DV 2004-07

ABSTRACTS OF ORAL PRESENTATIONS AND POSTERS, QUEBEC EXPLORATION 2004

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Énergie et Ressources naturelles
Québec

QUÉBEC

EXPLORATION 2004

November 22 to 25, 2004
Château Frontenac, Québec

Abstracts of oral presentations and posters

DV 2004-07

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Message from the Minister of Natural Resources, Wildlife and Parks

Québec's mining industry is increasingly asserting itself as a powerful economic lever and recent discoveries prove that our territory still has a few surprises left. The discoveries, particularly of nickel and diamond in northern Québec, eloquently reveal the riches our bedrock has to offer.

Our government recognizes the necessity of developing the mining sector and, beyond that, of just how important mining exploration is. In fact, there are several encouraging signs in Québec's mineral industry pointing to economic spin-offs that will benefit the workers, many communities, and businesses that count on that sector for their development.

Since our government believes in Québec's mining industry, we have made our flow-through share system permanent. It is also out of concern for the industry that we are taking action, in concert, to make sure that exploration is as efficient as possible and that the measures implemented for mining are positive for mining development. The results are convincing since $150 million were invested in exploration and mine development in 2003.

To maximize the industry's growth, we need to remain on the lookout for recent technological changes and available business opportunities. Québec Exploration is the ideal venue for exchanging geoscience information, creating new alliances, and establishing partnerships that are productive for both the industry and Québec. This event builds a bridge between the worlds of knowledge and business, between exploration and mining, and between Québec and the rest of the world.

There are major challenges ahead. Let us take advantage of this meeting to share our dreams and join forces for the mining industry.

Enjoy the event!

Sam Hamad

Minister of Natural Resources, Wildlife and Parks

Message from the Chairman of the Québec Mineral Exploration Association



The Québec Mineral Exploration Association, in partnership with the Ministère des Ressources naturelles, de la Faune et des Parcs, is inviting you again this year to the heart of historic Québec City for Québec Exploration 2004. In the wake of the Conférence Exploration-Mines held in May, in Rouyn-Noranda, and of "Abitibi 2004" presented in September, in Val-d'Or, Québec Exploration 2004 provides the mining exploration industry with an opportunity to get an update on mineral exploration and find out more about the most recent discoveries in Québec.

For the 2nd edition, the Organizing Committee is highlighting Québec's openness to business partnerships, which multiply opportunities to increase our share of world exploration investments and facilitate access to cutting-edge mineral exploration technology. In 2004, exploration investments in Québec will be the highest they have been in the past eight years. This enhancement will have a direct impact on the number of new discoveries and the development of mining projects. Technical sessions and exhibits at Québec Exploration 2004 will reflect this enthusiasm, which we would like to share with you.

Your stay in Québec will give you the opportunity to take advantage of the many social activities on the program, nicely combining business and pleasure. You will have many chances to discover that Québec is not only the best place in Canada for exploration, but also for fun!

I would also like to take this opportunity to cordially invite the members of the Association to attend the Annual General Meeting on November 24th. Be where the action is; run for election as a director.

Pierre Bérubé

Chairman, Québec Mineral Exploration Association



Message from the Honorary Chairman of Québec Exploration 2004

As a prospector-geologist trained with my initial work experience in Northern Québec, and as the founder of CMP flow through funds providing millions of dollars to exploration in Québec and throughout Canada, I am honoured and proud to have been asked to be the Honorary Chairman of Québec Exploration 2004.

The Government of Québec has created programs that are in favour of exploration and mining; Québec has vast mining expertise, and the resource commodity markets are poised for better times. This is a good time.

I anticipate that Québec Exploration 2004 will provide us with a wealth of information on all the exciting new exploration ideas and innovation in the mining exploration sector that is of such importance to our country's economy. I look forward to four days of learning and sharing a good time with fellow members of the Québec mining-exploration community.

Ned Goodman

Chaiman, CMP Group of Companies

Honorary Chairman of Québec Exploration 2004

List of organisers and their aids

Alain Simard
Ministère des Ressources naturelles, de la Faune et des Parcs

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Association de l'exploration minière du Québec

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Speakers Program

Georges Beaudoin
Université Laval
Département de géologie et de génie géologique

Pierre Verpaelst
Ministère des Ressources naturelles, de la Faune et des Parcs

Sessions
New Discoveries
Gaétan Lavallière and Georges Beaudoin

New Mining Exploration Technologies
Marc Legault and Marc Boivin

Superior Province: Québec-Ontario-Manitoba
Robert Marquis and Pierre Verpaelst

Expertise in Oil and Gas Exploration
Michel Malo and Jean-Yves Laliberté

Quaternary Geology and Mineral Exploration in Québec
Michel Parent and Rémi Charbonneau

Environmental Excellence in Exploration
Georges Beaudoin and Dave Comba

Business
Anne Slivitsky and Georges Beaudoin

Workshops and Short Courses

Chantal Dussault
Ministère des Ressources naturelles, de la Faune et des Parcs

Field Trips and Industrial Tours

Denis Raymond
SOQUEM INC.

Investors Night

Dominique Doucet
Ressources Sirios inc.

Accompanying Guest Program and Icebreaker

Richard Laplante
SOQUEM INC.

Partners

André Gaumond
Mines d'Or Virginia

Julie Charette
Association de l'exploration minière du Québec

Gala Evening

Marlène Bergeron
Ministère des Ressources naturelles, de la Faune et des Parcs

Gilles Therrien
Ministère des Ressources naturelles, de la Faune et des Parcs

Trade Show

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Jean-Claude Lapierre
Gilles Therrien
Ministère des Ressources naturelles, de la Faune et de Parcs

Adstracts of oral presentations and posters

Oral Presentations

November 23

Session 1 - New Discoveries

Chair: **Gaétan Lavallière**
SOQUEM inc.

8:15 **Welcoming address**

Alain Simard, Director (Géologie Québec) and Pierre Bérubé, Chair (Québec Mineral Exploration Association)

8:30 **Essential Elements of a Carlin-type gold deposit**

R. Tosdal (Mineral Deposit Research Unit, University of British Columbia), J. Muntean (Placer Dome Exploration), A. Hofstra (USGS) and K. A. Hockey (MDRU)

9:20 ★ **The Lapa Project: The Next Gold Mine in the Abitibi**

G. Long (Agnico-Eagle)

9:40 ★ **Doyon-Mouska Sector: Progress of Exploration Work and New Discoveries**

Y. Lei (Cambior inc.) and the geologists of the Geology Departments of the Doyon and Mouska Mines

10:00 ★ **New Copper-Gold Corridor Northeast of the La Dauversière Pluton, Chibougamau region**

P. Roy and P. Houle (MRNFP)

10:20 ★ **The Mont-de-l'Aigle Deposit: an Example of Paleozoic Iron-oxide Cu-Au in the Appalachians**

G. Beaudoin, J. Bernard, M. Simard (U. Laval), P. Pilote (MRNFP), M. Malo (INRS-ETE), A. Hupé and A. Ross (Ressources Appalaches)

10:40 ★ **Discovery of High-Grade Metamorphosed Volcanogenic Massive Sulphides in the Coulon Belt, James Bay**

P. Archer, M. Chapdelaine (Virginia Gold Mines) and F. Huot (Géo-conseils TB)

11:00 ★ **The PGE Potential of the Bell River Complex, Abitibi Subprovince**

J. Goutier (MRNFP)

11:20 ★ **The Lac Guéret Graphite deposit, Manicouagan region, Québec**

T. Docherty (Quinto Technology Inc.), F. Chartrand* and Y. Trudeau (SOQUEM INC.)

Session 2 - Environmental Excellence in Exploration

Chair: **Georges Beaudoin**
Université Laval

1:15 **Speech of Ned Godman**

Honorary Chairman of Québec Exploration 2004
Chairman, CMP Group of Companies

1:30 ★ **E3: The Worldwide Standard for Environmental Excellence in Exploration**

A. Gaumond (Virginia Gold Mines)

1:50 **E3 and Exploration Environmental Practice at Noranda and Falconbridge**

B. Mercer (Noranda Inc./Falconbridge Ltd.)

2:10 **Community Engagement and E3,**

D. Jones (IAMGold Corporation)

Session 3 - Business

Chair: **Robert Wares**
Osisko Exploration ltée

2:30 **Outlook for the Gold Price**

M. Murenbeeld (M. Murenbeeld & Associates Inc.)

3:20 **The Reserve Position and the Metal Price Outlook**

T. Ortslan (TSO and Associates)

3:40 **Diamonds: An assessment of the current market and future outlook**

R. Wake-Walker (WWW International Diamond Consultants Ltd.)

4:00 **Small Cap Stock Evaluation – Implication for Resource Exploration**

D. Mallalieu (BMO Nesbitt Burns)

4:20 ★ **What's New at the *Autorité* for Mining Exploration Companies?**

J. Deslauriers (*Autorité des marchés financiers*)

November 24

Session 4 - Superior Province: Québec-Ontario-Manitoba

Chair: **Robert Marquis**
Ministère des Ressources naturelles, de la Faune et des Parcs

8:30 **Subprovince architecture, Tectonic processes and Metallogeny in the Superior Province**

P. C. Thurston, (Laurentian University)

9:20 ★ **Orogenic framework for the western Superior Province**

J. Percival (Geological Survey of Canada) and western Superior NATMAP working group

9:40 **300 million years of Archean crustal evolution in the northwestern Superior Province in Manitoba and northwestern Ontario and implications for gold metallogeny**

M. T. Corkery (Manitoba Geological Survey), T. Skulski (Geological Survey of Canada), J. B. Whalen (Geological Survey of Canada), S. Lin (University of Waterloo), D. Stone (Ontario Geological Survey), C. O. Böhm (Manitoba Geological Survey) and D. W. Davis (University of Toronto)

10:00 ★ **The Eastern Limit of the Superior Province: towards a new definition of the Grenville Front**

S. Cadéron, D. Bandyayera, P. Rhéaume and P. Roy (MRNFP)

10:20 ★ **Geology and Mineralization of the La Grande Subprovince, James Bay**

C. Dion and J. Goutier (MRNFP)

10:40 ★ **Structural evolution of the Northeastern Superior Province (NESP) over 1 billion years, with emphasis on greenstone belts and their relation with enclosing granitoids**

A. Berclaz, A. Leclair and the Far North Team (MRNFP)

11:00 ★ **Geology and U-Pb Geochronology of the "High-Grade Zone", Red Lake Mine, Balmertown, Ontario**

B. Dubé (Geological Survey of Canada), K. Williamson (INRS-ETE/Goldcorp), V. McNicoll (Geological Survey of Canada), M. Malo (INRS-ETE), T. Skulski (Geological Survey of Canada), T. Twomey (GoldCorp) and M. Sanborn-Barrie (Geological Survey of Canada)

Session 5 - Expertise in Oil and Gas Exploration

Chair: **Michel Malo**
Institut national de recherche scientifique, Eau, Terre et Environnement

1:30 ★ **Exploration for Natural Gas and Oil in Canada: Current and Future Strategies**

C. Viau (Calpine Canada)

2:20 ★ **Reprocessing MRNFP Seismic Data: Early Devonian Tectonic Inversion in the Acadian Foreland Basin, Gaspé**

D. Kirkwood, É. Desaulniers (Université Laval), J.-Y. Laliberté (MRNFP) and A. Jardin (IFP)

2:40 ★ **Thermal Maturation and Source Rock Potential in the Paleozoic Basins of the Gaspé Peninsula and Northwestern New Brunswick**

R. Bertrand, S. Roy and M. Malo (INRS-ETE)

3:00 ★ **The Hydrothermal Dolomites of the Taconian and Acadian Forelands of Quebec: Analogues of the Albion-Scipio and Ladyfern fields**

D. Lavoie (Geological Survey of Canada), G. Chi (University of Regina) and C. Morin (Hydro-Québec)

3:20 ★ **Presence of Gas in Quaternary Sediments of the St. Lawrence Estuary observed using High-Resolution Geophysical Data**

B. F. Long, M. J. Duchesne and N. Pinet (INRS-ETE)

3:40 ★ **Seismic imaging of diagenesis: A tool for studying hydrothermal dolomite systems**

B. Hart, J. Sagan, J. Teboand and K. Atroshi (McGill University)

4:00 ★ **Aeromagnetism in the Service of Oil Exploration**

M. A. Vallée, T. McConnell, C. St-Hilaire (Fugro Airborne Surveys) and P. Keating (Geological Survey of Canada)

There will be simultaneous translation of all presentations.

Keynote speaker

Presentations marked with a ★ will be in English.

Oral Presentations

November 25

Session 6 - Quaternary Geology and Mineral Exploration in Québec

Chair: **Michel Parent**
Geological Survey of Canada

8:30 **Quaternary Geology in Mineral Exploration: Indicator mineral methods in mineral exploration**

H. Thorleifson (Minnesota Geological Survey)

9:20 ★ **Conditions and processes in the subglacial environment and kimberlite indicator mineral dispersal trains**

F. Hardy (INRS-ETE) and M. Parent (Geological Survey of Canada)

9:40 ★ **The Wemindji case: disparsal trains and drill holes**

R. Charbonneau (Consultants Inlandis) and J. Letendre (Majescor Resources inc)

10:00 ★ **Terrible till on the Assemetquagan: Laurentian deposits in the Gaspé region**

G. Martineau, D. Brisebois and M. Beaumier (MRNFP)

10:20 ★ **3D modeling of Quaternary deposits and exploration targets in the Casa-Berardi Mines**

S. Faure (Consorem) and F. Fallara (URSTM-UQAT)

10:40 ★ **Where do these pebbles come from? Some tools for determining glacial sediment dispersal in the Otish Mountain region**

R. Girard (IOS Services géoscientifiques), M. Parent (CGC), A. Aubin, J.-M. Belley and J. Lalancette (IOS Services géoscientifiques)

11:00 ★ **Diamond prospection in northern Québec: the role of polyphase glacial dispersal**

M. Parent and S. J. Paradis (Geological Survey of Canada)

Session 7 - New Mining Exploration Technologies

Chair: **Marc Legault**
Ministère des Ressources naturelles, de la Faune et des Parcs

1:30 **Applied Geochemistry and Minerals Exploration: past, present and future?**

P. J. Rogers (Chavin Consulting Limited)

2:20 ★ **The chemical discrimination of "kimberlitic" rocks in Québec**

D. Francis, J. Hartzler, J. Clark and A. E. Williams-Jones (McGill University)

2:40 **The role of 2-D and 3-D GIS Analysis in Exploration**

J. R. Harris and E. de Kemp (Geological Survey of Canada)

3:20 ★ **Valorization of MEGATEM Technology: Advancements and results**

D. Bois (UQAT) and M. Chouteau (École Polytechnique de Montréal)

3:40 ★ **INFINITEM: a new type of deep-penetration ground-based EM survey**

M. Boivin (SOQUEM inc.) and C. Malo-Lalande (Abitibi Géophysique)

4:00 ★ **An update on airborne EM systems**

M. Allard (Noranda Inc.)

4:20 **New approaches to airborne magnetometer and gravity surveying**

L. E. Reed (L. E.Reed Geophysical Consultant Inc.)

4:40 **Conclusion**

Session 1 8:30

Essential elements of a Carlin-type gold deposit

R. M. Tosdal (MDRU), J. Cline, (University of Nevada), J. Muntean (Placer Dome Exploration), A. Hofstra (USGS) and K.A. Hickey (MDRU)

The northern Nevada Carlin-type gold deposits, first recognized in the 1960's, have enormous gold endowments that made the Carlin trend 1 of 3 districts in the world to produce >50 million ounces of gold. Despite the endowment, their genesis has been difficult to determine owing to multiple hydrothermal events and related complications in obtaining and analyzing fine-grained, volumetrically minor but common minerals (pyrite, quartz, kaolinite, illite) genetically associated with gold. Understanding the Carlin deposits has also been complicated by the formation of approximately contemporaneous porphyry Cu, porphyry Mo, epithermal, and distal disseminated precious-metal deposits, which in some cases overprint or are overprinted by Carlin-type mineralization.

The sedimentary and structural history of the host terrane is critical to the formation of Carlin-type deposits. Important aspects include (1) crustal penetrative faults, which focused fluid flow and controlled sedimentary facies; (2) pyritic, carbonaceous, silty limestone, which are the primary host rocks in almost every Carlin-type deposit; and (3) shallow-dipping faults or deposition of siliciclastic rocks which formed shallowly dipping aquitards that inhibited fluid ascent. Mineralization involved fairly passive fluid flow associated with heterogeneous shear and minor reactivation of faults. The deposits formed within 800 m to 2 km of the surface. Ore fluids were moderate temperature (~180-240°C), low salinity (~ 2-3 wt % NaCl equivalent), CO_2-bearing (< 4 mole %), and CH_4-poor (<0.4 mole %) with sufficient H_2S (10^{-1} to 10^{-2} m) to transport gold. The singular occurrence of "invisible" gold in pyrite in unoxidized ore indicates that ore fluids were undersaturated in gold until fluids reacted with wall rocks to liberated reactive Fe to form pyrite, which destabilized the gold-bisulfide complex, as well as decarbonatized, argillized, and locally silicified the wall rocks. Isotopic studies have constrained sources for ore fluid components, but do not provide unequivocal sources with studies indicating a dominantly exchanged meteoric fluid, but other data suggesting the presence of mantle or magmatic fluids. Sulfur isotopes in ore pyrite can be derived from a sedimentary sulfur source, but a magmatic contribution may be important in some deposits.

Compelling similarities in all Carlin-type deposits indicate they formed in response to similar geologic processes. Currently models relate deposits to 1) epizonal plutons that contributed heat and possibly fluids and metals, 2) meteoric fluid circulation resulting from crustal extension and/or widespread magmatism, and 3) metamorphic fluids, possibly with a magmatic contribution, from deep crustal levels.

Session 1 9:20

The Lapa Project: The Next Gold Mine in the Abitibi

Alain Blackburn, Graham Long and Dino Lombardi (Agnico-Eagle Mines Ltd.)

The Lapa Project is located on highway 117, 4.5 km southwest of the Heva River, Quebec and 12 km east of the LaRonde Mine, currently the largest gold mine in Canada, operated by Agnico-Eagle Mines Ltd.

After an in-depth review of the Bousquet-Cadillac sector for unverified potential, focussing in particular on the famous Larder Lake-Cadillac Fault Zone, the Lapa Project has surfaced as one that meets our criteria. The property contains gold-bearing intersections at moderate depth that had not previously been verified and which merited futher investigation. In March of 2002, Agnico-Eagle Mines Ltd optioned the property from Breakwater Resources Ltd. In April 2003 it purchased all residual interests to acquire 100% ownership. The final stage of exploration was the borehole orientational survey performed using the Sperry Sun gyroscopic system for precise localisation of the gold-bearing intersections. This was combined with a borehole collar survey at surface by a survey firm, as our field crew had identified a major magnetic field at surface leading to uncertainties regarding the position and orientation of collars. With an accurate map of borehole collars and with borehole paths established using the gyroscopic system, a longitudinal map was produced and we began the first phase of drilling. Since then, we have continued to advance the project.

The geology of the Lapa Project consists of Cadillac-type sediments in the North, in contact with the mafic-ultramafic volcanics of the Piché Group in the South, which are in turn overlain by the Pontiac Group sediments, all Archean in age. A shear zone, found mainly in the Piché Group, represents the Larder Lake-Cadillac Fault. It is located at the volcano-sedimentary contact. This shear zone hosts the "Contact Zone" and a secondary branch running parallel to the main direction of shear hosts the "South Zone Contact". The shear zones are biotite-altered, silica-supersaturated and contain varying quantities of disseminated arsenopyrite, stibnite and pyrite with visible gold found locally.

In February 2004, we assessed the overall diluted mineral resource as 1,359,000 ounces of gold in 5,161,238 tons of ore for a diluted gold content of 8.2 g/t. Current drilling activities consist of deep holes which have returned encouraging gold values at a vertical depth of 1540 m. The deposit is open at depth.

In August 2004, Agnico-Eagle Mines Ltd announced expenditures of $US 30 million for advancement of a circular shaft 4.88 m in diameter, cement-lined to a depth of 823 m, allowing access for an underground drilling program to verify the deposit's potential at depth, to confirm the mining method and to extract a gold-bearing metallurgical sample of 15,000 tons. If the results are positive, the shaft will be deepened to approximately 1,372 m. The company expects to begin production in 2008.

Oral Presentations

Session 1 9:40

Doyon-Mouska Sector: Progress of Exploration Work and New Discoveries

Yueshi Lei (Canadian exploration division, Cambior Inc.) and the geologists of the Geology Departments of the Doyon and Mouska Mines

The Doyon and Mouska properties are located 40 km East of Rouyn-Noranda. They form part of the Bousquet mining camp which has already produced over 12 million ounces of gold and which contains resources totalling an additional 8 million ounces. With over 5 million ounces of gold produced since 1979, the Doyon Mine is a major gold-producing operation in Québec.

In early 2001, Cambior undertook an aggressive exploration program covering all of its properties. The work completed to date represents an investment of $15 million. This included surface and underground diamond drilling, downhole Pulse-EM surveys, compilation of geological and geochemical work, 3D modelling and the advance of an exploration adit eastwards from the Doyon Mine.

The efforts of our mine exploration teams has resulted not only in the extension of known zones, but also to the discovery of new gold-bearing zones. At the Mouska Mine, the main mineralized lenses were extended deeper, which justified the deepening of internal shafts to three supplmentary levels. At the Doyon Mine, drilling confirmed the extension of several major structures, replenishing reserves and leading to the discovery of zones J and K. These rich zones open a new specific sector at depth, to the east of existing underground infrastructures. Mineralization is veinlike in type, characterized by quartz-sulphide veins and stringers enclosed in volcanic rocks and the syn-volcanic Mooshla pluton.

The surface drilling work led to the discovery of two gold-bearing horizons at depth in the Westwood sector, located 2 km East of the Doyon Mine. Currently identified by a limited number of boreholes of between 1,350 to 2,100 metres in depth, these subparallel horizons are enclosed in the Bousquet Formation volcanites and spaced a few tens of metres apart. Mineralization is volcanogenic in type, appearing in the form of disseminated sulpides with semi-massive to massive bands/stringers. Intense sericitization dominates the Westwood horizon, while sericite, biotite and/or garnet alteration is intimately associated with mineralization along the North corridor. So far, seven boreholes have covered an area of 350 m in width by 900 m extension down the plunge axis as interpreted from the mineralized zones. The mineralized system remains open to exploration. The follow-up program will be continued from the new exploration adit of Level 14 of the Doyon Mine.

Session 1 10:00

New Copper-Gold Corridor Northeast of the La Dauversière Pluton, Chibougamau region

Patrice Roy and Patrick Houle (MRNFP)

As part of the Grenville Front mapping project, under the 2003-2006 three-year plan for Abitibi and James Bay, the geology of the Charron Lake (SNRC 32G08 and 32G09) region was revised at a scale of 1:50 000. The NE sector of the La Dauversière Pluton drew our attention in particular as it contained several copper-gold showings in a poorly understood geological context. This sector is principally occupied by Obatogamau Formation porphyry basalts which are cross-cut by the synvolcanic La Dauversière Pluton (2720 ±1 Ma) and the syntectonic Boisvert Pluton (2698 ±4 Ma). The showings in this sector are contained within a structural corridor, the *Palmer-Tippecanoe deformation zone* (PTDZ), intersecting the basalts.

The PTDZ extends NE of the La Dauversière Pluton and abuts against the Dufresne Lake deformation zone at the margin of the Grenville Front. This structure is at least 100 m thick, and more than 10 km in length. The PTDZ consists of several anastomosing shear zones, oriented EW with steep dip and lineation on the dipping surface. A lamprophyre dyke injected along the PTDZ suggests that this deep structure may intersect the base of the terrestrial crust.

Copper-gold showings within the PTDZ are cross-cut by many tonalite and diorite dykes. In the shear zones, basalt frequently exhibits zoned alteration with a distal envelope that has undergone chlorite-carbonate alteration and a proximal envelope altered to sericite-iron carbonates±chlorite. Mineralization consists predominantly of Py-Po-Cp-Au. It is associated with the proximal alteration envelope and with smoky quartz veins containing iron carbonate±chlorite±tourmaline.

The R-14 showing is a good example of this type of mineralization, as a value of 142.29 g/t Au over 2.44 m was obtained by trenching. Old borehole results at the R-14 showing and the discovery of the Pats showing 500 m away suggests deep lateral continuity of the mineralized system.

Mineralization within the Palmer-Tippecanoe deformation zone exhibits characteristics similar to those of the Rohault-Guercheville sector (Joe Mann gold mine), to the France River deformation corridor (north of Chibougamau) and to several orogenic-type deposits, suggesting strong gold-bearing potential for the PTDZ.

Session 1 10:20

The Mont-de-l'Aigle Deposit: an Example of Paleozoic Iron-oxide Cu-Au in the Appalachians

G. Beaudoin, J. Bernard, M. Simard (Laval U.), P. Pilote (MRNFP), M. Malo (INRS-ETE), A. Hupé and A. Ross (Appalaches Resources Inc.)

The Mont-de-l'Aigle deposit located in the northern part of the Lemieux Dome, Gaspé Peninsula, is a circular structure of carbonates, siltstones and Siluro-Devonian sandstones cross-cut by Devonian mafic to felsic dykes and sills. Mineralization within the Mont-de-l'Aigle deposit is characterized by veins, stockwork and hydrothermal breccia cemented by hematite, magnetite, quartz, chalcopyrite and dolomite. This mineralization is controlled by faulted and fractured corridors of steep to moderate dip, oriented NNE, ENE, SW and NNW, and Mantos-type stratabound mineralized horizons. The breccia are comprised of angular fragments of the local country rock. Copper mineralization developed over several episodes, variously antedating or coeval with the hematite breccias. The hematite found in the quartz- and chalcopyrite-cemented breccia is cataclastic. Hematite mineralization cross-cuts the mafic and felsic intrusions, skarns and amethyst veins typical of neutral epithermal mineralization in the southern portion of the Lemieux Dome. Hydrothermal alteration includes potassically-altered zones principally associated with intrusions, and decametric calcium-altered zones with epidote and chlorite, accompanied by decarbonatisation of calcareous units. The Mont-de-l'Aigle deposit possesses characteristics of iron-oxide copper-gold-type deposits, in particular, those of the Mesozoic deposits of the Andean Cordillera. It represents a rare example of a Paleozoic iron-oxide copper-gold deposit.

Session 1 10:40

Discovery of High-Grade Metamorphosed Volcanogenic Massive Sulphides in the Coulon Belt, James Bay

P. Archer, M. Chapdelaine (Virginia Gold Mines) and F. Huot (Géo-conseils TB)

In the summer of 2003, Virginia Gold Mines discovered volcanogenic massive sulphide mineralization (Cu-Zn-Pb-Ag) in the Coulon Belt, 25 km NNW of Fontanges, James Bay. Since the Coulon project was launched, Virginia has conducted propecting, lithogeo-chemical sampling, geophysical and drilling campaigns leading to the identification of two promising zones: DOM and DOM Nord.

The Coulon Belt is located at the intersection of four lithotectonic domains (La Grande, Ashuanipi, Minto and Bienville). Its southern half includes a metamorphosed volcano-sedimentary rock assemblage, of upper amphibolite and granulite facies, crosscut by anatectic granitoids. The segment containing the DOM and DOM NORD mineralized zones has been spared anatexis, although it too has been metamorphosed up to the granulite facies.

Listed in decreasing proportion, the volcano-sedimentary assemblage consists of quartz-plagioclase-biotite±sillimanite gneiss (felsic volcanoclastites), mafic to intermediate orthogneiss (basalts, andesites), paragneiss (wacke, arenite) and felsic orthogneiss (dacite-rhyolite). Its polymetallic mineralization includes pyrrhotite, pyrite, sphalerite, chalcopyrite and galena. These sulphides may be found disseminated throughout or as stringers, in anthophyllite, tremolite, quartz, chlorite, phlogopite, ±cummingtonite, ±garnet and ±orthopyroxene rocks, or in semi-massive to massive form in zoned plurimetric horizons. The first sulphide-enriched assemblage described would correspond to high-grade metamorphic hydrothermal alteration zones while the second would represent lenses of volcanogenic massive sulphides.

The best intersection obtained by trenching in the DOM zone yielded 1.01% Cu, 4.87% Zn, 0.38% Pb, 57.1 g/t Ag over 15.6 m while the highest values obtained by drilling were 15.39% Zn, 3.12% Pb, 0.46% Cu and 117 g/t Ag over 10.5 m. Across the DOM NORD zone, the best intersection obtained by trenching assayed at 1.54% Cu, 0.23% Zn, 0.02% Pb, 13.1 g/t Ag over 6.7 m and by drilling 1.36% Cu, 12.65% Zn, 1.54% Pb and 125.0 g/t Ag over 4.7 m. A new lens (09-25), located at about 200 m east of DOM NORD yielded 1.19% Cu, 3.12% Zn, 0.14% Pb and 36.3 g/t Ag over 20.3 m by drilling.

The work performed over summer 2004 also allowed the identification of other Cu- and Zn-anomalous zones over 4 km to the south-west. In total, the favorable folded horizon is over 10 km in length.

Oral Presentations

Session 1 11:00

The PGE Potential of the Bell River Complex, Abitibi Subprovince

Jean Goutier (MRNFP)

The Bell River Complex is an Archean layered intrusion (20 km by 65 km), located East of Matagami (32F). Metamorphism changes from west to east from greenschist to amphibolite facies. This intrusion differs from the Bushveld Complex in the absence of a basal ultramafic layer, the lack of a chromite layer and alternating gabbroic layers. It differs from the Doré Lake Complex in the reduced volume of anorthosite, the lack of plagioclase megacumulate layers and laterally contiguous layered beds of less significant thickness. The Bell River Complex consists of gabbro (gabbronorite, olivine gabbronorite and olivine and magnetite gabbronorite), anorthosite, pyroxenite, magnetite and peridotite-dunite. Three platinium element showings are associated with stratiform sulphide-type and intrusion breccia-type deposits. The Ebay showing (1863 ppb Pt, 612 ppb Pd, 0.04% Cu and 0.02% Ni) is enclosed within two bands of pyroxenite interbedded in a leucocratic and mesocratic gabbro. Mineralization is composed of very fine (<0.3 mn) disseminated (<1%) grains of pyrrhotite and chalcopyrite. The BWest showing is located in a corridor where many anomalous PGE analyses exist over 720 m. This is associated with a pegmatitic gabbro outcrop. Mineralization is composed of pyrrhotite, chalcopyrite and pyrite, from massive to disseminated (2 to 3%) in a sheared gabbro (794 ppb Pt, 1291 ppb Pd, 0.44% Cu and 0.24 % Ni). The Dotcom showing (1995 ppb Pt, 2872 ppb Pd, 0.34% Cu and 0.32% Ni) is associated with an intrusion breccia outcrop with pyroxenitic matrix (6.5 m by 8 m) cross-cutting the gabbro. This breccia is associated with a late assemblage of melanocratic gabbro and pyroxenite rather than with the Bell River Complex. Mineralization consists of disseminated sulphides (1 to 15%) in the pyroxenitic matrix. Pyrite appears in the form of fine xenomorphic grains or millimetric cubes. Chalcopyrite is disseminated or appears as blebs in exsolution with pyrrhotite and pyrite. By noting the Cu/Pd ratio lower than 6000, indicating the presence of a PGE-enriched magma, certain sectors were identified as meriting prospection as follows: the westward extension of the Ebay horizon, the extension of the BWest horizon and the various sectors associated with values of >100 ppb Pt+Pd. The search for intrusion breccia-type platinium element mineralization should focus near the large body containing the melanocratic gabbro and pyroxenite assemblage since these rocks exhibit the same chemistry as the pyroxenite of the Dotcom showing.

Session 1 11h20

The Guéret Lake Deposit, Manicouagan Region, Québec

Tyrone Docherty, Edward M. Lyons (Quinto Technology Inc.), Francis Chartrand* and Yvon Trudeau (SOQUEM INC.)

In 2001, the company Esbec Exploration discovered a significant graphite showing at the southwestern border of the Manicouagan Reservoir. Quinto Technology Inc. of Delta, British Columbia, quickly acquired the option rights permitting it to acquire the entire deposit. Following this discovery, new graphite showings and PGE were discovered in this region. This led SOQUEM INC. to collaborate with Quinto at the end of 2002 to develop this deposit and explore this region, now accessible via numerous logging roads.

Access to the project is by asphalt and gravel road to the NNW of the town of Baie-Comeau, at a distance of approximately 300 km. This significant deposit of crystalline graphite is located in the Gagnon Group schists and paragneisses. Exploration work of 2002 revealed significant surface accumulation of graphite in two linear, parallel zones found using helicopter-borne EM-Mag geophysical survey. The exploration work continued until the end of August 2004 focused mainly on exposing broad outcrop areas by stripping and channel-sampling, accompanied by some diamond-drilling.

The property is located in the Gagnon terrane, in the central part of the Grenville Province. It contains a metasedimentary sequence consisting of dolomitic marble, quartzite and an iron formation. These three units, which form the Gagnon Group, are overlain by a paragneiss assemblage including graphite-rich to quartz-feldspar-mica-garnet gneisses.

The graphite deposit on the Guéret Lake property forms two linear, parallel zones : i) the Graphite Road (GR) zone to the NW, and ii) the Graphite Cliff (GC) zone to the SE. These two zones straddle the SE margin of a major NE-SW oriented anticlinorum in paragneisses and quartzites, in close proximity to the iron formation. The GR zone extends for more than 1000 m while the GC zone contains a high value sub-zone (> 20 % Cg) of more than 1100 m. Both zones are oriented NNE with variable but generally moderate to steep dip. The plunge of mineralized zones appears to be shallow.

Graphite is present in the form of ribboned disseminations and semi-massive bands within host siliciclastic rocks. Most of the graphite consists of fine to large flakes ranging in size from 0.01 to > 4 mm in diameter.

*speaker

Session 2 1:30

E-3: The Worldwide Standard for Environmental Excellence in Exploration

André Gaumond (Virginia Gold Mines)

The notion of a worldwide standard of environmental excellence in exploration, E-3, began with a group of geologists who felt the need for the establishment of a best-practices environmental code. The Prospectors & Developers Association of Canada (PDAC) took on the task of completing the project. The E-3 standard is an indispensable tool, allowing prospectors up-to-date information on best environmental and socio-economic practices.

The main objective of E-3 is to improve the environmental management of exploration. This document consists of a compilation of current best practices in the exploration industry, stemming from methods broadly recognized as functional and effective. E-3 also offers the tools necessary for satisfactory management of environmental challenges encountered during exploration programs. Moreover, the manual contains guidelines for responsible community involvement, recognizing that companies must now obtain a "social licence" to operate a new mine. The guidelines laid out in E-3 were devised to be practical and effective rather than normative or theoretical.

E-3 can also serve as a resource-document to inform the public and governmental and non-governmental parties of the environmental and socio-economic impacts of exploration.

E-3 is available over the Internet, in CD format or in paper format. This document has been developed using the latest electronic platform for ease of use and updating.

Virginia Gold Mines uses E-3 and strongly supports its objectives. We recommend E-3 to all mining exploration companies, particularly juniors. The best practices described therein are a unique source of information and of great value. Application of these practices will help us best acquit ourselves of our obligations as corporations and elevate our public image while keeping the mining industry active and healthy.

Session 2 1:50

E3 and Exploration Environmental Practice at Noranda and Falconbridge

Bill Mercer (Falconbridge Limited/Noranda Inc)

Both Noranda and Falconbridge have a long history of formal environmental, health and safety (EHS) practice in exploration. A significant initiative resulting from the merger of the two exploration groups has been to bring those two histories together resulting in uniform practice.

At the corporate level with respect to EHS, the first steps were the writing of a joint "Code of Ethics" and joint "Sustainability Policy" which lay out the high level policies of each of the companies. These are accompanied by a corporate document known as the "EHS Operating Manual" which gives the management level coverage of EHS procedures.

Within exploration, we have created the foundation for joint health and safety practice through both a small pocket manual and a large detailed manual, all in English, French, Spanish and Portuguese. The pocket manual also includes environmental issues such as emergency response for spill management.

The companies do not have a single specific document that details environmental methodologies and in fact look to E3 to provide this. EHS performance is monitored through a series of audits accompanied by extensive checklists that are both random or scheduled. These audits are conducted by both field technicians and geologists. All field contracts are accompanied by EHS performance guarantees from the contractor. Checklists on activities involved contractors require the contractor to sign off on the conclusions. Country or region managers are responsible for oversight of these environmental activities.

The seriousness of the corporate view of E3 is illustrated by the fact that the two companies between them were the largest financial contributors to the initiative. At the time of writing, there are 33 employees who are registered users of E3. The companies view E3 as an essential component of their environmental practice enabling the geologist, during the preparation for a field campaign, to check his intended actions against those detailed in E3. It also acts as a reference on the details of specific types of prevention and mitigation efforts. The paper will present some of the ways that E3 has been used by the companies.

Oral Presentations

Session 2 2:10
Community Engagement and E3

Dennis Jones (IAMGold Corporation)

IAMGOLD was an early sponsor of the "Environmental Excellence in Exploration" initiative ("E3") and has continued to contribute to its content development through the advisory committee. The Company has seven registered E3 users at its head office in Toronto and at its regional exploration offices in West Africa and South America.

The presentation will show some examples of how IAMGOLD has used the principles of E3 in its exploration programs. It will emphasize the importance of this approach to the "bottom-line" of any company, paying particular attention to community engagement issues. It is typically the exploration geologist who is the company's first representative to engage the local community – he or she is the company's "ambassador". Those early contacts with the local community are important and can have far-reaching consequences - both good and bad.

Session 3 2:30
Outlook for the Gold Price

M. Murenbeeld (Murenbeeld & Associates Inc.)

The presentation will review a number of factors that have been important to the gold price in 2003-2004. The macro-economic factors include the US Dollar, "reflationary" monetary policies, and government and household debt. These factors have helped to spur investment interest in gold again. Gold-market-specific factors include the low contango, producer dehedging, flat mine output, and the introduction of gold investment certificates. The Central Bank Gold Agreement was also renewed in 2004. The presentation will conclude with a high-probability scenario for gold prices through 2005.

Session 3 3:20

The Reserve Position and the Metal Price Outlook

T. Ortslan (TSO and Associates)

Session 3 3:40

Diamonds: An assessment of the current market and future outlook

Richard Wake-Walker (WWW International Diamond Consultants Ltd)

The diamond industry is going through a revolution. Enormous opportunities are becoming available at every stage of the diamond pipeline from mine through to retail. During this talk, we will examine why the rough diamond markets have been so strong, the dynamics of the polished diamond trading market, the outlook for consumer demand and prices over the next ten years, and a detailed analysis of current mined production internationally, but with particular emphasis on Canada. We will also look at WWW International Diamond Consultants' forecasting model and the changing role of De Beers. The questions that needs to be answered are: what are the long term prospects for the diamond industry, does the world need more Canadian production and what sort of market will future producers be selling to?

Oral Presentations

Session 3 4:00

Small Cap Stock Evaluation – Implications for Resource Exploration

David Mallalieu (BMO Nesbitt Burns)

While small cap resource equities have tended to provide investors with superior returns (and larger losses) over discrete periods, we believe that some of the volatility in their share prices may have been a result of equity analysis that has been less rigorous than what has been applied to their large cap peers. With but a few exceptions most exploration companies do not have positive cash flow from operations and therefore tend to be evaluated on "blue sky" potential. We believe that deposits, even in an early stage of evaluation, can provide enough information that a view can be taken as to the probability of future development. Interpretations as to gross in-situ metal value, net smelter return, net operating margin etc. are critical metrics that may be able to be estimated very early on in the exploration process. By comparison of these metrics with those generated by analogous producing deposits, better and more rapid, "explore/don't explore" or "invest/don't invest" decisions should be able to be made. Once delineation drilling has been commenced and scoping studies are completed, metrics such as mine life, internal rate of return, net asset value, etc. can be considered as metrics which should direct management and investors to make the decision between develop/finance or terminate/sell. The small cap team at BMO Nesbiit Burns is actively using these screens as a means of identifying research opportunities. These same techniques, if applied more rigorously by the exploration industry could result in share prices with reduced volatility. We also believe that more economic analysis and less market cap analysis would serve to broaden the investor base from only those with a high risk tolerance to those who desire aggressive capital appreciation but wish to understand risks more fully.

Session 3 4:20

What's New at the *Autorité* for Mining Exploration Companies?

Josée Deslauriers (*Autorité des marchés financiers)*

The *Autorité des marchés financiers* (the Autorité) is a newcomer on the Quebecois financial markets scene, making its arrival on February 1, 2004. This new entity stems from the collective association of five para-governmental institutions responsible for regulatory administration of the financial sector. Thus, the Autorité takes the place of the *Commission des valeurs mobilières du Québec* as the market monitoring agency for securities across the region of Québec. Consequently, the mandate of the Autorité is, in particular, to enhance the efficiency of the Québec financial sector, ensure investor protection and to regulate the information (public disclosure) that mining exploration companies are required to provide to those who own their shares, when financed in the province of Québec.

At the same time that it provides consumer protection, another objective of the Autorité is to promote Québec as a promising environment for mining exploration industry financing, by establishing an equitable regulatory framework supportive of mining sector offerings. This process has seen significant modification in the last few years, while continuing to maintain protection of the public investor.

During the last year, the Autorité worked on numerous regulatory projects in order to best respond to the new realities faced by mining exploration companies seeking financing. These efforts lay within the regulatory reform strategy developed for the whole of Canada (national standards) by the Canadian Securities Administrators (CSA) wherein the purpose was to streamline the regulatory burden for market participants. The level of harmonisation to which the CSA aspired made room for the effectiveness of the current securities regulatory regime while also taking into account the distinctiveness of Québec.

Where are we today with respect to the continuous disclosure obligations, reporting on mining projects and the administration of mining exploration company financing? Since the regulatory environment of this sector is evolving at high speed, the objective of this presentation is to review and demystify the regulatory changes of the last few years and to identify those challenges which have arisen.

Session 4 8:30

Subprovince architecture, Tectonic processes and Metallogeny in the Superior Province

P. C. Thurston (Laurentian University)

At craton scale, the Superior Province comprises older (~3 Ga) composite volcano-plutonic terranes and super-terranes forming a central nucleus (North Caribou terrane), the N and W fringes (N. Superior Super-terrane), and scattered fragments e.g., Winnipeg River subprovince and Marmion terrane. Interspersed amongst older terranes are younger (<3 Ga) belt-like volcano-plutonic and sedimentary subprovinces in which ages of volcanism, plutonism, and shear zones young, somewhat systematically north and south off the central nucleus. These composite terranes are dominated by granitoid rocks and contain scattered, discontinuous fragments of "older" (>3 Ga) greenstone and granitic units unconformably overlain by quartz arenite-carbonate platforms, BIF, and komatiite-tholeiite units related to breakup of ~3 Ga microcontinental fragments. Greenstones above the breakup sequences (2.8-2.7 Ga) represent ensialic development. The volcanic rocks in the younger volcano-plutonic subprovinces display arc-backarc, plume, and oceanic geochemistry and reflection seismic evidence of lateral accretion.

Throughout the Superior Province, sedimentary subprovinces (English River, Quetico, Opinaca, etc.) comprising fine to coarse clastic units and related S-type granitoids stratigraphically overlying the volcanic rocks of volcano-plutonic subprovinces. The sedimentary subprovinces represent alluvial fan to abyssal flysch with a provenance in the adjacent volcano-plutonic subprovinces. The relationship is commonly obscured by late strike-slip faulting. The detrital zircons in the sedimentary subprovinces young systematically southward as do the ages of volcanism, etc., in adjacent volcano-plutonic subprovinces.

In younger volcano-plutonic subprovinces (e.g., N. Caribou, Wabigoon, and Wawa-Abitibi), patterns not in accord with simplistic accretionary tectonics are seen: systematic younging of volcanic assemblages away from major batholiths (Uchi, Wawa-Abitibi), recognition of submarine unconformities between "Keewatin" assemblages (Wawa-Abitibi, N. Caribou), isotopic inheritance, evidence for granitic contamination all point to autochthonous greenstone development. At a large scale, there is much evidence for lateral accretion, whereas at a smaller scale, there is evidence for autochthonous development.

The evidence suggests old, microcontinental fragments rifted at about 3 Ga accompanied by continental-breakup-related quartz-rich sedimentation and ensialic greenstones followed by re-aggregation of microcontinental fragments. Subsequently at 2.8-2.7 Ga, long, belt-like magmatic systems involving arc-plume interaction followed by late (2.7-2.6 Ga) strike-slip basin development along subprovince margins and within subprovinces. The Superior Province-wide ~2.68-2.65 Ga S-type and sanukitoid magmatism suggests delamination and intra-crustal and mantle melting.

Ultramafic intrusions with associated PGE's and Cu-Ni (Lac des Iles, Big Trout Lake) and continental break-up assemblages (detrital Au & U) occur along sutures between microcontinental fragments and at subprovince boundaries. Autochthonous stratigraphy within subprovinces offers the possibility of large-scale correlation of stratigraphically controlled VMS mineralization. Late Archean and Proterozoic reactivation of old structures and generates new structures controlling S-type magmas, carbonatites and kimberlites.

Session 4 9:20

Orogenic framework for the western Superior Province

J. A. Percival (Geological Survey of Canada) and western Superior NATMAP working group

New bedrock mapping and geophysical imaging have improved resolution on the timing and style of tectonic assembly of the western Superior Province. Microcontinental fragments and juvenile oceanic terranes were amalgamated into a composite Superior superterrane (CSS) in a series of orogenic events between 2.72 and 2.68 Ga, formerly collectively known as the Kenoran orogeny. The Northern Superior superterrane (3.8-2.8 Ga) docked with the northern margin of the North Caribou terrane (NCT; 3.0-2.8 Ga) at 2.72 Ga during the northern Superior orogeny. Amalgamation of the Wabigoon (2.77-2.72 Ga) and Winnipeg River (3.5-2.7 Ga) subprovinces occurred ca. 2.715 Ga in the central Superior orogeny. During the Uchian orogeny (ca. 2.70 Ga) the Wabigoon-Winnipeg River superterrane collided with and was subducted beneath the active southern margin of the CSS, resulting in deposition and burial of English River turbidites. Collision between the largely juvenile Abitibi-Wawa subprovince and its subduction beneath the CSS resulted in the 2.69 Ga Shebandowanian orogeny, including deposition and burial of Quetico turbidites. The final, ca. 2.68 Ga Minnesotan orogeny, is responsible for collision and underthrusting of the Minnesota River Valley terrane (3.6-2.7 Ga) beneath the CSS.

Common elements of the five discrete orogenies include: 1) calc-alkaline arc magmatism on the upper plate preceding collision; 2) deposition and rapid burial of syn-orogenic sediments (conglomerate, greywacke); 3) high-temperature, low-pressure regional metamorphism; 4) steep foliation and orogen-parallel strike-slip faults attributed to transpressive deformation; 5) emplacement of mantle-derived, post-orogenic plutons of the sanukitoid suite; and 6) widespread emplacement of late granitic plutons of crustal derivation. The orogenic framework for the western Superior Province may extend northeastward into the Minto block, based on common ages of magmatism, sedimentation, deformation and metamorphism. In particular, the Uchian orogeny is expressed in 2.70 Ga ages of high-grade metamorphism in the western Minto block, making the scale of Archean orogens comparable to that of Alpine-style mountain belts.

Oral Presentations

Session 4 9:40

300 million years of Archean crustal evolution in the northwestern Superior Province in Manitoba and northwestern Ontario and implications for gold metallogeny

M. T. Corkery (Manitoba Geological Survey), T. Skulski (Geological Survey of Canada), J. B. Whalen (Geological Survey of Canada), S. Lin (University of Waterloo), D. Stone (Ontario Geological Survey), C. O. Böhm (Manitoba Geological Survey) and D. W. Davis (University of Toronto)

Integrated bedrock mapping and structural, geochemical, geochronological and isotopic research in the northwestern Superior Province of Manitoba reveal several, fault bounded crustal terranes that record a complex history of crustal development culminating in the collision between the ~3.0 Ga reworked northern margin of the North Caribou terrane with the 3.6 Ga Northern Superior superterrane at 2.72 to 2.71 Ga. Post collisional crustal adjustment concomitant with at least two periods of metamorphism, between 2.70 to 2.65 Ga, is displayed as new and reactivated faults in a major series of anastomosing shear zones. These shear zones form the locus for a regional lode gold mineralization.

In the south, the Munro Lake domain comprises <2.86 Ga platformal sedimentary rocks and komatiite deposited on the reworked margin of the ~3.0 Ga North Caribou terrane. Plutonic rocks at 2.84 and 2.72 Ga have 3.0 Ga Nd model ages reflecting recycling of the North Caribou margin. To the north, in the juvenile oceanic Oxford Lake – Stull Lake terrane, ca. 2.86 Ga submarine depleted tholeiitic basalts were thrust (D1) prior to ca. 2.78 Ga, onto the Munro Lake domain. A 2.83 -2.72 Ga, isotopically juvenile, continental margin arc was built on the accreted crust and is cut by 2.72-2.71 Ga early- to syn-tectonic, isotopically juvenile plutons. To the north, 2.84-2.71 Ga plutonic rocks of the Northern Superior terrane have 2.9-3.6 Ga Nd model ages and zircon inheritance up to 3.57 Ga. Docking of the reworked margin of the North Caribou terrane and the Oxford Lake - Stull Lake terrane with the Northern Superior superterrane ca. 2.72 Ga resulted in 2.72-2.71 Ga arc volcanism, oblique convergence (D_2-D_3) and metamorphism at <2.72 Ga. Eruption of synorogenic < 2.71 Ga alkaline and shoshonitic lavas with negative epsilon Nd, and later deposition of continental sediments with local detrital zircons up to 3.6 Ga, reflect underthrusting and uplift of older continental crust across the Oxford Lake - Stull Lake terrane. These amalgamated terranes were subsequently segmented and tectonically interleaved by major northwest-trending, anastomosing greenschist facies shear zones, spaced 10-50 km apart.

Subsequent 2.69-2.68 Ga and 2.65 Ga metamorphic events, coupled with intrusion by syn- to post orogenic stitching plutons further complicate the accurate definition of the terrane boundaries and provide conduits and energy sources for lode gold.

Session 4 10:00

The Eastern Limit of the Superior Province: towards a new definition of the Grenville Front

Sandrine Cadéron, Patrice Roy and Daniel Bandyayera (MRNFP)

Recently the MRNQ began a new 1:50,000 mapping project along the Grenville Front between Val-d'Or and Chibougamau, to encourage mining exploration in this region which has traditionally been under-explored. Already, the work in progress permits a new interpretation of this geological boundary. Our multidisciplinary approach has already allowed us to characterize this tectonic boundary lithologically, structurally, metamorphically and metallogenically.

The Grenville Front was originally defined in order to delimit a vast zone of low magnetism at the extension of highly magnetic Superior Province rocks. Still, many uncertainties remained regarding the relative chronology of the metamorphic isograds recognized in the Grenvillian Parautochthonous Belt. The project under way will allow us to determine more precisely where and how the Grenvillian tecto-metamorphic signature became superimposed upon the Archean basement. We will also supply answers to the following questions: Can one define the Grenville Front as a "tectonic zone" or a "metamorphic line"? Must one really characterize it as a separate entity or associate it with the Superior Province? What is the dominant geological signature?

The new regional isograds that we can already trace follow the main structural lineaments. The garnet isograd is essential as it definitively marks the beginning of the Grenvillian Parautochthonous. Specific metamorphic textures characterize a late tectonic uplift event. Our mapping activities demonstrate that the metamorphic signature of the Front varies from NE to SW and appears to be controlled by its structural architecture. Within the Archean craton, at the edge of the Front, rocks locally exhibit a Grenvillian metamorphism which may define protected zones which underwent a Himalayan type "thrust effect". At the Front, the Grenvillian orogen reoriented the Archean structures and the high-grade metamorphic hydrothermal alteration envelopes indicate the presence of prior VMS-type Archean mineralization. All of our observations show that the Archean tecto-metamorphic signature remains significant within the Parautochthonous Belt.

Therefore, we propose that at the Grenville Front, the Grenvillian orogen played a mere secondary role in imposing structural and metamorphic effects. The Grenvillian period was characterized by a reorientation of Archean structures and assemblages by tectonic uplift and significant decompression of deep units of the roots of Abitibi Sub-Province rock. Consequently, the Grenville Front represents a promising area for the preservation and recognition of remobilized Archean mineralization.

Session 4 10:20

Geology and Mineralization of the La Grande Subprovince, James Bay

Jean Goutier and Claude Dion (MRNFP)

The La Grande Subprovince is located in the eastern part of the Archean Province of the Superior at James Bay. On its southern margin, the Opinaca Subprovince corresponds to an enormous metamorphosed turbidite basin. The La Grande Subprovince is bounded to the north and east by the Bienville and Ashuanipi Subprovinces which represent high-grade metamorphic domes. The arrangement of these subprovinces does not correspond to a collage of exotic terranes but to the evolution of a protocraton and volcano-sedimentary sequences that have been preserved despite metamorphism ranging from greenschist to granulite facies.

The La Grande Subprovince consists of three distinct sectors characterized by different geology and styles of mineralization. The best documented is the Yasinski sector, consisting of an ancient basement (3360-2788 Ma) upon which rests a unconformable sequence of arenitic and conglomeratic platform sediments (Apple Formation). In contrast to the arenitic sequences of the Ontario, dated at between 3.0 and 2.8 Ga, the Apple Formation is overlain in stratigraphic continuity by mafic tholeiites and submarine calc-alkaline volcanites dated at between 2750 and 2732 Ma. Metallogenically, this sector is characterized by the presence of mineralization emplaced in a relatively stable tectonic environment, such as uraniferous paleoplacer type deposits, iron formation and layered ultramafic intrusions. East of the Yasinski sector, the Guyer Lake-LG Quatre sector is characterized by volcanic belts containing komatiites and synvolcanic ultramafic intrusions. One of these belts has been dated at 2820 Ma. This sector is also distinguished by the great quantity of copper-bearing mineralizations, lenses of massive sulphides and the presence of marble. Although the Guyer Lake-LG Quatre sector is relatively poorly known, it is likely that it extends towards the north into the Goudalie domain. Finally, the Eastmain sector, in contrast with the other two, exhibits no evidence of continental basement underlying the volcanic rocks. This sector is composed of volcanites with a juvenile isotopic signature and dated at 2752 to 2705 Ma. The Eastmain sector is distinctive mainly due to the magmatic origin of its mineralization (Moukhsil *et al.*, 2003, ET 2002-06).

The most significant gold-bearing mineralization occurs along the major deformation zones at the margins of the La Grande and Opinaca Subprovinces, in all three sectors.

Session 4 10:40

Structural evolution of the Northeastern Superior Province (NESP) over 1 billion years, with emphasis on greenstone belts and their relation with enclosing granitoids

A. Berclaz, A. Leclair and the Far North Team (MRNFP)

Bimodal greenstone belts (GB) and enclosing granitoids of the NESP were emplaced as sequential magmatic pulses spanning over 1 Ga. Early-Archean (3.8-3.6 Ga) to mid-Archean (2.88-2.76 Ga) GB consist of tholeiitic basalts and komatiites interlayered with mafic to ultramafic sub-volcanic bodies, which dominate relative to calc-alkaline felsic volcaniclastic rocks (assemblage 1). Late-Archean (2.76-2.70 Ga) GB are characterized by higher volumes of calc-alkaline felsic volcaniclastic rocks and paragneisses relative to tholeiitic and calc-alkaline mafic volcanic rocks (assemblage 2). Rock assemblages 1 and 2 are both variously and upwardly interlayered with iron formations, paragneisses, carbonaceous rocks and conglomerates (assemblage 3).

Volcano-plutonic rocks of the NESP were affected by four phases of ductile deformation (D1-D4). Early-Archean (3.8 Ga) Nuvvuagittuq belt preserves a rock assemblage 1 and mylonitic tonalitic gneisses affected by early-Archean foliation and isoclinal folding (S1/F1). Rock assemblages 1 are refolded and transposed into larger, E-W isoclinal to open folds (F2) and have strongly to moderately plunging linear fabrics (L1/L2). Mid-Archean GB are engulfed in coeval tonalite-trondhjemite (TT) plutonic suites, which preserve evidence of synmagmatic deformational features. These are oriented E-W to WNW-ESE and associated with strongly to moderately plunging linear fabrics (L1). This involves N-S to NNE-SSW compression and corresponds to D2 in the NESP evolution history. Late-Archean GB are surrounded by coeval granite-granodiorite (GG), enderbite-opdalite-charnockite (EOC), tonalite-diorite (TDi) or diatexite (D) plutonic suites, whose emplacement coincides with D3 and peak regional metamorphism. D3 is characterized by a pervasive NW-SE to N-S striking foliation (S3) which is axial planar to regional folds (F3) and contains axis-parallel, strongly plunging lineations (L3). Mylonitic shear zones (S3), with kinematic indicators of dextral strike-slip movement, occur as corridors striking N-S to NNW-SSE. These shear zones have GG/EOC/TDi/D infillings which preserve magmatic textures and grade out along strike into GG/EOC/TDi/D plutons. The geometric relation between strike-slip mylonitic shear zones and low-angle, coeval and subvertical plutonic fabrics is consistent with emplacement under a transcurrent regime involving N-S to NNE-SSW compression, and where late-Archean, rock assemblages 2/3 were emplaced in synmagmatic and syntectonic pull-apart basins. In early- to mid-Archean rock assemblages 1 and TT plutonic suites, D3 fabrics superposed D1/D2 fabrics, producing fold interference patterns. Locally, late-Archean assemblages 2/3 preserve low-grade, but polydeformed, primary structures, indicating that syn-D3 volcano-sedimentation was still operative at a late- to post-metamorphic stage in the evolution of the NESP. Late-D3 to D4 phase of deformation (2.685-2.64 Ga) is associated with the formation of oblique shear zones and controlled the emplacement of late GG-D and syenite-carbonatite.

Oral Presentations

Session 4 11:00

Geology and U-Pb Geochronology of the "High-Grade Zone", Red Lake Mine, Balmertown, Ontario

B. Dubé (GSC), K. Williamson (INRS-ETE/Goldcorp), V. McNicoll (GSC), M. Malo (INRS-ETE), T. Skulski (GSC), T. Twomey (Goldcorp) and M. Sanborn-Barrie (GSC)

The Campbell-Red Lake deposit, operated by Placer Dome Inc. (Campbell Mine) and Goldcorp Inc. (Red Lake Mine), represents one of the largest Archean gold-bearing deposits in the Superior Province (>20 M oz Au). The High-grade Zone mined by Goldcorp at Red Lake Mine has produced 1.5 M oz at an impressive grade of 88 g/t Au since it began production in 2001. It is the richest gold-bearing zone currently under production in the world. New U-Pb dates, combined with detailed mapping work, provide new relative limits on the formation of this exceptionally rich zone. The results indicate that the main phase of high grade mineralization occurred before 2712 Ma and that a second phase, smaller in volume but spectacular in grade, occurred after 2702 Ma. This second phase is attributed to the remobilization of the gold of the first phase, which occurred coevally with: 1) the thermal gradient and deformation associated with the emplacement of the Cat Island Pluton (2699 Ma); or 2) a regional, post-orogenic thermal event at ca. 2.63-2.66 Ga documented elsewhere in the Uchi Sub-Province. It has been proposed that the main phase of gold mineralization occurred between ca. 2723-2712 Ma, synchronously with the main phase of regional deformation D_2 and the emplacement of the Dome and McKenzie Island intrusions, the Albino diorite and the Hammell Lake batholith. Lamprophyre dykes associated with the mineralization are 10 Ma younger than the main gold-contributing phase.

A conglomerate located stratigraphically above the deposit was formed after 2747 Ma, and has been correlated with the Huston assemblage. The age of this conglomerate confirms that this deposit is proximal to a regional folded unconformity and supports empirical relationships between gold-bearing deposits and unconformities as documented elsewhere in Archean greenstone belts. This paleosurface represents a prime exploration target. Furthermore, the main phase of mineralization (2723-2712 Ma) is older than that of the Abitibi (ca. 2680-2670 Ma). This underscores the fact that the major gold-bearing deposits of the Superior Province are not limited to the Abitibi nor to the end of the Archean, and provides a clear illustration of the potential of the greenstone belts of the central and northern portions of the Superior Province.

Session 5 1:30

Exploration for Natural Gas and Oil in Canada: Current and Future Strategies

Christian Viau (Calpine Canada)

Natural gas continues to be in high demand as a clean-burning fuel for today and the future. The ongoing availability of supplies of natural gas in North America however has become a major uncertainty and along with numerous other factors contributes to price volatility for natural gas.

Why is it that despite record drilling and completion activity in the last decade, overall production and reserves of natural gas in Canada are declining? This presentation will review the rapid changes that have occurred in the oil & gas industry in the last decade and bring a western Canada perspective on the current and future strategies, drivers and challenges for hydrocarbon exploration in Canada by addressing the following questions and focusing on natural gas.

What is the remaining natural gas and oil potential in Canada? Where are those resources? What are the historical trends in the Exploration and Production sector with respect to drilling activities, production, and reserves additions? What is the current competitive business landscape in Canada and how is it evolving? What are the current business strategies for growth and creating value in the oil and gas sector? How does exploration and managing risks fit in various growth strategies? What is the potential impact of developing unconventional gas sources? What is the potential impact of improved technologies? How can production and reserves be increased to meet projected demands for the future?

Session 5 2:20

Reprocessing MRNFP Seismic Data: Early Devonian Tectonic Inversion in the Acadian Foreland Basin, Gaspé

D. Kirkwood, É. Desaulniers (Laval University), J-Y Laliberté (MRNFP) and A. Jardin (IFP)

It remains essential to obtain high quality seismic images to perform dependable geological interpretation of stratigraphic and structural matters. The excellent quality of the seismic data collected by the MRNFP in 2000, 2001 and 2002 in the Gaspé Peninsula opened the door to fundamental research pertaining to seismic processing and interpretation of the geology of the peninsula. The problem of image quality is a major issue in tectonically complex zones such as the Gaspé Peninsula. Stimulated by the interest evoked by the MRNFP results, a scientific collaboration project was established involving the MRNFP, Laval University and the French petroleum institute (IFP) bearing on the seismic imaging of the Gaspé and concentrating on reprocessing and interpretation of the 2002-MRN-10b seismic data profile.

The data reprocessing work was performed at the IFP using data before summation. A geophysical approach was selected which calls upon several different sequences of data processing. In particular, the data were migrated over time and depth, before and after the summation phase. Concurrently with depth migration processing, a velocity model of the subsurface was built based on borehole logs and the surface geology of the Gaspé. Several new images were extracted from the various processing sequences. Combining all images obtained allowed the tracing of imaged reflectivity on each image and to position the seismic horizons at depth, while at the same time continuing to enhance the lateral continuity of events. The complementary nature of the images was a crucial factor in the production of a critical and insightful new geological interpretation. Briefly, the new stratigraphic and structural components identified in the units of the subsurface Gaspé Belt are: 1) normal faults in the lower Chaleurs units, 2) thickening in the lower units of the St-Léon and York Lake/York River Formations, 3) syntectonic migration of the Huit-Miles Lake syncline in the Middle Devonian, 4) fault-folds on the south flank of the Huit-Miles Lake syncline, and 5) a segment of the north dipping Causapscal fault. These new components confirm an earlier hypothesis proposed by many researchers that the units of the Gaspé Belt are arranged in a foreland basin in an active tectonic environment during the Ludlovian (Lower Silurian) to the Emsian (Middle Devonian). The structural interpretation drawn from these new images implies a tectonic inversion of early extensive structures into compressive structures.

Session 5 2:40

Source rock potential of Paleozoic sedimentary successions in the Gaspé Peninsula and northwestern New Brunswick: An exploration guide.

Rudolf Bertrand, Stéphanie Roy, Michel Malo (INRS-ETE), Denis Lavoie (GSC) and Jean-Yves Laliberté (MRNFP)

The Gaspésie region has been a target area for oil & gas exploration since the late nineteenth century. Several surface and well showings are known, but only one gas deposit is currently in production, the Galt field. Exploration has picked up again in Gaspésie and New Brunswick since the discovery, nine years ago, of a deposit to the west of Newfoundland, but exploration remains difficult in these Paleozoic sedimentary successions. Tools that help determine their potential as source rocks may serve as exploration guides. These tools are used in three areas: Gaspé, Monts Berry – Lac Matapédia and northwestern New Brunswick.

Paleozoic successions form three distinct tectono-sedimentary assemblages. The first consists of Cambrian to Ordovician rocks deformed during the Taconian orogeny in the late Ordovician. Rocks of the second sedimentary assemblage were deposited from the late Ordovician to the early Devonian, in a successor basin unconformably overlying the first basin. They were deformed during the Salinian episode and the Acadian orogeny (late Silurian to middle Devonian). This successor basin is divided into three tectonic units: the Gaspé–Connecticut Valley and Chaleur Bay synclinoriums and the Aroostook–Percé anticlinorium. The third Carboniferous sedimentary assemblage unconformably overlies and borders the first two basins, but it has no hydrocarbon potential within the study areas.

An assessment of the source rock potential of the Cambrian-Ordovician assemblage shows sedimentary successions that overall, are beyond the hydrocarbon preservation threshold. Locally, a few units are in the gas window, and more rarely so, in the oil window.

However, an assessment of the Ordovician-Devonian successor basin indicates that vast segments of the Gaspé–Connecticut Valley and Chaleur Bay synclinoriums do have the potential to preserve oil. These segments are discontinuous and variable in size. Their boundaries are coherent with basin lithostratigraphy and structure. Prospective zones are controlled by the burial, tectonic and magmatic history.

Ordovician successions host the best source rocks. Certain Devonian units may also have significant potential however. The maturation history of Ordovician source rocks is locally favourable to the formation of deposits in Silurian-Devonian successions. Isotopic geochemistry and biomarker studies have not yet been successful in clearly identifying the origin of oil showings. While these tools are not a panacea, they are however useful to define the most promising areas to discover deposits.

Oral Presentations

Session 5 3:00

The Hydrothermal Dolomites of the Taconian and Acadian Forelands of Québec: Analogues of the Albion-Scipio and Ladyfern fields

D. Lavoie (GSC-Q), G. Chi (University of Regina) and C. Morin (HQPG)

Research into Appalachian hydrocarbon systems (Targeted Geoscience Initiative: 2003-2005) suggests that the hydrothermal dolomitisation process recognized in certain enormous Middle Ordovician fields in the USA (Albion-Scipio and Fingers Lake) and the Devonian of western Canada (Ladyfern) can also be seen in the carbonates of eastern Québec.

On Anticosti Island, the Romaine and Mingan Formations (Ordovician) have recorded many episodes of dolomitisation and hydrocarbon migration. In the case of the Romaine Formation, a hydrothermal event was responsible for partial occlusion of porosity by high-temperature (T_h: 120°C) baroque dolomite precipitated from saline fluids (24 wt% $NaCl_{equi}$) and by a late phase of hydrocarbon inclusion-rich calcite. High-temperature dolomite was also documented replacing calcite in the Mingan Formation. This dolomite is characterized by elevated temperature (T_h: 105°C) and salinity (24 wt% $NaCl_{equi}$).

In the Gaspé, the dolomitised sections of the Sayabec Formation (Lower Silurian) are adjacent to the South Shickshock fault. The dolomite appears either as a strongly brecciated unit, or replacing peritidal carbonates at the base of the formation. Bituminous residues are present in these dolomitic zones. The matrix dolomite was early-forming and recrystallized in the presence of high-temperature fluids ($\delta^{18}O_{VPDB}$ = 6.3 to 7.8‰). Baroque dolomite crystals precipitated from high-temperature (T_h : 165EC ; $\delta^{18}O_{VPDB}$ = 14.5 to 17.9‰) saline fluids (26 wt % $NaCl_{equi}$) fill dissolution porosity and fractures. Late dissolution can be observed in the form of micro-eroded surfaces which are covered in calcite of meteoric origin ($\delta^{18}O_{VPDB}$ = 9.1 to 11.2‰, $\delta^{13}C_{VPDB}$ = 6.9 to 0.3‰, T_h <50EC, 2-4 wt% $NaCl_{equi}$). The meteoric phase is associated with a low Pridolian sea-level. This event provides a temporal limit for hydrothermal dolomitisation and hydrocarbon deposition within the Sayabec Formation.

Among the carbonates of eastern Quebec, the best reservoir rocks are Ordovician. Reservoirs are formed early by hydrothermal dolomitisation. On Anticosti Island, seismic work illustrates the collapse of the platform and the loss of seismic markers in the extensional domains. In the Gaspé, the seismic data document compressive structures within the seismostratigraphic interval containing the Sayabec. Several horizontal anomalous seismic reflectors in the Lower Silurian also suggest the presence of hydrocarbon reservoirs.

Session 5 3:20

Presence of Gas in Quaternary Sediments of the St. Lawrence Estuary observed using High-Resolution Geophysical Data

Mathieu J. Duchesne, Bernard F. Long* and Nicolas Pinet (Institut National de la Recherche Scientifique Eau-Terre-Environnement)

Recently, 1200 km of high-resolution monotrace seismic marine profiles were collected downstream from Les Escoumins and upstream from Pointe-des-Monts and 500 km^2 of multibeam bathymetric survey was performed around the Manicouagan peninsula.

The seismic profiles allowed visualisation of the contact with the Proterozoic-Paleozoic basement, for improved characterization of the seismo-stratigraphy of Quaternary deposits *(sensu lato)* and to observe bright spots (seismic amplitude anomalies) attributed to the presence of gas in the sediments. These bright spots are associated with two main seismic patterns: gas venting forms ("chimneys") which may entirely or partially cross-cut the Quaternary layers, and gas horizons of variable extension.

On the north slope of the Lawrentian trough, the chimneys are characterized by visible depressions on multibeam images. These depressions are sometimes arranged like beads along the length of probable tectonic structures. In many instances, the seismic data shows that gas migration occurs along the surfaces of faults expressed in the underlying basement, towards the surface via the chimneys. In other instances, seismic amplitude anomalies form horizons which are probably associated with the degradation of organic matter contained in the Quaternary deltaic deposits on the margins of the Gulf of St. Lawrence.

In the heart of the Lawrentian trough, gas chimneys are located above the basement swellings. In a few cases, the reflections of opposite dips were captured from the sides of these swellings, indicating their anticlinal nature.

Seismic anomalies of very high amplitude were recorded in the upstream portion of the study zone. These anomalies represent a bottom-simulating-reflector linked to the presence of gas hydrates. The upper limit of these horizons corresponds to a marked acoustic impedance contrast suggesting the presence of a less permeable lithological unit capping the gas horizons. The depth of these anomalies is located in the hydrate stability zone as documented in the literature. The presence of numerous basement-involved faults suggests a thermogenic origin for the gas which could have migrated from the underlying basement (Paleozoic platform) to the permeable Quaternary units located in the hydrate stability zone.

*speaker

Session 5 3:40

Seismic imaging of diagenesis: A tool for studying hydrothermal dolomite systems

Bruce Hart, Justine Sagan, Juliana Tebo, Kamal Al Atroshi (McGill Seismic Research Group, McGill University)

Hydrothermal dolomite prospects are often defined seismically, using a combination of qualitative criteria that includes sags on key horizons, fault geometry, changes in amplitude or frequency of the seismic data, and other observations. Drilling results may be "mixed" and little insight is typically gained into the controls on porosity and permeability development. In this presentation we show how integration of seismic and wireline log data may be used to map porosity associated with dolomitization in carbonates. We use both seismic inversion and seismic attribute studies to map (in 2- and 3-D) the distribution of porosity in dolomitized reservoirs of the Appalachian Basin (Trenton–Black River Groups), Williston Basin (Red River Formation) and Jurassic of the Gulf Coast (Smackover Formation). By examining the distribution of porosity we have helped to resolve fundamental questions about the controls on diagenesis in each area. A critical aspect of these studies is the integration of porosity prediction with other types of analyses. Detailed structural and stratigraphic analyses need to be undertaken concurrently using seismic, log and other types of data. Our analyses indicate that hydrothermal dolomitization in the Trenton–Black River Groups is associated with complex basement-involved wrench faulting. The Trenton–Black River and other studies provide results that can be used directly in field management, or in the exploration for, or development of, analog fields elsewhere.

Session 5 4:00

Aeromagnetism in the Service of Oil Exploration

Marc A. Vallée, Terence McConnell, Camille St-Hilaire (Fugro Airborne Surveys) and Pierre Keating (Geological Survey of Canada)

Aeromagnetism is a technique that has been used for mining and oil exploration since the end of the second World War. Traditionally, aeromagnetic surveys were used in oil exploration to infer the depth of a sedimentary basin and to identify the basement structures located beneath this basin. During the last forty years, there have been many technological breakthroughs. These include the develop of more sensitive and rapid sensors, the digital recording of data, the compensation system for in-flight effects, and finally, GPS localization. This has led to an evolution in survey parameters and an improvement in data quality. Recent surveys for oil exploration allow the localization of formations or structures located within the sedimentary basin itself. This has been confirmed by the example of a survey performed in the Gaspé in the 1960s, which was repeated in 1998. In the latter case, the resolution of the data was far superior, particularly in the short wavelengths associated with shallowly buried sources. Field work has shown that the source of these anomalies correspond with either faults, or increased magnetite content in certain sedimentary beds. Recent data processing techniques such as tilting the magnetic field have helped to refresh the applicability of the magnetic method as a tool for oil exploration.

Oral Presentations

Session 6 8:30

Quaternary Geology in Mineral Exploration: Indicator mineral methods in mineral exploration

Harvey Thorleifson (Minnesota Geological Survey)

Indicator mineral methods rely on sampling of sediments such as glacial and stream sediments, and detection of mineral deposit indicators dispersed by mechanical processes. These methods are part of a spectrum of clastic sediment-based approaches ranging from boulder tracing to detection of detrital debris or their weathering products by chemical analysis of soil parent materials and sediments. These methods are part of the array of mineral exploration tools that we now use in the search for base metal, precious metal, and gemstone deposits. Methods applied directly to prospective rocks at the preliminary stages of grassroots prospecting and the advanced stages of property evaluation include visual inspection, petrography, and lithogeochemistry. Intermediate between these phases of exploration are methods for remote detection of mineral deposits, achieved by geophysical or satellite observation, or by the detection of mineral deposit indicators transported from source. Whereas application of exploration geophysical methods is directed at the mineral deposit and/or associated alteration by detection of electrical, gravity, magnetic, seismic, or thermal properties, geochemical and indicator mineral methods involve tracing of material dispersed from source. Whereas purely geochemical methods rely on indicators dispersed from source by aqueous and/or gaseous chemical processes, indicator mineral methods are based on clastic indicators that have been dispersed from source by mechanical means alone. Elemental analyses of soil parent materials and sediments may be used to detect a combination of chemical and clastic signals, although a survey usually is directed at one signal or the other. For example, the B horizon might be sampled and appropriate analytical procedures applied to seek a dominantly chemical signal, while the C horizon might be sampled and analyzed to seek primarily a clastic signal residing in mineral grains or their weathering products. In the case of visible indicator mineral grains, the signal is attributable to mechanical dispersal processes alone. The scope of these mineral-grain-based methods is expanding from well-established procedures, such as those for gold grains and kimberlite indicator minerals, to new approaches for targets such as base metals. A key element of survey design is selection of an appropriate sampling medium, and consistency in its application.

Session 6 9:20

Conditions and processes in the subglacial environment and kimberlite indicator mineral dispersal trains

F. Hardy (INRS-ETE) and M. Parent (GSC-Québec).

One of the determining factors for the concentration of indicators in basal till is their proximity to the source of the dispersal train. Numerous other factors, however, can also influence their transport distance and detectability. We will discuss some of these other factors, namely glacial flow and subglacial discharge of meltwater.

Changes in ice flow directions have two main consequences. The first and most obvious is the dispersal of any pre-existing train and the creation of a fresh and more distinct train. The second consequence, although more subtle, influences the ultimate detectability of the indicator. Constant flow over a long period of time during a glacial cycle produces the same effects as those associated with rapid flow (ice streams), as frequently discussed in the recent literature. The result in both cases is erosion of the substrate profile (whether it be rocky or sedimentary) to attain equilibrium with the stable flow direction. A characteristic feature of an equilibrium profile is erosion has attained a section that offers the least resistance to the existing subglacial shear stresses. Any change in the flow direction will profoundly modify the distribution and magnitude of subglacial stresses and will therefore modify the degree of subsequent erosion, the quantity of material in subglacial sedimentary transit, and the down-ice sedimentation.

Field reconnaissance work to detect episodes of subglacial meltwater drainage will are necessary when it is time to interpret the effectiveness of distance of indicator transport. Eskers are the most easily recognized fluvioglacial features because of their distinctly different sedimentation processes compared to till deposits. Nevertheless, the velocity of subglacial meltwater in numerous examples was high enough that sedimentation was not possible and an esker is not observable. In either case, whether or not sedimentation occurred or not, the sedimentary substrata will be significantly modified at the local scale and these changes will have a clear influence of the absolute values of indicator abundances.

Session 6 9:40

The Wemindji case: dispersal trains and drill holes

R. Charbonneau (Consultants Inlandsis) and J. Letendre (Majescor Resources Inc.)

The Wemindji kimberlite was intersected during drilling by Majescor Resources Inc. in the spring of 2002 after tracing indicator minerals and kimberlite fragments in 39 pits at the head of a dispersal train that was previously delineated by surface till sampling. The indicator mineral chemistry and the magmatic differentiation facies revealed by the till fragments correspond to those of the kimberlite encountered during drilling, thereby demonstrating that the latter represents the source of the dispersal train. The kimberlite forms a subhorizontal sill with an average thickness of 2 m. No diamonds of commercial size (>0.85 mm) have yet been recovered during bulk sampling of 8.5 metric tons of kimberlite, although caustic fusion of 190 kg produced two microdiamonds.

The sampling and pit work were important for elucidating the Quaternary geology of the area. The work revealed the extent of a gravelly lithofacies that largely consists of angular and jointed clasts, overlying a typical glacial diamicton. Although it was originally interpreted as an outwash or ablation till, this gravelly sediment displays few of the typical characteristics indicative of reworking by meltwater. Instead, an alternative proposal is presented in which the matrix between the sediment clasts was liquefied and extruded following transport. The kimberlite discovery at Wemindji thus highlights the usefulness of glacial lithofacies during mineral exploration, although certain aspects regarding their origin require further study.

Session 6 10:00

Terrible till on the Assemetquagan: Laurentian deposits in the Gaspé region

G. Martineau, D. Brisebois* and M. Beaumier (MRNFP)

Laurentian ice made a major incursion into the Gaspé region during the last glacial maximum. The Laurentian ice cap was responsible for the deposition of the Langis till and the dispersion of Precambrian blocks, now observed almost exclusively in the western part of the Gaspé. The Langis till is compact, dark grey, calcareous and slightly oxidized at the surface. Its lithological content consists primarily of blocks from calcareous and sandstone-type sources in the region, a lesser amount of slatey schists and a few blocks of typical Precambrian lithologies. On high plateaus west of Lac Matapédia, Laurentian ice followed the southern slopes of the Chic-Choc Mountains until Mont Albert and then spread out southward beyond the Restigouche River. Over this territory, Laurentian ice deposits generally consist of undifferentiated tills that cannot be associated with any particular formation. The deposits, which rest on weathered bedrock, are discontinuous, thin and often exhibit several erratic blocks from variable sources. According to Lebuis and David, erratic blocks from the shield rarely exceed 5% of the lithological content of the tills, and they typically account for significantly less (<1%).

The second author (D.B.) recently observed concentrations of Precambrian blocks in the western plateau sector at significantly higher levels than previously reported. Initial field verification revealed a deposit with an oxidized, silto-sandy matrix and high levels of blocks of Precambrian origin.

This till masks the usual geochemical signature of stream sediments, which is problematic since stream sediment signatures are traditionally interpreted as reflecting the lithological composition of nearby rocks. By studying the non-concordance between the geochemical response of the sediments and the normal response for the bedrock, we were able to delineate a territory of at least 350 km^2. We interpret this region of the Gaspé as a sector where the presence of a Grenvillian-derived till disturbs the geochemical signature of stream sediments and we believe that a similar situation may also exist elsewhere in the Appalachians, which may constitute a *real terror for mineral exploration!*

*speaker

Oral Presentations

Session 6 10:20

3D modeling of Quaternary deposits and exploration targets in the Casa-Berardi mine sector

S. Faure (CONSOREM) and F. Fallara (URSTM-UQAT)

The Quaternary stratigraphy and glacial dispersion in north-western Abitibi is poorly known due to the thickness of the glaciolacustrine sediments and the scarcity of stratigraphic sections. Gold anomalies in the till overlying the Casa-Berardi mines have been traditionally reported as erratic and interpreted as secondary geochemical enrichment or as glacial remobilization. We performed 3D modeling of the stratigraphy and of the Au and As anomalies in the till and glaciofluvial sediments over the gold deposit. The objective was to better understand the geometry of the geochemical anomalies and the dynamics of the glacial activity in this sector in order to improve exploration strategies.

The database consisted of 1,659 reverse circulation drill holes distributed over an area 50 km long (E-W direction) by 10 km wide (N-S). In addition, the data from 1,948 diamond drill holes were integrated into the database in order to generate bedrock topography. A block measuring 8.5 km E-W by 6.5 km N-S was chosen for modeling above the mineralized zones. From the base to the summit, seven litho-stratigraphic Quaternary units were distinguished: ancient till, Lower Matheson till, Missinaibi sediments, Upper Matheson till, Ojibway sediments, Cochrane till and humus.

Three-dimensional analysis of the data reveals that topographic lows in the bedrock correspond to mineralized zones and regional faults. Topographic highs correspond to volcanic rocks and iron formations. The Quaternary stratigraphy is coherent and laterally continuous. The pattern of Au and As anomalies is in agreement with the polyphase glacial dispersion already established for the region. In deep depressions, anomalies in the older till reflect the presence of the mineralized lenses of the West Zone. The Main and East zones are reflected by step anomalies in the Matheson till. The glacial dispersion above these two zones is controlled in large part by the down-ice bedrock topography; a spur south of the Casa-Berardi fault constrains the Au and As anomalies to a narrow band oriented E-W. The anomalies pick up again at the summit of the Upper Matheson till to the southeast.

As a result of this study, a glacial remobilization hypothesis is favoured. Three-dimensional visualization permitted several new exploration targets to be identified and thus represents a key tool in the interpretation of regional geochemical dispersion.

Session 6 10:40

Where do these pebbles come from? Some tools for determining glacial sediment dispersal in the Otish Mountain region

Réjean Girard (IOS Services Géoscientifiques), Michel Parent (Geological Survey of Canada), Alexandre Aubin, Jean-Michel Belley and Jonathan Lalancette (IOS Services Géoscientifiques)

Diamond exploration techniques are based mainly on the sub-glacial dispersal of particles and minerals derived from the erosion of (most commonly) kimberlitic rocks. However, interpreting the sources of signals in this secondary environment is complex, and too many overly simplistic assumptions may be made if a pre-established protocol does not exist. Conventional methods of interpretation generally employ photo-interpretation, grain-size analysis and the study of fabrics in the glacial deposits. This presentation will also provide an overview of other strategies for interpretation – ones that use subsidiary data collected at all stages of an exploration program, from field sampling to laboratory processing. The method of pebble counting (linking pebble type to nearby lithologies) will be presented in detail using a number of practical examples from various regions in Québec. The dispersal of Proterozoic sandstones will be used as a case example. Various other methods will also be introduced, like magnetite distribution, grain-size proportions, constituent mineral abundances, heavy mineral or mud geochemistry, glacial deposit magnetic signatures, and various mathematical tools, from conventional statistical parameters to Monte Carlo simulations.

The objective of the exercise is to determine, using simple tools and a little imagination, the direction(s) of material transport, the distance of transport, the level of mixing and the proportion of foreign material, background levels, the presence of blind zones, the shape of dispersal trains and plumes, the effect of polyphase systems, and the general reliability of the data. An understanding of these methods will allow for the optimization of drill patterns in the field and laboratory-based sample treatment.

Session 6 11:00

Diamond prospection in northern Québec: the role of polyphase glacial dispersal

Michel Parent and Serge J. Paradis (GSC-Québec)

The ongoing intensive search for diamondiferous kimberlites in northern Québec has placed glaciosedimentary prospection at the forefront of exploration methods employed by private companies for regional reconnaissance surveys and local studies. As this frontier region was affected by several phases and directions of glacial movement, reconstructing the complex dynamics of the Laurentian ice cap and understanding the consequences for both regional and local dispersal patterns have become essential components in the search for mineral resources, especially in the case of diamond exploration.

The work conducted by Geological Survey of Canada in support of diamond exploration in northern Québec consists of three main themes: (1) the reconstitution of successive glacial movements using cross-cutting striated surfaces and other morphological indicators; (2) the discrimination of dispersal trains using lithological indicators in fluvioglacial (eskers) and glacial sediments (tills) with the aim of formulating regional models of glacial dispersion; (3) the promotion of diamond prospection in frontier regions using reconnaissance surveys for kimberlitic indicator minerals (KIMs) in esker sediments.

The complex glacial dynamics evidenced by this work are characterized by major reorientations up to 90° or more at the core of the eastern dome in the ice cap, whereas reorientations along the inside periphery of this dome were of lesser magnitude. The reorientations were primarily controlled by the location and migration of the main glacial divide within the eastern dome, which covered most of the Québec-Labrador Peninsula. In the external peripheral regions, alongside epicontinental seas and large depressions around the perimeter of the Québec-Labrador Peninsula, the reorientations once again became major and very sharp, attributable to the episodic development of large glacial currents, mainly in the Hudson Strait and the Gulf of Saint Lawrence.

Dispersal trains comprising impactite clasts from Lac à l'Eau Claire and clasts of sandstone and quartzite derived from remnants of the Sakami Formation are shown to be composite trains, consisting of long banded and palimpsestic trains. These trains invoke models of glacial dispersal marked by regionally variable features that must guide glaciosedimentary prospection strategies in northern Québec.

Session 7 1:30

Applied Geochemistry and Minerals Exploration: past, present and future?

Peter J. Rogers (Chavin Consulting Limited)

Applied or exploration geochemistry has a distinguished history since developing in Russia and crossing North America in the 1950's. Spectacular successes of stream and soil sampling coincided with cheaper and accurate analytical technology from field colorimetry to sophisticated Mass Spectrometers with low cost multi element packages. Many discoveries were made by notable pioneers often members of the Association of Applied Geochemists. More importantly landscape models were developed for climatic zones, past and present while charting the highly variable behaviour of elements in different environments. The unfortunate downside to this success was that the science was oversold on simplicity being described as dirt bagging – a very undeserved label.

Until very recently the impression was one of a science looking for a home; a grey haired industry, no professional recognition of geochemists as Qualified Persons, few active teaching schools, and low university enrolment. This is a direct result of the low budgets of the last 5-year bust cycle during which both academics and government scientists turned to the environmental field for funding sources. In Canada geochemistry is particularly neglected with an over reliance on geophysics despite clear evidence that geochemistry was successfully used in fully 75% of recent discoveries in the Circum Pacific. There is a marked lack of 'green fields' programs – the industry's R&D – coupled with an ever shrinking core of geochemists in a high cost scenario where sparse discoveries are ever harder to make.

2004 brings a new cycle of higher demand and prices – a boom – where the future is bright for exploration geochemistry. Research in North and South America and Australia in particular will help to make the cost effective future discoveries that the industry demands. The development of integrated sampling strategies based on single sample collectors for both gases and metals for buried bodies, efficient vegetation sampling, mobile field heavy mineral separators and analyzers and field chemical analysis offer concrete solutions. The fusion and convergence of technologies across disciplines continues unabated – the empowered 21st century geochemist can rely on integrated software packages, Expert System and Neural Net data models – all of this delivered across virtual or wi-fi networks at low computing cost. Decision-making can now be downloaded in the field to both shorten the exploration cycle and lower costs. Lastly, this does not mean low cost geochemical robots are feasible – quite the reverse as qualified earth scientists are required for the geochemical exploration programs of the future.

Oral Presentations

Session 7 2:20

The chemical discrimination of "kimberlitic" rocks in Québec

Don Francis, Joy Hartzler, Jim Clark and Anthony E. Williams-Jones (McGill University)

Despite their mineralogical diversity, taken together, the alkaline ultramafic dykes that host diamonds constitute a compositional extreme in the array of primitive terrestrial lavas and an important enriched component in the mantle sources of many basalts. Until recently, sampling problems have limited our knowledge of the compositions of the magmas responsible for these rocks and their classification has remained a rather esoteric process, often best left to experts. A survey of recent analyses of hypabyssal-facies ultramafic lamprophyres (aillikites), group-I and II kimberlites, olivine lamproites, minettes, and meimechites suggests, however, that a whole-rock major element analysis can not only reliably distinguished these diverse dyke types, but also provides a preliminary assessment of their diamond potential. Both aillikites and group-I kimberlites have lower Si contents than olivine so that the fractionation of olivine (and or phlogopite) from such magmas leads to Si-poor residual liquids that are rich in carbonate. In contrast, the more micaceous group-II kimberlites (orangeites), olivine lamproites, and minettes, as well as meimechites, have higher Si contents than olivine and thus fractionate towards more Si-rich residual liquids. On the Si-poor side of olivine, there is gradation from the low Fe contents of group-I kimberlites (FeO < 11 wt.%) through transitional *kimberlites* to Fe and Ti-rich aillikites (FeO > 12 wt.%); whereas on the Si-rich side, group-II kimberlites (orangeites), olivine lamproites, and minettes are characterized by low Fe contents, while meimechites are relatively Fe-rich. Most intriguingly of all, however, is that there appears to be an inverse correlation between diamond grade and whole-rock Ti content, with economic pipes typically containing less than 1.5 wt.% TiO_2.

The foregoing criteria were applied to hypabyssal dykes from Québec *kimberlite fields* in the Otish, Wemindji, Temiscamingue, Torngats, and Desmaraisville areas. Accordingly, the Proterozoic ultramafic dykes of the Torngats (as well as other Ungava localities) and those of the Desmaraisville area range from aillikites to meimechites, and are too rich in Fe and Ti to be likely hosts of economic diamond grades. The Precambrian Wemindji sill is a highly fractionated group-I kimberlite, whereas the Cretaceous Temiscamingue dykes appear to be group-II kimberlites. The late Proterozoic dykes of the Otish Mountains are largely group-I kimberlites, but range in composition to group-II kimberlites. The low-Ti dykes (most < 1 wt.% TiO_2) of the Otish Renard field have significantly higher diamond potential than the higher Ti dykes of the Beaver Lake and Tichégami localities (>2 wt.% TiO_2).

Session 7 2:40

The Role of 2-D and 3-D GIS Analysis in Exploration

Jeff R. Harris and Eric De Kemp (Geological Survey of Canada)

Geographic Information Systems (GIS) are now commonly used by exploration companies. Much of the GIS research over the past 10 years have been directed towards how various geoscience datasets can be visualized and integrated for 2-D and 2.5-D applications. Recently new 3-D GIS tools have been developed that facilitate mapping and exploration in 3 dimensions.

Firstly, this presentation provides an update on how 2-D GIS analysis, in concert with spatial modeling software, can be used to assist in the exploration process for new mines. Methods and software tools for producing mineral favourability maps are reviewed using examples from the Superior, Grenville and Slave provinces.

Secondly, new 3-D visualization and analysis GIS tools, developed by the Geological Survey of Canada, are presented using examples from a regional structural study in central Baffin Island and in a local mine study from the Kidd Creek mine in Timmins, Ontario.

Session 7 3:20

Valorization of MEGATEM technology: Advancements and results

Denis Bois (Mineral Technology Research and Services Unit, (UQAT)) and Michel Chouteau (École Polytechnique de Montréal)

Many regions across the country are experiencing difficulty in ensuring the renewal of mineral resources. These regions face significant economic problems if the situation is not corrected.

The MEGATEM Technology Valorization Project was initiated by UQAT with the collaboration of Polytechnique, Fugro, Noranda, CED and the MERRD. It aims to evaluate and optimize MEGATEM mineral exploration technology with the goal of mineral resource renewal within a regional and scientific development perspective. The project began in the spring of 2003 and this presentation outlines the work conducted thus far and the results obtained.

The airborne MEGATEM transient electromagnetic system covered almost 1,400 km of line over three sectors in the Rouyn-Noranda region of Quebec, an area well known for its volcanogenic massive sulfide bodies.

All available geoscientific data from public and private domains were compiled for these three sectors, following which it was possible to construct 3D geological models that were deemed representative for the purposes of evaluating MEGATEM responses.

MEGATEM data for the each of the three sites were acquired using the *Full Stream* (raw data) and *Stacked* modes (corrected, summed, smoothed and resampled final data). Flight objectives included, among other things, the comparison of responses using various system geometries (transmitter – mineralized body – receiver), frequencies and flight altitudes, as well as the recording – by cutting the transmitter – of electromagnetic frequencies that affect signal reception (mainly *sferics* and high tension lines).

Apart from the evaluation and calibration of MEGATEM technology, the other main objective of the project is to develop new tools for data interpretation. Although the project is only midway and the results still preliminary, we can nonetheless conclude that:

- In a resistive environment, mineralized bodies with a conductance on the order of 50 Siemens (like the ISO deposit) can be detected at depths in excess of 250 m.

- Surveys with a sufficiently high number of electromagnetic events *(sferics)* are useable in the manner of the AFMAG method from the 1970's.

- Results of the project can be used to valorize surveys already conducted using smoothed data. It is evident that raw data (*Full Stream Data* mode), although seldom used, presents a wealth of information that could improve exploration for mineralized bodies.

Session 7 3:40

INFINITEM: a new type of deep-penetration ground-based EM survey

Marc Boivin (SOQUEM) and Circé Malo-Lalande (Abitibi Géophysique)

In 2000, SOQUEM and Abitibi Géophysique embarked on a major revaluation of ground-based electromagnetic (EM) methods used for base metal exploration in the Matagami region. The idea for the review began when SOQUEM planned a ground-based geophysical campaign to follow up on some MEGATEM™ anomalies.

Tests were conducted in 2001 and 2002 using several EM configurations, including moving loop and fixed loop with "in-loop" and "out-of-loop" configurations. This work lead us to the conclusion that the conventional "out-of-loop" configuration demonstrated serious deficiencies, and that the "in-loop" configuration was a superior approach for cases of deep reconnaissance geophysical investigation.

In 2003, after obtaining assistance from Canada Economic Development (CED) and the NRCC, Abitibi Géophysique and SOQUEM undertook a series of field tests over the Caber deposit in the Abitibi to characterize the "in-loop" electromagnetic signature. The Caber deposit, located more than 125 metres below the surface, offered a considerable level of difficulty due to its zincian signature and its cover of conductive overburden.

The results demonstrated the effectiveness and sensitivity of the "in-loop" method. Several different sizes and positions for the emitting loops were used to characterize the geophysical responses. These tests also led to a better understanding of data interpretation.

In an attempt to improve the effectiveness of this type of survey, we have created and tested a new fixed loop configuration known as INFINITEM™. The results obtained using this new configuration over the Caber deposit were particularly informative in terms of the sensitivity of the configuration.

Subsequent trials and surveys allowed the technical parameters to be optimized with respect to the operation of INFINITEM™. Tests over a deeply buried mineralized zone confirmed the significant depths to which this configuration can detect targets. SOQUEM has since used its INFINITEM™ configuration on several of its properties. Several EM conductors were detected at sites where the MEGATEM method previously detected nothing. The drilling of one of these anomalies resulted in the discovery of a significant mineralized showing in the Matagami region.

Oral Presentations

Session 7 4:00

An update on airborne EM systems

M. Allard (Noranda Inc.)

Airborne electromagnetic (AEM) methods have experienced renewed popularity during the past several years due to the development or refinement of several systems. The major examples are: AEROTEM, HOISTEM, MEGATEM, THEM and VTEM. With the exception of MEGATEM, which is mounted on a DASH 7 airplane, the new systems use helicopters as their platform. They all, however, have one feature in common: they function as time domain systems. Today, like 50 years ago, the design of an AEM system seeks to optimize the following parameters:

- resolution;
- sensitivity or signal/noise;
- depth of investigation;
- conductance window; and
- discrimination between different types of conductors.

In practice, it is very difficult to optimize all parameters at the same time, and compromises must be made. In general, the designers choose to optimize certain parameters that will respond specifically and most economically to the needs of a particular type of exploration (e.g., diamond, gold, VMS, nickel, etc.).

It is within this context of "specifications versus applications" that each of the systems will be reviewed briefly and their most significant particularities highlighted. In addition, examples of results obtained will illustrate the clear improvement of these recent systems over older systems, like INPUT. It is mainly the advent of the GPS, remarkable increases in recording, memory and digital data treatment capacities, and a significant increase in the power of transmitters that have permitted the acquisition of a quantity and quality of data that was unthinkable twenty years ago.

Finally, several difficulties that limit the application of AEM methods will be presented (for example, the fact that the transmitter and the receiver must always be moving), in addition to several possible solutions that could allow the techniques to be further improved.

Session 7 4:20

New approaches to airborne magnetometer and gravity surveying

Laurie E. Reed (L. E. Reed Geophysical Consultant Inc.)

Magnetometer surveying from the air has had a long standing application in geophysical mapping. Significant coverage has been achieved in Canada for over the last 50 years. This surveying has been accomplished largely from single sensor surveys, although various vertical and horizontal gradient systems have been in use for the last 30 years. As the demands for greater and greater resolution of the magnetic field in detail have arisen, more sensors have been attached to aircraft. The demand for detail has pushed for lower terrain clearance, beyond ordinary safety limits for fixed wing aircraft. Recently, a helicopter magnetometer system, MIDAS, made available to the market by Fugro Airborne Surveys has been flown in Northern Ontario. This system, flying 50 metres or lower to the ground, with sensors at the ends of 6 metres booms extended horizontally on either side of the aircraft, develops a total field and a horizontal gradient that has higher resolution than sensors flown at higher levels. The horizontal gradient permits calculations of the field between the flight lines, so extending the details of the survey.

Gravity surveying has traditionally been carried out on the ground where the stable conditions required for this sensitive measurement can be achieved. For some considerable time (as long as airborne magnetic measurements have been made) it has been the desire of geophysicists to measure gravity from the air. Numbers of false starts were made. Some of these measured gravity, but not to the resolution or accuracy required for detailed geological applications such as could be achieved on the ground. Some airborne gravity systems have been used over the past 20 years in the petroleum industry, where large scale regional gravity could be measured. Recently, new systems with higher resolution have been developed, the BHP Billiton Falcon and the Bell Geospace gravity gradiometer systems are among these. A total gravity field system has been placed into service by Sander Geophysics (the AIRGrav system) and flown in Northern Ontario. This system develops data that matches ground gravity reasonably well at a 1 km interval.

The Fugro helicopter magnetometer gradiometer and the Sander airborne gravity system have been flown as part of the Discover Abitibi Initiative. Data from these surveys will be presented along with comparisons to previous air and ground survey data. Data from these surveys have been published by the Ministry of Northern Development and Mines (MNDM) of Ontario.

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Abitibi geochronology

C. Dion (MRNFP), J. David (GÉOTOP-UQAM) and the SGNO team

This geochronology program is designed to support the work of the SGNO in the Abitibi region. Following the 2004 field campaign, ten samples were sent to GEOTOP. Of these, two samples did not contain any zircon (SGNO-2004-02 Montviel carbonatite and SGNO-2004-03 Delbridge rhyolite).

Lac Olga III:

- SGNO-2004-08: A rhyolite from a felsic volcanic unit interpreted as the eastern extension of the Lac Watson Gr. (32F/10) recog-nized in the Matagami area. This rhyolite is particularly interesting in that it constitutes the host unit of VMS deposits in this mining camp.

- SGNO-2004-07: A melanosyenite from the Montviel alkaline Complex (32F/15). This complex contains a carbonatite unit with niobium and rare earth mineralization, a fairly rare occurrence in Archean carbonatites.

Grenville Front II:

- SGNO-2004-01: A conglomerate of the Caopatina Fm. (32G/07) interpreted as belonging to the first cycle of sedimentation in the Abitibi (< 2720 Ma). Goutier *et al.* (in preparation) obtained an age of sedimentation of < 2684.9±2.6 Ma for the Taibi Gr. (32F/10), also previously considered as part of Cycle 1. An age for the Caopatina Fm. would help clear up questions on the existence of Cycle 1 sediments in the Abitibi.

- SGNO-2004-06: A coronitic gabbro dyke (32B/14) from the Grenville Parautochthonous Belt. These intrusions are metamorphosed to the amphibolite facies and weakly deformed compared to surrounding country rocks. Therefore, they constitute a good marker to distinguish Grenvillian vs. Kenoran deformation and metamorphism.

- SGNO-2004-10: An intermediate tuff of the Lacroix Fm. (32B/14). These tuffs are interstratified with komatiites, and should help date ultramafic volcanism in this part of the Urban-Barry belt.

Blake River East II:

-SGNO-2004-09: A QZ-PG-phyric rhyolite assigned to the Millenbach rhyolite unit (32D/06). This analysis should help date the main VMS-hosting sequence (Noranda Fm.) of the Blake River Gr.

Blake River West I:

-SGNO-2004-05: A spherulitic rhyolite from the western Blake River Gr. (32D/06), to the west of the Flavian Pluton.

Destor-Porcupine III:

-SGNO-2004-04: A conglomerate of the Duparquet Fm. (32D/06). This sample comes from the central part of the sedimentary basin, and is probably more representative of the sediment source than the sample dated by Davis (2002) at < 2697±3 Ma.

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The REFORMIN Project in Bolivia

Marc Bélanger and Denis Lefebvre (MRNFP)

The REFORMIN project supports the mining industry reform in Bolivia. It is financed by the Canadian International Development Agency (CIDA), with $4.6M distributed over a 5-year period (2001-2006). The ministère des Ressources naturelles, de la Faune et des Parcs (MRNFP) was chosen by the CIDA as the executing agency for the Project.

Supervision of the project is overseen by a management committee comprising the Vice Minister of the Bolivian Vice Ministry of Mining and Metallurgy (VMM), a representative of CIDA, the director of the Project in Quebec City, and technical coordinators from Quebec and Bolivia. The MRNFP has placed two employees (one from Quebec and one from Bolivia) on site in La Paz to coordinate the project.

The Project encompasses four main themes that focus on the transfer of knowledge and technology: 1) Mining environmental management; 2) Living conditions in mining communities; 3) Mine-related working conditions in mining communities; and 4) Promotion and management of mineral resources. In order to coordinate and implement the numerous interventions required for successful results in these four domains, the Project relies on the expertise of its personnel to transfer their sound administrative practices in the management and promotion of mineral resources. In addition, it has enlisted a number of Bolivian and Canadian collaborators who are bound by contracts to deliver goods and services. The following groups are already involved in the Project: the Or-et-des-Bois School Commission in Val d'Or, the Mineral Technology Research and Service Unit in Rouyn-Noranda, the Canadian Centre for International Studies and Cooperation (CECI) in Montreal and La Paz, SNC-Lavalin in Montreal, and the *Centro de Promocion Minera* and the *Cumbre del Sajama* in Bolivia. Most of the subprojects are aimed toward the acquisition of skills and know-how, with the ultimate goal of improving the living conditions in the Bolivian mining sector.

Quebec is known worldwide for the responsible management of its mineral resources. The transfer of this expertise is intended to assist Bolivian institutions that administer to the environmental and mineral resources sectors, while improving the quality of life in Bolivian communities that depend on mining for their livelihoods.

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Assessment of the potential for volcanogenic massive sulphide (VMS) deposits in Abitibi

D. Lamothe, J.-Y. Labbé (MRNFP) and J. Harris (GSC)

Géologie Québec will publish in March 2005 a syn-thesis assessment of the base metal potential in the Abitibi Subprovince and the Frotet-Evans belt. This vast study, which covers all Archean volcanic rocks between the 47th and 51st parallels, is the first of its kind in Québec, given the scope of the study area, the vast array of integrated data and the quality of the processing resolution. Performed jointly by the authors with the cooperation of resident geologists in the Abitibi region, this assessment aims to define and document, for the study area, a certain number of targets that show the most promising potential for new discoveries.

The methodology is based on a knowledge-driven approach using the volcanogenic massive sulphide (VMS) ore deposit model. In this type of approach, all geological, geochemical and geophysical parameters linked to the presence of VMS-type occurrences are processed using an "inference model" flow chart. The model-maker controls the final result of the process, by determining at each step how the model will evolve according to his judgment as to what role each parameter plays. The weight of each parameter is calculated statistically based on its spatial association with known VMS occurrences, a probabilistic approach that eliminates the arbitrary nature of a traditional knowledge-driven approach.

This study will allow Géologie Québec, by generating new targets, to contribute to the discovery of new copper deposits to compensate for the depletion of mining reserves affecting various mining camps in the medium term. The final product will include a 1:500,000 scale map of the study area, as well as about 120 maps at 1:50,000 scale, created with ArcGIS and released in PDF format on DVD. Intermediate products in digital format will also be available, namely the lithological map of the Abitibi with closed polygons, generated us-ing 1:20,000 scale and 1:50,000 scale maps available for the entire area.

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Anticosti Island as an example of protecting and valorizing outstanding geological sites in Québec

André Desrochers (University of Ottawa) and Pierre Verpaelst (MRNFP)

Anticosti is a large island located in the Gulf of St. Lawrence and a remarkable site of scenic and geological value. Firstly, the gently SW-dipping exposures along 600 km of unspoilt coast and major river valleys provide one of the most complete sedimentary successions across the Ordovician-Silurian boundary in the world. They comprise about 1000 m of shallow-water, fossiliferous limestones deposited over a period of 20 million years including the Hirnantian, which spans a period unrepresented over much of North America. Secondly, the Anticosti strata have long been known for their abundant, diverse and superbly preserved marine invertebrate fossils. These fossils record a global crisis associated with the first mass extinction event of the Phanerozoic, being the second largest in terms of percentage of genera and families lost. On a geological scale, marine fossils preserved in the Anticosti strata display not only this extreme biodiversity crisis related to global climatic and related environmental changes (*i.e.* large Gondwana ice cap) but also its recovery and return to normal conditions in tropical shallow-water reef ecosystems. Thirdly, geomorphological attributes of Anticosti Island include an impressive array of caves and karst features, deep canyons, high sea cliffs and wide intertidal platforms. Fourthly, the area has been investigated over a period of 150 years by major North American paleontologists and stratigraphers including Charles Schuchert and W.H. Twenhofel, and documented by over 450 reference items on geological, paleontological and geo-morphological research. Fifthly, Anticosti Island has a unique geological heritage but needs protection for the future. The Québec government has recently agreed to increase its protected areas to 8% of the land area and recognized the need to protect not only its biodiversity but also its geodiversity. The government has formed a working group whose objective is to develop and establish a network of outstanding geological sites (OGS or geosites) to protect Québec's geological heritage. This is unique in Canada, where various categories of protected areas including national parks are largely managed on principles of ecological integrity. The legal recognition of outstanding geological sites like Anticosti Island will contribute not only to the protection of Québec's geological heritage for future generations, but also to the education of a broader public to the Earth Sciences and to local economic development and geotourism.

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Using the Internet to get to know the architectural stones of Québec: consult our web site!

Yves Bellemare, Cathy Lapointe, France Arcand and Solange Saillant (MRNFP)

The objective of the *Architectural Stone* Internet project, created in collaboration with members of Québec's industry, is to provide users with an Internet resource in French (and soon, English) with which they can find information about the architectural stone sector. The use of this consultation tool also improves accessibility to the SIGEOM database and MRNFP geological reports.

Numerous photos accompany factual and geological data on the different varieties of architectural stone, as well as other information relating to the field in general. Through a series of hypertext links, the Internet site allows the user to access more detailed information, including:

- descriptions of the geological contexts for the various exploited substances;
- detailed pages for each variety of stone;
- web sites or electronic addresses of industry contributors;
- descriptive files for each quarry or deposit in the SIGEOM database;
- MRNFP geological reports;
- a location map showing active quarries in 2004;
- a table listing all active quarries in 2004.

The site presently includes two submenus. The first contains information on the exploration for architectural stone and includes data on historical work by prospectors and companies from 1997 to 2003, the findings of MRNFP geologists regarding promising geological contexts, and highlights on new varieties of stone that were the subject of recent development work.

The second submenu describes the exploitation of architectural stone. Users can search the information by substance or by colour. For example, the user can find all the different types of sandstone that are exploited in Quebec, or all the green-coloured rocks. One can also consult a more visually oriented section that includes photos of every type of architectural stone exploited in Quebec.

As a follow up to this project, industry contributors have requested that new submenus be added. As one example, submenus could provide bibliographic references and other pertinent links for architectural stone, a history of quarry work, the exploitation potential of various lithological units, and information on the processes involved in stone transformation.

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Continuation of the Saguenay graben beneath Appalachian rocks: implications for hydrocarbon exploration in the Bas Saint-Laurent region

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

A structural corridor oriented ESE-WNW crosses the Témiscouata area of the Bas Saint-Laurent region. It is detected by: 1) large lineaments observed in satellite images; 2) the emplacement of numerous lamprophyre dykes (and other mafic intrusions) of mantle origin; and 3) a significant number of Pb-Zn-Ba mineralizations, as well as elevated contents of these elements in stream sediments. The corridor is interpreted as the continuation of the Saguenay graben under Appalachian rocks.

Long lineaments parallel to the normal faults that delimit the Saguenay graben are observed in satellite images of the Bas Saint-Laurent region. The northern and southern limits of the graben, approximately 50 km apart, can be followed eastward for more than 175 km from the Saint Lawrence River to just southwest of the Baie des Chaleurs in New Brunswick. In addition, other lesser lineaments found between the two main structures may represent a series of Riedel-type faults.

The locations of five lamprophyre dykes identified within the study area correspond to the approximate continuations of the northern and southern margins of the Saguenay graben beneath Appalachian sequences. Considering the mantle origin for these intrusive rocks, this spatial association tends to confirm the presence of deep structures that extend to the base of the crust.

The sector between the two main lineaments contains several Pb-Zn-Ba showings of hydrothermal origin, as well as numerous stream sediment anomalies. The migration of hydrothermal fluids along these deep crustal faults could have served not only to concentrate metals, but also to dolomitize the limestone present in this region (*cf.* model for hydrothermal dolomites), thus considerably increasing their potential as hydrocarbon reservoir rocks. As such, Silurian limestone of the Sayabec Formation, common in the Témiscouata region, and Cambro-Ordovician rocks of the St. Lawrence Platform contained within the Saguenay graben beneath Appalachian rocks, represent favourable targets for hydrocarbon exploration.

Cambrian age grabens associated with the opening of the Iapetus Ocean, like the Saguenay and Ottawa-Bonnechere grabens, represent prime targets in the exploration for hydrocarbons. Numerous high yield deposits associated with hydrothermal dolomite along similar grabens were recently discovered in the United States, yet this model has never been tested in Québec.

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New outlook on the hydrocarbon potential of the Gaspé region: integration of Radarsat technology and multisource geoscience data

Robert Thériault, Jean-Yves Laliberté (MRNFP), Michel Rheault (MIR), Daniel Brisebois, Denis-Jacques Dion (MRNFP) and Denis Lavoie (GSC)

Increasing energy consumption throughout the world will soon provoke a gradual decline in hydrocarbon reserves, which will in turn promote exploration for medium-sized deposits in Paleozoic sedimentary basins, like those found in the Gaspé region. We must immediately resort to new techniques that accelerate the discovery of such deposits if we are to prepare for the eventual shortage.

We present a fresh outlook on the hydrocarbon potential of the Gaspé region based on new geoscience data that was analyzed by specialists with expertises specific to the types of data involved. Within the framework of the Canada-Québec agreement on the development and usage of radar data, we have employed RADARSAT-1, topographic, geochemical, aeromagnetic, gravimetric and seismic data to generate new mapping tools and to demonstrate the hydrocarbon potential of the Gaspé region. The following are some examples of the products that have resulted from this endeavour:

- RADARSAT-1 mosaic
- Fusion of high-resolution magnetic data with the RADARSAT mosaic
- Fusion of new gravimetric data with the RADARSAT mosaic
- Fusion of stream sediment geochemistry with the RADARSAT mosaic
- Fusion of geologic compilation data with the RADARSAT mosaic
- Integration of seismic, aeromagnetic and RADARSAT data into oblique views

The primary use for this collection of products is to improve the regional scale understanding of structural geology in the Gaspé region, which is of fundamental importance in the search for new hydrocarbon reservoirs. At the more local scale, they can be used to upgrade geological maps. Several regional scale tools will be presented and supplemented by an example of modifications made to a geological map of a sub-region. Remote sensing and geophysical data can be used in this way to adjust previously interpreted lithological contacts or to propose new fracture zones that have remained unrecognized.

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New gravimetric data for the eastern segment of the Gaspé region

Denis-Jacques Dion, Julie Bélanger, Benoit Rioux, Mélanie Bourque and Eric Hoffmann (MRNFP)

In 2002, the ministère des Ressources naturelles, de la Faune et des Parcs initiated a gravimetry survey project covering the equivalent of 16 NTS sheets (1:50,000) in the Gaspé region. The work was conducted in partnership with SOQUEM Inc. and Hydro-Québec. Data acquisition was spread out over a four-month period in 2002 and another month and a half in 2004.

The survey was subsequently improved and annexed to the Geological Survey of Canada's (GSC) Targeted Geoscience Initiative (Phase 2). The equivalent of seven additional sheets were added to the original 16 for complete coverage of the eastern segment of the Gaspé region.

In all, 2,650 new stations now define the gravimetric field of the area. The average distance between stations, distributed mainly along logging roads, is three kilometres.

The Geodesic Survey Division of the GSC loaned two Lacoste and Romberg gravimeters and supplied the logistical support for their operation. A Trimble GPS was used to define positions and elevations as precisely as possible. Positioning data was corrected using a commercial base in Rimouski.

Overall precision for the survey after compilation and reduction of gravity measurements was on the order of 0.5 milligals.

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New aeromagnetic and gravimetric data from the eastern Gaspé region: their significance for understanding the subsurface architecture

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A high-resolution aeromagnetic survey was recently conducted over the northeastern part of the Gaspé Peninsula (average flight altitude = 163 m; line spacing = 400 m). Analysis of total magnetic field maps and various other maps of filtered data (pseudogravity, low-pass filter...) permitted imaging of the deep structure in the Gaspesian segment of the Appalachian Orogen, as well as the recognition of two domains of Cambro-Ordovician rocks on either side of a NE boundary running parallel to the Madeleine River. To the west, a positive anomaly extending in a NE direction was located vertically beneath the Des Landes and Cloridorme formations. To the east, a string of ovoid anomalies mark the northern border of a Siluro-Devonian basin. A map-based analysis of the aeromagnetic survey (notably vertical derivative and analytic signal maps) allow for precision imaging of specific lithologic contacts that correspond to weak variations in magnetic susceptibility ($<0.2*10^{-3}$ SI). Faults are detected by the truncation of linear anomalies. Data analysis also allows for the validation or modification of specific mapped elements, or the proposal of new structures.

A new gravimetric survey acquired over the last two years covers the Gaspé Peninsula east of 67°W. The average spacing for the gravimetric stations was 3 km and the data had a precision better than 0.5 mGal. In the Cambro-Ordovician sequence, the survey clearly imaged strong lateral geometric variations on either side of a NE boundary running parallel to the Madeleine River. West of this zone, a very strong negative anomaly (-30 to -60 mGal along the shore) borders the positive anomaly (+/- 15 mGal) associated with the Shickshock Group. East of this zone, the gravimetric survey confirms that the positive regional anomaly (10 to 32 mGal) actually consists of two elongated zones oriented E-W and NW-SE. In the Siluro-Devonian rocks, a series of elongated anomalies aligned in a NE direction create a relative gravimetric high between Murdochville and Carleton, thus dividing the Siluro-Devonian basin in two. The existence of such a zone, highly oblique with respect to major faults, should be taken into account when formulating regional models.

This semi-quantitative analysis will be completed over the next few months using cross-section modeling of gravimetric and magnetic data.

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Contribution of high-resolution reflection seismology data from the Saint Lawrence Estuary to the recent geometry and tectonics of the Appalachian foreland

Nicolas Pinet, Mathieu Duchesne (INRS-ETE), Denis Lavoie (GSC-Québec), Bernard Long (INRS-ETE) and Pierre Brouillette (GSC-Québec)

In 2003, a high-resolution marine seismic reflection survey totaling 1,206 km was conducted in the Saint Lawrence estuary between Les Escoumins (upstream) and Pointe-des-Monts (downstream). In addition to fulfilling the primary objective of mapping the *sensu lato* Quaternary deposits, the seismic data also imaged their contact with underlying Proterozoic and Paleozoic rocks.

South of 48°45'N, various lithotectonic domains present seismically distinct morphological signatures in the estuary. The western border of the Appalachian wedge, characterized by a steep morphology due to the presence of weathering-resistant formations, is located in the centre of the Laurentian Channel and the maximum width of the autochthonous domain (the Saint Lawrence Platform) is 10 km. To the north, the autochthonous domain widens and dominates the estuary. Reflector horizons with opposing dips confirm the presence of open folds in the autochthonous units. Gas-releasing features were observed extending vertically through antiforms in the autochthonous rocks and, less commonly, along faults that cut through quaternary deposits. This type of distribution suggests a thermogenic origin for the natural gas.

Steeply dipping major faults bound the Laurentian Channel south of 48°45'N. Further north, the fault escarpments diminish in height and their orientation is more speculative. The correlation in the south between fault escarpment height and the thickness of *sensu lato* Quaternary deposits that exceed 0.35 s double-time (>350 m) strongly suggests normal movement during the Pleistocene epoch. Apparent movements that contradict both present-day seismic activity and regional tectonic models that date back to the Mesozoic suggest an origin related to glacial mass fluctuations during Quaternary time. According to this hypothesis, the Saint Lawrence estuary would constitute one of the rare cases in which the glacial history of a region not only influenced its rate of deformation, but also its tectonic regime. The diachronous nature of the retreating Laurentian and Appalachian ice sheets, the low level of friction along rift-related supracrustal faults (based on repeated reactivations during the Paleozoic and Mesozoic), the presence of meteoric fluids at seismogenic depths, and rapid sediment accumulation may have collectively favoured extensional movements within a globally compressional tectonic regime.

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Geologic compilation of NATMAP Transect IV (Anticosti–Gaspé–Campbellton): From the Anticosti Platform to the Gaspé Belt of northern New Brunswick

Sébastien Castonguay (GSC-Q), Daniel Brisebois (MRNFP), André Desrochers (U. Ottawa), Reginald Wilson (NBGSB), Michel Malo (INRS-ETE) and Denis Lavoie (GSC-Q)

The *Geological Bridges of Eastern Canada* is a five-year (1999-2004) multi-partnered collaborative geoscience endeavour. The *Bridges* traverse critical geological segments of Québec, northern New Brunswick, and western Newfoundland. The objective of the *Bridges* is to use five narrow geological transects to bridge the knowledge gaps that exist in the domains of the St. Lawrence platform, the Appalachian foreland thrust-fold belt, and the successor basins. The project has coordinated bedrock and surficial mapping activities as well as a series of thematic studies, in order to help assess the economic potential of these areas.

In the course of the project, various regional-scale bedrock compilations and companion structural cross-sections were produced for the geological bridges/transects of southern Québec (I Montréal–Mégantic and II Québec City–Rivière Chaudière transects) and of the Gaspé, Chaleur Bay and Anticosti Island (III Matane-Restigouche and IV Anticosti-Gaspé-Campbellton). These transects offer our current geoscience interpretation of these regions and are critical in identifying areas in need of new mapping and thematic data.

The Anticosti-Gaspé-Campbellton transect was built in three 1:125,000-scale sheets with the help of the New Brunswick Geological Surveys branch (NBDNR) and Géologie Québec (MRNFPQ) for the regions of northern New Brunswick and adjacent Silurian-Devonian belt in Québec, respectively, and from recent university studies and exploration work on Anticosti Island. An important aspect to note is that the same stratigraphic nomenclature was used on both sides of the interprovincial border. The new lithostratigraphic correlations improve our comprehension of the basin and of its hydrocarbon potential. However, the geology presented for the Cambrian-Ordovician Humber Zone along the northern segment of the Gaspé Peninsula is essentially based on a 1990 synthesis and is, compared to neighbouring geologic areas, in need of modern geological mapping and studies. Unlike the western Gaspé and Anticosti regions, for which recent seismic surveys greatly improve our understanding of the sub-surface structural style, the architectures of the eastern Gaspé Peninsula and northern New Brunswick, as illustrated on current structural cross-sections, are still essentially interpreted from surface data, and therefore should be tested.

Ongoing federal-provincial research oriented on the hydrocarbon potential of eastern Canada already benefits from the compilation and interpretation efforts resulting from the *Geological Bridges* project.

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The Targeted Geoscience Initiative *Appalachian Energy* project: a multipartner-multidiscipline approach to defining the hydrocarbon potential of the Appalachian frontier basins

Denis Lavoie (GSC-Québec), Nicolas Pinet, Bernard Long, Mathieu Duchesne (INRS-ETE), Pierre Keating, Régis Dumont (GSC-CGD), Daniel Brisebois, Denis-Jacques Dion, Jean-Yves Laliberté (MRNFP), Frank Kiss, Mike Thomas, Warner Miles (GSC-CGD), Pierre Brouillette, Sébastien Castonguay, Kathleen Lauzière (GSC-Québec), Michel Malo, Rudolf Bertrand (INRS-ETE), Peter Giles (GSC-Atlantic), Jim Hunter (GSC-TSD Marteen Douma (GSC-TSD), Clint St. Peter, Joe MacIntosh, Reginald Wilson (NBGSB), Martin Fowler, Jim Dietrich, Godfrey Nowlan, John Utting (GSC-Calgary), Elliott Burden, Tom Calon (Memorial), Robert Morris, Diane Jobin, Alain Belzile (GC-DLG), Chris Jauer (GSC-Atlantic), Rob Naylor (NSDNR) and Ian Knight (GSNL)

The Targeted Geoscience Initiative *Appalachian Energy* project (TGI 2003-2005) was defined by provincial geological services and the Geological Survey of Canada to better understand the hydrocarbon systems of the Appalachians. To this end, the Earth Sciences Sector of NRCan will invest 2.2 M$ in data acquisition and interpretation over an 18-month period.

In Québec, a marine-based seismic survey (3,000 linear kilometres; fall 2003 and summer 2004) was conducted across the Saint Lawrence River. A commercial high-resolution aeromagnetic survey (HRAM; 32,000 linear km) was also conducted over the eastern sector of the Gaspé region and maps were published in the fall of 2004. A new HRAM survey totaling 52,000 linear kilometres was flown over the southern Gaspé sector at the beginning of 2004, and the data will become public in the spring of 2005. Gravimetric data for the entire Gaspé region was acquired and published from 2003 to 2004.

In northern New Brunswick, a detailed study of the Siluro-Devonian Gaspé belt is underway and includes the collection of data relating to organic matter maturation and the potential for source rocks and hydrocarbon reservoirs. HRAM data was used to fill in the missing zones in the Restigouche survey and to link it with the survey conducted in the southern Gaspé region. In addition, an HRAM survey of 30,000 linear kilometres was flown across over a Carboniferous basin and its basement rocks in southern New Brunswick. A digital synthesis of all organic maturation data for this basin is in progress and the first maturation maps will be available this fall.

Data synthesis for a Carboniferous basin in the centre of Nova Scotia is also underway. New maps at a scale of 1:50,000 are to be published and will include a detailed evaluation of the litho- and biostratigraphy of this poorly understood basin. Data synthesis for the hydrocarbon system will include the re-treatment of recent seismic data from industry sources. In western Newfoundland, mapping of the allochthonous Cambro-Ordovician Humber Arm at a scale of 1:50,000 will be completed, and the study will include a major sampling program to determine the hydrocarbon potential of source rocks and the thermal maturation of the region. Samples from Carboniferous basins were also examined for their source rock potential.

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Polyphasic Glacial Dispersion and Diamond Exploration in the Eastern Saindon-Cambrien Corridor (northern Québec)

Michel Parent (GSC-Q), Marc Beaumier (MRNFP), Serge J. Paradis and Pierre Brouillette (GSC-Q)

Reconnaissance surveys of glacial dynamics indicators and kimberlite indicator minerals (KIM) in esker sediments were conducted throughout the Saindon-Cambrien corridor, a deeply fractured zone of the Archean basement where there remain many slices of Proterozoic sediments and therefore, where the diamond-bearing potential is elevated. The nearly 80 samples collected in 2003 in the eastern portion of the Saindon-Cambrien corridor led to the identification of many new kimberlite indicator minerals (KIMs), including picroilmenites, magnesian chromites, an eclogitic garnet (G3) as well as "mantle" diopsides (Parent *et al.* 2004); the preliminary results of the 2004 sampling program (map sheets 23 N, 24 C and 23 M) will be made public during the conference. The KIMs identified to date are distributed the length of two corridors which cross each other almost perpendicularly: the first, approximately a hundred kilometres wide, is oriented east-west on the Bienville Lake (33 P) and Gayot Lake (23 M) map sheets while the second, about 75 km wide, is oriented on a NNE-SSW axis crossing the Maricourt Lake (24 D) and Gayot Lake (23 M) map sheets. These directions correspond to the orientation of basement fracturing visible on digital models of the regional directions of glacial dispersion. The intersection zone of the two corridors is located in the western portion of the region studied, in map sheet 23 M.

Given the significant migrations and reorientations of the main ice divide of northern Québec, the Gayot Lake region is characterized by particularly complex glacial movement. Nonetheless, the slices of the Sakami Formation which outcrop near the glacial drainage divide have provided a unique occasion to identify and characterize the dispersion models resulting from this polyphasic glacial dynamic. The last movement of the ice toward the west and the late glacial reorientation toward the north-east each produced ribboned glacial outwash extending some 200 km in nearly diametrically opposite directions. The dispersion trains associated with the older glacial movements, first toward the NNE then the NW, were remodelled by subsequent movements but remained discernable beneath the forms of palimpsest trains. Finally, the eastward migration of the divide associated with the last glacial maximum produced a train of about 150 km long oriented WSW from the Gayot Lake (23 M/15,16) slice, and uniquely, traversing the final position of the ice divide. The composite dispersion trains brought to light can serve as models for diamond exploration in the region.

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Map of glacial indicators for the Lac Maricourt (24D) and Lac Gayot (23M) areas, north-central Québec.

Serge J. Paradis and Michel Parent (GSC-Q)

Glacial indicator maps at 1:250,000 scale for the Lac Maricourt (24D) and Lac Gayot (23M) areas were compiled within the scope of the "Ice Flow Dynamics, Quaternary Stratigraphy, and Diamond Exploration Potential of Nunavik, Northern Québec, and the James Bay Lowlands" project, coordinated by M. Parent and conducted in partnership with the Ministère des Ressources naturelles, de la Faune et des Parcs (MRNFP). The inventory of indicators is based on the identification of a dozen glacial features identified on conventional black & white aerial photographs at 1:40,000 scale supplied by the MRNFP. Shaded fields show areas where the photo coverage is incomplete. This compilation of ice flow indicators provides a very clear picture of major ice flow movements previously identified in the summer 2003 via conventional glacial striation measurements. These movements are very different, particularly on either side of the glacial divide. In the northeastern half of the Lac Gayot area and in the entire Lac Maricourt area, northeast of the glacial divide, three major glacial movements are recognized. The earliest movement, corresponding to the glacial maximum, is oriented east-northeast. It is essentially observed in the southeastern part of the Lac Gayot area. The second movement, trending northeast and widespread throughout the entire area regardless of topography, is outlined by reworking of drumlins and the orientation of morainic trains in sheltered zones. It is attributed to a phase that postdates the glacial maximum. The third and youngest movement is oriented to the north and is associated with deglaciation. In the southern half of the Lac Gayot area, *i.e.* south of the glacial divide, two major ice flow movements are recognized. The earliest, presumably emplaced at the penultimate glacial maximum, trends northwest and is visible mostly in the southernmost part of the map area. The second movement, associated with the glacial maximum, is oriented to the southwest and is omnipresent throughout the area, but is particularly prominent in the southwestern corner of the map area, due to reworking of drumlins. The compilation of ice flow indicators therefore provides an opportunity to identify and reconstruct major ice flow movements which may be used as tools/guides for glacial sediment prospecting, and also helps determine the exact location of the glacial divide, in the central part of the Lac Gayot map area.

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Platinum group element (PGE) distribution in the Thetford Mines ophiolite from the mantle to the crust: new targets and exploration strategies

Philippe Pagé (INRS-ETE), Jean H. Bédard (GSC-Quebec), Alain Tremblay (UQAM), Jean-Michel Schroetter, Valérie Bécu (INRS-ETE) and William Minarik (McGill)

The Thetford Mines Ophiolite Complex of Ordovician age represents a complete ophiolite sequence that includes a 5 km section of mantle, 1.5-2.5 km of plutonic crust comprising ultramafic and mafic cumulates with dunitic, pyroxenitic and gabbroic zones, a dyke complex that was partially eroded and replaced by dolerite breccia and overlain by tholeiitic to bonninitic volcanics (up to 3 km), dacitic tuffs and a fore arc flysch.

The mantle consists of harzburgite that displays orthopyroxenitic banding and pyroxenitic dykes. The harzburgites are foliated and display relatively undeformed porphyroclastic to protogranular textures. The dunites form irregular masses or dykes (<0.1- 5 m), the largest of which contain massive or nodular chromitite in the centres. The refractory mineralogy of the mantle and its low CaO, Al_2O_3 and heavy rare earth element (REE) contents suggest that it represents a melt residue (up to 25 % melting). Peridotites display U-shaped chondrite normalized REE profiles (with light REE enrichment) and several also reveal preferential enrichment in Pt-Pd with respect to Os-Ir. This enrichment is attributed to metasomatism by a fluid or liquid derived from the dehydration of the subducted plate. PGE profiles normalized to primitive mantle (PMN) reveal negative to slightly positive slopes for harzburgites and dunites, with Pd/Ir ranging from 0.21 to 3.1 and Pt/Ir from 0.20 to 8.60 for the harzburgites, and Pd/Ir ranging from 0.01 to 0.60 and Pt/Ir from 0.007 to 2.26 for the dunites.

The complex stratigraphy of the plutonic crust suggests that it was constructed via intracrustal injections and/or cycles of filling and fractionation in a magmatic reservoir. The PMN PGE profiles illustrate that these metals were fractionated as a function of lithology (stratiform chromite Pd/Ir <1, dunite Pd/Ir <10-20, pyroxenite Pd/Ir <100 to 150, gabbro Pd/Ir <180 to 1000), and suggests that they were incorporated into common minerals, thus allowing their behaviour to be modeled. Economic concentrations of PGEs have been detected in discordant intracrustal chromitites within the pyroxenitic zone (up to 20g/t) and pyroxenites (500 ppb) without visible mineralization. The nature of the PGE phases demonstrates that Hg, S and As were involved, and the parageneses suggest that mineralizing fluids were of magmatic (Hall deposit) or deuteric origin (StarChrome).

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Geology of La Minganie and the Wakeman Group: the Havre-Saint-Pierre Natashquan Transect

Léopold Nadeau (GSC-Q), Sharon Parsons (INRS-ETE) and Pierre Brouillette (GSC-Q)

This study is the result of field survey work performed as part of Phase 1 of the Targeted Geoscience Intiative of the GSC. The work allowed us to conduct a detailed review of all outcrops and reconstitute a continuous geological transect of over 100 kilometres along the coastal corridor and highway 138 between Havre-Saint-Pierre and Natashquan. This region is remarkably suitable for geological observation as it is distinguished by the presence of vast outcrops, generally devoid of weathering alteration and lichen.

The transect crosses many extensive geological entities that make this region unique in the Grenville Province. From west to east, it cuts the marginal units of the Havre-Saint-Pierre anorthositic suite, the Romaine shear zone, the Buit Complex, the sourthern portion of the Davy synform which consists essentially of the Wakeham Group rocks and the Robe-Noire metagabbro suite, the Caron Lake shear zone and the Aguanish Complex. These units are cross-cut by Late Grenvillian granite dykes and stocks of the La Galissonnière suite and by post-tectonic aplitic microgabbro-granite composite dykes.

The abundance, persistence and maturity of the Wakeham Group quartz arenites and subarkosic arenites, in the absence of flysch and significant quantities of clay and carbonate sediments, indicate a stable pericratonic depositional environment, of shallow water depth with fluvial or deltaic contributions. On the other hand, the intrusive relationships between the Wakeham Group and the granitic orthogneisses of the Buit and Aguanish Complexes are indisputable. The porphyric granitic orthogneisses of these complexes share a suite of petrographic, geochemical and structural features that attest to their related origin. They contain several co-magmatic phases that exhibit complex sub-solidus structures (similar to those seen in migmatitites) which can be attributed to a signficant late-magmatic deformation event. These relationships indicate a radical change, within a few million years, of the geodynamic context between the deposition of the Wakeham Group and the intrusion of the granitic plutons, in a tectonically active Andean margin during the Pinwarian Orogeny.

Despite the detailed observations made along the length of this transect that overall, has permitted the refinement and confirmation of numerous geological relationships described in previous work, many new petrogenetic, metamorphic and structural observations intimate a greater level of complexity than initially anticipated. Finally, several of these observations shed new light on the regional geological history.

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Assessment of the potential for sillimanite and muscovite in the Mont-Laurier area

N'golo Togola, Suzie Nantel and Kamal N. M. Sharma (MRNFP)

During the summer 2004, fieldwork was carried out northeast of Mont-Laurier, in NTS sheets 31J/14, 31J/15 and 31O/02. This work consisted in an evaluation of sillimanite and muscovite occurrences in paragneisses and diatexites of the Central Metasedimentary Belt, Grenville Province, as a potential source of industrial minerals. The mineralogical and physical characteristics of sillimanite and muscovite samples will be determined in the course of the coming year.

Several of the occurrences examined had already been reported (Nantel, 2000; Nantel and Pintson, 2001). The Lac Brockaby, Lac Beauregard, Lac Rouge and Lac de la Dame areas show promising potential for sillimanite. As for muscovite, it is relatively abundant in the Lac Rouge and Lac à la Côte Jaune areas.

West of Lac Brockaby (31J/15), sillimanite is locally abundant (10 to 20%) in garnet-sillimanite-biotite-graphite paragneisses of the L'Ascension metamorphic Suite (Nantel and Pintson, 2001).

West of Lac Beauregard (31J/15), a diatexite unit hosts mm-scale to cm-scale sillimanite and muscovite-rich laminations. Sillimanite constitutes 10 to 20% of the volume of the rock. In this area, a few bands of sillimanite-garnet-muscovite paragneiss contain 10 to 20% sillimanite.

Northwest of Lac Rouge (31J/15), a diatexite unit also contains mm-scale to cm-scale sillimanite and muscovite-rich laminations. Sillimanite forms up to 20 to 30% of the volume of the rock, whereas the muscovite content ranges from 10 to 15%.

In the Lac de la Dame area (31J/14), rusty brown sillimanite-muscovite-biotite-garnet-graphite paragneisses assigned to the Rabot metamorphic Suite (Nantel, 2000) contain up to 30 to 50% sillimanite in a few locations. They are also locally rich in muscovite.

Northwest of Lac à la Côte Jaune (31O/02) and of Lac Rouge (31J/15), muscovite is associated with sillimanite in diatexites. The muscovite content in these rocks ranges from 15 to 20%.

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DIVEX: Diamonds and platinum group elements

Sarah-Jane Barnes (UQAC) and A. E. Williams-Jones (McGill)

The mineral potential of mafic and ultramafic rocks in Québec is very promising, especially for base metals (nickel and copper), platinum-group elements (PGE: platinum, palladium, etc.) and diamonds. Thirteen projects, essentially focused on the last two, are funded by DIVEX:

Intrusive and extrusive rocks with PGE potential

Enrichment of platinum group elements in ophiolite sequences
Project leader: Jean Bédard (GSC-Q)

Nickel, copper and platinum group elements in mafic rocks
Project leader: Marc Constantin (Laval)

PGE transport mechanisms

Vapour transport of platinum group elements at magmatic temperatures
Project leader: Sarah-Jane Barnes (UQAC)

Hydrothermal transport of palladium in mafic and ultramafic rocks
Project leader: A. E. Williams-Jones (McGill)

Extraction technologies for platiniferous chromite

Enrichment of platiniferous chromites
Project leaders: Mario Bergeron and Marc Richer-LaFlèche (INRS)
Exploration tool for platinum group elements

Diamond-prospective rocks (kimberlites and associated rocks)

Geochemical and isotopic discrimination of kimberlitic magmas
Project leaders: A. E. Williams-Jones (McGill)
and Nuno Machado (UQAM)

Structural control on kimberlite intrusions
Project leaders: Normand Goulet (UQAM) and Denis Bois (UQAT)

Geophysical signature of kimberlite intrusions
Project leader: Michel Chouteau (Poly)

Garnet composition as an indicator of kimberlite fertility
Project leaders: Richard Cox (UQAC) and Sarah-Jane Barnes (UQAC)

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DIVEX: Sedimentary and metamorphic environments

Michel Chouteau (Poly) and Michel Malo (INRS)

Sedimentary environments

More than half of the world's zinc and gold production, and more than a quarter of its copper, is extracted from ore deposits hosted in sedimentary rocks. DIVEX is particularly interested in the Appalachians, the St. Lawrence Lowlands and the Mistassini basin. Known zinc, gold and copper showings in sedimentary environments targeted by DIVEX will serve as field laboratories to meet four objectives: 1) better define the geological setting of occurrences, 2) elaborate ore-bearing hydrothermal fluid circulation models, 3) develop new tools borrowed from oil & gas exploration, and 4) develop models to assist exploration. Three projects were selected to develop new exploration strategies:

Copper, lead and zinc in platform deposits of the Mistassini basin
Project leader: Yvon Héroux (INRS)

Copper in Appalachian redbeds
Project leader: Georges Beaudoin (Laval)

Carlin-type gold in Gaspésie limestones
Project leader: Michel Malo (INRS)

Metamorphic environments

Québec's landmass is predominantly composed of under-explored metamorphic rocks. By analogy with similar environments elsewhere in the world, we know the potential for economic base and precious metal deposits is very strong. DIVEX will develop basic exploration tools through the following projects:

Rutile composition as a prospecting tool for metamorphosed metal deposits
Project leader: A. E. Williams-Jones (McGill)

Pilot project: The use of rutile as a tracer for metamorphosed metal deposits
Project leader: Jim Clark (McGill)

Guide to hydrothermal alteration in high-grade metamorphic terrains
Project leader: Louise Corriveau (GSC-Québec)

DIVEX will then focus on the genetic processes and the signature of base and precious metal deposits in these environments, and on prospecting tools. Two targets have been selected in the Grenville Province:

Mineralogy and geophysical properties of disseminated zinc deposits in marbles of the Grenville Supergroup
Project leaders: Michel Gauthier (UQAM) and Michel Chouteau (Poly)

Olympic Dam-type deposits (magmatic-hydrothermal breccias associated with iron oxide zones)
Project leader: Michel Jébrak (UQAM)

Another project will improve our knowledge of the geometry and structure of brecciated deposits in metamorphic environments:

3D modelling of mineralized breccias in metamorphic rocks
Project leader: Michel Jébrak (UQAM)

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DIVEX: A research network to diversify mineral exploration in Québec

Michel Jébrak (UQAM) and Michel Malo (INRS-ETE)

Some thirty geoscientists from universities and government agencies joined forces in April 2002 to create a network to promote the diversification of mineral exploration in Québec (DIVEX). This new scientific research organization, the first of its kind in Québec, was made possible thanks to funding by Valorisation-Recherche Québec, of the Ministère de la Recherche, de la Science et de la Technologie.

The primary objectives of DIVEX are, on the one hand, to coordinate and focus scientific research efforts on the most recent and promising avenues in mineral exploration, and on the other hand, to allow and promote the direct transfer of results to the public in general and to mining stakeholders in particular. Four main themes are at the core of DIVEX's research program: two of these aim to determine the discovery potential for new commodities in Québec (diamond and platinum group elements), and the last two are centered on non-traditional geological environments in Québec (sedimentary environments and high-grade metamorphic terrains).

DIVEX has successfully rallied nearly all research institutes in the Earth Sciences in Québec, and is also supported by several mining organizations and companies. In 2004 and 2005, DIVEX will launch and is looking to start up new projects in partnership with industries and public agencies. Contact info@divex.ca for more information. DIVEX is also heavily involved in the promotion of meetings in the form of oral presentations and short courses. One of its main objectives is to rapidly release the results of its research, through various modes of dissemination: Internet (www.divex.ca), oral presentations, scientific journals and reports of activities.

Eighteen projects funded by DIVEX are listed in the following two posters: DIVEX – Sedimentary and metamorphic environments, and DIVEX – Diamond and platinum group elements. Each project is likely to result in the development of new exploration methods in the short term, thereby increasing the odds of economic discovery.

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Development of a common-earth 3D model along the Grenville Front

Olivier Rabeau (URSTM-UQAT), Normand Goulet (UQAM), Michel Hocq (MRNFP), Francine Fallara, Li Zhen Cheng (URSTM-UQAT), Daniel Bandyayera, Patrice Roy, Sandrine Cadéron, Pierre Rhéaume, Jean Goutier (MRNFP) and Karine Bédard (U. Laval)

The Grenville Front is interpreted as a major structural discontinuity on the North American continent, the result of a collision between the Grenvillian allochthon and the southeastern Superior craton. The Parautochthonous Domain represents an important package of deep crustal Archean rocks that were exhumed during this collision. On a local scale, the Grenville Front consists of a complex zone of tectonically imbricated domains, or as a tectonic and metamorphic transition zone.

The 3D geological modelling project launched in the summer 2004 was initiated by DIVEX, with the close cooperation of the URSTM and MRNFP. Its purpose is to provide some insight on the geology at depth along the Grenville Front. The study area covers roughly 150 x 50 x 35 km, between the 49th and 50th parallels, where the Grenville Front meets the Opatica-Abitibi suture in the Chibougamau area.

The proposed model will help interpret the subsurface geometry of this area, in order to formulate hypotheses on its potential as a structural control for the reactivation of major structures and the emplacement of kimberlite intrusions. The geological interpretation shown here was completed using 15 original structural sections (11 cross-sections and 4 longitudinal sections) based on all available public data. In conjunction with this work, the MRNFP has conducted recent mapping and thermobarometry studies since 2002, while the UQAM performed detailed studies to characterize thrust structures. This synthesis effort provides an update on the surface geology, has identified new deep-seated structures and provided detailed information on thrust movements along certain major structures. Furthermore, a gravity survey (500-m grid spacing) was carried out in the summer 2004 within the study area, in order to perform geophysical inversions to be integrated to the geological 3D model.

Eventually, this modelling project will be integrated into a regional synthesis covering the Grenville Front from the Val-d'Or area to the Monts Otish basin. We expect to validate the geometry of geological entities at depth, over this entire segment of the Grenville Front, based on interpretations from the study area and with the help of unconstrained magnetic and gravimetric inversions.

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New preliminary geological data on Ni-Cu-PGE showings in the Portneuf-Mauricie belt

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

The Portneuf-Mauricie belt is located about 100 km west of Québec City, in NTS sheets 31I and 31P. It is composed of metasedimentary rocks and metatuffs of the Montauban Group (~1.45 Ga), cut by calc-alkaline dioritic to granitic intrusions of the La Bostonnais Complex (~1.40 Ga). The assemblage probably formed in a magmatic arc setting. The sequence is injected with differentiated mafic-ultramafic plutons that host several occurrences of massive and disseminated sulphides with Ni-Cu±PGE mineralization.

Fieldwork carried out in the summer 2004 in the La Tuque area consisted in the examination and assessment of seven of these showings for their sulphide potential. These are, from north to south: the Réservoir Blanc, Lac Matte and Lac Kennedy showings, the Lac Édouard deposit, and the Lac Boivin, Rochette and Lac-à-la-Vase showings. These occurrences, including the Lac Édouard deposit, are characterized by the presence of disseminated (up to 8%) to semi-massive sulphides. The mineralization is essentially composed of pyrrhotite, chalcopyrite, pyrite, pentlandite, and magnetite. Host units include gabbronorite, norite, pyroxenite (± plagioclase ± olivine) and rare peridotite. The Rochette showing is an exception however. The two mineralized zones in this location are hosted in pyroxenite (± plagioclase), norite, paragneiss and calc-silicate rocks. A brecciated facies was also observed at the Lac Matte, Lac Kennedy and Lac Édouard occurrences. This facies is characterized by the presence of gabbroic to pyroxenitic enclaves from 1 to 10 cm in size, enclosed in a matrix of amphibolitized gabbro.

Based on these preliminary observations and on subsequent metallogenic, petrologic and geodynamic studies, this project will help define the genesis of these showings in the belt and assess their mineral potential.

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Petrographic and structural study of the Duparquet syenite, Destor-Porcupine Fault, Abitibi Subprovince

Simon Patry, André E. Lalonde (U. Ottawa) and Marc Legault (MRNFP)

This project consists of a study involving the MRNFPQ and the Department of Earth Sciences of the University of Ottawa. The objectives are: (1) to map in detail lithological units of the Duparquet syenitic complex, (2) to characterize the petrography, mineralogy and geochemistry of these intrusive rocks, and (3) to document the cataclastic and hydrothermal events that modified these rocks. The study is based on the desire to understand the close relationship between these syenitic rocks and the numerous gold occurrences in this important mining camp. The same type of association also exists elsewhere along major E-W faults in the Abitibi Subprovince, and has been studied in the Matheson and Kirkland Lake areas in Ontario.

The Duparquet syenitic complex, dated at 2682±1 Ma (Mueller *et al.*, 1996), is located approximately 40 km northeast of Rouyn-Noranda, in the Abitibi Subprovince. It forms a small elongate intrusion, roughly 4 km long by 450 m wide, oriented east-west and located just north of the Destor-Porcupine Fault. The rocks of the complex are observed at many former minesites in the area (Beattie, Central Duparquet, Donchester). Three main textural facies are recognized: (1) a porphyritic facies with a brown aphyric groundmass (Beattie facies), (2) a lath facies, and (3) a glomerophyric facies (previously referred to as "plum porphyry"). Another facies is also reported: the Donchester megaphyric facies. All these facies contain abundant, often idiomorphic alkali feldspar phenocrysts, and all were affected by late cataclastic deformation, which resulted in the presence of abundant fractures and small breccia zones. The units were also subjected to intense hydrothermal circulation.

The project was launched in the summer 2004, with detailed mapping on several surface strippings in the complex. A preliminary petrographic study of collected samples indicates that, in most samples, feldspar megacrysts consist of albite, and that K-feldspar is practically absent. The rocks are effectively albitites. Observed textures suggest the feldspars were initially K-feldspars that were albitized by hydrothermal alteration. The rock is also strongly altered to fine muscovite (sericite), hematite and carbonates. Primary mafic minerals are completely replaced.

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Geological mapping and metallogeny of the Blake River Group and adjacent units

Benoit Lafrance, Claude Dion, Pierre Rhéaume and Marc Legault (MRNFP)

Over the past few years, the MRNFP has carried out surveys and studies in the Doyon-Bousquet-LaRonde (DBL) and Duparquet mining camps, as well as to the west of Rouyn-Noranda. The purpose of this work is to provide some insight on the stratigraphy, volcanology, age and metallogeny of the Blake River Group (BRG), and to characterize its northern border (Destor-Porcupine Fault). Geological maps, as well as the copper and gold potential of the BRG and the Duparquet area are shown here.

The first phase of geological mapping in the eastern BRG took place from 2000 to 2002 in the DBL mining camp. This work enabled us to define the Bousquet Formation and to establish the position of ore deposits at different stratigraphic levels. Geological surveys carried out since that time in the area between the Doyon mine and Rouyn-Noranda in 2003 and 2004 were aimed at assessing the metallogenic potential of the Reneault-Dufresnoy Formation, by comparing it to the Noranda and DBL mining camps. The objective of this work is to determine the location of boundaries between the Reneault-Dufresnoy Formation (cycle 5), the Noranda Formation (cycle 4), and the Rouyn-Pelletier Formation (Horne mine), in order to orient exploration efforts. Several volcanic centres and VMS-prospective horizons were defined and traced by characterizing folding in the units.

The western BRG, west of the Flavrian Pluton, was mapped in the summer 2004. This survey is intended to refine local stratigraphy, to characterize volcanic and tectonic processes and to compare this part of the BRG with the mining camps. The area is mainly characterized by the presence of a major homoclinal succession of felsic volcanic rocks dominated by aphyric or QZ-phyric rhyolites and mainly brecciated PG-phyric dacites. This work should result in the definition of volcanic centres and stratigraphic horizons with VMS potential, as well as structures which may be associated with epigenetic gold mineralization.

Work carried out along the Destor-Porcupine Fault (DPF) since 2002 aims to complete the regional mapping of the area launched in the 1990s, and to attract explorationists in the area via a regional metallogenic synthesis. Six types of gold occurrences are recognized, each with distinctive characteristics. Defining these characteristics will allow exploration to zero in on the right targets along the DPF. This study also reveals that gold was emplaced at various depths (epithermal to mesothermal) and at different stages (synvolcanic to late-tectonic) in the geological evolution of the area.

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New stratigraphy of the Lac Olga area (32F)

Jean Goutier (MRNFP)

The Lac Olga area is located between the towns of Matagami and Chibougamau. The area is underlain by Archean rocks of the Abitibi Subprovince to the south and of the Opatica Subprovince to the north. In this area, the Opatica Subprovince is composed of foliated and locally gneissic tonalite and diorite. Ages obtained from samples collected north of map sheet 32F indicate that at least some of these rocks are older than Abitibi rocks. Opatica-Abitibi juxtaposition took place prior to 2696-2693 Ma, during a period corresponding to the emplacement of the Canet, Olga, Waswanipi, Barlow and Ouescapis plutons, injected at or near the contact between the two subprovinces.

Tholeiitic volcanic rocks of the Matagami area (Lac Watson Group, 2725-2723 Ma; Mortensen, 1993, and Wabassee Group) occur on either side of the Galinée anticline, the core of which is occupied by the Bell River layered gabbroic Complex (2725-2721 Ma; Mortensen, 1993). Composite volcanoes developed on the vast Wabassee basaltic plain to form the Dussieux (2720 Ma; Davis, unpublished) and Imbault formations. They formed transitional to calc-alkaline, intermediate to felsic lavas and pyroclastic rocks. These volcanic rocks are partially overlain, paraconformably or unconformably, by turbidites and polymictic conglomerates of the Morris Formation and the Taibi Group (< 2685 Ma; Goutier *et al.*, in preparation) and by alluvial conglomerates and wackes of the Matagami Group (< 2701 Ma; Goutier *et al.*, 2004). These new age dates indicate an important hiatus between the end of volcanism in the Lac Olga area and the onset of sedimentation. Furthermore, these ages also indicate that sedimentation in the vast turbiditic basins (Pontiac, Kewagama, Cadillac, Chicobi, Taibi, Laguiche) is coeval over the entire Abitibi and James Bay regions.

Differences between the Lac Olga and Chibougamau areas include: the absence of Obataugamau-type glomerophyric basalts in the Lac Olga area; westward younging of tholeiitic felsic centres (Lac Watson vs. Waconichi) and of layered complexes (Bell River vs. Lac Doré). Certain units may be correlated: the Wabassee is a lateral equivalent of the Gilman; the Dussieux and Imbault formations are coeval and equivalent to the lower Blondeau; the Morris is equivalent to the Daubrée, the Bordeleau and the upper Blondeau Formation, while the Matagami Group and conglomeratic units of the Taibi Group are coeval with Stella and Chebistuan units. Equivalents of the Haüy Formation (potassic volcanic rocks) were not observed in the Lac Olga area. Moreover, the Berthiaume (2691 Ma; Goutier *et al.*, in preparation) and Montviel alkaline intrusions are contemporaneous with the Lac Shortt intrusion (2691 Ma; Joanisse, 1994), but older than the Beattie and Clériсy intrusions (2682 Ma; Mueller and Mortensen, 1996; Mortensen, 1993) in the Rouyn-Noranda area.

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Mapping in the Lac Pine and Lac Adonis area: Northern Central Metasedimentary Belt, Grenville Province

Suzie Nantel, Emmanuelle Giguère, Pierre Lacoste and Alain Berclaz (MRNFP)

The northern part of the Lac Pine area (NTS 310/02) and the southern part of the Lac Adonis area (NTS 310/07) were mapped at 1:50,000 scale within the scope of a mineral potential assessment of the northern Central Metasedimentary Belt.

Metasedimentary rocks of the L'Ascension metamorphic Suite (1.4-1.25 Ga) outcrop mainly in the northeastern part of the Lac Pine area. They consist of a series of m-scale beds of biotite quartzofeldspathic gneiss and biotite quartzose paragneiss associated with minor biotite±muscovite±sillimanite±fibrolite paragneiss, calc-silicate rock with diopside±amphibole±epidote±magnetite±sulphide, and calcitic or dolomitic marble. Certain calc-silicate units are strongly magnetic. Some are interbedded with amphibolites.

Beyond the metasedimentary sequence, the bedrock mainly consists of white and medium-grained or grey and fine-grained leucocratic biotite±hornblende tonalites (Lacoste intrusive Suite, 1.45-1.38 Ga). Along the contact with metasedimentary rocks, the tonalites exhibit a mylonitic texture.

In the Lac Adonis area, tonalites alternate with pink monzogranitic orthogneisses, or are cross-cut by the latter. These monzogranitic orthogneisses (Bethune intrusive Suite, 1.28 Ga) also form discrete bodies in the area. Another type of monzogranite (Brockaby monzogranite, 1.07 Ga), generally interdigitated with pink pegmatites, cross-cuts all other lithologies in the area.

Metasedimentary rocks and tonalites are metamorphosed to the granulite facies, and retrograded to the middle amphibolite facies. These rocks underwent a first phase of folding with E-W axial traces. A second phase of folding, with N- or NNE-directed axial traces also affected these rocks, as well as rocks of the Bethune intrusive Suite and Brockaby monzogranites.

About 15 samples of biotite±garnet±sillimanite quartzofeldspathic paragneiss and another 15 samples of calc-silicate rock or diopside-bearing skarn were collected for assays. These samples all contain pyrrhotite, pyrite and occasional trace chalcopyrite; only one sample contains sphalerite (0.5% Zn). Sulphides were namely observed in diopside-rich rocks along the contact with Brockaby-type monzogranites or white pegmatites with rusty spots of unknown origin. A hill of Brockaby-type pegmatite may constitute a potential source of architectural stone. The pegmatite is not fractured, and contains coarse pink feldspar crystals in a groundmass of quartz and white feldspar. Its texture and dominantly white colour would make it a unique variety of stone.

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Geology of the Lac Varin area (22F/10), Côte-Nord

André Gobeil, Martin Simard, Thomas Clark, Alain Leclair and Claude Hébert (MRNFP)

The Lac Varin area (22F/10) was mapped at 1:50,000 scale in the summer 2004. It covers a surface area of roughly 1,000 km^2, the centre of which is located 65 km northwest of Baie-Comeau.

Rocks in the area, all Proterozoic in age, belong to the Allochthonous Polycyclic Belt of the Grenville Province. They are grouped into three assemblages:

1- An anorthositic suite oriented E-W, which covers the northern two-thirds of the area. The suite contains anorthosite, leuconorite, troctolite, gabbronorite, and mangerite, which commonly exhibit primary layering or a magmatic foliation. These rocks are affected by metamorphic recrystallization, which increases northward, changing from an igneous texture to a granoblastic texture.

2- The second assemblage is composed of porphyritic or augen-textured monzonite, quartz monzonite, and granite. It also includes minor charnockite, tonalitic gneiss and amphibolite.

3- The last assemblage consists of late granitic intrusions and a few diabase dykes of minor extent.

The rocks in the area are affected by a regional metamorphic foliation of variable intensity. The degree of deformation increases considerably toward the north, near the contact between the anorthositic suite and the gneissic complex. The contact zone, located outside of the map area, is characterized by the presence of straight gneisses. This zone appears to correspond to a thrust fault, where anorthositic rocks were thrust onto the gneisses. The recrystallization of anorthositic rocks may be coeval with this deformation. The southern contact of the anorthositic suite, with the granitic rocks, seems to correspond to a series of normal faults, as suggested by observed kinematic indicators. Deformation is intense, but concentrated along narrow zones.

The area hosts three main types of occurrences: 1) magnetite and ilmenite, disseminated or in semi-massive horizons in anorthositic rocks, 2) disseminated apatite in magnetite-ilmenite-rich layers in anorthositic rocks, and 3) disseminated or stringer sulphides (chalcopyrite, pyrrhotite, pyrite) in anorthosite. The first type forms a layer some ten metres thick, traced for at least 2.3 km along strike. The host rock corresponds to an oxide-rich dunite or troctolite; however the oxide content locally exceeds 50%. The apatite-bearing rock (up to 35%) is a nelsonite (magnetite, ilmenite, apatite, olivine, orthopyroxene), which forms a main 5-m-thick layer, as well as a few veins up to a metre wide. Anorthositic rocks which host up to 5% disseminated sulphides are strongly recrystallized, and border a multi-km-scale granitic intrusion.

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Inventory of quarries in the Bas-Saint-Laurent – Gaspésie region (update) and potential of White Head limestones as cement stone

Charles Gosselin (MRNFP)

The inventory of quarries in the Bas-Saint-Laurent and Gaspésie regions, completed in 1991, was updated in the summer 2004. Twenty-nine new quarries were inventoried, 7 of which produce more than 100,000 m^3 of rock. Thirteen quarries initially inventoried in 1991 underwent considerable development, going from an output of a few tens of thousand m^3 to more than 100,000 m^3. Sixty-five of the 167 reported quarries are active. They are operated by fifteen different stakeholders, many of which (10) are important players in the construction material industry.

Since 1991, several quarries of silica-rich sandstone and pure limestone ceased operations or restricted their production to crushed stone or rip-rap. A new dolomitic limestone quarry opened in 2003 near La Rédemption however. It produces magnesian lime.

A brief study of limestones of the White Head Formation was also conducted. Its purpose is to determine the potential of these rocks as cement stone. Areas near Nouvelle, Chandler and Percé were selected, given the proximity of the limestone unit to the coast. Hand samples were collected at 24 different outcrops. The results allow us to draw the following conclusions:

a- The composition of upper units of the White Head Formation in the Percé area appears to correspond to specifications required by the cement industry: $CaO = 48\text{-}50\%$, $Na2O+K2O < 0.6\%$, $MgO < 2.5\%$, $S < 0.2\%$, $Cl < 10$ ppm. Furthermore, the competency contrast between resistant beds of pure limestone ($CaO = 52\text{-}53\%$) and friable clay interbeds may prove useful to adjust the composition of the pre-burning mixture (raw materials) in carbonate, silica, alumina and iron, depending which crushing and recovery processes are used.

b- The Chandler and Nouvelle areas are dominated by the lower sequence of the formation. The latter generally consists of a banded facies formed of limestone beds and clay interbeds sutured together and forming a massive assemblage which is difficult to characterize. Grab samples have a CaO content between 31 and 42%. Note that an adequate potential assessment of these areas requires more detailed work, involving the search for more calcareous stratigraphic horizons.

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Silurian-Devonian volcanism in the Gaspé Belt

Pierre Pilote and Daniel Brisebois (MRNFP)

The characterization of volcanism and the mineral potential assessment of the Chaleur Bay area and the Gaspé Belt are performed within the scope of the MRNFP's three-year (2002-2004) exploration plan for the Appalachians. The Gaspé Belt is an essentially sedimentary basin that covers the southern three-quarters of the Gaspésie region, northern New Brunswick and the Bas-Saint-Laurent region. It consists of siliciclastic rocks and limestones spanning a period from the late Ordovician to the middle Devonian. These rocks unconformably overlie Cambrian-Ordovician strata deformed by the Taconian orogeny during the middle and late Ordovician. The Gaspé Belt was deformed by the Acadian orogeny at the end of the early Devonian and in the middle Devonian. A local phase of deformation, the Salinian phase, took place during the Pridolian (late Silurian). It is unconformably overlain by weakly folded late Devonian and Carboniferous strata.

This project involved the systematic sampling of volcanic sequences in specific localities, namely the Chaleur Bay area, the Lac McKay area, the Josué anticline and the Lemieux dome. The purpose is to compare the lithogeochemistry of each sequence and to date (by U-Pb zircon analysis) the main felsic effusive episodes encountered in the Gaspésie region, in order to determine if volcanism, which predates the propagation of regional Acadian deformation, evolved from north to south over time.

Several volcanic episodes are known in the Gaspé Belt. The earliest, during the early Silurian, is essentially exposed in New Brunswick, although Wenlockian volcanism with tuffs and effusive mafic and felsic rocks is associated with the La Vieille Formation. During the Pridolian, basaltic volcanism accompanied the Salinian deformation and locally overlies this unconformity. During the early Devonian, intense volcanism is recorded in the central part of the Gaspé Peninsula. Volcanic rocks of the Archibald Settlement Formation (formerly known as the "Dalhousie volcanics"), the upper part of which was dated at 408.8±0.7 Ma, are lateral equivalents of the Upper Gaspé Limestones.

Volcanism culminated with mafic-felsic episodes lodged in the upper York River Formation and the base of the Battery Point Formation, exposed at Mont Lyall and Mont Tuzo, which border the Lemieux dome area. Based on its characteristics, this volcanism is typical of a continental rift setting. This last area also hosts an extensive neutral epithermal system with Zn-Pb±Au mineralization. It is also unusual given the high density of mafic and felsic dykes and intrusions.

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Geology and mineral potential of the Rivière Cascapédia area (NTS 22B/16-0200-0101)

Serge Lachance and Pierre Pilote (MRNFP)

The 1:20,000 scale geological map of the Rivière Cascapédia area was updated, and its mineral potential was evaluated, within the scope of the three-year exploration plan for the Appalachians.

The northern third of the area is underlain by Cambrian-Ordovician rocks, in faulted contact (Shickshock fault zone) with Silurian-Devonian strata to the south.

The Cambrian-Ordovician is represented here, from the base upwards, by Neoproterozoic sediments and basalts of the Shickshock Group and lower Ordovician siliciclastic rocks of the Rivière Ouelle Formation, followed by three Ordovician lithodemic units, namely the Mont-Albert ultramafic Complex, the Diable Amphibolite and the Ruisseau Isabelle Melange. These units were deformed during the middle to late Ordovician by the Taconian orogeny, then by the Acadian orogeny during the middle to late Devonian.

The Silurian-Devonian, much less affected by the Acadian orogeny, is represented in the area by a southeast-facing homoclinal sequence essentially composed of mudrock, limestone and sandstone, with intercalated basaltic to rhyolitic volcanic sequences such as those at Mont Squaw Cap and Mont Tuzo. These rocks are grouped into three different lithostratigraphic assemblages, which are, from the base upwards: (1) the Silurian to lower Devonian Awantjish, Val-Brillant, Sayabec, Gascons, West Point, Indian Point and Saint-Léon formations of the Chaleur Group, (2) the lower Devonian Forillon, Shiphead and Indian Cove formations of the Upper Gaspé Limestones, and (3) the lower to middle Devonian York Lake, York River and Battery Point formations of the Gaspé Sandstones.

These rocks were locally intruded by the Mont Chauve granitoid stock, and by felsic and mafic dykes and sills, attributed to the Lemieux intrusive Suite, which spans the Silurian to the late Devonian.

The rhyolitic volcanic sequence at Mont Squaw Cap and Mont Tuzo (top of the York River Formation) shows good potential for industrial minerals (obsidian and bentonite) and semi-precious stones (chalcedony, agate, druses and geodes). Traces of copper (chalcopyrite) were locally observed in dolomite veins in the southwestern part of the area. Along the Shickshock fault zone, ultramafic lenses that host nickel and chrysotile occurrences are locally strongly dolomitized and silicified (listwaenites).

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Characterization of a till in the Gaspésie region

Marc Beaumier, Daniel Brisebois, Dominique Turmel and Cathy Lapointe (MRNFP)

During the last glacial maximum, the Laurentide ice sheet was responsible for the deposition, in the Gaspésie region, of the Langis till (David and Lebuis, 1985) and the dispersal of Precambrian blocks almost exclusively observed in the western part of the peninsula (David and Lebuis, 1985; Hétu and Gray, 2002). The Langis till is compact, dark grey, calcareous and slightly oxidized on surface. Its lithological content is dominated by blocks from the calcareous and sandy formations of the Gaspésie region, some slaty schists and a few typically Precambrian lithologies. On the high plateaus west of Lac Matapédia, the Laurentide ice sheet is inferred to have followed the southern face of the Chic-Choc mountain range to the south of Mont Albert, and spread out southward beyond the Rivière Restigouche. In this area, glacial deposits generally consist of undifferentiated tills which cannot be associated with a formation. They are thin, discontinuous, and often represented by a few erratic pebbles of various sources, resting on the weathered bedrock. Erratics from the shield rarely exceed 5% of the lithological content of the tills.

Fieldwork conducted in the western high plateaus essentially consisted of block counts and sampling of the matrix of certain deposits. We noted much higher concentrations of Precambrian blocks than previously reported for the area. We also observed the presence of a thin deposit with an oxidized, silty-sandy but never calcareous matrix. We interpret this deposit as a till.

This till masks the geochemical signal of stream sediments. This signal has always been considered as a reflection of the lithochemical composition of proximal bedrock. An examination of this discrepancy between the geochemical response of stream sediments and the expected response from the bedrock allowed us to define a surface area of at least 350 km^2. We interpret this part of the Gaspésie region as an area where the geochemical response of stream sediments is disturbed by the presence of till with a high Grenvillian content. We believe similar situations may exist elsewhere along the Appalachians.

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Geochemistry and Nd isotope study of volcanic and plutonic assemblages in the Far North (Phase III)

Michel Boily (GÉON), Alain Leclair, Charles Maurice, Alain Berclaz and Jean David (MRNFP)

Recent neodymium isotope data acquired from volcanic and plutonic assemblages in the southern and northwestern parts of Québec's Far North region indicate that Neoarchean suites (2.76 to 2.68 Ga) are for the most part derived from repeated crustal recycling, involving the assimilation or melting of variable proportions of early crust (2.9 to 3.8 Ga). Sharply negative eNdi values (-1.2 to -6.9) from the Lac à l'Eau Claire area (NTS 34B and 34C) and the Montrochand area (NTS 33O), located in the Minto, Bienville and Tikkerutuk domains, yield model ages (TDM) of 2.83 to 3.47 Ga. These data confirm the early, albeit slightly younger, model ages (TDM = 2.88 to 3.30 Ga) obtained by Boily et al. (2004) for Neoarchean plutonic rocks of the Bienville, Minto, La Grande-Goudalie and Utsalik domains exposed in the eastern and southeastern parts of the Far North. We conclude that with the exception of early (2.88 to 2.79 Ga) mafic-ultramafic volcanic assemblages, Far North magmatism is essentially intracrustal in origin, and probably in situ. Triggered by the periodic injection of mafic-ultramafic magmas at the base of the crust, crustal melting led to the diapiric rise of tonalitic to granitic plutons in an extensional tectonic setting (Bédard et al., 2003). Neoarchean magmatism is therefore inferred to be largely associated with vertical tectonics rather than subhorizontal tectonics controlled by a continental subduction process (Percival and Skulski, 2000).

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Mineral occurrence map for the northeastern Superior Province, Far North Project

Jean-Yves Labbé and Pierre Lacoste (MRNFP)

This poster unveils the synthesis map of mineral occurrences derived from the Far North metallogeny project, led in conjunction with mapping surveys since 1998. A total of 169 mineral occurrences have been reported to date. Some of these correspond to discrete, little-known showings, but most of the mineral occurrences shown on the map have been explored by mining companies. In a few rare cases, a mineral resource has been calculated.

These mineral occurrences may be classified into roughly twenty distinct deposit types that are either syngenetic or epigenetic.

There are six types of syngenetic Archean occurrences: 1) Algoma-type iron formations (Fe), 2) volcanogenic sulphides (Cu, Zn, Au, Ag, Pb), 3) magmatic Ni-Cu, 4) Fe-Ti-V in mafic intrusions, 5) U-Th in porphyry granites, and 6) porphyry Mo. Syngenetic occurrences are also reported in Proterozoic cover rocks: 1) Cu-Ag in volcanic or sedimentary redbeds, and 2) sedimentary U.

Several epigenetic Archean occurrences are also observed: 1) polymetallic disseminated Cu-Zn-Ag, mainly in volcano-sedimentary rocks, 2) disseminated Au±Zn±Cu±Ag mainly in volcano-sedimentary rocks, 3) Au in iron formations, 4) Au-bearing quartz veins (±Cu-Zn-Ag), 5) polymetallic quartz veins in shear zones (without Au), 6) polymetallic sulphide veins in ultramafic rocks (Cu-Au-Ag±Ni), 7) metasomatic REE in carbonate rocks, 8) vein U, and 9) Mo remobilization in faults. Two types of epigenetic occurrences are hosted in Archean rocks, but may be Proterozoic in origin: 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) Mississippi-Valley-type Pb-Zn, and 2) unconformity-associated vein U.

The map should be published in 2005, in ArcGIS and MapInfo format. It will be accompanied by a descriptive report on the metallogenic synthesis of the Far North project.

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Geological synthesis of the Northeastern Superior Province (NESP)

A. Leclair, A. Berclaz, Jean David and the Far North Team (MRNFP)

A new subdivision of the NESP, based on lithological and aeromagnetic features, suggests the presence of at least seven major N- to NW-trending domains. The gross lateral heterogeneity in the distribution of various lithologies across the region appears to mainly reflect the extent of widespread, younger (< 2.79 Ga) magmatism that is responsible for extensive occlusion of older rocks. The westernmost domain I is characterized by a relatively low aeromagnetic anomaly trending north and an abundance of clinopyroxene-bearing tonalite-diorite, enderbite (2.73-2.70 Ga) and granite (2.71-2.69 Ga) enclosing older tonalitic units (2.84-2.75 Ga). It also contains the oldest volcano-plutonic sequence (*ca.* 3.8-3.6 Ga) recognized in the NESP, and is distinguished from domains to the east by generally older Nd model ages (3.0-4.0 Ga). Domain II also consists mainly of pyroxene-bearing plutonic rocks and older tonalites, similar in age to those of domain I, but displays a higher magnetic intensity with NW-trending negative anomalies in the south. The tonalitic units contain rare supracrustal rocks and enclaves of tonalitic gneisses (*ca.* 3.02 Ga). Many lithologies of domain II appear to continue southward into domain III where they have been intruded and largely assimilated by voluminous granite-granodiorite plutonic suites (*ca.* 2.71-2.69 Ga). Domain III displays curvilinear, northwesterly trending aeromagnetic anomalies, and is bordered to the north by a major deformation zone. Domain IV contains a significant amount of supracrustal rocks and coeval tonalites (< 2.76 Ga), along with pyroxene-bearing plutonic rocks, migmatitic paragneisses and related diatexite and granite intrusions (2.73-2.70 Ga). It displays a distinct striated aeromagnetic pattern of alternating, narrow positive and negative anomalies. Domain V forms a NW-trending aeromagnetic low, with patchy highs, that extends along the central part of the NESP and appears to merge with the volcano-plutonic La Grande Subprovince to the south. This domain is characterized by large belts (20 by 120 km) of volcano-sedimentary rocks ranging in age between about 2.88 and 2.71 Ga. These rocks are engulfed by widespread, coeval tonalite-trondhjemite-granodiorite plutonic suites, and intruded by enderbite, diatexite and granite plutons (2.73-2.68 Ga). Rare tonalitic units with ages up to 3.0 Ga are also present. To the east, domain VI forms a prominent, broad, N- to NW-trending aeromagnetic high that is associated predominantly with plutonic rocks. It is dominated by enderbite, granodiorite and granite intrusions (2.74-2.69 Ga), with sporadically preserved tonalites and supracrustal rocks. In the northeasternmost domain VII, two large, ovoid charnockitic massifs (2.74-2.73 Ga) with mottled aeromagnetic patterns are emplaced in an aeromagnetic low which corresponds to a vast tonalitic complex (2.88-2.75 Ga) containing several small volcano-sedimentary belts. All these rocks are intruded by granodiorite, granite and monzonite plutons (*ca.* 2.73-2.69 Ga) and are overprinted to the northeast by Proterozoic ductile deformation. Rocks of domains II to VII have inherited xenocrystic zircons and Nd model ages as old as 3.2 Ga.

Workshops

New findings from the Blake River Group

Benoit Lafrance, Claude Dion, Pierre Rhéaume et Marc Legault

This interactive session combines three presentations that focus on the copper and gold potential of the Blake River Group and the Porcupine-Destor Fault sector.

The objectives of the 2003-2004 geological surveys between Rouyn-Noranda and the Doyon mine were to improve the understanding of the volcanic and tectonic processes that affected this portion of the Blake River Group. The discovery potential for polymetallic volcanogenic sulfides was evaluated by comparing the study area with the Noranda and Doyon–Bousquet–LaRonde mining camps. Emphasis was placed on the stratigraphy, volcanology and structural characteristics of the Reneault-Dufresnoy Formation (cycle 5), the Noranda Formation (cycle 4) and the Rouyn-Pelletier Formation (Horne mine block). The study also aimed to define volcanic centres and favourable horizons for VMS deposits; characterization of the folding style allowed these favourable horizons to be traced across the study zone.

The western portion of the Blake River Group, east of the Flavrian Pluton, was also the focus of a geological program in the summer of 2004. The objectives were to study the stratigraphy in greater detail, to characterize the volcanic and tectonic processes, and to compare the rocks from this portion of the Blake River Group with those from the Noranda and Doyon–Bousquet–LaRonde mining camps. A suite of felsic volcanic rocks was the dominant characteristic of the study area. The series is homoclinal with a NNE-SSW orientation and tops facing ESE. The following units were observed from bottom to top: andesites, spherulitic andesites with quartz and plagioclase phenocrysts, volcanic breccia, rhyolitic tuffs, quartz phyric rhyolites, and plagioclase phyric dacites (mostly brecciated). Gabbro-diorite intrusions and spherulitic felsic dyke swarms cut through the volcanic pile. The data from this study will be used to define volcanic centres, favourable stratigraphic horizons for VMS deposits, and structures that may be associated with epigenetic gold mineralization.

The last two years of work along the Porcupine-Destor Fault aimed to complete a regional mapping program that began in the 1990's and demonstrate the value of the sector by implementing a regional metallogenic synthesis. At least five types of gold mineralization were observed. Epithermal veins display open-space crystallization textures and reveal anomalous concentrations of Zn, Pb and Hg, both characteristic of low-sulfidation epithermal mineralization. Leached disseminated sulfides are now observed as residual concentrations of massive quartz and pyrite, suggestive of acid epithermal deposits. Quartz-carbonate veins in strongly altered (iron carbonate) deformation zones are typical of orogenic-type deposits. Silver-bearing quartz veins that occur as tension veins with elevated values of Cu, Sb, Zn and Hg share the same characteristics as Ag-Pb-Zn veins found in clastic metasedimentary rocks. Disseminated sulfide showings related to intrusions were subdivided according to the composition of the intrusion. Those associated with alkaline rocks are richer in sulfides, display intense silicification, and are interpreted as typical examples of disseminated sulfides associated with syenites. Showings associated with calc-alkaline rocks are sulfide-poor and generally display strong carbonatization, possibly representing a variation on the classic orogenic-type deposit. These recent findings for gold showings and deposits in the study areas collectively indicate that gold was emplaced at different depths and at several stages during the geological evolution of the sector. Only the quartz-carbonate veins and the disseminated sulfide mineralization associated with alkaline intrusions appear to have the potential for economic concentrations of gold. The other types are too small, or the gold grades too low or sporadic.

New metallogenic, geological and metamorphic data from the Grenville Front

Sandrine Cadéron, Patrice Roy and Daniel Bandyayera (MRNFP)

The MRNFP (Ministry of Natural Resources, Wildlife and Parks) has undertaken a mapping program along the Grenville Front at a scale of 1:50,000. This work represents an integral part of the *2003-2006 Triennial Plan for the Abitibi-James Bay Region*, and responds to the needs of the mineral industry. The main objective for the project is to identify the metamorphic equivalents of the Abitibi Subprovince volcano-sedimentary belts within the Grenville Parautochthon, with the goal of opening up new mineral exploration frontiers. This interactive session is based on mapping work that was completed during the summers of 2003 and 2004. The session is organized as a multidisciplinary approach and will put forth an innovative interpretation of the Grenville Front. The workshop combines all the latest lithological, geochemical, structural, metamorphic and metallogenic data for four 1:50,000 maps that are strategically located along the Grenville Front.

The first day will be dedicated to the Lac Lagacé (32B/14) and Lac Mitshisso (32H/13) regions. The Lac Lagacé region is east of the Urban-Barry Belt and comprises Archean rocks of the Abitibi Subprovince (intrusive complexes, volcano-sedimentary and bimodal volcanic belts) that are separated from the Grenville Parautochthon by the Buteux Fault. The geotectonic context of the amphibolites of the Lac Legacé region and their lithological and stratigraphic relationships with the Urban-Barry Belt will be discussed. The amphibolites present an interesting potential for Cu ± Ni ± Co ± PGE deposits, volcanogenic exhalative deposits and mesothermal gold deposits. This part of the session will also examine the results of a study on the reorientation of E-W Kenorean structures into N-E orientations during the Grenvillian Orogeny. The Lac Mitshisso (32H/13) region forms the eastern extension of the Chibougamau mining camp. In the western part, it represents the continuation of Archean rocks from the Abitibi Subprovince, including the Chibougamau Pluton, the Lac Doré and Cummings complexes, and the Obatogamau and Gilman formations. Grenville Parautochthon units dominate the eastern part, and preliminary data from recent geological work revealed remnants of amphibolite and anorthosite in the heart of the tonalitic gneisses. The structural and metallogenic issues of the region will be the main focus of discussions, as well as the stratigraphic correlations between Superior and Parautochthon units.

The second day will focus on the mapping of the Lac Charron region (sheets 32G/08 and 32G/09), from the Abitibi Subprovince to the interior of the Parautochthon Domain. This region covers the southeast extension of the supracrustal rocks in the Chibougamau mining camp (the Gilman and Obatogamau formations, La Dauversière and Boisvert plutons), and the eastern Caopatina segment (volcano-sedimentary sequences). An overview of the main volcano-sedimentary and intrusive units associated with these segments will be provided. Several of these units can be traced across the Grenville Front into the Parautochthon Domain on the basis of lithological, structural and geochemical criteria. Finally, we will offer a regional metallogenic outlook by examining the timing of mineralization as a function of orogenic events. Favourable environments will be presented for orogenic-type deposits, volcanogenic massive sulfides and skarns.

The third day will focus on a metamorphic synthesis of the mapped regions. Deciphering the thermodynamic evolution of the lithologies along the Grenville Front is an essential component to understanding the overall evolution of these high-grade metamorphic terrains (amphibolite to granulite). This portion of the interactive session will present preliminary results of a metallogenic-metamorphic study that is currently underway. The participant will gain a better understanding of the relative timing of mineralizations during the polymetamorphic evolution of the Grenville Parautochthon rocks. We will also present the first results of pressure and temperature estimates from metamorphic traverses extending from the Superior Province to the Grenville Front. The geological complexity of this major orogenic front is, in part, due to the difficulty in discriminating Grenvillian metamorphic and metallogenic signatures from those of Kenorean relics. Furthermore, the recognition of metamorphosed VMS-type Archean deposits and syn- to late-metamorphic orogenic-type gold deposits requires the characterization of mineralogical and chemical indicators in alteration halos. Several avenues of research are being explored during the course of this research in order to develop a metallo-metamorphic model adapted to mineral exploration in these high-grade terrains.

In summary, this interactive session gathers all the latest MRNFP findings for the Grenville Front. Numerous discussions and debates remain (and are welcome) concerning our understanding of its evolution. The recent mapping program has already generated new ideas that will improve our interpretation of this tectonic, metamorphic and metallogenic boundary zone, and this session will allow us to highlight these, as well as past and future contributions that will collectively lead us to a greater global understanding of the Grenville Front.

Workshops

Ni-Cu-PGE deposits in the Ungava and New Québec orogens: geological contexts and characteristics

Thomas Clark, Abdelali Moukhsil and Serge Perreault (MRNFP)

After more than 50 years of Ni-Cu-PGE exploration in the Ungava and New Québec orogens (UO and NQO, respectively), the mining industry has put a deposit in the UO into production (Katinniq). Exploration for other deposits in this orogen is intense. On the other hand, exploration in the NQO has not been as successful and is at the moment relatively calm. This presentation will examine the geological similarities and differences influencing the Ni-Cu-PGE potential of the two orogens (see, for example, St-Onge and Lucas, 1993, Memoir 438 (G.S.C.); Picard *et al.*, 1994, MB 94-30; Picard, 1995, MB 95-01; Clark and Wares, 2004, DV 2004-03).

The evolution of the UO began with the opening of a rift in the Archean continent and the development of a marine platform (Lamarche Group sedimentary rocks, >2038 Ma). Following the collapse of the continental margin, tholeiitic basalts of continental affinity erupted (Povungnituk Group, 2038 - ~2000 Ma). Later, crustal extension led to the formation of a true ocean basin, distinct from the Povungnituk basin (Watts Group, 2000-1995 Ma). After a relatively inactive period (1991-1918 Ma) marked locally by alkalic volcanism (Cécilia Formation, 1959 Ma), olivine basalts (highly magnesian lavas), pyroxene basalts, and plagioclase basalts (Chukotat Group, ~1918 Ma), chemically similar to MORB, were erupted in a basin adjacent to the Povungnituk. At the same time, peridotite and peridotite-gabbro sills were emplaced into Povungnituk and Chukotat rocks. An active margin associated with a south-dipping subduction zone developed to the north, and tholeiitic to calc-alkalic volcanic rocks were erupted onto Watts Group rocks (Parent Group, 1898-1860 Ma). The last major event in the development of the UO was strong deformation related to the Hudsonian Orogeny (1860-1800 Ma).

The evolution of the NQO likewise began with the opening of a rift in the Archean continent (Seward Group, >2169 Ma), followed by the development of a marine platform on the rifted margin (Pistolet Group). MORB-type basalts and minor felsic volcanic rocks accumulated on top of the rift sediments in a marine basin adjacent to the platform (Swampy Bay Group, 2169-2142 Ma). During this period, gabbro sills were intruded into the volcanosedimentary sequence. After a period without evidence of volcanism or sedimentation, a marine platform was reestablished (Attikamagen Group dolomites, <2060 Ma?). Following another long period of time, detrital and chemical sediments, including a major iron formation, as well as some alkalic volcanic rocks, were deposited on this platform (Ferriman Group, 1880 Ma). Carbonatitic intrusions and volcaniclastic rocks were emplaced locally (Castignon Complex). Sinking of the margin led to the deposition of turbidites and, in the axis of the adjacent basin, of tholeiitic basalts with MORB, in part transitional to intraplate basalt, chemistry (Retty and Koksoak groups, 1880-1874 Ma). Primitive lavas (picrites and komatiitic basalts) were erupted locally. Gabbro and peridotite-gabbro sills were intruded into the volcanosedimentary sequence during this activity. The end of the volcanic period was marked by the intrusion of a very large carbonatite (LeMoyne). Later, in the hinterland, the granitic De Pas and Kuujjuaq batholiths were emplaced above an east-dipping subduction zone (1840-1810 Ma). Finally, the area was strongly deformed during the Hudsonian Orogeny (1820-1770 Ma).

Primary Ni-Cu-PGE deposits in the UO are related to Chukotat Group magmatism. The deposits occur as massive, net-textured, and disseminated sulfides. Some deposits (including Katinniq) are found in the Raglan horizon, located at the base of the Chukotat Group and composed of ultramafic flows and sills (pyroxenite, peridotite). Other deposits occur in ultramafic sills and dikes cutting the middle part of the Povungnituk Group. The two types of deposits are derived from magmas of basaltic komatiite composition (18 - 20% MgO). Still other deposits form horizons of disseminated sulfides in the upper parts of differentiated peridotite-gabbro sills cutting the Povungnituk.

Ni-Cu-PGE deposits in the NQO are related to mafic magmatism associated with the Retty and Koksoak groups. Some deposits of massive and disseminated sulfides are located near or at the base of differentiated, aphyric peridotite-gabbro sills. These intrusions crystallized from a magma with a high-magnesium to picritic basalt composition (8.2-13.2% MgO). Other deposits of massive and disseminated sulfides are located in glomeroporphyritic (plagioclase) gabbro sills. In the northern part of the NQO, massive to disseminated sulfides are found near or at the base of differentiated flows and sills formed from picritic magmas (13-18% MgO). Lastly, disseminated sulfides occur in horizons of pegmatitic gabbro in the upper parts of differentiated gabbro sills. Both orogens contain remobilized sulfides enriched in Cu, Pd, and Au.

The following characteristics reveal important similarities between the two orogens: 1) both orogens developed after rifting of the Archean continent; 2) they contain abundant mafic rocks formed from magma produced during mantle fusion and emplaced during multiple magmatic episodes; and 3) they contain a large number of Ni-Cu-PGE deposits. However, they differ in other ways: 1) the UO is composed of one main sedimentary cycle, whereas the NQO is composed of two; 2) the UO contains a larger quantity of rocks crystallized from highly magnesian magmas; 3) a true ocean basin opened in the UO; and 4) rifting, sedimentation and magmatism were not synchronous in the two orogens. Mineral deposits in the two orogens differ in the metal tenor of the sulfide phase and in their Cu/Pd ratios; these differences reflect, among other things, the degree of magmatic differentiation and the style of magmatic emplacement.

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

Acronymes

AIRGrav	Gravimètre aéroporté référencé inertiellement – Airborne Inertially Referenced Gravimeter
CED	Canada Economic Development
CG Ottawa	Centre géoscientifique d'Ottawa-Carleton
CGC	Commission géologique du Canada
CGC-DGC	Commission géologique du Canada, Division de la géologie du continent Ottawa
CGC-Q	Commission géologique du Canada, Québec
CGC-ST	Commission géologique du Canada – Sciences des Terrains
CONSOREM	Consortium de recherche en exploration minérale
DEGNB	Direction des Études Géologiques, ministère des ressources naturelles du Nouveau Brunswick
E3	Environmental Excellence in Exploration
FUGRO	Fugro Airborne Surveys
GC-DLG	Géomatique Canada – Division des levés géodésiques
GSNL	Geological Survey of Newfoundland and Labrador
GÉON	Firme géo-conseil
GÉOTOP-UQAM-McGill	Centre de recherche en géochimie et géodynamique – UQAM McGill
GSC	Geological Survey of Canada
GSC-Q	Geological Survey of Canada – Québec City Division
HQPG	Hydro-Québec Gas and Petroleum
IFP	Institut Français du pétrole
IGC	Initiative géoscientifique ciblée
INRS	Institut national de la recherche scientifique
INRS-ETE	Institut nationale de la recherche scientifique – Eau terre et environnement
IOS	IOS Services Géoscientifiques inc
LAVAL	Université Laval
MERRD	Ministry of Economic and Regional Research Development
McGill	Université McGill
MIR	MIR Télédétection inc
MRNFP	Ministère des Ressources naturelles de la Faune et des Parcs
NORANDA	Noranda Inc. – Exploration Division
NBGSB	New Brunswick Geological Survey Branch
POLY	École polytechnique, Université de Montréal
SGNO	Service géologique du Nord-Ouest – Ministère des ressources naturelles de la Faune et des Parcs
U. LAVAL	Université Laval
UQAC	Université du Québec à Chicoutimi
UQAM	Université du Québec à Montréal
UQAT	Université du Québec en Abitibi-Témiscamingue
URSTM	Unité de recherche et de service en technologie minérale de l'Abitibi-Témiscamingue
U. Ottawa	Université d'Ottawa

List of exhibitors

Salle de Bal

1 Abitibi Géophysique
2 Alexandria minerals corp.
3 Junex inc.
4 Tres-Or resources ltd.
5 Ressources Sirios et Exploration Dios / Osisko Exploration
6 Ressources d'Arianne / Korem
7 Niocan Inc. / Mines Cancor
8 Société d'Exploration Minière Vior inc.
9 IOS
10 Géostat
11 Les hélicoptères canadiens
12 Cambior
13 Quinto Technology
14 PDAC
15 Ministère des Ressources naturelles du Nouveau Brunswick
16 Centre géoscientifique de Québec (RNCAN)
17 Ontario Ministry of Northern Development and Mines
18 Instrumentation GDD
19 Exploration Typhon
20 SRK Consulting
21 Mira Géoscience
22 Fordia
23 Soquem - Ashton
24 Knight Resources ltd
25 UQAT
26 Ressources Medco
27 Canadian Royalties inc.
28 Fugro Airbone
29 Mines d'Or Virginia
30 Mir Télédétection
31 Héli-Max
32 TerraPlus
33 Exploration Azimut inc.
34 Pétrolia
35 Société de développement de la Baie-James
36 Alschemex
37 Corporation minière Alexis

Bellevue

40 Géophysique GPR international inc.
41 Géotic inc.
42 Novawest Resources inc.
43 Commissaire au Lobbyisme de Québec
44 Ressources Dianor inc.
45 Actlabs
46 SADC
47 Géophysique TMC
48 Goldbrook Ventures inc.
49 Fonds d'exploration minière du Nunavik
50 Université Laval
51 SGS Mineral Services
52 Ordre des géologues du Québec
53 Commission géologique du Canada
54 Québec Labradorite
55 UQAT

Verchères

56 CCN Matthews
57 CNW Telbec

Jacques Cartier

000 Abitibi geochronology
101 The REFORMIN Project in Bolivia
102 AQUEST : the new Québec Earth Sciences Association
103 Assessment of the potential for volcanogenic massive sulphide (VMS) deposits in Abitibi
104 Cégep (general and vocational college) de l'Abitibi-Témiscamingue
105 National scientific research institute
106 University of Ottawa
107 McMaster University
108 University of Toronto
109 Laurentian University
110 École Polytechnique
111 Université du Québec à Montréal (UQAM)
112 McGill University
113 Université du Québec à Chicoutimi (UQAC)
114 Université Laval
115 Anticosti Island as an example of protecting and valorizing outstanding geological sites in Québec
116 Outstanding geological sites in Québec
117-118 Using the Internet to get to know the architectural stones of Quebec: consult our web site!
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120-121 New outlook on the hydrocarbon potential of the Gaspé region: integration of Radarsat technology and multisource geoscience data
122 New gravimetric data for the eastern segment of the Gaspé region

List of exhibitors

123 New aeromagnetic and gravimetric data from the eastern Gaspé region: their significance for understanding the subsurface architecture

124 Contribution of high-resolution reflection seismology data from the Saint Lawrence Estuary to the recent geometry and tectonics of the Appalachian foreland

125 Geologic compilation of NATMAP Transect IV (Anticosti-Gaspé-Campbellton): From the Anticosti Platform to the Gaspé Belt of northern New Brunswick

126 The Targeted Geoscience Initiative Appalachian Energy project: a multipartner-multidiscipline approach to defining the hydrocarbon potential of the Appalachian frontier basins

127 Polyphasic Glacial Dispersion and Diamond Exploration in the Eastern Saindon-Cambrien Corridor (northern Québec)

128 Map of glacial indicators for the Lac Maricourt (24D) and Lac Gayot (23M) areas, north-central Québec

129 The Québec scanography laboratory : a geoscientific reality

130 Platinum group element (PGE) distribution in the Thetford Mines ophiolite from the mantle to the crust: new targets and exploration strategies

131 Geology of La Minganie and the Wakeman Group: the Havre-Saint-Pierre Natashquan Transect

132 Assessment of the potential for sillimanite and muscovite in the Mont-Laurier area

133 DIVEX: Diamonds and platinum-group elements

134 DIVEX: Sedimentary and metamorphic environments

135 DIVEX: A research network to diversify mineral exploration in Québec

136-137 Development of a common-earth 3D model along the Grenville Front

138 New preliminary geological data on Ni-Cu-PGE showings in the Portneuf-Mauricie belt

139 Diamonds in Quebec

140 Petrographic and structural study of the Duparquet syenite, Destor-Porcupine Fault, Abitibi Subprovince

141-142 Geological mapping and metallogeny of the Blake River Group and adjacent units

143 New stratigraphy of the Lac Olga area (32F)

144 Lithotectonic and metallogenic synthesis map of the Labrador Trough

145 Mapping in the Lac Pine and Lac Adonis area: Northern Central Metasedimentary Belt, Grenville Province

146-147 Geology of the Lac Varin area (22F/10), Côte-Nord

148 Inventory of quarries in the Bas-Saint-Laurent – Gaspésie region (update) and potential of White Head limestones as cement stone

149 Silurian-Devonian volcanism in the Gaspé Belt

150-151 Geology and mineral potential of the Rivière Cascapédia area (NTS 22B/16-0200-0101)

152 Characterization of a till in the Gaspésie region

153 Geochemistry and Nd isotope study of volcanic and plutonic assemblages in the Far North (Phase III)

154 Mineral occurrence map for the northeastern Superior Province, Far North Project

155 Geological synthesis of the Northeastern Superior Province (NESP)

156-157 A selection of research projects at CONSOREM

158 Université du Québec en Abitibi-Témiscamingue

Montcalm

Cree Mineral Exploration Fund

Nunavik Mineral Exploration Fund

Saguenay-Lac-St-Jean Mineral Fund

Denis Cyr, self-employed prospectors

Côte-Nord Mineral Exploration Fund

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

Timrod Project

Fonds minier de Nutashkuan

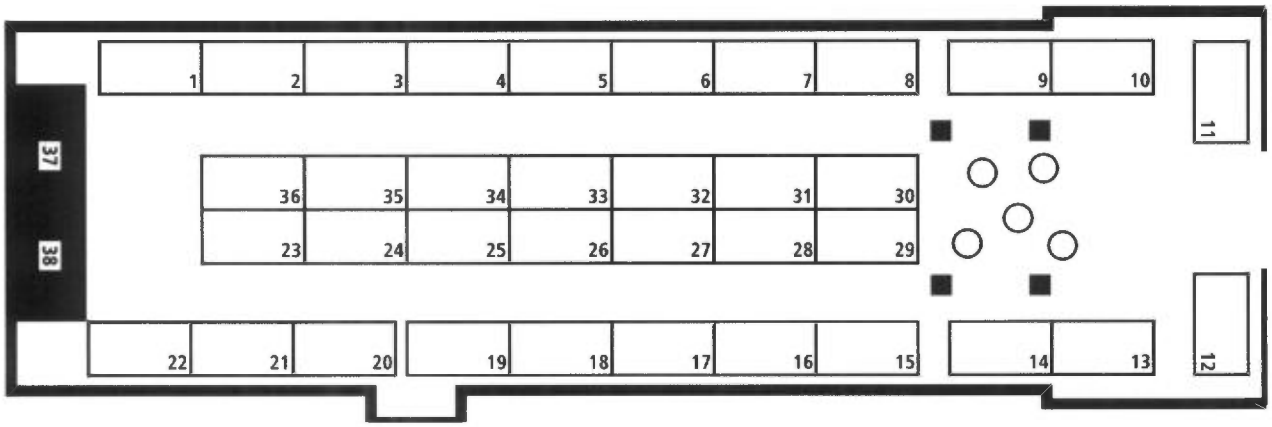
Innu Nitassinan Mineral Fund

James Bay Joint Action Mining Committee

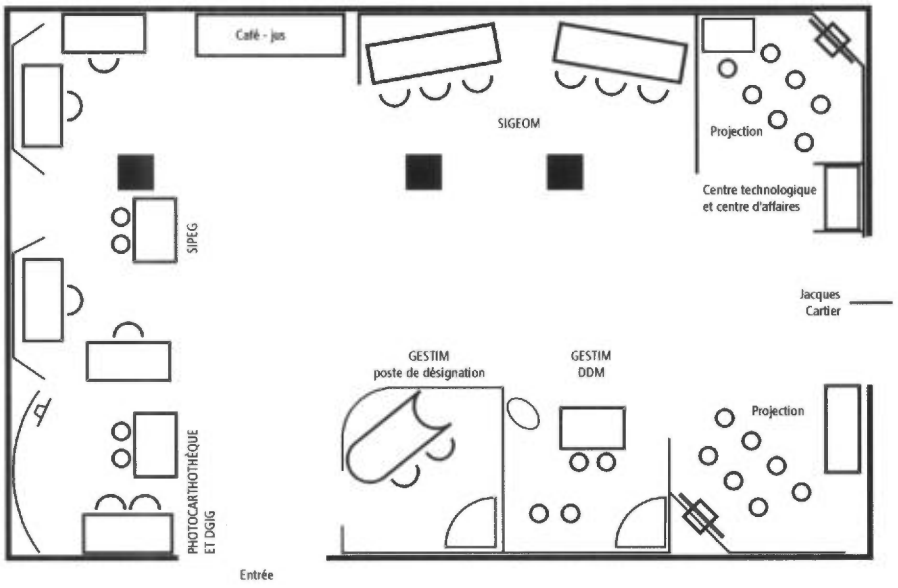
EX-IN

Maps of exhibit rooms

Salle de Bal
Trade Show

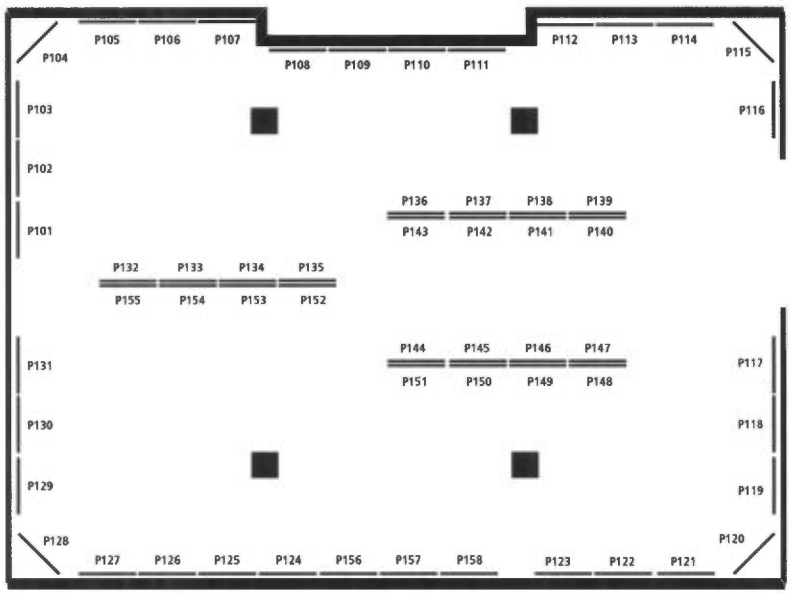


Place d'arme
Technology Centre

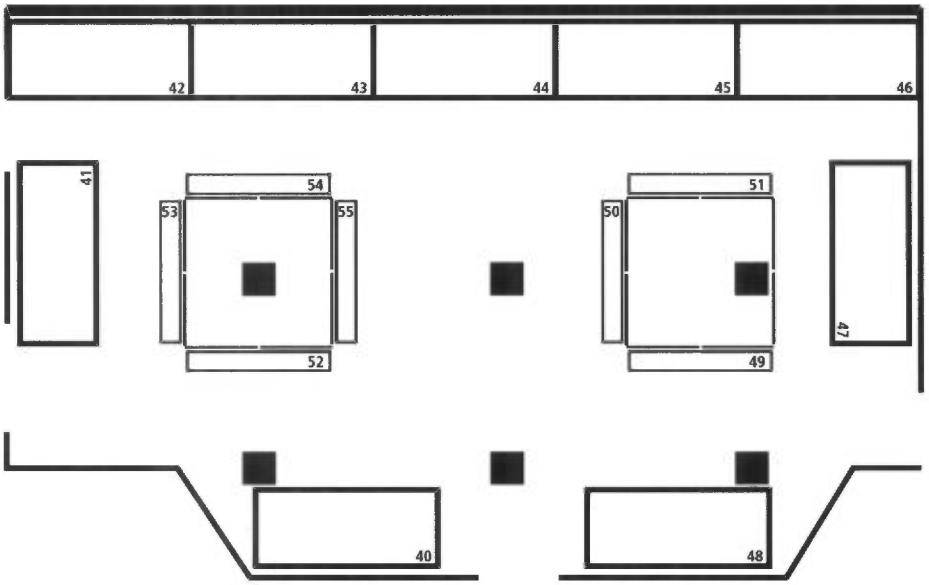


Maps of exhibit rooms

Jacques Cartier
Geoscience Exhibit

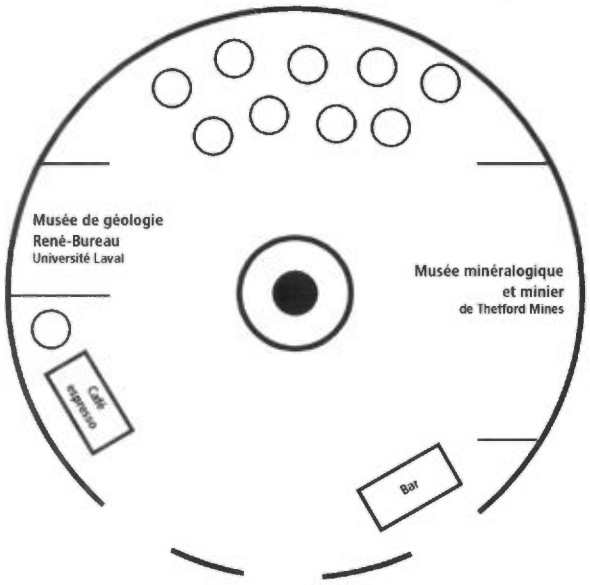


Bellevue
Trade Show

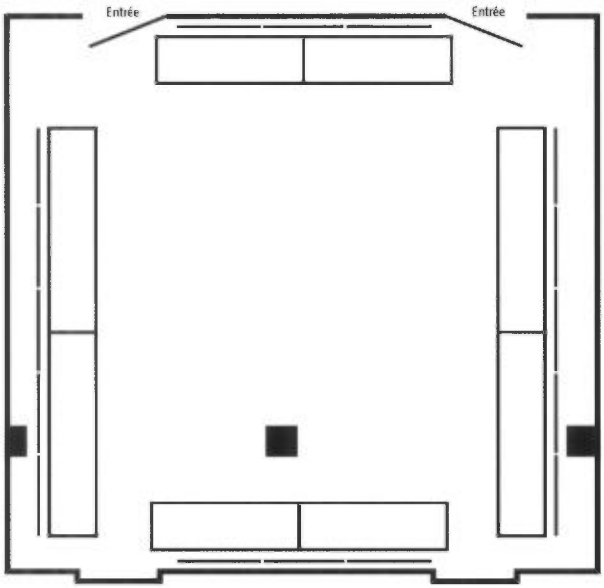


Maps of exhibit rooms

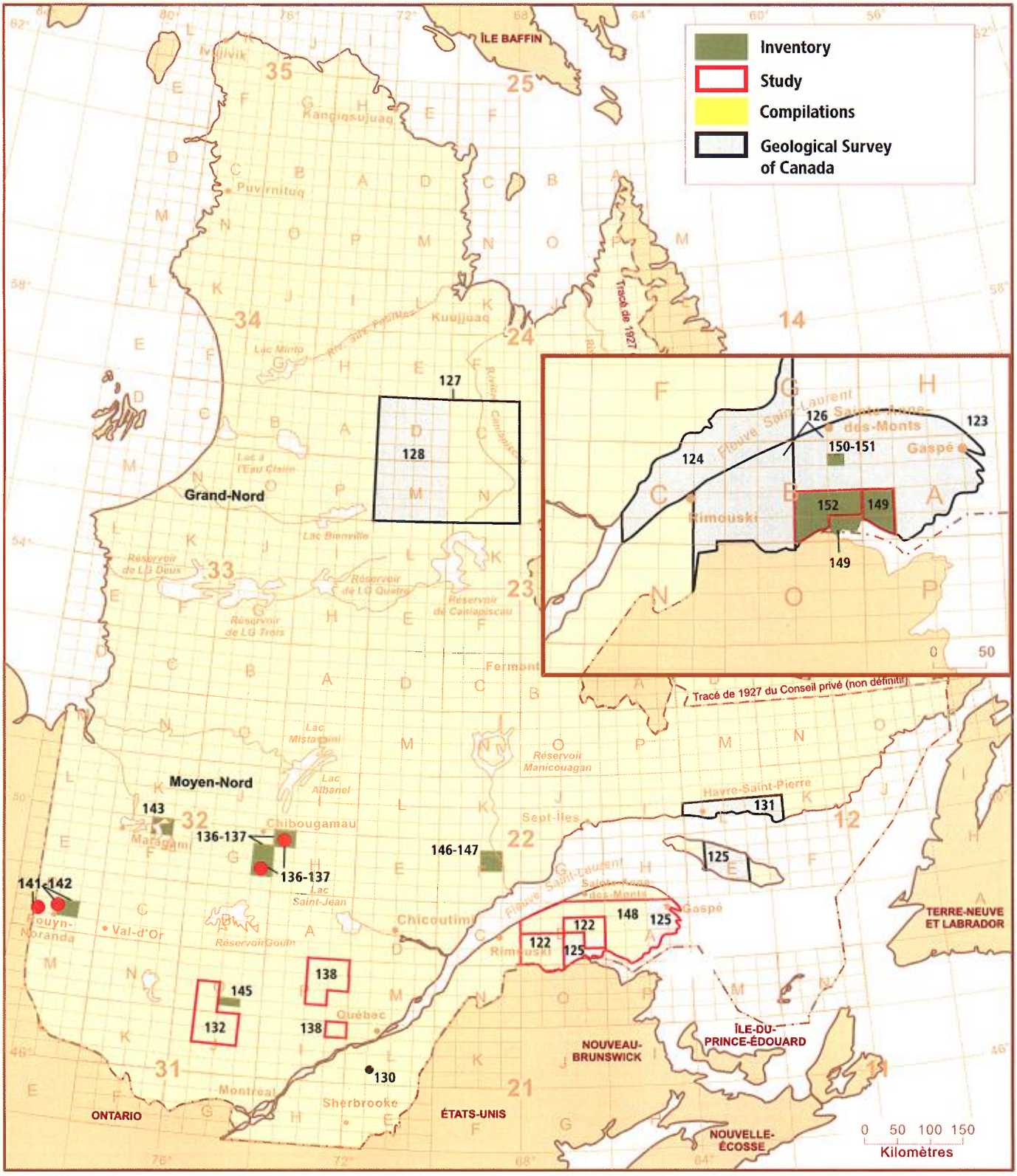
Salon Rose
Mineralogical Exhibition



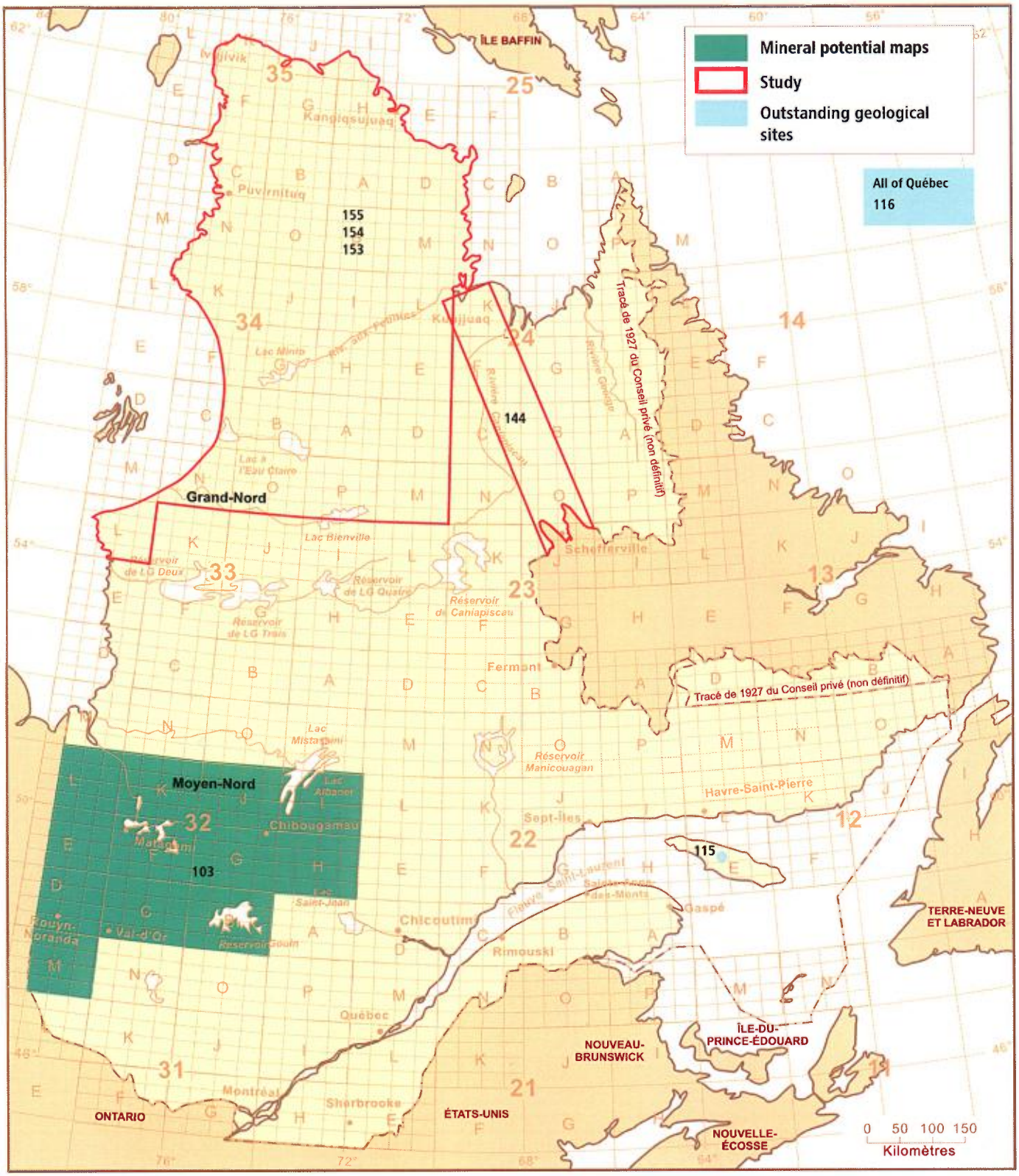
Salon Montcalm
Prospectors' Tent



Fields projects



Others projects



Ressources naturelles, Faune et Parcs
Québec