydrothermal uranium deposits associated with granites of the Variscan mountain belt of Central Europe, which collectively have yielded more than 500,000 t U, provide the most comprehensive evidence, at different scales, that the genesis of major uranium deposits requires an enriched source. Maps showing heat flow and heat production variations in thermally-balanced zones such as Brittany reveal that ore deposits are located in a crustal segment with a radioactive element content 2 to 3 times the regional average, over thicknesses on the order of 15 km. Granites associated with these deposits are derived from a low degree of partial melting of this crustal segment (two-mica peraluminous leucogranites) and are enriched in uranium 3 to 5 times the Clarke value for granites. The same granites occurring outside of this crustal segment are not enriched and are not associated with significant uranium deposits. On another scale, in massifs hosting the most important intragranitic uranium deposits in the Variscan belt (massif de Saint-Sylvestre, NW Massif Central, France), the largest orebodies are located within a band a few kilometres wide that shows evidence of two phases of uranium enrichment, at the magmatic to late-magmatic stage.

A number of other deposit types show evidence of a direct correlation with uranium-enriched sources: the richest high-tonnage deposits in the world, associated with Proterozoic unconformities, are spatially related to uranium-enriched Paleoproterozoic continental platform-type metasedimentary formations (Athabasca, Canada; Kombolgie, Australia; Pasha Ladoga, Russia); sandstone-hosted deposits in Niger are associated with volcanic-derived uranium preconcentrations; conglomeratic placer-type deposits (Witwatersrand, South Africa; Elliot Lake, Canada) require a granitic and/or pegmatitic source sufficiently rich in uranium to crystallize uraninite...

Session 6 10:40

Exploration Guides in the Athabasca Basin 20 Years After the Discovery of Cigar Lake

Philippe Portella and Claude Caillat (COGEMA Resources Inc., AREVA Group)

Thirty percent of worldwide uranium production comes from the Athabasca Basin. These unconformity-type ore deposits are characterized by very high grades: McArthur (235,000 t U @ 19.6% U to 500 m depth) and Cigar Lake (135,000 t U @ 15.5% U to 400 m depth).

The basin is characterized by the presence of Proterozoic (1750-1650 Ma) unmetamorphosed "continental" sediments reaching a maximum thickness of 1500 m, unconformably overlying a Paleoproterozoic to Archean metamorphosed basement. In the eastern part of the basin, the basement essentially consists of metasedimentary rocks of the Wollaston Group, metamorphosed and deformed during the Hudsonian orogeny (1860-1760 Ma).

Two deposit types are recognized: polymetallic (U+As-Ni-Co-Cu...) sandstone-hosted deposits located directly at the unconformity, and essentially monometallic basement-hosted deposits (between 0 and 400 m depth). The age of these deposits is still hotly debated, with one or several episodes of uranium deposition, and several phases of remobilization: 1570 Ma, 1350 Ma, 900-1000 Ma. Base metal sulphides clearly postdate uranium deposits.

Recent research indicates these deposits formed along the unconformity, at long-lived stationary redox fronts, due to the interaction between reduced hydrothermal fluids derived from basement structures and oxidized uranium-rich diagenetic brines circulating in the sandstones.

Reduced basement-derived hydrothermal fluids, enriched in K, Mg, B, etc., are responsible for alteration observed in sandstones and basement rocks, with the formation of illite, chlorite (sudoite) and dravite (Mg-rich tourmaline), as well as silica leaching and argillic alteration.

Recognizing "hidden" deposits calls for the integration of a wide range of exploration techniques, namely geophysical, geochemical and IR spectrometry:

- Geophysics: combination of various methods:
  - Magnetic: mainly airborne;
  - Electromagnetic: airborne (MEGATEM, GEOTEM, VTEM, TEMPEST, etc.), ground (fixed loop, moving loop, magnetotelluric, etc.), and downhole;
  - Gravity: airborne (Falcon, etc.) and ground;
  - Electrical;
- Geochemistry, with multi-element analyses:
  - Regional approach focussing on sandstone float to identify regional alteration zones;
  - Detailed approach: systematic analysis of drill core (sandstone and basement), with special attention to the distribution of uranium in its mobile form (partial acid digestion) and clay phases (with normative calculations);
- Infrared spectrometry to identify clay phases.

The integration of these different methods, coupled with geological and structural data, provides a better framework in which to define drilling targets.

Session 6 11:00

The Otish Basin: Uranium Potential and Correlations with Proterozoic Analogs in Eastern Canada

Serge Genest (URANOR Inc.)

The Otish Basin and the Paspaskwasati Cuvette spatially associated with the Mistassini Basin are well known for their uranium potential. Overall, the evolution of these basins is marked by four (4) megacycles of terrigenous sedimentation. The first two cycles are clearly oligomictic with quartz pebbles. The basal unit is locally polymictic in the few metres above the unconformity, and its composition is a close reflection of the underlying basement. The basement surface is variably weathered to regolith in certain areas, illustrating the differential conditions of a foothill environment subject to fluvial erosion. Certain data suggest a reducing sedimentation environment. The two upper sedimentary cycles are characterized by polymictic conglomerate units, by the presence of carbonates and of oxidizing conditions. The evolution of the Otish Basin is also marked by the intrusion of gabbros, among which three (3) main sets of dykes as well as massive flows capping the basin. The Grenville orogenic Front is marked by the presence of uplifted stratigraphic units in the southern part of the Otish Basin as well as faulting of the latter further south (outlier zone).

The evolution of the Otish Basin is similar to that of the Huronian Supergroup, and in part to that of the Labrador Trough. Correlations include the presence of terrigenous sedimentary megacycles, which culminate in delta environments laterally grading into evaporite basins or distal anoxic environments.

Proterozoic sediments in Eastern Canada have proven uranium potential, namely in the Elliot Lake mining district in Ontario. Several exploration models are applicable in the Otish Basin and other Proterozoic basins: unconformity, paleoplacer, albitite and roll front models to name a few. However, economic conditions in the early 80s forced companies to retreat and abandon several relatively advanced and promising projects, which were highly prized during the last rush. It is important however to realize that the last 25 years of indifference in the uranium market has led to the attrition of qualified manpower in Eastern Canada.

Session 7 1:30

Abitibi Volcanogenic Massive Sulphide Deposits: the spectrum of environments, modern analogs and implications for exploration

Harold Gibson (MERC-DES), James Franklin (FGL, MERC), Mark Hannington (DESUO, MERC) and Stephen Piercey (MERC-DES)

The Archean Abitibi Subprovince is host to 82 volcanogenic massive sulphide (VMS) deposits with an aggregate tonnage (geological) of approximately 730 Mt that represents an *in-ground* metal content of approximately 9.8 Mt Cu, 22.7 Mt Zn and 37 M oz of Au. Six of the deposits contain >20 Mt and, of these, 3 are giant deposits exceeding 50 Mt (Horne 53.7 Mt, LaRonde 69.2 Mt, Kidd Creek 147.8 Mt). Two (Horne and LaRonde) account for almost 20 M oz of Au. The deposits range in age from 2698 Ma (e.g., Noranda) to 2730 Ma (Normetal), and are clustered within 13 districts comprised of 1 (e.g., Quevillon) to 22 (e.g., Noranda) deposits.

The deposits, save for two (e.g., Selbaie, bimodal felsic), are in the bimodal mafic group; however their associated lithofacies vary extensively between flow and volcaniclastic end members resulting in a spectrum of volcanic environments. Within volcaniclastic successions felsic volcaniclastic rocks dominate, and the VMS deposits formed on and below the seafloor. Those with elevated Au content, and or with aluminosilicate assemblages, arguably formed within shallower water environments (e.g., Horne, LaRonde, Selbaie and Estrades). Basaltic volcaniclastic host rocks are not common and those that are recognized formed within deeper water environments (e.g., Potter).

VMS deposits within flow-dominated successions tend to be smaller, except for Kidd Creek, but typically have higher base metal grades. These deposits include the Kidd mine that formed within a rhyolitic lava shield that was constructed upon an ultramafic flow lava field, as well as more typical deposits such as those in the Noranda and Matagami districts where the VMS deposits are associated with proximal, vent facies rhyolitic and, to a lesser extent, basaltic flows. The deposits formed on and below the seafloor.

Like their Proterozoic and Phanerozoic analogs, bimodal-mafic (and bimodal-felsic) deposits of the Abitibi are associated with bimodal volcanism, high temperature (FII-FIV rhyolites), sill-like, multiphase subvolcanic intrusions, dike swarms, and subsidence structures ranging in scale from grabens to calderas; features that are consistent with their formation within rift environments, and that provide the best criteria for area selection in exploration. Abitibi VMS deposits may have formed within rifted arcs and back arcs like their Proterozoic and Phanerozoic counterparts. However, this is equivocal as the large volume of felsic rocks and the large size of some of the central volcanic complexes that host Abitibi VMS districts are not recognized in most modern back arc and arc environments (e.g., Lau Basin).

Oral Presentations

Session 7 2:20

Economic Models for VMS and Implications for Exploration Strategies

Gérald Riverin (Cogitore Resources, Woodruff Capital Management Inc.)

As a class of mineral deposits, volcanogenic massive sulphide (VMS) deposits are an important source of base and precious metals. They are relatively well distributed worldwide and collectively constitute an exploration target of choice for both junior and major mining companies. Some of the main attractions of VMS deposits are their polymetallic nature often yielding higher unit values, their high specific gravity and a relatively effective exploration model.

However, a rigourous look at VMS deposits reveals a number of other aspects which seriously impact their economics and competitiveness relative to other sources of metals (such as large SEDEX, porphyry or skarn deposits). DCF calculations were used to define the minimum parameters of an economic VMS, and then a database of world VMS was analyzed to estimate the probability of discovering a VMS that has the required parameters. The results show that once a new VMS deposit is found, the probability that it meets minimum tonnage and grade criteria to be economic may be as low as 1.5% or 1/67.

It is important to understand these challenges before deciding whether to explore for VMS deposits. It is only after all aspects are considered that a mining company should decide whether VMS are right for it and whether the expected rewards justify the risks involved.

The approach used here in the case of VMS deposits could be used also for other deposit types for which there is a sufficient and valid database for tonnage and grade. Ultimately, and depending on the quality of the database, companies may then be able not only to select deposit types that offer the best probabilities of success, but also to quantify those probabilities and thus make better informed decisions.

Session 7 2:40

Structure and Stratigraphy of the Urban-Barry Belt: New Tectonostratigraphic Vision and Implications for Volcanogenic Occurrences

Pierre Rhéaume, Daniel Bandyayera (MRNF) and D. W. Davis (University of Toronto)

Recent mapping, lithogeochemistry and geochronology studies by Géologie Québec have dramatically changed our understanding of the geology and stratigraphy of the Urban-Barry Belt (UBB). The structural style of the UBB is characterized by thrusting from the SSE to the NNW of a series of multi-km-scale structural blocks consisting of essentially volcanic rocks. The age of these volcanic rocks progressively increases from the north (2707 Ma) to the south (2791 Ma). The Fecteau Formation (2791 Ma) is the oldest volcanic unit in the UBB; it is considerably older than supracrustal rocks typically encountered in the Abitibi (2755 to 2685 Ma). Units that postdate the Fecteau Fm, namely the Urban, Panache, Macho, Limpide, Rouleau, Belmont, Chanceux and Lacroix formations can be broadly correlated with units recognized in the Chibougamau area, except for the youngest: the Urban Fm. Felsic centres in the latter yielded ages of 2714 and 2707 Ma, comparable to those of the Kidd-Munro (2718 to 2711 Ma) and Tisdale (2710 to 2703 Ma) assemblages.

These recent data are compatible with a geodynamic model involving a relatively complete Wilson cycle. This cycle includes pre-Abitibi rocks (Fecteau Formation, 2791 Ma), the opening of an ocean basin and related formation of oceanic crust with local island arcs from 2730 to 2707 Ma, followed by the closing and imbrication of this basin during the Kenoran orogeny. Pre-Abitibi volcanic rocks of the Fecteau Formation, primarily mafic and intermediate, are comparable in age and chemistry to certain greenstone belts of the Opatica Subprovince. The onset of rifting is marked by the development of komatiites (Lacroix Formation) and possibly carbonatites (Lacroix Carbonatite), suggesting the involvement of a mantle plume in the opening of the Northern Volcanic Zone (NVZ). Younger units bracketed between 2727 and 2707 Ma, may represent the development of island arcs on typical NVZ oceanic crust.

This new tectonostratigraphic model helps constrain the setting of known volcanogenic occurrences in the UBB, which can thus be divided into three different groups:

1. Gold occurrences associated with alteration pipes in the Windfall Member (2718 Ma);
2. Gold occurrences associated with exhalative and metasomatic activity marked by the presence of tourmalinites in the Souart Horizon, within the Limpide Formation;
3. Polymetallic exhalative occurrences associated with massive sulphides in the Fecteau Formation (2791 Ma).

Session 7 3:00

Geochemical Signature of Rhyolites and Volcanogenic Deposits Fertility: Myth or Reality

Damien Gaboury (UQAC-CERM-CONSOREM) and Vital Pearson (CONSOREM)

For nearly 20 years, the preferential association between volcanogenic occurrences and rhyolite geochemical signatures has been proposed as an exploration tool to discriminate fertile felsic centres. The most widely used classification is that of Lesher *et al.* (1986), modified by Barrie *et al.* (1993) and Hart *et al.* (2004). This classification, based on REE and incompatible element contents, discriminates 4 types of rhyolites: FI, FII, FIIIa and FIIIb. FI are calc-alkaline, with strongly fractionated REE patterns and strongly negative Ta and Nb anomalies. They are considered barren to rarely productive. FII are calc-alkaline to transitional, with moderately fractionated REE patterns and moderate Ta and Nb anomalies. They are considered relatively rarely productive. FIIIa and FIIIb are tholeiitic and are considered as the most productive. FIIIa show weakly fractionated REE patterns and weak to nil Nb and Ta anomalies. FIIIb are high-temperature rhyolites exclusive to the Archean. Their REE patterns are flat and they show no Ta and Nb anomalies.

In 2003, the CONSOREM sampled the different felsic centres, both mineralized and barren, in the Québec portion of the Abitibi. A hundred or so samples were analyzed at the Geo Labs facility in Sudbury by X-ray fluorescence (major elements) and closed beaker digest ICP-MS (trace elements). The objective was to generate a uniform database to test the validity of the classification. Unfortunately, this approach is limited by our knowledge on fertility. FI are genetically correlated with gold-rich volcanogenic occurrences, atypical relative to the "Noranda" model and including: LaRonde, Selbaie, Sleeping Giant, Eagle-Telbel, Comtois, Duvan. We propose that F1 are highly fertile, but host styles of mineralization different from the classic model. FII represent "background" rhyolites of the Abitibi, and very few deposits are associated with the latter, except for those in the Val-d'Or camp and the Jay Copper, Hunter, Coniagas and Abcourt deposits. Deposits associated with FII, with the exception of Louvicourt, mainly consist of disseminated ore with low Cu and Zn grades. FIIIa are found in the Noranda camp, where their characteristics were originally defined. Nevertheless, the FIIIa signature is homogeneous throughout an area of about 2,000 km^2: fertility thus becomes quite relative at this scale of exploration. Moreover, in small felsic centres that show an evolution in volcanism (FI-FII-FIII), deposits are directly associated with FIIIa rhyolites, thereby demonstrating their discrimination potential. Examples include Joutel Copper, Poirier, Normétal, Langlois and Vendome. Finally, FIIIb occur in the Matagami camp and at the Lemoine deposit. These rhyolites are, in essence, highly prospective.

Session 7 3:20

GIS Data Integration as an Exploration Tool: Potential Assessment for VMS in the Abitibi as an Example

Daniel Lamothe (MRNF) and Jeff R. Harris (GSC)

The increasing interest for ore deposit modelling by GIS data integration stems from the increasing availability of geological databases over the past decade. Various integration approaches are used to create a reliable and comprehensible image of the potential of an area for one or many given substances, by combining various geological parameters based on an ore deposit model.

A favourability map at 1:500,000 scale of the Abitibi for VMS deposits was created using 27 parameters derived from geological, geochemical and geophysical data. Each parameter is represented by an image composed of cells, the value of which defines various distance, composition or intensity classes depending on the nature of the parameter. The weight of each parameter is determined using the *Weights of Evidence* method, by calculating the statistical association of each class with a control set of 58 active or closed VMS mines. Weighed parameter images are then combined according to a fuzzy logic approach using an inference network relevant to the VMS model.

The resulting favourability map shows a high predictability, with 90% of known VMS mines occurring within 1% of the surface area of the Abitibi corresponding to the highest favourability zones. Two significant elements are shown on the map: 1) areas of high favourability for the discovery of new ore deposits, defined by a minimal favourability threshold which includes more than 90% of VMS ore deposits, and 2) a set of 155 targets consisting of high-favourability zones which were not staked at the time of publication. Industry response to this type of product has been very positive; in fact, 58 of these targets were staked between March and September 2005.

Oral Presentations

Session 7 3:40

Towards New Discoveries thanks to the Application of 3D Modeling in the Noranda Camp

Louis Martin and Mario Masson (Falconbridge Ltd)

The recent construction of 3D models in the Noranda camp has provided geologists with the ability to perform visual inspections and quantitative queries with the goal of developing quality volcanogenic massive sulphides targets. The vast historical and recent data which includes geological, geochemical, geophysical and structural data is treated within a "common earth model" using Gocad, a 3D GIS tool.

The initial 3D model centered over the Central Camp and which included the majority of past producing mines served as a base study for future work. The Central Camp 3D model provided a common platform which included the digitization of over 20 historical base metal mines, underground development, 3D geological interpretation, numerous drillholes, assay samples and lithogeochemical data as well as various 2D and 3D geophysical surveys.

The model helped in defining characteristics and trends of existing massive sulphides deposits, as well as outlining favorable areas within the Central Camp for future exploration. This included the trend of multiple ore bodies, their association with various formations and structures as well as the relationship with alteration patterns. Exploration tools were developed through this initial model that would later be carried over and used in the larger Noranda camp model.

The discovery of the Montbray showing (5.61% Cu, 1.70% Zn, 0.34 g/t Au and 17.7 g/t Ag over 5.16 m) is an example of how the application of Gocad in a greenfields environment can quickly highlight the best target areas. Areas with sparse data can be evaluated as well as selecting MegaTEM anomalies most likely associated with VMS deposits using a series of favorable criteria.

The West Ansil deposit is an example of a brownfields discovery located 1.8 km from the past producing Ansil mine. The target area was selected based on the intersection of a series of favorable structures at the junction with the Lewis Exhalite associated with alteration. The discovery was highlighted by an intersection of 3.57% Cu over 52.7 m.

Gocad technology and 3D GIS capability has provided us with an exploration tool with widespread and versatile applications. It has applications on a daily basis which include; data validation, target selection, deposit definition and preliminary orebody calculations.

101 - 102

The new 1:500,000 geological map of the Abitibi Subprovince and the study of plutons with a focus on copper

Jean Goutier, Mario Melançon, Pierre Pilote and Jean-Yves Labbé (MRNF)

Synthesis maps for the Abitibi date back to 1984 (DV 83-16) and 1990 (DV 89-04). In the time since their publication, a great amount of new data has become available (drill holes, new mapping projects, U-Pb dating, paleomagnetism). Most of this information is integrated into new compilation maps at 1:20,000, 1:50,000 and 1:250,000 available from SIGÉOM. The new 1:500,000 map for the Abitibi will cover NTS map sheets 31M, 31N, 32D, 32C, 32B, 32E, 32F and 32G. The focus will be on stratigraphic and geochronological correlations.

The objective of our short period of fieldwork in the summer of 2004 was to sample specific intrusions in the northwestern Abitibi. The plutons we visited included those of Montbray and Bernetz (Senneterre region), Franquet, Beehler and Marest (Lebel-sur-Quévillon region), Dunlop and McIvor (Matagami region), and Mistaouac and Poularies (La Sarre region). Plutonic compositions range from a pre-tectonic diorite-tonalite suite to syn- to post-tectonic monzonite and granodiorite.

The region hosting the Mistaouac, Marest and Bernetz plutons holds a particular interest due to the fact that mapping and magnetic susceptibility maps clearly demonstrate a multi-stage emplacement for the various facies. The region also consists of large anticlinal domes showing, in many places, conformable boundaries with rhyolitic volcanic structures. In addition, the Bernetz pluton displays a complex evolution, with an early facies of foliated gneissic tonalite crosscut by granodioritic facies and aplites. Our fieldwork was conducted within the framework of "Plan Cuivre", the objective of which is to renew copper reserves in the Abitibi through various initiatives.

103

Evaluation of the potential for Cu-Au porphyry-type deposits in the Abitibi region: preliminary theoretical model

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

An evaluation of the potential for Cu-Au porphyry-type deposits in the Abitibi is underway following recommendations stemming from a "Plan Cuivre" workshop in Rouyn-Noranda in March of 2005. A mineral potential map, to be constructed using ArcGIS and covering NTS map sheets 32C, 32D, 32E, 32F and 32G, is planned for spring 2006.

The envisioned model is based on four favourability factors: favourable lithologies, structural control, alteration characteristics, and signs of mineralization. The favourable lithology factor relies on the reclassification of intrusive rocks according to their lithological and textural characteristics. The structural control factor, widely employed in other studies of this type described in the literature, will take into account major regional lineaments. The presence of sericite, chlorite and epidote alteration zones will be considered as favourable, as will magnetite- or hematite-bearing intrusions. Finally, the mineralization factor will involve electro-magnetic anomaly maps and geochemistry maps for sediments and rocks. Breccia textures, fracturing and multiple dykes are also considered as possible signs of porphyritic mineralization.

A conceptual model based on fuzzy logic will be advocated instead of an empirical model given that most porphyry-type deposits are in the Chibougamau sector and few examples are known elsewhere in the Abitibi.

Posters

104

Stratigraphic relationships between the Parautochthon and the Abitibi Subprovince in the Chibougamau region: implications for mineral exploration

Daniel Bandyayera, Sandrine Cadéron and Patrice Roy (MRNF)

In the context of its three-year plan for 2003-2006, the Ministry of Natural Resources and Wildlife mapped along the Abitibi-Parautochthon boundary east of the Chibougamau, Caopatina and Urban-Barry segments at a scale of 1:50,000. The mapping allowed us to trace the equivalents of certain volcano-sedimentary units of the Abitibi Subprovince into the Grenvillian Parautochthon. These units are metamorphosed to amphibolite and granulite facies. The correlations are based on U-Pb dates, crosscutting relationships between the units, preserved primary textures and structures, and the chemical composition of each of the units.

More specifically, the data accumulated over the past three years allowed amphibolitized units of the Parautochthon units to be correlated with supracrustal units of the Northern Volcanic Zone or the Urban-Barry Belt. The Parautochthon includes the extensions of the following formations: Obatogamau, Waconichi (2730 ± 2 Ma), Gilman (2720-2730 Ma), Caopatina (maximum age of 2707 ± 2 Ma), Lacroix, Fecteau (2791 ± 1 Ma), and Urban (2707 – 2714 Ma). Furthermore, anorthosite enclaves can be linked to the stratiform anorthositic Lac Doré Complex (2727 ± 1 Ma). East of the Chibougamau segment, recent ages for the Boisvert Pluton (2698 ± 4 Ma) and a late quartz-bearing tonalite-diorite intrusion (2704 ± 4 Ma) allowed us to obtain a minimum age for Archean supracrustal rocks that lie within the Parautochthon and are crosscut by intrusive units. East of the Urban-Barry Belt, U-Pb dating on zircons taken from the leucosome of a migmatite in the Parautochthon suggests an age of 2647 ± 1 Ma. This implies that migmatization in the Parautochthon is the product of an Archean, and not Grenvillian, process. And finally, the Paleoproterozoic (2412 +28/-23 Ma) age determined for a garnet-bearing coronitic gabbro dyke belonging to a NNE-trending group of dykes provides a geochronological marker for post-Archean events.

These correlations provide a means to identify lithologies in the Grenvillian Parautochthon with comparable mineral potential to those of the Chibougamau mining camp or the Urban-Barry Belt. Moreover, the Parautochthon contains Archean exhalative horizons and alteration that may be associated with massive volcanogenic sulphide environments. Late copper mineralization reflects post-Archean hydrothermal activity.

105

Geointegrated 3D model for the Lac aux Loutres sector, Urban-Barry Belt (Abitibi): identification of new exploration targets

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

The aim of 3D modeling in the Lac aux Loutres sector is to complete the MRNFP's regional mapping work that began in the summer of 2000 and highlight the mineral potential of the Urban-Barry Belt (UBB). 3D modeling was performed as part of a new regional metallogenic synthesis (Rhéaume *et al.*, 2004, 2005), which defines three types of mineralization ranging from synvolcanic to synorogenic. The main objectives are to:

1. Construct a 3D model by combining geoscientific data into a voxet measuring 9.0 x 5.0 x 1.5 km^3.
2. Interpret the 3D distribution of lithologies, metals and alteration.
3. Validate the geology by applying constrained and unconstrained geophysical inversions to the 3D model.
4. Maximize the usefulness of the data by formulating queries to identify new gold and base metal exploration targets.
5. Evaluate the applicability of gOcad© software in an explored sector outside of traditional mining camps where the density and distribution of data is heterogeneous.

Proximal and distal zones were identified by formulating selection criteria adapted to synvolcanic mineralization models. Within the proximal zones, it was also possible to distinguish sub-zones of leaching and sectors that are more favourable for mineral precipitation. The proximal model employs lithogeochemical data, whereas none were available for the distal model, reflecting the heterogeneity of data distribution. The distal model is based solely on the penetrative properties of the magnetic reversal and geological affinities. As such, the distal model is protected from bias that could be invoked by sampling heterogeneity. Target definition for orogenic-type gold exploration was also determined by proximal and distal targets.

The geointegrated 3D model for the Lac aux Loutres sector allowed for:

1. Concurrent development of the map and geointegrated 3D model using an iterative validation process.
2. Optimal use of data by creating a reliable model that facilitates three-dimensional visualization and understanding.
3. Gold and base metal target definition according to geochemical and geophysical constraints.
4. The demonstration of the relevance of such a tool outside mature mining camps.

3D modeling could prove to be a dynamically useful exploration tool in the context of mineral exploration in the preliminary stages, even if geological data are scarce and their spatial distribution heterogeneous.

106

Structural and metamorphic interpretations across the Grenville Front: initial stages of a geointegrated 3D model south of the Chibougamau mining camp

Patrice Roy, Sandrine Cadéron (MRNF), Francine Fallara, Li Zhen Cheng (URSTM-UQUAT) and Toby Rivers (MUN)

Our mapping program southeast of Chibougamau covered the Grenville Front Tectonic Zone (GFTZ) along the boundary between the Abitibi Subprovince and the Grenvillian Parautochthon (GP). Based on this work, we propose a new tectono-metamorphic interpretation of the GFTZ and the GP, and are integrating it within a 3D model.

The most comment structural element of the GFTZ and the GP is a penetrative stretching lineation that plunges moderately to the southeast. We also identified at least three phases of deformation – defined by foliation, folding and faulting – that reorient or overprint Kenorean deformation. The first deformation reorients Archean structures to the NE. The second produced NNE-trending brittle-ductile faults characterized by oblique movement with reverse and sinistral components. These faults divide the units into blocks. The third is defined by E-W crenulation cleavage and the reactivation or creation of E-W to ENE shear zones with L-S-type tectonites.

At the regional scale, the metamorphic grade increases from NW to SE, passing from greenschist facies in the Superior Province, to amphibolite in the area affected by the GFTZ, to lower granulite facies in the GP. Metamorphic isograds follow the major structural lineaments and display kilometre-scale oblique displacements. At a smaller scale, a reverse metamorphic phenomenon is observed due to NW thrusting of GP units over the Archean craton. Our current observations favour a model in which regional high-grade metamorphism is pre-Grenvillian and reverse metamorphism is syn-Grenvillian. Regional isograds represent Archean relics exhumed along major amphibolite-grade mylonitic structures. Within these structures, metamorphic minerals are concentrated in alteration zones associated with Cu-Au showings. An understanding of the tectono-thermal evolution of the GFTZ is thus important for finding late mineralization.

A geointegrated 3D model will be constructed using surface geology maps, drilling and structural sections. The database will include the distribution of available properties, such as metamorphic isograds, lithogeochemical analyses and metal grades. Constrained and unconstrained geophysical inversion will be used to validate the geological model. The model could be used to identify geochemical and mineralogical alteration zones, metal concentrations, and major deformation corridors within the framework of a metallogenic approach based on known deposit models.

107 - 108

Preliminary map (2nd edition) of the northern part of the Central Metasedimentary Belt, Grenville Province

Suzie Nantel and Serge Perreault (MRNF)

The preliminary 1:50,000 map of the northern part of the Central Metasedimentary Belt is the culmination of our field mapping program from 1996 to 2004 at a scale of 1:50,000. It represents the second version of a compilation map published in 2001, which summarized our work that continued into 2002.

Among the most significant changes in the second version is that the Tic-Tac-Toc and Guénette intrusive suites have been abandoned.

New lithogeochemical analyses reveal that the gabbros that essentially comprise the Tic-Tac-Toc Intrusive Suite are, in fact, equivalent to the mafic rocks of the intrusive Lacoste Suite. The Guénette Intrusive Suite, which is represented entirely by pink biotite granites, has been replaced by the lithodeme "Brockaby Monzogranites" so that the source of these syncollisional anatectic granites – the metatexites and diatexites containing biotite or sillimanite schlieren – could be included.

The stratigraphic legend of the map in the northern part of the CMB reveals four groups of metasedimentary rocks. Although the age of sedimentation is not known, certain observations suggest that the metasediments of the L'Ascension Metamorphic Suite, dominantly consisting of finely interbedded biotite paragneiss and less common quartzite units, are older than or contemporaneous with a continental arc represented by tonalites, diorites and gabbros of the Lacoste Intrusive Suite (1.45-1.38 Ga). Other observations suggest that the metasediments east of the Labelle Shear Zone, as well as west and south of the Lièvre Shear Zone, would be younger than the continental arc, but are in fact older than the monzogranitic orthogneiss with an intraplate signature represented by the Béthune Intrusive Suite (1.28 Ga). These metasediments are part of the Rabot Metamorphic Suite, the Rouge-Mattawin Metamorphic Suite and the Sourd Supracrustal Suite, and are characterized by much thicker horizons of biotite paragneiss and quartzite, and by a greater proportion of marble compared to the metasediments of the L'Ascension Metamorphic Suite.

Since 1996, the northern part of the Central Metasedimentary Belt has been the site of development work (geophysical surveys, soil surveys, stripping and drilling) for Zn, Cu, Cu-W-Mo and Cu-Au showings, industrial minerals (sillimanite, garnet) and architectural stone (brownish red granite, green granite, white marble). In addition, many claims were registered in 2005 for uranium showings drilled during the 1970's.

Posters

109

Geochemical survey of lake sediment in the Manicouagan region: more than just an exploration tool

Marc Beaumier and Michel Leduc (MRNF)

In 2003, the MRNF of Québec conducted a lake sediment geochemistry survey in the Manicouagan RCM that revealed a multitude of targets for mineral exploration.

The survey also identified the presence of geochemical domains that represent natural concentrations of heavy metals from various sources, which will lead to improved implementation of the *Soil Protection and Rehabilitation of Contaminated Sites Policy*, as well as a more precise definition of anomaly thresholds.

Comparing the recent results to those from 1976 provides a basis for monitoring the evolution of anthropogenic changes in the territory. According to the data, no significant geochemical changes occurred in the Manicouagan RCM over the past 35 years due to its economic development.

Based on the data for uranium, we are able to target areas with a higher risk for radon gas emissions. Many post-tectonic plutons are present in the southern part of the RCM, and it is these inhabited sectors that warrant attention.

The survey identified sectors with deficiencies in magnesium, potassium and phosphorous. The presence of these trace elements (Bernier and Brazeau, 1988a), or their presence in specific ratios (Marquis and Paré, 2005), plays a key role in the regeneration of logged forests. Logging of some areas will thus experience difficulties when re-establishing vegetation, as well as a decline in long term lumber productivity.

The absence of significant mercury levels is reassuring for fish farming. Another important consideration is pH, which is a key factor in the management and stocking of lakes, and helps identify lakes with optimal conditions (6.0 to 7.2) for the reproduction of young fish. Fish populations in more acidic environments (pH between 4.9 and 5.3) have very low survival rates (Lachance *et al.*, 2000). The cumulative effect of certain metals is an additional consideration. Fish perish in locales where Fe levels are > 9,000 ppm (0.9 mg/l) and pH is 5.5, and thus it is possible to identify lakes c where stocking would be futile.

The survey data can also be used to assess the extent of glacial movement, and thus provides a quasi-indispensable tool for deducing the glacial history of the region.

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110

Satellite and geomorphology inventory of the Mid-North

Ghismond Martineau (MRNF)

A geomorphological inventory of Québec's Mid-North will be available to clients of the Ministry during the next few months. The survey will be based on the interpretation of available satellite images in Québec's satellite database managed by the Ministry. Image maps and SPOT images will be used initially, followed by geomorphological interpretation as other products become available.

The territory to be covered is located within the limits of the Level II topographic map sheets 23D and 33A. In the end, some 20 Level III topographic map sheets should be accessible through SIGEOM.

The surveyed land displays the main features of Québec's glaciated Mid-North, including zones of drumlins, drumlinoids, eskers, outwash, peat bogs and swamps, as well as bedrock surfaces and other types of till cover.

111

Evaluation of the sillimanite and muscovite potential northeast of Mont-Laurier

N'golo Togola and Kamal N.M. Sharma (MRNF)

In the Mont-Laurier region, sillimanite and muscovite showings associated with paragneiss and diatexites were identified by the Ministry of Natural Resources and Wildlife (Nantel and Pintson, 2001; Nantel and Giroux, 2005).

During 2005, mineralogical studies and concentration tests for sillimanite were conducted on six representative samples from the Lac Brockaby, Lac Beauregard, Lac de l'Oursière and Lac Rouge sectors (NTS map sheet 31J/15). Ressources Maxima Inc. also performed similar studies in 2003 on seven representative samples from the Lac de la Dame sector (NTS map sheet 31J/14).

The Lac de la Dame sector northeast of Saint-Anne-du-Lac shows good potential for sillimanite, notably in sillimanite-muscovite-garnet-biotite-graphite paragneiss units. Our mineralogical study indicates that this rock contains between **10 to 25%** sillimanite. In addition, a characterization test performed on the samples from this sector revealed that the sillimanite fibres are generally of good quality and that their association with other minerals is typically simple.

Mineralogical and characterization studies for the Lac Brockaby and Lac de l'Oursière samples demonstrate that the sillimanite content of the paragneiss is fairly low (**5 to 15%**) and that the size of the crystals varies from fine to medium. The production of sillimanite concentrate for industrial use would likely be difficult and costly. Sillimanite content in the Lac Beauregard and Lac Rouge sectors varies from **3 to 15%**, but the crystals in diatexites and mafic paragneisses are generally fine-grained. Consequently, the separation of sillimanite from other minerals in the host rocks could prove to be difficult and very costly. Finally, our mineralogical study revealed low muscovite contents (**1 to 5%**) in paragneisses and diatexites from the study areas.

112

Update of the quarry inventory for the Chaudière-Appalaches and Capitale-Nationale regions

Charles Gosselin (MRNF)

The inventory of quarries in the Chaudière-Appalaches and Capitale-Nationale regions, created by the Québec Government between 1991 and 1995, underwent a significant update in the summer of 2005. This recent work concentrated on crushed stone and industrial stone quarries. Twenty-three new quarries were identified, of which six had a extracted rock volume that exceeded 100,000 m^3. Also of note is that 28 quarries already included in the database have experienced significant development, increasing their extracted volume by more than 100,000 m^3 and in some cases by several million m^3. There are currently about 70 active quarries in these regions that are run by many different operators, of which about a dozen are major players in the field of construction material (crushed stone).

The **Chaudière-Appalaches** region belongs to the geological Appalachian Province. The majority of its quarries produce aggregate from sandstone, siltstone and mudstone. Several major quarries also work basaltic lava, volcaniclastic rocks and intrusive mafic rocks. The latter generally produce crushed stone of very high quality that can be used in the production of finishing asphalt and cement concrete.

In the **Capitale-Nationale** region, the limestones of the Saint-Lawrence Lowlands are the primary sources for crushed stone. These rocks are quarried in pits that reach impressive sizes (> 1,000,000 m^3) and are sometimes used for industrial stone. Their chemical composition allows them to be used for cement (Ciment Québec at Saint-Basile and Grondines) as well as aggregates for industrial, agricultural or comestible uses (Graymont-Portneuf at St-Marc-des-Carrières). Numerous quarries can also be found in the geological Grenville Province where intrusive charnockitic rocks and orthogneiss are exploited. These lithologies produce a highly durable aggregate of excellent quality. Also of note is a quarry in high purity quartzite (SiO_2 >99%) north of Saint-Urbain in the Charlevoix region. The quarry mainly produces pieces of high-grade quartzite for use in the metallurgical industry (ferrosilicon and silicon metal). A lesser component of the production is silica sand for the ceramic industry (silicon carbide) and quartz granules for the artificial stone industry.

Posters

113 - 114

Geological map of the Gaspésie and Saint-Lawrence Lowlands

Daniel Brisebois, Pierre Pilote, Robert Thériault, Joanne Nadeau (MRNF) and Sylvain Desbiens (MDDEP)

Corrections to the geological map of the Gaspésie and Saint-Lawrence Lowlands are based on new field data acquired in 2004 and 2005. The revised sectors are: 1) the region between Matapédia and Bonaventure for which six 1:50,000 NTS sheets were verified; and 2) the Lac Kegwick region south of Rimouski near the New Brunswick border, where various scattered data were acquired. The changes applied to the map are minor, but do have consequences for known stratigraphic, paleogeographic and structural models.

In the first study area, our work indicated that the Sellarsville slice, north of Pointe-à-la-Croix, consists of a stratigraphic sequence of Lower Silurian to Lower Devonian age and is therefore not restricted to the West Point Formation. In the sector between the Grande-Cascapédia and Mont Saint-Joseph faults, north of Carleton, we observed major facies changes in the La Vieille Formation, which primarily consists of siliciclastics in this area. U-Pb dating of the base of the Maria Volcanics provided an age of 432 Ma, which places them in a Lower Silurian timeframe and in stratigraphic concordance with the underlying La Vieille Formation. The upper part of these volcanics is, however, of Devonian age because it is concordantly overlain by sediments of the Saint-Léon Formation, which has been dated as Lower Devonian. Further east, in the Baie des Chaleurs Synclinorium, minor changes were made to the position of geological contacts.

In the second study area, minor modifications were made to the traces of: 1) the Causapscal Fault; and 2) the contacts between Silurian and Devonian rocks (Chaleurs Group and Upper Gaspé Limestones) to the north. South of the fault, we clarified the distribution and age of the Gaspé Sandstones and were able to include the underlying rocks in the Gaspé Sandstones as part of the Témiscouata Formation. The Gaspé Sandstones are similar to those of the York River Formation, but the presence of Amphigenia brachiopods brackets them as Lower Devonian (end Emsian) or beginning of Middle Devonian (early Eifelian), whereas the York River Formation in eastern Gaspésie is a little older. The Témiscouata Formation (e.g., the Gaspésie Fortin Group) contains a unit that is transitional with the Gaspé Sandstones consisting of fine-grained argillaceous sandstones and variably calcareous mudstones with a greenish patina. This unit was previously assigned to the Gaspé Sandstones or to the Upper Gaspé Limestones.

115

New geochemical data for Ni-Cu-PGE showings in the Portneuf-Mauricie Domain

Anne-Aurélie Sappin, Marc Constantin (U. Laval) and Thomas Clark (MRNF)

The Portneuf-Mauricie Domain is mostly located in NTS map sheets 31I and 31P. It is consists of metasediments and metatuffs of the Montauban Group (1.45 Ga), crosscut by plutons of the La Bostonnais Complex (1.40–1.37 Ga). The sequence was injected by differentiated mafic-ultramafic intrusions containing several Ni-Cu±PGE showings. The goal of this research project is to understand the genesis of five of these showings (Lac Matte, Lac Kennedy, Lac Édouard mine, Rousseau, Lac Nadeau) as well as the plutonic host rocks.

The Ni-cu-PGE potential of the region is evident by the occurrence of a deposit that was mined during the 1970's near the town of Lac Édouard. Our work in 2003 – in particular, our recalculation of Ni, Cu, PGE and Au contents to 100 % sulphides – confirmed that Fe-Ni-Cu sulphides from the Lac Nadeau showing are distinguished by their elevated metal contents. U-Pb dating of zircons from a pegmatitic quartz-bearing diorite at the same showing yielded an age of 1396 +6/-5 Ma, which falls into the age range for the La Bostonnais Complex.

Our work in 2004-2005 demonstrates that the Fe-Ni-Cu sulphides of the Portneuf-Mauricie Domain display many similar characteristics. The mineralization, mainly consisting of disseminated sulphides, is rich in Ni and Cu: 4–16% Ni_{100} (Ni at 100 % sulphides) and 1–9% Cu_{100}. The Lac Nadeau and Rousseau showings are the only ones that contain sulphides enriched in precious metals: 3–65 g/t $(Pd+Pt)_{100}$ and 2–30 g/t Au_{100}. Sulphur involved in sulphide formation in all study areas was derived from a mantle source. Nonetheless, certain chemical characteristics suggest that some of the sulphur could be of crustal origin. Sulphide-bearing intrusive bodies include gabbroic rocks, pyroxenites and peridotites. The mafic-ultramafic rocks of the Lac Matte, Lac Kennedy and Lac Nadeau showings, and of the Lac Édouard mine, have trace element signatures that are typical of magmatic arc environments. The Rousseau showing, however, displays a distinct composition, similar to the signature of E-MORB magmas.

The new geochemical data allow for a better evaluation of the Ni-Cu-PGE potential in the Portneuf-Mauricie Domain and help explain the genesis of the intrusions and Ni-Cu-PGE mineralizations in this domain and in the Grenville Province as a whole.

116

The importance of atmospheric oxygenation for Labrador Trough metallogeny

Thomas Clark (MRNF)

The concentration of free oxygen in the terrestrial atmosphere has increased substantially beginning about 2.3 Ga. This change had a great impact on the metallogeny of the 2.2 to 1.8 Ga Labrador Trough. This explains the nature of the oldest sedimentary rocks in the Trough: rift-related arkoses and conglomerates that occur as red beds derived from the weathering of the Archean basement under oxidizing atmospheric conditions. The red beds of the Trough are among the oldest on Earth. Conditions at the time allowed groundwater to dissolve and transport uranium – a substance that is present in the granites of the Archean basement and is sensitive to redox conditions. Uranium was subsequently precipitated in reducing sedimentary environments. The biggest sedimentary uranium deposits in the region are hosted by Paleoproterozoic slices in the Superior Province west of the Trough (e.g., Lac Dieter: 20 Mt at 0.05% U_3O_8). On Paleoproterozoic Earth, the proliferation of bacterial life under oxidizing conditions resulted in the accumulation and burial of great quantities of organic matter. One piece of evidence supporting this event in the Trough (as elsewhere across the planet) is the heavy carbon isotope composition of carbon in dolomites deposited along continental margins that developed after rifting. The diagenetic decomposition of bacterial colonies in dolomitic strata (stromatolites) produced a primary porosity in which considerable quantities of copper were precipitated. The copper was dissolved from oxidized deposits in the underlying rift system, transported by oxidizing fluids and precipitated in dolomites with locally reducing conditions. The Lac Romanet deposit (possible resources of 20 Mt with samples assaying between 0.14 and 1.48% Cu) is an example of these stratiform sedimentary copper deposits. Nonetheless, despite the oxygenated atmosphere, the largest iron formations were not produced until 1.9 Ga. It was only at this time that all the necessary local tectonic and hydrographic conditions came together to cause an increase in the reduced iron stockpile of deep marine waters, its oxidation in the oxygenated surface layer, and its precipitation at a massive scale. The apparent absence of SEDEX deposits in the Trough may be due to the enrichment of reduced iron in deep waters (before the deposition of iron formations) and their consequent depletion in reduced sulphur.

117

Geological compilation at 1:750,000 of the northeastern Superior Province in Québec's Far North

Alain Leclair, Alain Berclaz, Jean-Yves Labbé, Pierre Lacoste, Kamal N.M. Sharma and Martin Simard (MRNF)

The new 1:750,000 geological map for the northeastern Superior Province was created using geological data acquired over the past 15 years in Québec's Far North. The map represents the compilation of geological surveys conducted by Québec's Ministry of Natural Resources at a scale of 1:250,000 between 1998 and 2003 as part of the Far North Program. It also incorporates the work performed by the Geological Survey of Canada between 1989 and 1996, as well as earlier geological maps from various sources with scales ranging from 1:50,000 to 1:1,000,000. The territory covered by the map is approximately 300,000 km^2, including most of the Archean terrains north of the 55th parallel that are bordered by the Paleoproterozoic Ungava and New Québec orogens. The northeastern Superior Province contains Archean rocks (3.82-2.62 Ga) belonging to the Minto, Bienville, La Grande and Ashuanipi subprovinces. The compilation map provides an overview of the geology of this homogenous ensemble of Archean terrains, distinguishing the main rock types and major faults. It reveals a territory mostly comprised of felsic to ultramafic plutonic rocks containing biotite, hornblende and/or pyroxene. These rocks are variably foliated and enclose numerous slices of supracrustal rocks that are metamorphosed to greenschist and granulite facies. Felsic plutonic rocks – the most common and widespread rock type – are grouped into 14 main lithological units that include tonalites (40%), granites (21%), granodiorites (14%), charnockitic rocks (14%), diatexites of sedimentary origin (3%), and monzonites and syenites (<1%). Dioritic, gabbroic and ultramafic rocks occur as small isolated intrusions representing less than 2% of the bedrock. The rest of the Archean rocks are metavolcanic and metasedimentary, grouped into four main units. These rocks form discontinuous linear belts that can attain 10 km in width and 120 km in length. The report that accompanies the map provides a brief overview of the regional geology of the northeastern Superior Province, and presents succinct descriptions of the lithological units, including their structure and mineral potential.

Posters

118

New geochronological data for eastern Grenville: clarifications regarding magmatic evolution

André Gobeil, Claude Hébert, Thomas Clark (MRNF), Jean David (GEOTOP-UQAM-McGill) and Donald W. Davis (U. Toronto)

Six samples from eastern Grenville were the subject of isotopic study. In the Lac De La Blache sector (north of Baie-Comeau), megacrystic monzonite and charnockitic granite from the Hulot Complex revealed respective ages of 1373 ±3.0 and 1376 ± 2.0 Ma. These intrusions represent magmatic activity of an age comparable to that of the Matamec Complex located further east. The latter consists of an allochthonous sheet transported to its current position during the Grenvillian orogeny. It revealed ages from 1378 to 1351 Ma. The age of the intrusions in the Hulot Complex are also close to those obtained from the Rivière Pentecôte anorthosite (1354 to 1365 Ma), west of Sept-Îles. Finally, the ages of both intrusions are close to the 1327 ±16 Ma age of the De La Blache mafic plutonic suite.

In the Lac Varin region, quartz monzonite of the Varin Plutonic Suite yielded an age of 1491 +3.1/– 2.9 Ma, which falls in the 1520 to 1460 Ma range that characterizes the development of the Pinwarian magmatic arc in the eastern Grenville. In the same region, olivine mangerite from the Vallant Anorthositic Suite gave imprecise ages of 1149 ±34 and 1333 ±61 Ma (TIMS). The *in situ* (LA-MC-ICP-MS) analysis of zircons from the mangerite gave an average age of 1140.5 ±7.4 Ma; these results demonstrate that the emplacement of the Vallant Anorthositic Suite is synchronous to that of the Lac-Saint-Jean Anorthositic Suite (1160–1140 Ma). An age of 1333 ±61 Ma appears to be an inherited age, similar and possibly related to the age of emplacement of the mafic De La Blache Plutonic Suite (1327 ±16 Ma) to the northwest.

A late composite intrusion of monzogabbro-mangerite-granite (Boutereau intrusions) in the region of the Manitou and Nipisso lakes provided an age of 1005.4 ±3.1 Ma. This intrusion and several others in the region display strong circular magnetic anomalies characterized by high-temperature minerals (orthopyroxene), bimodal magmatism and enrichment of light rare earth elements. The granites are A-type, typical of postorogenic magmatism. North of Lac Manitou, IOCG-type Cu-Au-REE mineralization may be related to this magmatic event.

119 - 120

Comparative favourability for the orogenic gold potential of the Abitibi: hybrid fuzzy logic versus neural analysis

Daniel Lamothe (MRNF) and Jeff R. Harris (GSC)

The authors have produced two 1:500,000 favorability maps for the orogenic (mesothermal) gold deposit potential of the Abitibi. In both cases, 19 geological parameters related to the target deposit type were used. The goal of the work is to study the differences or similarities generated by two very different methods and to compare their relative efficiency (or predictivity).

The first method, known as Hybrid Fuzzy Logic (HFL) consists of a mixed approach that is both conceptual and empirical in nature. Using ArcSDM, fuzzy operators combine the weighted image for each of the parameters by respecting a sequence defined by an interference model. The weighted values are calculated by the "weight of evidence" method, which rates the spatial association of each parameter with a set of 178 orogenic gold deposits comprising mines or deposits with known tonnages that are located in the study area. The second method, known as Neural Analysis (NA), is a purely empirical approach based on a neural network simulator that uses a radial basis functional link algorithm that was developed for ArcSDM. The same set of 178 deposits was used to train the system.

The map generated by NA is significantly more predictive than that generated by HFL. The main reason for this difference is the different types of parametric maps for the two approaches (binary for AN versus multiclass for HFL).

121

Structural analysis of the Vilanova anticline in the Ebre Basin, eastern Pyrenees, Spain

Emilie Tremblay-Paquet, Michel Malo (INRS-ETE) and Jaume Vergés (Institut de Ciencies de la Terra "Jaume Almera" CSIC)

The Vilanova anticline is a detachment fault in the Ebre fore-arc basin of the eastern Pyrenees in Spain. It is located approximately 30 km southeast of the tectonic front that is represented in this area by the Segre thrust fault, a lateral ramp between the nappes of the central and eastern Pyrenees. The sedimentary sequence of the Ebre Basin consists of a series of marine deposits (Paleocene to Eocene) overlain by lacustrine marls and continental deposits of sandstone and conglomerate (end of Eocene to Oligocene). Three evaporite horizons are found in this sequence: gypsum of the Beuda Formation (47 Ma), rock salt of the Cardona Formation (37 Ma), which marks the transition between marine and continental deposits, and gypsum of the Barbastro Formation (29 Ma). Within the basin, a series of anticlines oriented NE-SW and NW-SE developed above the décollement planes that coincide with the evaporitic horizons. The décollement in the Barbastro Formation is at the base of the NE-SW-oriented Vilanova anticline. By studying the geometry of the sedimentary deposits that make up the fold, we were able to test the hypothesis that the units above the Barbastro Formation were deposited during fold development. Orthophoto interpretation reveals unconformities between folded units and a difference in the thickness of the units between the two flanks. Structural analysis of the attitude of bedding planes indicates that the units nearest the axial trace are more inclined than those located towards the fold exterior. Two seismic profiles oriented perpendicular to the axial trace of the Vilanova anticline reveal a basal décollement in the gypsum of the Barbastro Formation and the development of growth-strata.

122

Analogical modeling in tectonic research: approaches at crustal and lithospheric scales

Elena Konstantinovskaya (INRS-ETE)

Analogical modeling in tectonic research provides us with indispensable data for better understanding the evolution of geologic structures. These data represent a considerable contribution to mineral and petroleum exploration.

The combination of two approaches at the scale of the crust and lithosphere allow us to take into account a great number of physical and geometric parameters that characterize the tectonic processes and structural evolution of mountain chains along the fronts of tectonic plates.

The evolution of an arc-continent collision can vary due to different parameters, such as the resistance of the crust along the continental margin, the thickness of the crust under the volcanic arc, the distance between the arc and the trench, and the friction between tectonic plates in the subduction zone.

Modeling the deformation of a continental margin during an arc-continent collision allows us to evaluate the exhumation process for continental sheets at the front of an arc that is thrusting over the margin. Diamonds are found in rocks exhumed from great depths. Quantitative analysis of the deformation of the thrusting plate that contains the volcanic arc provides a means to define the parameters that lead to the emplacement of basic-ultrabasic massifs during arc obduction along the continental margin. In the case of Kamtchatka, these massifs contain economic levels of platinum group metals.

Modeling in sand provides a means to study structures in the sedimentary cover of the fore-arc basin accretionary wedge during an arc-continent collision. In doing so, it is possible to observe the compression and emergence of the accretionary wedge, the development of out-of-sequence thrusting and thrust zones, and the displacement of the deformation front of the wedge towards the base of the volcanic arc. Submerged sedimentary sequences in the wedge and the fore-arc basin represent protential hydrocarbon traps.

The study of an accretionary wedge under the effects of erosion has shown that the path of exhumation depends on the dynamics in the lower wedge. The wide variety of modes of exhumation is controlled by the geometry of the thrust faults and by the style of fault propagation, which are variable due to friction along the base of the wedge.

Analogical modeling of geologic structures can thus contribute to the targeting of new exploration sites for gold, platinum group metals, non-precious metals, diamonds and hydrocarbons.

Posters

123

New stratigraphic perspectives for the Roy Group, Chibougamau: implications for exploration

F. Leclerc (INRS-ETE), Jean Bédard (CGC), Normand Goulet (UQAM), L. B. Harris (INRS-ETE) and Patrick Houle (MRNF)

A geological survey was performed in the summer of 2005 for the Northern Volcanic Zone of the Abitibi Subprovince along the southern flank of the Chibougamau syncline (NTS 32G/16) north of the Lac Doré Complex. The objective is to refine the internal stratigraphy of the Gilman Formation (2nd volcanic cycle in the Roy Group), currently mapped as monotone massive to pillowed basalt flows intruded by differentiated sills.

The survey updates an assemblage of lapilli tuff, block tuff (mafic to felsic fragments, sulphides, cherts), crystal tuff (plagioclase) and rhyolitic flows in the Gilman Formation. The assemblage is laterally continuous for more than 20 km and separates the basaltic lavas of tholeiitic affinity in the lower Gilman from the andesitic lavas of calc-alkaline affinity in the upper Gilman. We propose to divide the Gilman at the level of the pyroclastic horizon, with the type section located at Allard Park. The recognition of a pyroclastic marker horizon of regional extent, combined with disseminated mineralization (py-po-cp), semi-massive sulphide fragments (py-chert), an overlying massive rhyolite unit, and crosscutting synsedimentary faults constitute a favourable environment for VMS mineralization. This context appears comparable to the Lemoyne horizon within the Waconichi Formation (1st volcanic cycle in the Roy Group).

Recent roadwork has exposed the Cummings Complex for several kilometres northeast of Chibougamau. Along this section, several imbricated sheets are bounded by south-verging listric shear zones. Our thin section study revealed granophyric gabbros, clinopyroxene cumulates and serpentinized peridotites, all of which were initially injected into the pillowed basalts and the reworked pyroclastic rocks of the Gilman and Blondeau formations. A detailed structural and geochemical study of this section is underway with the goal of reconstructing the stratigraphy.

Several mapped sills in the Gilman Formation display an internal differentiation similar to that of the Bourbeau sill (Cummings Complex): pyroxenitic base, gabbroic centre and ferrogabbro summit. According to Allard (1976), sills constitute up to 25% of the Gilman Formation. We plan to study the geochemical affinity between the sills hosted by the Gilman Formation and those in the Cummings Complex, hosted mainly by the Blondeau Formation. If a geochemical equivalence can be demonstrated, it would imply that the Cummings Complex is rooted at lower stratigraphic levels.

124

Influence of early structures on propagation fold geometry: reconstruction and direct kinematic modeling in 3D

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

The San Corneli anticline in the central Pyrenees of Spain is a folded and faulted structure within a foreland setting. This compressional structure was generated during the development of the thrust belt over the Iberian plate during Cenozoic time. Geometrically, the San Corneli anticline is a propagation fault developed above the Boixòls thrust, which represents the most frontal structure of the Boixòls nappe. Pre-compression extensional structures have been recognized within the anticline and consist of a network of normal faults and early fractures that were activated during sedimentation in Mesozoic extensional basins. The goal of our research is to test the influence of these normal faults on the development of the San Corneli anticline and their effect on the particular geometry of this propagation fault. Three-dimensional modeling is a crucial component towards better understanding the relationships between early faults and the resulting geometry in the developing fold. The San Corneli anticline also outcrops, which offers the possibility of more easily modeling its geometry using surface data. Our approach will be to first apply inverse 3D modeling. The geologic model will be reconstructed using the "3D Reconstruction" module of gOcad. Inverse 3D modeling is based on the balancing of the section. This technique will allow us to obtain a paleogeographic 3D model that we can use to deduce the emplacement and geometry of pre-existing normal faults during basin sedimentation. We can then begin a series of direct kinematic models that will test various hypotheses concerning the mode of anticlinal structure development. Three-dimensional direct kinematic modeling involves returning to the current deformational state of the model. We can also better establish the chronology of the events that affected the fold, and determine if the faults influenced the development of these events.

125

Geophysical imaging of the Gaspésie and the Saint-Lawrence Lowlands: 1- gravimetric data

Nicolas Pinet, Denis Lavoie, Pierre Brouillette (CSC-Q), Denis-Jacques Dion (MRNF), Pierre Keating (CSC-C), Daniel Brisebois (MRNF), Ruth Boivin (CSC-Q), Michel Malo (INRS-ETE) and Sébastien Castonguay (CSC-Q)

The entire Gaspé Peninsula is now covered by recent gravimetric surveys. From 2002 to 2004, 3,850 gravimetric measurements were acquired. Gravimetric stations had an average spacing of 3 km and the precision of the data was better than 0.5 mGal.

The Bouguer anomaly map and various filtered maps are presented. These maps are taken from a geophysical atlas for the Gaspé region that was created through a recent geoscience initiative led by the Geological Survey of Canada and the Ministry of Natural Resources and Wildlife in collaboration with various partners.

The Bouguer anomaly map clearly reveals strong lateral geometric variations within the Late Proterozoic to Late Ordovician rocks of the Humber Zone. West of Cap-Chat, a very strong negative anomaly (-30 to -60 mGal along the coast) borders, to the northwest, a positive anomaly (+/- 15 mGal) associated with the Shickshock Group, which consists of high-density metavolcanic rocks. Further east, the positive regional anomaly (10 to 32 mGal) extends from the Gulf of Saint-Lawrence to the northern part of the Gaspé and includes two gravimetric highs that trend along the structural fabric.

In the Siluro-Devonian basin, a series of anomalies aligned in a NE-SW direction form a relative gravimetric high between Murdochville and Carleton and divide the Gaspé Belt in two. West of this geophysical corridor, a gravimetric low (-31.5 mGal) centres on the Monts-Berry syncline that includes outcrops of Battery-Point Formation, which is of intermediate density and the lowest density of the large lithological assemblages. East of the Murdochville-Carleton corridor, the gravimetric minimum (-27.7 mGal) is located in the Mont-Alexandre sector and the isovalues of the gravitational field display curvilinear forms that crosscut geological contacts.

Maps of the vertical and horizontal derivatives of the Bouguer anomaly respectively allow the gravimetric signatures of relatively superficial sources to be enhanced and their boundaries to be mapped. The determination of the maximums for the horizontal gradient Bouguer anomaly using upward continuation to different altitudes allows the dip of structures associated with density contrasts to be defined.

126

Geophysical imaging of the Gaspésie and the Saint-Lawrence Lowlands: 2- aeromagnetic data

Nicolas Pinet, Denis Lavoie, Pierre Brouillette (GSC-Q), Denis-Jacques Dion (MRNF), Pierre Keating (GSC-C), Daniel Brisebois (MRNF), Ruth Boivin (GSC-Q), Michel Malo (INRS-ETE) and Sébastien Castonguay (GSC-Q)

High-resolution aeromagnetic surveys were recently acquired for the Gaspé region. These surveys cover the equivalent of 24 map sheets at 1:50,000. The average flight altitudes for these surveys were 150 m and 163 m, and line spacing was 300 m and 400 m.

The total magnetic field map and various filtered maps are presented. These maps are taken from a geophysical atlas created for the Gaspé region during a recent geoscience initiative led by the Geological Survey of Canada and the Ministry of Natural Resources and Wildlife in collaboration with various partners.

Qualitative analysis of the total magnetic field maps and various filtered maps (pseudo gravity, low-pass filter, etc...) that enhance long wavelength anomalies (often attributable to "deep" geological bodies) allow the general architecture of the Gaspesian Appalachian orogen to be imaged. These maps display similarities with the Bouguer anomaly map and define two magnetic lows within the Gaspé Belt.

Several methods were used to enhance the short wavelength magnetic anomalies that are associated with susceptibility contrasts within the stratigraphic column or magmatic rocks. By studying the maps, pre-existing cartographic elements can be validated or modified, or new structures can be proposed. Faults, which generally do not display magnetic signatures, can be identified by the truncation of linear anomalies during this type of analysis, and in some cases their horizontal throw can be estimated. A fairly good correspondence is observed between magnetic lineaments and existing geological maps for the Gaspé Belt. The interpretation of the magnetic maps revealed: 1) a structural NNE corridor that crosscuts the entire Gaspesian peninsula and extends to New Brunswick; 2) NE faults in the western part of the study zone; 3) WNW faults that border the Baie des Chaleurs to the north; and 4) the regional extent of sub-southern faults in the Carleton region.

Posters

127

The use of geophysical data to understand the geometry of the Appalachian orogen: gravimetric modeling of regional geological transects

Nicolas Pinet, Denis Lavoie, Pierre Brouillette (GSC-Q), Denis-Jacques Dion (MRNF), Pierre Keating (GSC-C), Daniel Brisebois (MRNF), Ruth Boivin (GSC-Q), Michel Malo (INRS-ETE) and Sébastien Castonguay (GSC -Q)

Gravimetric data from sedimentary basins are traditionally used to determine the depth of the "basement". In the Gaspé region, quantitative modeling of Lower and Middle Paleozoic basins is difficult due to: 1) the weak density contrast between the "basement" and cover, and 2) probable variations within the rocks that constitute the "basement". Geophysical modeling must therefore place greater importance on integrated approaches in which all the available data (geological, petrophysical, seismic...) are taken into account.

During our gravimetric modeling, the regional component of the Bouguer anomaly was removed by examining profiles that were much longer than the study area. The coherence of the regional component is validated by the comparison of subtracted values at points of intersection between transverse and longitudinal profiles.

Geological sections, in some cases supported by seismic data, served as a base for defining large geological ensembles (polygons) that were assigned a density. This approach is possible thanks to a petrophysical database indicating that: 1) density variations are small within Cambro-Ordovician sequences, with the notable exception of the Shickshock Group; and 2) density increases with rock age in the Gaspé Belt.

The geometry of the initial model was modified by successive iterations to obtain a satisfactory correlation between measured and calculated profiles. The models display a regional coherence and allow geological sections to be balanced from a geophysical point of view.

The majority of positive residual anomalies in the northern Gaspé region (Humber Zone and Gaspé Belt) are related to the presence of metavolcanic rocks (Shickshock Group). This interpretation suggests that: 1) the volume of syn-rift volcanic rocks is considerable; 2) east of the Rivière Madeleine fault, the Ordovician deformation front is in the Saint-Lawrence Gulf, north of its traditionally proposed position; 3) syn-rift volcanic rocks are deeply buried in the eastern part of the Gaspesian peninsula, whereas they form the high point of the structural forms in the region of the Chic-Choc Mountains, indicating a laterally variable tectonic evolution.

In the southern part of the Gaspesian peninsula, residual gravimetric anomalies are of smaller amplitude, and high density geological bodies do not need to be invoked for their interpretation.

128

Hydrothermal dolomitization and hydrocarbon reservoirs: the case of Ordovician, Silurian and Devonian sequences in Québec

Denis Lavoie (GSC-Q)

In North America, important discoveries of world-class hydrocarbon reservoirs have been made in hydrothermal dolomites. These recently discovered fields include Finger Lakes (New York, Ordovician), Ladyfern (British Columbia, Devonian) and Deep Panuke (Nova Scotia, Jurassic).

The relevance of this process for Québec's sedimentary basins is evident by the discoveries of significant hydrocarbon reservoirs in border regions. Within the framework of research projects supported by its own funding, or in partnership with Québec's Ministry of Natural Resources and Wildlife and the private industry, the Geological Survey of Canada has undertaken the documentation of hydrothermal dolomites in Québec's sedimentary basins.

Hydrothermal dolomites are known in Lower Ordovician sequences (Beekmantown Group, Romaine Formation). These carbonate rocks are present in the Saint-Lawrence platform and as tectonic slices along the Appalachian front. Saddle dolomite is abundant in the brecciated and fractured segments of these units. A significant oil discovery at the St. Flavien gas field is hosted by Beekmantown dolomites.

Middle and Upper Ordovician carbonates (Black River and Trenton groups, Mingan Formation) of the Saint-Lawrence platform are affected by early hydrothermal alteration that caused dissolution, massive dolomitization and saddle dolomite. These units host world-class discoveries in the state of New York and in the American Midwest.

Lower Silurian carbonates (Sayabec and La Vieille formations) are characterized by dolomitic breccias, fracturing and the generation of massive dolomitization and saddle dolomite in the north and south of the Gaspé region. Abundant bitumen is visible in many open pores.

Upper Silurian-Devonian carbonates (West Point Formation) are locally (central Gaspésie) characterized by considerable fracturing filled by dolomite. New observations made in the summer of 2005 are now in the stages of petrographic and geochemical study with the aim of confirming or refuting a hydrothermal origin.

Finally, carbonates in the Lower Devonian external platform (Upper Gaspé Limestones) locally display considerable fracturing and infilling by saddle dolomite. The production of natural gas from the Galt field in eastern Gaspésie is associated with an intensely brecciated zone marked by the presence of saddle dolomite.

129

Integration of multibeam data and seismic-reflection data in the geological interpretation of the Saint-Lawrence Estuary

Mathieu Duchesne, Nicolas Pinet (GSC-Q), Bernard Long (INRS-ETE), Calvin Campbell, Scott Hayward (GSC-A), Roger Côté, Louis Poliquin (CHS), Andrée Bolduc and Denis Lavoie (GSC-Q)

Over the past few years, the Geological Survey of Canada – with the help of its partners – acquired high-resolution seismic-reflection data, multibeam data (very high resolution bathymetry) and marine magnetometry data for the Saint-Lawrence Estuary between Tadoussac and Pointe-des-Monts. This information was acquired as part of the "Targeted Geoscience Initiative 2: Appalachians Energy" and "Geoscience for Ocean Management: Saint-Lawrence Estuary" projects.

In marine geology, the coupling of seismic-reflection and multibeam data greatly facilitates the interpretation of current and ancient geological processes. The entire Quaternary stratigraphic sequence of the estuary is imaged by the seismic-reflection data, right down to the contact with the Proterozoic and Paleozoic basement. Within the Quaternary deposits, the seismic data distinguishes seismo-stratigraphic sequences with laterally variable thicknesses. Seismic anomalies attributed to the presence of gas in sediments were also documented. Preliminary observation of the multibeam imagery reveals evidence of mass movement scars, debris lobes, submarine cones and channels, as well as *en echelon* morphological structures and numerous gas events on the floor of the estuary.

The coupling of multibeam bathymetric and seismic data provides a better understanding of the three-dimensional architecture of Quaternary deposits in the Saint-Lawrence Estuary, their mode of emplacement and their relationship to the basement. The bathymetric expression of seismically observed sedimentary bodies and structural elements will also facilitate their geological interpretation. Furthermore, the concurrent analysis of seismic anomalies related to gas-bearing sediments and imaged events from the multibeam survey will allow for better documentation of the relationship between gas venting forms and geological domains (Grenville, Platform, Appalachians). It will also help clarify the link between the distribution of events and the structural elements of the underlying basement. Finally, the magnetic data will help define basement geology and pinpoint the presence of gas-related anomalies.

130

Distribution and contents of major gold deposits in Canada and the world

Patrice Gosselin and Benoît Dubé (GSC-Q)

The Geological Survey of Canada presents two open file reports that focus on the distribution, geological parameters and gold contents of major gold deposits in Canada (OF4896) and the world (OF4895). Both reports are accompanied by a map displaying the location, classification and gold content for each deposit (OF4893 and OF4894). More than 128 Canadian deposits with gold production or reserves of 250,000 ounces or more are shown on the Canadian map, whereas 452 deposits from 61 countries containing more than 1,000,000 ounces of gold are presented on the world map.

The information is provided in the form of a database. In addition to geographical location and economic data (production, reserves, resources and inferred resources), geological data includes the deposit's classification, host rocks and environment, tectonic context, alteration, local and regional structure, mineralogy, etc. All the data is link to a reference, allowing the user to easily trace the source of the information. Furthermore, a concise textual summary derived from the information in the database is also provided for each deposit.

The databases aim to: 1) increase and consolidate the geoscientific knowledge regarding gold deposits; 2) stimulate gold exploration in Canada by providing the industry with a new tool for mounting exploration programs, and 3) stimulate geoscientific research as public files can be consulted, modified and interrogated by all users.

The "query" mode for the database allows the user to perform useful deductions and projections by combining geological and economical parameters. For example, it is possible to identify the most productive geological periods for gold and to identify the deposits associated with those timeframes. According to the database for world gold deposits, the total of gold production and reserves (including the Witwatersrand of South Africa) amounts to 120.689 tonnes Au. Canada represents 7.7% of this total, with 9.276 tonnes. Quartz-carbonate orogenic vein-type deposits represent only 13.1% of world production, but 66.6% of Canadian production. With 4.470 tonnes, the Superior Province – and particularly the Abitibi Subprovince – represents 72.4% of the Canadian production for this deposit type and is undoubtedly the richest gold region in the country.

Posters

131

3D modeling of the Saint-Mathieu - Berry esker (32 D/08 and 32 D/09) using Gocad® software

Andrée Bolduc and Serge J. Paradis (GSC-Q)

In order to support a groundwater research project in the Amos region, Abitibi, we have constructed a geomodel using the 3D Gocad® modeling and visualization software of Earth Decision Sciences. The available data included: (1) drill hole descriptions from the well-digger database of the Ministry of Natural Resources and Wildlife, the Municipality of Amos, the bottler Eaux Vives Harricana, and other private sources; (2) cartographical data from SIGÉOM and maps of superficial formations; and (3) new data from our fieldwork. We created two data sets for the reconstruction of six geological surfaces: bedrock, till, esker, argillaceous plains, littoral sediments and organic deposits. For each surface and before interpolation, we defined fixed XYZ data points (Gocad® control nodes, such as geological contacts in drill holes or the locations of outcrops) and mobile data points along the Z-axis (Gocad® control points, such as approximate locations of outcrops or interpretations based on geologic sections). Each surface was interpolated (DSI: discrete smooth interpolation; default interpolator of Gocad®) within a region measuring 24 x 11 km, and the interpolation was repeated until the surface was acceptable. The surfaces, along with an arbitrary base, were used in pairs (base-rock, rock-till, till-esker, etc.) to create geological volumes (Sgrids in Gocad®) with cells measuring 100 m x 100 m x the thickness between the two stratigraphically superimposed units. As the aquifer was located in the esker, the Sgrid was constructed so that the cells were not more than 1 m thick. Once the six Sgrids were constructed, they were fused and properties were assigned to each geological region. Using the detailed information available for the esker, we were able to define the most gravely zones within it. The zone of gravel corresponds to the core of the esker and runs more or less along its crest. The geomodel can thus help answer questions concerning the geological history of the esker and the best location for future wells, as well as providing local parties with a powerful communication tool.

132

Polyphase glacial dynamics and fracture networks in the basement of the Otish Mountains and LG-4 region of Québec's Mid-North

Michel Parent (CGC-Q) and Pierre Brouillette (CGC-Q)

The intensive search for diamondiferous kimberlites in northern Québec has placed glacio-sedimentary surveying at the forefront of exploration methods used by private companies for both regional reconnaissance work and local studies. In the manner observed in adjacent regions (Parent *et al.*, 1995, 2004), the Otish Mountains were affected by several phases and directions of glacial flow, and it is likely that the dispersal trains for kimberlitic indicator minerals are also characterized by polyphase glacial transport. Our previous work demonstrated that if the most recent direction of regional flow produced classic banded dispersal trains, then it also caused substantial reworking of earlier deposits to produce palimpsestic trains. The polyphase dispersal trains recognized in several regions in northern Québec present various levels of complexity (Parent *et al.*, 1996, 2004), and represent one of the keystones in diamond exploration.

A reconnaissance survey conducted by the GSC in collaboration with the Ashton-Soquem partnership examined the striated surfaces of about thirty rock outcrops spread over approximately 10,000 km^2 in the region to the north of the Otish Mountains (parts of map sheets 33A, 33H, 23D and 23 E). The survey focused on the Renard kimberlite sector and revealed a succession of three regional glacial movements. From oldest to youngest, the movements are directed to the NNW (340°), the NW (300°) and finally to the SW (225°). The oldest movement (NNW) was only observed at three sites, all within the Lac Naococane map sheet (23 D). Nonetheless, the strong development of striated surfaces indicates that this early movement was likely regional in scope. It was followed by a major regional movement to the NW, observable on approximately 30% of outcrops. Recognized all the way up to Ungava during our earlier studies, this NW movement appears to extend southward to Otish latitudes. Given the high frequency of striated surfaces and the significance of the accompanying glacial transport over all of northern Québec, this movement is assigned to the second-to-last glacial maximum (~70,000 years). The youngest and most geomorphologically dominant movement is attributed to the last glacial maximum (~20,000 years) and to subsequent deglaciation due to the long dispersal trains that it created towards the SW.

The analysis of digital field models reveal that the regional bedrock is crossed by two main networks of late fractures. The dominant system is oriented NNW-SSE and is particularly well developed in the Archean bedrock to the west of the region. It is absent from the Proterozoic Otish and Mistassini basins but is parallel to the Mistassini dyke swarm and thus assumed to be of the same age (2470 Ma). The other well developed system is oriented SW-NE and likely of the same age as the parallel Preissac dyke swarm (2167-2214 Ma), the extension of which can be detected under the Otish and Mistassini basins using aeromagnetic maps.

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133

A catalytic model for the origin of the Archean cratonic lithosphere

Jean Bédard (GSC-Q)

There is no consensus regarding the processes responsible for the quasi-synchronous origin and formation of: (1) the Archean continental crust, mainly composed of plutons belonging to tonalite-trondhjemite-granodiorite suites (TTG), (2) komatiitic to tholeiitic lavas (KT), and (3) the ultra-depleted subcontinental lithospheric mantle (SCLM). The Douglas Harbour Domain (2.7-2.9Ga) of the Superior Province includes two TTG suites, Faribault-Thury West (FTW) and East (FTE), which contain embedded KT greenstone belts. The FTE-W tonalities display elevated La/Yb ratios and are enriched in LILE (Ba-Rb-K-Cs-U-Th-Pb) with + Sr-Pb anomalies and B Nb-Ta-Ti anomalies. These signatures are often explained by variable melting rates of the subducted oceanic crust, but could also be the result of melting at the base of a basaltic plateau in the presence of garnet and rutile. With increasing SiO_2 content and the depletion of CaO-FeO-MgO-TiO_2-P_2O_5, the degree of Y-Yb depletion and the size of the Sr-Eu B anomalies increase. Field relationships (in-situ segregations of trondhjemite), phase equilibria (hornblende stabilized at high pressure), petrography (corroded phenocrysts of epidote and muscovite; rarity of plagioclase as phenocrysts), and trace element models collectively imply that the evolution of trondhjemitic tonalite resulted from hornblende-dominated crystallization and is probably not caused by variable rates of partial melting in the subducted oceanic crust. The geochemistry of the FT tonalites can be modeled by 15-30% melting of the FT tholeiitic basalts, leaving clinopyroxene/garnet/hornblende/rutile residues of 98/2/0/0.1 (FTW) and 50/25/25/0.2 (FTE). The modeled residues have similar compositions to those of eclogitic xenoliths in kimberlites. It is suggested that these eclogitic xenoliths generated at the base of a basaltic plateau were delaminated and mixed with underlying depleted mantle, which became refertilized and allowed it to remelt and generate the ultra-depleted SCLM. A representative trace element model implies that the remelting of such an ultra-depleted source contaminated by crustal eclogitic residues could generate Munro-type komatiites. Degassing of unmelted delaminated domains could generate boninites. Through repetition, this process of catalytic delamination explains the synchronous genesis of Archean crust and mantle, explains progressive crustal maturation (tonalite to granite transition), and simplifies tectonic models because all Archean magmatic suites can be generated in a single environment.

135

Diamonds and platinum group elements

Sarah-Jane Barnes (UQAC), Michel Chouteau (E. Polytechnique) and Marc Constantin (U. Laval)

Garnet composition as an indicator of kimberlite fertility

Richard Cox and Sarah-Jane Barnes (UQAC)

Garnet is frequently used as an indicator mineral for kimberlites. Its nickel content acts as a geothermometer and may indicate if the mineral formed within the diamond stability window (900-1200°C). Trace elements and rare earth elements provide information about secondary processes that can affect the stability of diamonds. This project allowed us to develop a LA-ICP-MS analytical protocol for garnets and to build a reference database with which to evaluate the diamond potential of the source rocks of the analyzed minerals. The low detection limits for LA-ICP-MS allows individual grains, thin sections, or rock fragments to be analyzed. The geochemistry of kimberlitic garnets was studied using heavy mineral concentrates and xenoliths.

Geophysical signatures of kimberlites in Québec

Michel Chouteau and Benoît Tournerie (E. Polytechnique)

The goal of this project is to determine the geophysical signatures associated with kimberlites with the aim of assisting exploration companies in their search for diamonds in Québec. One of the avenues of study will be to characterize the physical properties of kimberlites by performing density, magnetic susceptibility and electrical conductivity measurements directly on samples of kimberlitic rocks. Measurements have already been made on samples from Québec and elsewhere in Canada. Furthermore, the direct relationship between the age of kimberlite emplacement and its remanent magnetism allowed us to develop a method for determining magnetization parameters using the measured magnetic field.

Metallogeny and petrology of the Ni-Cu-Co-PGE deposit of the Renzy mine

Marc Constantin and Luc Laperrière (U. Laval)

The Renzy mine in the Outaouais region produced 0.7 Mt of ore grading 0.72% Ni and 0.70% Cu in the early 1970's. Other Ni-Cu-PGE showings have also been recorded in the area. The favourable geological factors for mineralization are the presence of olivine-bearing mafic and ultramafic rocks, the availability of crustal contimants (paragneiss) that promoted sulphide immiscibility and precipitation, and the presence of large regional tectonic structures. The origin of the mineralizations, their paleotectonic context, their mode of formation and their temporal relationship to regional magmatic activity remain poorly understood. The goals of the project are to : 1) establish the age of the Lac Renzy intrusion, 2) evaluate sulphide fractionation in the sills, 3) evaluate the role of crustal contamination by the paragneiss of the Grenville Supergroup and the importance of this process in mineralization, 4) establish the presence or absence of petrogenetic links between the different ultramafic intrusions, and 5) clarify the regional geodynamic context using geochemical and structural data.

Posters

136
Sedimentary and metamorphic environments

Georges Beaudoin (U. Laval), Michel Chouteau (E. Polytechnique), Michel Gauthier and Michel Jébrak (UQAM)

Red-bed copper deposits in the Québec Appalachians

Georges Beaudoin and Alexandre-Raphael Cabral (U. Laval)

Copper deposits associated with red beds in the eastern Québec Appalachians fall into two classes: "volcanic red-bed copper", of which the best example is the Cu-Ag deposit of Mont Alexandre, and "continental red-bed copper", like that of the Transfiguration Cu-Ag deposit. Mineralization at Mont-Alexandre is hosted by spilitized and hematized Silurian basalt. Two modes of native copper have been identified: 1) inclusions in plagioclase, most likely of magmatic origin, and 2) epigenetic, associated with malachite in cavities and stringers. Elevated levels of silver (100-1,000 ppm Ag) are present in solid solution for both types. At Transfiguration, copper mineralization is found in grey sandstones overlain by red beds, which were partially reduced during diagenesis, occurring near the base of the Robitaille Formation (Silurian) that is marked by a zone of nodular calcrete within green sandstone above the Taconian unconformity.

Mineralogy and geophysical properties of disseminated zinc deposits in marbles of the Grenville Supergroup

Michel Chouteau (E. Polytechnique), Michel Gauthier (UQAM), Bernard Giroux (E. Polytechnique) and Jean-François Larivière (UQAM)

Two types of disseminated zinc mineralization can be found in southwestern Québec: sulphides at Cadieux and silicates and oxides at Bryson. These deposits constitute a new mineral target for the exploration industry. The mineralogical study of the non-sulphide deposits provides a useful tool for prospectors. Mapping of the marble units will result in a better understanding of how these deposits are related to the host evaporite platform deposits. Disseminated sphalerite mineralization does not respond to traditional geophysical methods (IP, EM, Mag). The physical properties measured for drill core and outcrop samples, and those estimated using existing geophysical surveys, demonstrate that gravimetry may be an effective exploration method because the density of the marbles increases with increasing sphalerite grades.

3D modeling of mineralized breccia bodies

Michel Jébrak, Renan Furic, Marc-André Brulotte and Martin Lalonde (UQAM)

Fieldwork in the Chibougamau region revealed different styles of magmatic-hydrothermal Cu-Au breccias: hydraulic breccias at Troilus, and fluidized transtensional zones at the summit of an early porphyry at Queylus. Digital modeling provided a better understanding of breccia formation, and revealed that fragment shape is dependant on the dissolution law and therefore on rock-fluid disequilibrium. This work resulted in the development of tools that can be used during mineral exploration.

137
Results of new research projects

Denis Bois (UQAT), Robert Marquis (MRNF) and Anthony E. Williams-Jones (U. McGill)

3D mapping and gold potential evaluation of the western segment of the Cadillac-Larder Lake in Québec

Olivier Rabeau (UQAT), Robert Marquis (MRNF) and Denis Bois (UQAT)

A large number of gold deposits in the Abitibi are associated with deformation corridors, including the Destor-Porcupine and Cadillac-Larder Lake faults. The latter extends from Matachewan, Ontario, to the east of Val-d'Or, Québec. Numerous deposits mark these faults, except along the Ontario-Québec border and in the Cadillac region. This absence of major deposits is due to the Proterozoic sedimentary rock cover. The few structures that are not buried host replacement-type gold mineralization associated with highly altered brittle-ductile deformation zones (Francoeur and Kerr Addison mines). These deposits have great economic value and are characterized by relatively constant grades, considerable tonnage and thicknesses that systematically exceed two metres.

This project aims to produce a georeferenced 3D model that integrates all available geological, geophysical and geochemical data on a single high performance computer platform (gOcad). Three-dimensional modeling of the Cobalt Group will target sectors where the thickness of the sedimentary cover is minimal. By combining new geophysical data and recognizing significant alteration patterns in 3D, and by using Normat indices, queries should reveal precise new exploration targets related to geological structures that have been inferred using all available data.

Experimental study of copper transport in H_2S-H_2O vapour

Denis Zezin and Anthony E. Williams-Jones (U. McGill)

Current models for the origin of porphyry systems are based on the idea that brines transported the metals. However, analyses of gaseous porphyry inclusions and geochemical calculations suggest that both liquids and gases transported the metals. Recent experimental work also revealed remarkably high concentrations of metals complexed with chlorine in the gases. Still unknown is the role of H_2S – a molecule known for creating stable copper complexes and one that may be strongly partitioned into the vapour phase.

The goal of this project is to conduct experiments on the solubility of copper in sulphidic vapours. This innovative approach could have a major impact on genetic models for this important class of deposits.

138

The Blake River Group: an imbricated caldera complex

Vital Pearson (CONSOREM)

A new genetic model for the Blake River Group (BRG) of the Archean Abitibi Subprovince is presented. The model builds on the results of several previous studies, but is mainly based on fieldwork conducted by the author from 1980 to 2000. Mapping was carried out in both Québec and Ontario segments of the BRG. The proposed model could change many paradigms and mineral exploration concepts for the region.

This research redefines the BRG as the product of the construction of a large scale differentiated volcano-plutonic complex: a supervolcano that experienced at least three phases of collapse. The supervolcano consisted of a series of overlapping calderas of various ages and sizes. The Misema caldera is a newly recognized feature and represents the first phase of collapse. Its scale – more than 100 x 150 km – almost corresponds to the present-day boundaries of the BRG, and would be comparable in size to the Taupo (New Zealand) and Yellowstone (United States) caldera structures. Late stage deformation partly modified the geometry of the rocks, but without losing the main elements of the original architecture. The preserved radial and concentric arrangement of mafic dykes in the heart of the BRG and the preponderance of pyroclastic deposits and carbonate alteration zones along its periphery are elements that led to the interpretation of large collapse-related annular faults. These faults would have served as conduits for mafic magma, pyroclastic eruptions and the circulation of hydrothermal fluids.

The second phase of collapse is represented by another newly recognized structure known as the New Senator Rouyn caldera. This caldera is of a more modest size, but its known area may represent only one part of a larger caldera with a collapse zone oriented N-S to NW-SE.

The third phase of collapse corresponds to the well-known Noranda caldera proposed by De Rosen Spence (1976), Dimroth *et al.* (1982) and Gibson (1989). This caldera is associated with an E-W collapse system within which numerous synvolcanic faults controlled VMS mineralization.

The interpretation of the BRG as a series of overlapping calderas has implications for mineral exploration. The metallogenic impact of the Noranda caldera is well known, but the importance of the other two calderas remains to be evaluated. According to preliminary interpretations, the Horne mine is located near the bounding fault of the New Senator Rouyn caldera. The Magusi-Iso and Bouchard-Hébert deposits, as well as the prolific Bousquet camp, may be associated with the annular faults of the Misema caldera.

141

Epithermal mineralization in the Gaspé Belt, Québec, Canada: the Dôme de Lemieux (Pb-Zn-Ag) and Sainte-Marguerite (Au-Ag) deposits

Alan D'hulst, Georges Beaudoin (U. Laval) and Michel Malo (INRS-ETE)

The Devonian rocks in the Gaspésie host several low- to intermediate-sulphidation epithermal deposits. Dôme de Lemieux is an anticlinal structure consisting of Devonian sedimentary and volcanic rocks cut by numerous faults. Mineralization is undeformed and unmetamorphosed. The Sainte-Marguerite showing is located along the Acadian Sainte-Florence Fault, within the volcanic and pyroclastic rocks of Sainte-Marguerite, and is associated with mudstones of the Fortin Group. Mineralization is deformed and metamorphosed to the greenschist facies.

The southern part of the Dôme de Lemieux deposit consists of 13 veins of quartz-dolomite with sphalerite, galena ± pyrite, chalcopyrite and hematite. Quartz displays crustiform textures and dolomite is occasionally present as lamellar dolomite: these are characteristic features of low- to intermediate-sulphidation epithermal deposits. The Sainte-Marguerite deposit displays two main vein types. Deformed veins of quartz, pyrite, sphalerite, galena, chalcopyrite, arsenopyrite and adularia are cut by undeformed veins of quartz, arsenopyrite, sphalerite and pyrite. Grains of electrum were observed along fractures in cataclastized pyrite, along the margins of recrystallized pyrite grains, or within inclusions in pyrite or arsenopyrite. Mineralized veins are surrounded by carbonatization and "phengitization" alteration haloes within metre-scale zones of pervasive silicification.

The $\delta^{18}O$ isotopic composition of Dôme de Lemieux quartz is from 6.4 to 13.7‰, suggesting the action of a hydrothermal fluid with a composition of -2 to 3‰ at a temperature of 250°C. Such a composition indicates the significant presence of a superficial, marine or meteoric fluid. The $\delta^{18}O$ compositions for quartz at Sainte-Marguerite fall between 16.5 and 18.7‰ (fluid = 4.5 to 7.5‰), suggesting the action of a fluid that interacted with sedimentary rocks. The similar $\delta^{13}C$ compositions for calcite, dolomite and ankerite at Dôme de Lemieux (-5.5 to -1.5‰) and at Sainte-Marguerite (-5 to 0.5‰) indicate a component of inorganic carbon in the fluids of both deposits. The $\delta^{34}S$ compositions for pyrite, sphalerite, galena and chalcopyrite at Dôme de Lemieux range from -4.5 to 5.1‰ and suggest the presence of a magmatic sulphur component, and possibly a lighter sedimentary sulphur component as well. At Sainte-Marguerite, the $\delta^{34}S$ for pyrite, arsenopyrite, sphalerite and galena are 3.5 to 9.5‰ and likely implicate crustal sulphur of possible basaltic rock origin. And finally, the Pb isotope data at both deposits suggest that lead was leached from a single supracrustal source with the occasional contribution of lower crustal lead, probably leached from Grenvillian basement.

Posters

142

The crustal architecture and tectono-sedimentary evolution of the Gaspé Basin

Martin Beche (U. Laval)

The Gaspé Peninsula lies within the northeastern part of the Québec re-entrant and includes the most complete Mid-Paleozoic stratigraphic sequence in the Canadian Appalachians. The rocks of the Gaspé Peninsula were affected by two orogenic phases as the Taconian orogeny was overprinted by the Acadian orogeny.

The recent revival of petroleum exploration activity in the Appalachians, in particular the acquisition of new seismic data as part of an initiative by Quebec's Ministry of Natural Resources and Wildlife in the Gaspé Peninsula, has helped boost research projects that examine the hydrocarbon potential of this region.

It is evident that if we are to understand the petroleum system and pursue exploration projects, we must better define the crustal architecture and tectono-sedimentary evolution of the region. The objective of our work is to clarify the regional tectono-sedimentary and petroleum history by integrating geological data into the operation and processing of seismic profiles and into the modeling of geologic structures.

We have reprocessed the MRNFP's acquired seismic data to obtain a series of prestack depth images. Wave equation based geophysical software from the *Institut Français du Pétrole* was used for the migration and tomography of more problematic zones.

Seismic image interpretations were consistently validated by the geological observations at the surface. These interpretations will be used to construct balanced sections with LOCACE software to verify if the current geometry is compatible with the most likely previous state and if a progressive deformational path exists between the two. BALISS software will then be used to restore the sections to their pre-deformation configuration and the history of burial and emergence for the sequences can be quantified.

The subsequent step will be to model rock deformation with the Thrustpack kinematic modeling software using our interpretations complemented by maturation data to improve the model.

This approach, which integrates surface geological data and seismic data processed using various software from IFP, will allow us to more precisely define the thrusting and décollement zones as well as the architecture of synorogenic deposits and unconformities, and to propose tectono-evolution scenarios from the deposition of Cambro-Ordovician sequences until the final phases of Upper Paleozoic deformation.

143

Production of second-generation geological maps through analysis of multi-source data in a GIS environment: an example from the Grenville Province, Québec

S Parsons (INRS-ETE), L Nadeau (GSC-Q) and M Malo, (INRS-ETE)

The decrease in easily accessible/unexplored territories coupled with the increase in costs of field mapping creates a growing need to progress toward modern and innovative mapping techniques. In parallel, the recent surge in the availability of multi-source geoscience data allows data sets to become increasingly larger and tough to manage. Geographic Information System (GIS) platforms provide powerful tools to integrate, analyse and interpret data sets of diverse nature to produce new predictive maps, and to update aging geological map sets.

This study presents the various approaches and limitations surrounding the preparation of second- generation geological maps, through empirical and mathematical analysis of geoscience data in a GIS environment. The large amount of available remotely sensed data in the Mingan region (NTS 12L) and the area's wide range of lithologies and complex regional structure render it an ideal area for a comprehensive GIS-based study of the geology.

Integrated datasets include: i) geological maps (some >50 years old) containing lithological and structural data, ii) aeromagnetic and radiometric data, iii) Landsat TM-7 and Radarsat-1 satellite imagery, iv) air photographs and, v) 2D and 2.5D topographic elevation models. Techniques and approaches developed in this study are applied to the evaluation and interpretation of these data sets. Ultimately, correlation models between analytic signals and geological units are elaborated for each.

Correlations are achieved by superposing or combining bands of images. Our evaluation of the different treatment methods shows, for example, that the radiometric flight line data are much more effective at defining boundaries between the geological domains than are the contoured map data. Treatment of the aeromagnetic data shows that certain transformations are more effective at differentiating lithologies, while others are more effective for mapping contacts. Evaluation of the radar digital elevation model indicates that variations in topography correlate with different lithologies. Finally, satellite data are generally more effective for use in structural interpretation.

Aeromagnetic data modeling and geostatistical analyses permit to identify limitations and deficiencies associated with this type of integration study and help to define ways in which these may be overcome. As illustrated in this study, the full integration and analysis of existing geoscience data on a GIS platform is the number one step required prior to undertaking future targeted geological field mapping. Finally, this study shows the paramount importance of the geologist input at all stages in the decision making process leading to more precise geological maps with greater predictive potential.

Salon Laval - November 22 and 23

11:00 Potential of the Blake River Group

Claude Dion, Marc Legault (MRNF) and Olivier Rabeau (URSTM-UQAT)

This session consists of two presentations on the geology and the copper and gold potential of the Blake River Group and the Cadillac Fault to the west of Rouyn-Noranda.

The geological survey of the western Blake River Group, to the west of the Flavrian Pluton, continued in the summer 2005. The objectives of this project were to clarify the stratigraphy, characterize volcanic and tectonic processes, and compare rocks in this part of the Blake River Group to those in the Noranda and Doyon-Bousquet-LaRonde mining camps. Fieldwork conducted this past summer was mainly concentrated in the northwestern part of Beauchastel Township, south of the Four Corners deposit. The geology in this area is characterized by a felsic and mafic-intermediate bimodal volcanic sequence assigned to the Duprat-Montbray Formation of the Blake River Group. This SE-facing homoclinal sequence strikes NE-SW. Several gabbro-diorite intrusions (*e.g.*, Horseshoe Gabbro), a porphyritic tonalite intrusion (Twin Lake Pluton) and Proterozoic gabbro-diabase dykes cut the volcanic pile. Many of these intrusions occupy extensional structures that probably represent synvolcanic faults. The sequence is also cut by a series of NW and NE to NNE-trending faults. At least four types of mineralization are known in the study area: (1) VMS-type polymetallic occurrences associated with thin exhalative horizons along contacts between volcanic units. The best example of this type of mineralization is the Four Corners deposit; (2) Cu-Ni±PGE occurrences associated with mafic intrusions. This type includes the RM Nickel deposit, located along the eastern margin of the Horseshoe Gabbro, and the Ley showing, associated with a Proterozoic gabbro-diabase dyke; (3) gold-bearing mesothermal quartz-carbonate veins; (4) gold (±Cu, Ag, Mo) occurrences associated or not with quartz veins, characterized by the presence of disseminated and lenses of magnetite and pyrite and by intense albite and hematite alteration (*e.g.*, Nordis-Zone E). This work should help define prospective volcanic centres and stratigraphic layers for VMS deposits, as well as structures which may be associated with the different types of gold mineralization.

The Cadillac-Larder Lake Fault (CLLF) represents a major tectonic feature and an important regional structural control for the emplacement of gold occurrences. The western segment of the Québec side of this important structure, as well as most of its subsidiaries, is overlain by Proterozoic sediments of the Cobalt Group. The presence of these sediments renders most traditional gold exploration methods useless. A project funded in part by DIVEX and undertaken with the cooperation of UQAT, UQAM and the MRNF was launched in the summer 2005. The objective is to map in three dimensions the sedimentary Cobalt Group. The 3D model of the Cobalt Group will help identify areas where the sedimentary cover is thinnest. Furthermore, the team will attempt to decipher the geometry of geological units in the underlying Archean basement and trace the CLLF and its subsidiaries using drillholes going through the sedimentary cover as well as geophysics. The MRNF has also undertaken a metallogenic synthesis of gold occurrences spatially associated with the CLLF. Following a brief field study and a compilation of the various deposits, we can conclude that most gold occurrences in the area are associated with quartz-carbonate veins typical of orogenic deposits. However, other less common types of mineralization are also present, namely occurrences spatially associated with syenites, characterized by copper and molybdenum enrichment. The CLLF area also shows a certain potential for other types of mineralization, which sometimes occur in as yet unclaimed parts of the study area.

Interactive sessions

Salon Saint-Louis - November 22 and 23

11:00 Québec's Far North: Profile of Geology and Mineral Potential

Alain Berclaz, Jean-Yves Labbé, Pierre Lacoste, Alain Leclair, Kamal N.M. Sharma, Martin Simard (MRNF) and Michel Boily (GÉON)

From 1998 to 2003, twenty mapping projects at 1:250,000 scale covering 32 NTS sheets were conducted in the northeastern Superior Province (NESP) within the scope of the Far North Program of Géologie Québec. Twenty geological reports and close to a dozen studies were published as a result of this work, in addition to several other contributions (undergraduate theses, Master's theses, articles) by students and research scientists from the academic field. Since 2004, the Far North team has focussed its efforts on synthesizing stratigraphic, geochronology, geochemistry, structural, metamorphic and ore deposit data. A global report presenting the results of this synthesis is to be released in 2006. This interactive session covering two time blocks will present the current results of this ongoing synthesis. The first day will be devoted to geological and stratigraphic settings, structural geology, metamorphism and geochemistry. The second day will focus on metallogeny and ore deposit studies. The selected format for these two sessions consists of an informal presentation using maps and PowerPoint presentations, to make these sessions as interactive as possible. Discussions between participants are strongly encouraged.

The NESP provides a remarkable record of episodic growth and repeated reworking of the Archean crust over a time interval from 3.82 to 2.62 Ga, *i.e.* spanning more than 1.2 billion years in the Archean eon. Based on current data, the NESP may be subdivided into at least ten major geological domains dominantly trending NW-SE to NNE-SSW, the configuration of which is interpreted as the result of a succession of at least ten major geological events.

Geochronology and neodymium isotope geochemistry data suggest that several paleocratons with ages ranging from 3.85 to 2.90 Ga covered the western (Inukjuak sub-domain), southern (Bienville, LaGrande-Goudalie domains) and northeastern (Douglas Harbour domain) parts of the NESP. In the field, geological elements related to these paleocratons consist of isolated volcano-sedimentary belts (Nuvvuagittuq Belt) and rare enclaves of tonalitic gneiss which represent the remains of an early sialic crust derived from at least three growth and reworking events during the Eoarchean (event I associated with phase of deformation D1), the Paleoarchean (event II), and the Mesoarchean (event A).

The Neoarchean period extending from 2.88 to 2.745 Ga is marked by the emplacement of: (1) a series of juvenile tonalite-trondhjemite-type magmatic suites, (2) greenstone belts dominated by tholeiitic basalts and komatiites interlayered with mafic to ultramafic subvolcanic bodies, and variably associated with felsic tuffs, iron formations, paragneisses, carbonate rocks and conglomerates, and (3) localized granodiorite units and nepheline syenite plutons. These units were emplaced during three major events (B, C and 1); they essentially outcrop in the LaGrande, Douglas Harbour, Goudalie, Minto and Tikkerutuk domains. Phase of deformation D2, oriented E-W to WNW-ESE and coeval with magmatism and volcanism, is locally preserved.

The Neoarchean period from 2.74 to 2.68 Ga represents a major change in the evolution of the NESP. This period is characterized by the emplacement of (1) several magmatic suites, from enderbite-opdalite-charnockite-type rocks, to granite-granodiorite, tonalite-diorite, and mafic to ultramafic intrusions, and (2) greenstone belts dominated by calc-alkaline felsic volcaniclastic rocks and paragneisses. The emplacement of these units over the course of three major events (2 to 4) coincides with the peak of regional metamorphism accompanied by the formation of diatexite and regional-scale phase of deformation D3, characterized by a regional foliation oriented NW-SE to N-S.

The last event (5), between 2.68 and 2.62 Ga, coeval with phase of deformation late-D3 to D4, is associated with the formation of oblique shear zones which controlled the emplacement of rare late units of granite-granodiorite and syenite-carbonatite, setting the stage for late to post-kinematic hydrothermal activity.

The second interactive session will be devoted to mineral deposits of the NESP and will cover the different types of mineralization observed, focussing on those with the most interesting economic potential. A total of 21 deposit types were recognized and classified based on their syngenetic vs epigenetic nature. Syngenetic Archean occurrences include: 1) Algoma-type iron formations (Fe), 2) volcanogenic sulphides (Cu, Zn, Au, Ag, Pb), 4) magmatic Ni-Cu, 4) Fe-Ti-V in mafic intrusions, 5) U-Th in porphyritic granites, and 6) porphyry Mo. Syngenetic occurrences are also present in Proterozoic cover rocks: 1) Cu-Ag in volcanic or sedimentary redbeds, and 2) sedimentary U. Several types of Archean epigenetic occurrences are also observed: 1) polymetallic disseminated occurrences (Cu-Zn-Ag), mainly in volcano-sedimentary rocks, 2) disseminated Au±Zn±Cu±Ag, mainly in volcano-sedimentary rocks, 3) iron formation-hosted Au, 4) gold-bearing quartz veins (±Cu-Zn-Ag), 5) polymetallic quartz veins in shear zones (with no Au), 6) polymetallic sulphide veins in ultramafic rocks (Cu-Au-Ag±Ni), 7) metasomatic REE in carbonate rocks, 8) vein-type U, and 9) Mo in fault zones. Two types of epigenetic occurrences are found in Archean rocks but may have formed during the Proterozoic: 1) Cu-Co quartz-magnetite veins, and 2) polymetallic (Cu-Zn-Pb) quartz veins. Finally, two other types of epigenetic occurrences are clearly Proterozoic in age: 1) Mississipi Valley-type Pb-Zn, and 2) unconformity-related vein-type U.

Salon Québec - November 22 and 23

11:00 Exploring for Architectural Stone in Québec

Yves Bellemare (MRNF)

The purpose of this session is to review what's been done over the last ten years in terms of exploration for architectural stone in Québec. We will namely:

- describe the results obtained;
- assess the effectiveness of current exploration methods;
- present targeted geological settings;
- draw up a profile of current trends;
- propose new potential geological settings for architectural stone exploration.

From 1995 to 2004, more than 400 prospecting and exploration projects for architectural stone were reported on an annual basis in Québec. Most of these projects were conducted in the Saguenay–Lac-Saint-Jean and Capitale-Nationale (Rivière-à-Pierre) regions. During the decade, 35 new quarries were brought into production but only 13 are still considered active today. These quarries are located mostly in southern Québec.

Most of the prospecting work was performed by the staff of quarry operators or by individual prospectors, who completed a prospecting course and who had access to financial and technical assistance under the Québec Mineral Exploration Assistance Program. Most prospecting projects were not followed up by conventional exploration work (geological, geochemical or geophysical surveys) but preceded development work such as stripping, sampling of m-scale blocks, polishing tests and physical characterization studies. Overall, geologists and geological engineers are largely absent in the early phases of exploration, with the result that no geoscience reports describing geological entities, identifying the best targets and describing the type of development work performed on initial discovery sites, are available.

During the interval from 1995 to 2004, granite (rocks from charnockitic suites, anorthosite, gabbro, diabase) was by far the most targeted substance for most prospecting and exploration projects. Since 1998, substances other than granite are sought for the production of architectural stone, namely slate, limestone, marble, sandstone and gneiss. Granite and gneiss exploration is concentrated in the Grenville Province and targets Proterozoic deposits. The remaining substances are Paleozoic in age and largely belong to the Appalachian Province.

Since the start of the 21st century, demand for stone for interior decoration purposes (kitchen or bathroom countertops) and landscaping (cobblestone, flagstone, paving and curbstone) has considerably increased. This demand, along with a drastic change in client preferences, has shifted the search towards rocks of different colours and textures. Furthermore, the modernization of processing plants and the use of innovative technologies now make it possible to extract and produce new stone varieties. This recent turn of events has opened up new geological settings for architectural stone exploration in Québec. Thus, the number of projects targeting slate, sandstone, marble and gneiss varieties has increased.

In the Témiscouata area, the search for slate has led to the opening of the Glendyne quarry, which produces a bluish black slate exported to Europe and the United States. Good-quality slate exposures are also found in the Gaspésie and Chaudière-Appalaches regions. The renovation of heritage buildings and demand for landscaping stone has bolstered interest for sandstone in Québec. A new quarry of red sandstone and another of green sandstone were opened in the Bas-Saint-Laurent and Gaspésie regions, where the exploration potential is quite high. Since 2001, several exploration projects have focused on the search for marble deposits in the Montérégie and Gaspésie regions. Positive results from this work has led to the opening of two quarries. More detailed work should also be conducted on green marbles (serpentinite) associated with the various ophiolitic complexes. Apart from the deposit located near Tadoussac, in operation since the 1950s and deposits in the Rivière-Pentecôte area, open since the 1990s, gneiss varieties were never very popular in Québec prior to the year 2000. Since then, two new quarries were brought into production in the Lac-Saint-Jean and Côte-Nord regions. Steatite and volcanic rocks are two other varieties of stone that warrant further investigations.

The current trend appears to indicate that prospectors and companies are slowly losing interest in stone exploration, heralding a drop in the number of projects over the next few years. Several factors may explain this situation, namely the lack of financial support for fieldwork, the lack of infrastructure for technical and professional training of explorationists and the relative weakness of associations or groups representing the latter.

Acronyms, list of Exhibitors, maps of exhibit rooms, project location maps and promotional presentations

Acronyms

AAEC	Anglo American Exploration Canada Inc.
AEMQ	Association de l'exploration minière du Québec
CERM	Centre d'études sur les ressources minérales
CGC-A	Commission Géologique du Canada, Atlantique
CGC	Commission géologique du Canada
CGC-C	Commission Géologique du Canada, Calgary
CGC-C	Commission Géologique du Canada, Centre du Canada
CGC-Q	Commission géologique du Canada, Québec
CONSOREM	Consortium de recherche en exploration minérale
CONSOREM0-UQAC	Consortium de recherche en exploration minérale - Université du Québec à Chicoutimi
CREGU	Centre de Recherche sur la Géologie des Ressources Minérales et Energétiques
DESUO	Department of Earth Sciences, University of Ottawa
DDH	Direction du développement des hydrocarbures
DG	Direction de Géologie Québec
E. Polytechnique	École Polytechnique
FGL	Franklin Geosciences Ltd
GÉON	Firme géo-conseil
GEOTOP-UQAM-McGill	Centre GEOTOP de l'Université UQAM-McGill
INRS-ETE	Institut National de la Recherche Scientifique, Eau-Terre-Environnement
MDDEP	Ministère du Développement durable, de l'Environnement et des Parcs
MIR	MIR Télédétection
MRC	Municipalité régionale de comté
MERC	Mineral Exploration Research Centre
MERC-DES	Mineral Exploration Research Centre, Department of Earth Sciences, Laurentian University
MRNF	Ministère des Ressources naturelles et de la Faune
MUN	Memorial University of Newfoundland
SIDEX	Société d'investissement dans la diversification de l'exploration
SHC	Service hydrographique du Canada
TSX	Toronto Stock Exchange
U. Laval	Université Laval
UHP	Université Henri Poincaré
U. McGill	Université McGill
UMR CNRS G2R	Unité Mixte de Recherche, Centre National de la Recherche Scientifique, Géologie et Gestion des Ressources Minérales et Energétiques
UQAT	Université du Québec en Abitibi-Témiscamingue
URSTM-UQAT	Unité de Recherche et de Service en Technologie Minérale – Université du Québec en Abitibi-Témiscamingue
U. Toronto	Université de Toronto, Département de géologie

List of Exhibitors

Salle de Bal

1 Abitibi Géophysique inc.
2 Ressources Appalaches inc.
3 Géophysique GPR International inc.
4 Tres-Or Resources Ltd
5 Ressources Sirios et Exploration Dios inc.
6 Goldbrook Ventures Inc.
7 Osisko Exploration ltée
8 Vior inc.
9 IOS Services Géoscientifiques inc.
10 Systèmes Géostat International inc. - Géovariances
11 Les hélicoptères canadiens ltée
12 Cambior inc.
13 Quinto Technology inc.
14 Prospectors and Developers Association of Canada
15 Ministère des Ressources naturelles du Nouveau-Brunswick
16 Centre géoscientifique de Québec
17 Ministère du Développement du Nord et des Mines de l'Ontario
18 Activation Laboratories Ltd
19 Exploration Typhon
20 SRK Consulting
21 Mira Geoscience Ltd
22 Groupe Fordia ltée
23 SOQUEM inc. - Ashton
24 SGS Minerals Ltd
25 Université du Québec en Abitibi-Témiscamingue (UQAT)
26 Ressources Metco inc.
27 Golden Valley Mine Ltd
28 Fugro Airborne Surveys
29 Mines d'Or Virginia inc.
30 MIR Télédétection inc.
31 Héli-Transport Inc. - Héli-Max ltée
32 Terraplus Inc.
33 Exploration Azimut inc.
34 Commissaire au lobbyisme du Québec
35 Société de développement de la Baie-James
36 Aurora Laboratory Services Ltd
37 Corporation minière Alexis
38 Quantec Geoscience Inc.

Bellevue

40 Commission de la santé et de la sécurité au travail
41 Nolinor Aviation
42 Diagnos Inc.
43 Scintrex Ltd
44 Géophysique TMC inc.
45 Ressources naturelles Canada - Centre d'information topographique
46 Aeroquest Ltd
47 CNQ-Canadian New Stock Exchange
48 Groupe Investors inc.
49 Fonds d'exploration minière du Nunavik
50 Université Laval
51 Maxwell Geoservices Inc.
52 Ordre des géologues du Québec
53 Géotic Inc.
54 Université McGill
55 Commission géologique du Canada

Verchères

60 Canadian Royalties Inc.
61 Instrumentation GDD inc.
62 Groupe conseil LVMB inc.
63 Geotech Ltd

Place d'Armes

90 Dianor inc.
91 Stoncor Group
92 Gestion environnement, santé et sécurité au travail
93 Borinfo Inc.
94 Falconbridge Ltd
95 Century Mining Corporation

Salon Rose

1 Hydro-Québec Pétrole et Gaz
2 Conquest Seismic Ltd - Manderson Exploration Inc.
3 HCL National Inc. - Austin Powder Ltd - Bertram Drilling Ltd
4 Gastem inc.
5 Pétrolia inc.
6 Geophysical Applications Processing Services Ltd
7 Junex inc.
8 MRNF - Développement des hydrocarbures
9 MRNF - Développement des hydrocarbures
10 MRNF - Développement des hydrocarbures
11 Ressource et énergie Squatex inc.
12 MIR Télédétection inc.

Salle Jacques Cartier

101-102 La nouvelle carte géologique (1 : 500 000) de la Sous-province de l'Abitibi et l'étude de plutons pour le cuivre

The new 1:500,000 geological map of the Abitibi Subprovince and the study of plutons with a focus on copper

103 Évaluation du potentiel des gîtes de type Cu-Au porphyrique dans la région de l'Abitibi : modèle théorique préliminaire

Evaluation of the potential for Cu-Au porphyry-type deposits in the Abitibi region: preliminary theoretical model

List of Exhibitors

104 Correspondances stratigraphiques entre le Parautochtone et la Sous-province de l'Abitibi dans la région de Chibougamau : implications pour l'exploration minière

Stratigraphic relationships between the Parautochthonous and the Abitibi Subprovince in the Chibougamau region: implications for mineral exploration

105 Modèle 3D géo-intégré du secteur du lac aux Loutres, Ceinture d'Urban-Barry (Abitibi) : identification de nouvelles cibles d'exploration

Geointegrated 3D model for the Lac aux Loutres sector, Urban-Barry Belt (Abitibi): identification of new exploration targets

106 Interprétations structurales et métamorphiques à travers le Front du Grenville : étapes initiales d'une modélisation 3D géo-intégrée au sud du camp minier de Chibougamau

Structural and metamorphic interpretations across the Grenville Front: initial stages of a geointegrated 3D model south of the Chibougamau mining camp

107-108 Carte préliminaire (2e édition) de la partie nord de la Ceinture centrale des métasédiments, Province de Grenville

Preliminary map (2nd edition) of the northern part of the Central Metasedimentary Belt, Grenville Province

109 Levé géochimique des sédiments de lacs dans la région de Manicouagan : plus qu'un outil de prospection

Geochemical survey of lake sediments in the Manicouagan region: more than just an exploration tool

110 Inventaire satellitaire de la géomorphologie du Moyen Nord

Satellite and geomorphology inventory of the Mid-North

111 Évaluation du potentiel en sillimanite et muscovite au nord-est de Mont-Laurier

Evaluation of the sillimanite and muscovite potential northeast of Mont-Laurier

112 Mise à jour de l'inventaire des carrières dans les régions de Chaudière-Appalaches et de la Capitale-Nationale

Update of the quarry inventory for the Chaudière-Appalaches and Capitale-Nationale regions

113-114 Carte géologique de la Gaspésie et du Bas-Saint-Laurent

Geological map of the Gaspésie and Saint-Lawrence Lowlands

115 Nouvelles données géochimiques sur des indices de Ni-Cu-EGP dans le Domaine de Portneuf-Mauricie

New geochemical data for Ni-Cu-PGE showings in the Portneuf-Mauricie Domain

116 Importance de l'oxygénation de l'atmosphère pour la métallogénie de la Fosse du Labrador

The importance of atmospheric oxygenation for Labrador Trough metallogeny

117 Compilation géologique (1 : 750 000) du nord-est de la Province du Supérieur, Grand-Nord du Québec

Geological compilation at 1:750,000 of the northeastern Superior Province in Québec's Far

118 Nouvelles données géochronologiques dans l'est du Grenville : précisions sur l'évolution magmatique

New geochronological data for eastern Grenville: clarifications regarding magmatic evolution

119-120 Favorabilité comparée du potentiel en or orogénique de l'Abitibi : logique floue hybride versus analyse neurale

Comparative favourability for the orogenic gold potential of the Abitibi: hybrid fuzzy logic versus neural analysis

121 Analyse structurale de l'anticlinal de Vilanova dans le bassin de l'Ebre, Pyrénées orientales, Espagne

Structural analysis of the Vilanova anticline in the Ebre basin, eastern Pyrenees, Spain

122 Modélisation analogique en recherche tectonique : les approches en échelle de la croûte et de la lithosphère

Analogical modeling in tectonic research: approaches at crustal and lithospheric scales

123 Nouvelles perspectives stratigraphiques pour le Groupe de Roy, Chibougamau : implications pour l'exploration

New stratigraphic perspectives for the Roy Group, Chibougamau: implications for exploration

124 Influence des structures précoces sur la géométrie des plis de propagation : restauration et modélisation cinématique directe en 3D

Influence of early structures on propagation fold geometry: reconstruction and direct kinematic modeling in 3D

125 Imagerie géophysique de la Gaspésie et du Bas-Saint-Laurent : 1- données gravimétriques

Geophysical imaging of the Gaspésie and the Saint-Lawrence Lowlands: 1- gravimetric data

126 Imagerie géophysique de la Gaspésie et du Bas-Saint-Laurent : 2- données aéromagnétiques

Geophysical imaging of the Gaspésie and the Saint-Lawrence Lowlands: 2- aeromagnetic data

127 Apport des données géophysiques pour la compréhension de la géométrie de l'orogène appalachien : modélisation gravimétrique de transects géologiques régionaux

The use of geophysical data to understand the geometry of the Appalachian orogen: gravimetric modeling of regional geological transects

128 Dolomitisation hydrothermale et réservoirs à hydrocarbures, les cas de l'Ordovicien, du Silurien et du Dévonien du Québec

Hydrothermal dolomitization and hydrocarbon reservoirs: the case of Ordovician, Silurian and Devonian sequences in Québec

129 Intégration des données multifaisceaux et des données de sismique-réflexion pour l'interprétation de la géologie de l'estuaire du Saint-Laurent

Integration of multibeam data and seismic-reflection data in the geological interpretation of the Saint-Lawrence Estuary

130 Distribution et contenu des principaux gisements aurifères au Canada et dans le monde

Distribution and content of major gold deposits in Canada and the world

131 Modélisation 3D de l'esker Saint-Mathieu - Berry (32 D/08 et 32D/09) à l'aide du logiciel Gocad®

3D modeling of the Saint-Mathieu - Berry esker (32 D/08 and 32 D/09) using Gocad® software

132 Dynamique glaciaire polyphasée et réseaux de fracturation dans le socle de la région des monts Otish et LG-4, Moyen Nord québécois

Polyphase glacial dynamics and fracture networks in the basement of the Otish Mountains and LG-4 region of Québec's Mid-North

133 Un modèle catalytique pour l'origine de la lithosphère cratonique archéenne

A catalytic model for the origin of the Archean cratonic lithosphere

134 Révision de la carte géologique de la région de Havre-Saint-Pierre (SNRC 12L) à l'échelle 1 : 250 000 : nouveau regard sur le groupe Wakeham

Revision of the geological map for the Havre-Saint-Pierre (SNRC 12L) region at a scale of 1:250,000: a new perspective for the Wakeham Group

135 Le diamant et les éléments du groupe du platine

Diamonds and platinum group elements

136 Les environnements sédimentaires et métamorphiques

Sedimentary and metamorphic environments

137 Résultats des nouveaux projets de recherche

Results of new research projects

138 Le Groupe de Blake River : un complexe de caldeiras imbriquées

The Blake River Group: an imbricated caldera complex

139-140 Résultats des projets de recherche au CONSOREM

Resultats of CONSOREM research projects

141 Minéralisations épithermales dans la ceinture de Gaspé, Québec, Canada : gîtes du Dôme de Lemieux (Pb-Zn-Ag) et de Sainte-Marguerite (Au-Ag)

Epithermal mineralization in the Gaspé Belt, Québec, Canada: the Dôme de Lemieux (Pb-Zn-Ag) and Sainte-Marguerite (Au-Ag) deposits

142 L'architecture crustale et l'évolution tectono-sédimentaire du bassin de la Gaspésie

The crustal architecture and tectono-sedimentary evolution of the Gaspé Basin

143 Production de cartes géologiques de deuxième génération par analyse de données de sources multiples dans un environnement SIG : un exemple tiré de la Province du Grenville, Québec

Production of second-generation geological maps through analysis of multi-source data in a GIS environment: an example from the Grenville Province, Quebec

144 Hommage Jérome Rémick

Tribute to Jérome Rémick

Montcalm

1 Denis Cyr, prospecteur

2 Fonds régional d'assistance à la prospection minière de la Gaspésie et des Îles-de-la-Madeleine

3 Fonds régional d'exploration minière de la Côte-Nord

4 Fonds minier du Saguenay – Lac-Saint-Jean

5 Exploration Flair

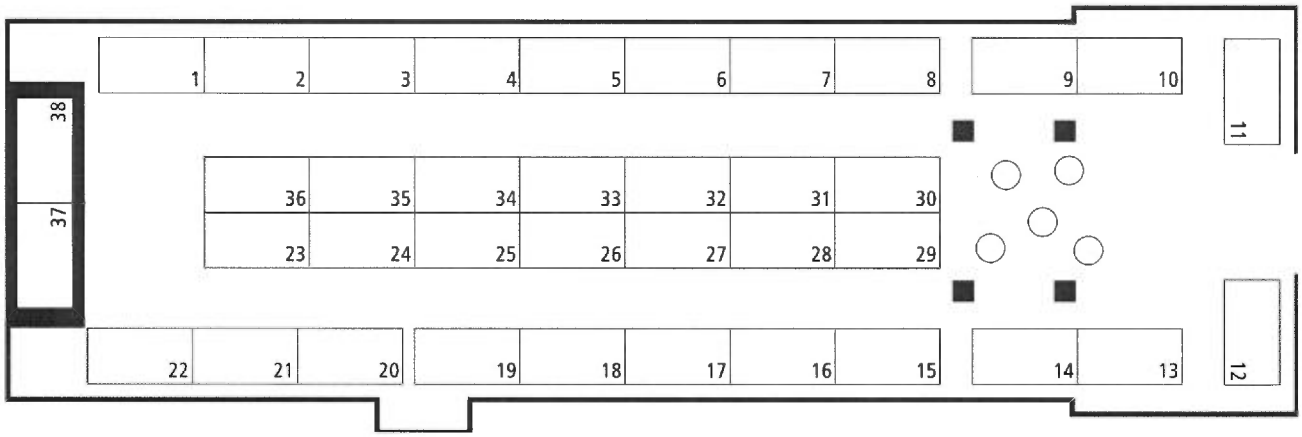
6 Projet Timrod

7 Conseil Cri sur l'exploration minérale

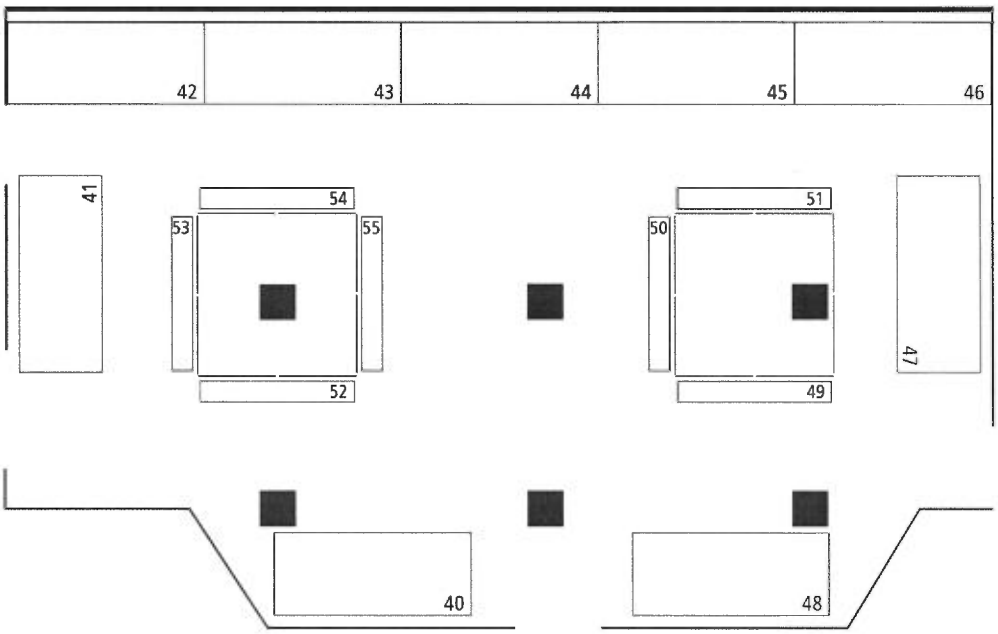
8 Table jamésienne de concertation minière

Maps of exhibit rooms

Salle de Bal
Trade Show

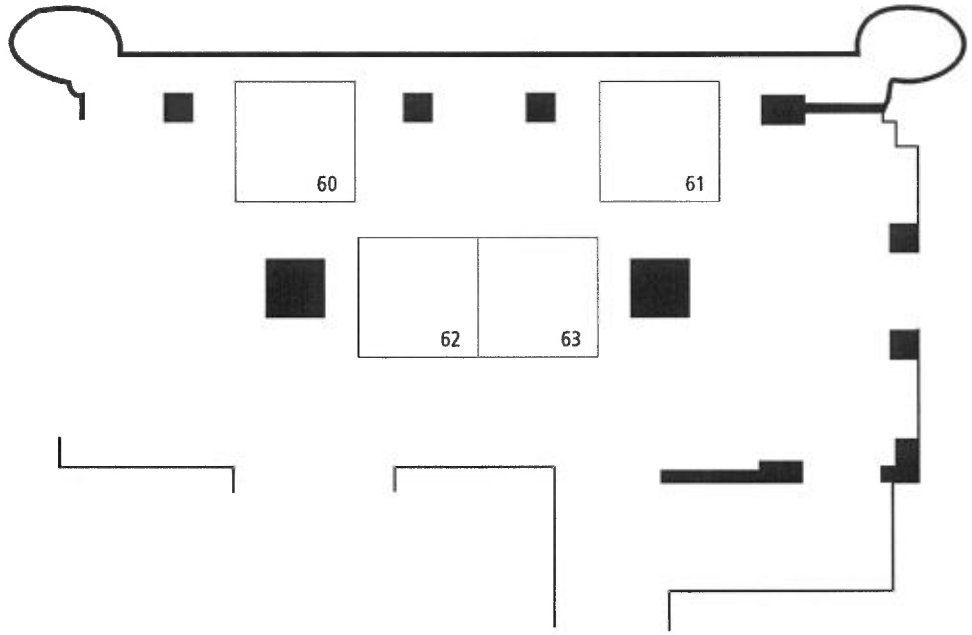


Bellevue
Trade Show

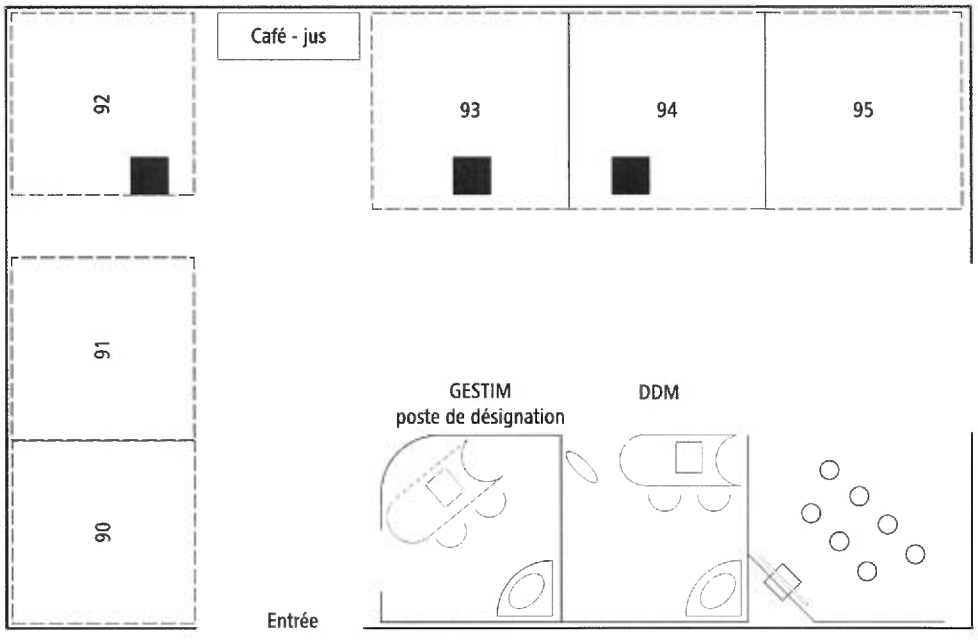


Maps of exhibit rooms

Verchères
Trade Show

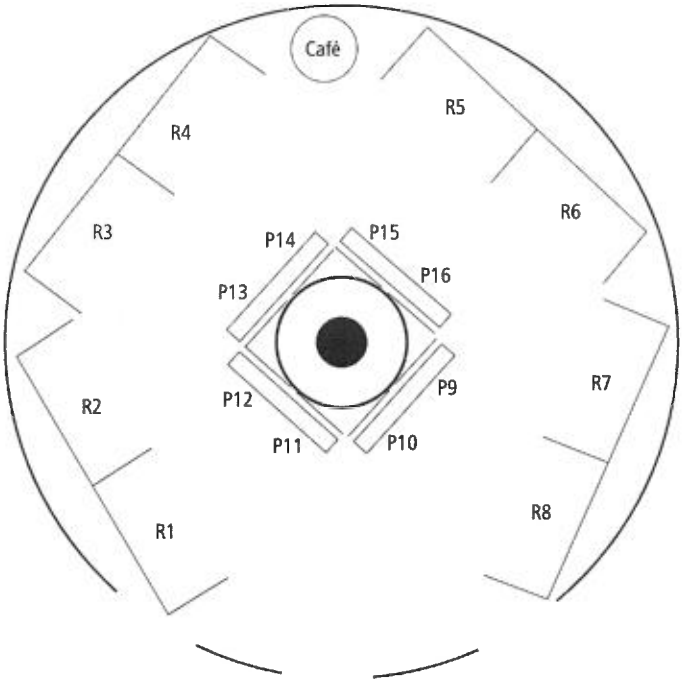


Place d'Armes
Trade Show

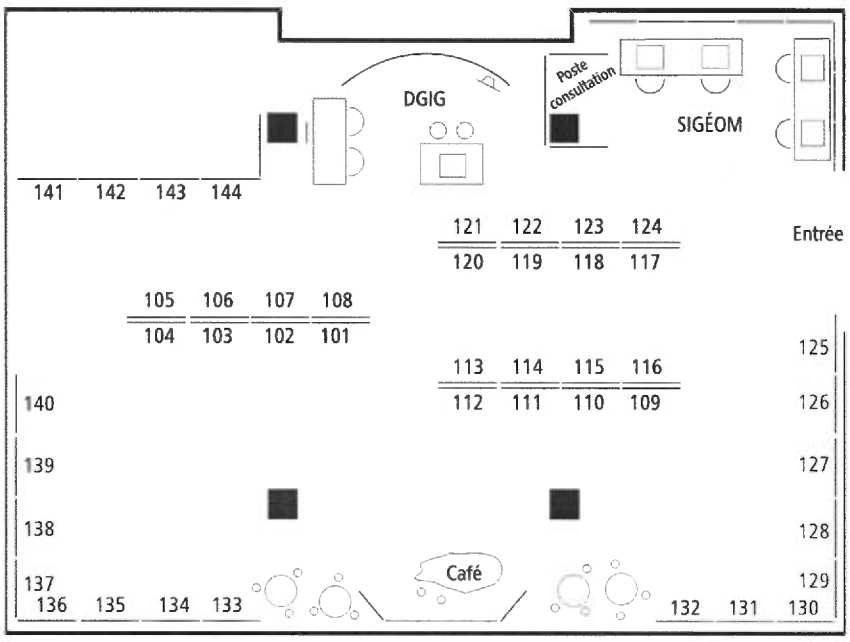


Maps of exhibit rooms

Salon Rose
Gas and oil

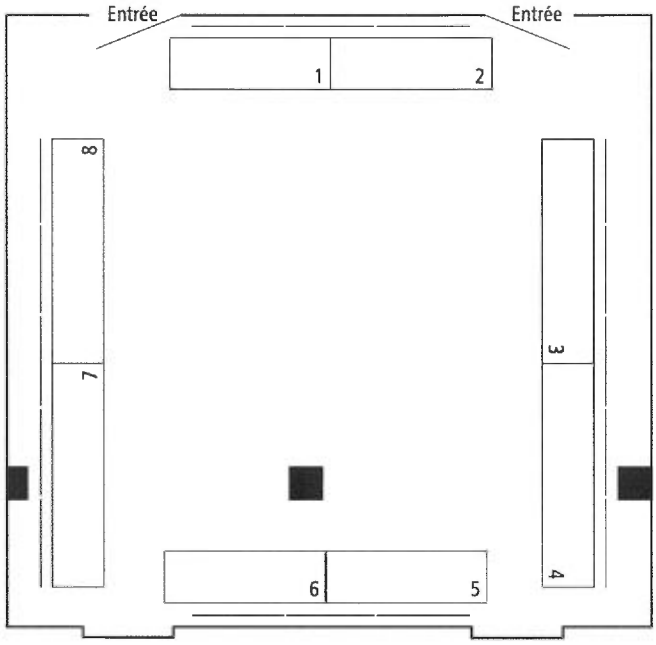


Jacques Cartier
Geoscience Exhibit, DGIG, SIGÉOM

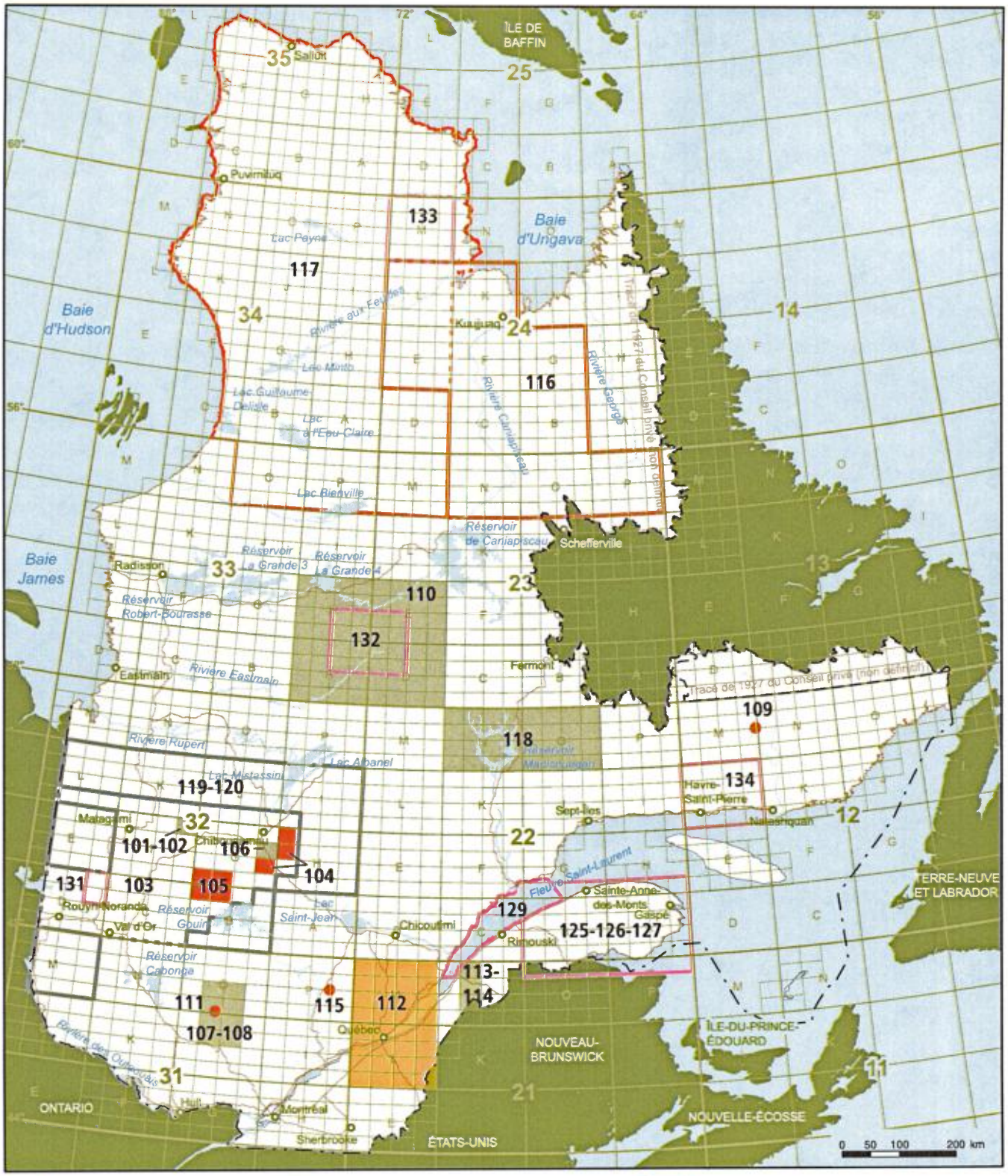


Maps of exhibit rooms

Montcalm
Prospectors' Tent



Projets location



Inventory

Compilations

Geological Survey of Canada

Study

Mineral potential maps

Promotional presentations

Tuesday, November 22

	Laval (60 persons)
1:30	Ressources Sirios inc.
1:50	Canadian Royalties Inc.
2:10	Golden Valley Mines Ltd
2:30	Les Mines Ashton du Canada inc.
2:50	Falconbridge Ltd
3:10	Woodruff Capital Management / Ressources Cogitore
3:30	Cambior inc.

	Saint-Louis (40 persons)
1:30	Servipetrol Int.
2:10	Junex inc.
2:30	Hydro-Québec, Gaz et Pétrole
3:00	Pétrolia inc.
3:20	Talisman Energy Inc.
3:40	Schlumberger Canada Ltd/Junex inc.
4:00	DIAGNOS inc.
4:20	Veritas

	Petit-Frontenac (100 persons)
1:30	DIAGNOS inc.
1:50	Abitibi géophysique inc.
2:10	Groupe Fordia ltée
2:30	Instrumentation GDD inc.
2:50	Développement Économique Canada
3:10	INRS-CGC
3:30	Fugro Airborne Surveys

Wednesday, November 23

	Laval (60 persons)
1:30	Groupe TSX
1:50	Lakeshore Gold Corp.
2:10	Groupe Conseil LVMB
2:30	Geotech Ltd
2:50	Conseil Cri sur l'exploration minérale
3:10	IOS Services Géoscientifiques inc.
3:30	Exploration Azimut inc.

	Saint-Louis (40 persons)
1:30	Forest Gate Resources Inc.
1:50	Contact Diamond Corporation
2:10	Uranor Inc.
2:30	Exploration Typhon inc.
2:50	Société d'exploration minière Vior inc.
3:10	Quinto Technology Inc.
3:30	Ressources Metco inc.

Ressources naturelles et Faune
Québec