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EXPLORING IN QUEBEC : REDISCOVER ABITIBI

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Rediscover Abitibi

Program with abstracts, 2000
Geological Research Information Seminar

Québec

Explore in Québec : Rediscover Abitibi

Geological Research Information Seminar Program with Abstracts 2000

DV 2000-04

FOREWORD

Each year, Géologie Québec of the ministère des Ressources naturelles devotes an important part of its budget to the gathering of geoscience data. Its objective is to promote mineral exploration in Québec and pave the way for the discovery of new mineral deposits.

The results of geological studies conducted by Géologie Québec and its partners from the mining industry and universities are presented in a single volume that groups abstracts concerning both field programs and conferences given within the framework of the Information Seminar. Please note that the abstracts have not gone through an editorial process ; they are an exact reproduction of manuscripts submitted by the authors, except for a standard page layout destined to ensure a proper quality of reproduction.

The 2000 "Program with Abstracts" is distributed to all participants of the Information Seminar free of charge. We hope the geoscience information it contains will translate into new mineral exploration projects, and ultimately, into economically viable discoveries.

Interim director,

A. Simard

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MESSAGE

All the information contained in this document is also available on Géologie Québec's website, in the section reserved for the Seminar, which can be accessed at the following address:

http://www.mrn.gouv.qc.ca/geologie/seminaire_2000/index.htm

While viewing the list of posters or the conference schedule, or even the location map of field projects, it will be possible to access, through a hyperlink, abstracts of poster presentations or conferences.

The Seminar website is also available in English, and can be accessed from the homepage by clicking on the "English Version" button.

This information will remain accessible on the website until the next Seminar.

ACRONYMES

Géologie Québec	Ministère des Ressources naturelles du Québec
UQAC	Université du Québec à Chicoutimi
UQAM	Université du Québec à Montréal
CGC	Commission géologique du Canada
URSTM-UQAT	Université du Québec en Abitibi-Témiscamingue
INRS	Institut national de la recherche scientifique
OGS	Ontario Geological Survey
ROM	Royal Ontario Museum, Toronto
GÉON	Firme géo-conseil
UBC	University of British Columbia

"EXPLORING IN QUÉBEC : REDISCOVER ABITIBI"

CONFERENCE PROGRAM

Wednesday November 22ND

Mineral exploration : recent geological finding ans technological advances

7 h 45 — Registration at the Salon Verchères

Session 1 Far north project

Chairman : Martin Parent (Géologie Québec)

9 h – 9 h 10 — Introduction

9 h 10 – 9 h 40 — Projet Grand-Nord : nouvelles connaissances sur la géologie régionale, potentiel minéral et faits saillants des levés de l'été 2000*

Far North Project : New undestanding of the regional geology, mineral potential and outstanding features of the summer 2000 field-work

Leclair, A. Berclaz, M. Beaumier, A.-M. Cadieux, J. David, C. Gosselin, J.-Y. Labbé, P. Lacoste, Y. Larbi, L. Madore, M. Parent, K. Sharma, M. Simard, R. Thériault (Géologie Québec)

9 h 40 – 10 h — Projet Grand-Nord : découvertes de l'été 2000*

Far North Project : Discoveries of the summer 2000

J.-Y. Labbé, P. Lacoste, A. Leclair, M. Parent, L. Madore, Y. Larbi, A. Berclaz, A.-M. Cadieux, C. Gosselin, M. Simard (Géologie Québec)

10 h – 10 h 20 — Les minéralisations en Ni-Cu-Co-ÉGP du projet Gayot, ceinture de Vénus, Grand-Nord*

Ni-Cu-Co-PGE mineralizations of the Gayot project, Venus belt, Far North

M. Chapdelaine, P. Archer (Mines d'or Virginia Inc.)

10 h 20 – 10 h 40 — Le volcanisme archéen dans le nord-est du Supérieur*

Archean volcanisme in the NE Superior Province

C. Maurice, D. Francis (Université McGill)

10 h 40 – 11 h — Influence de la dynamique glaciaire polyphasée sur la géochimie des tills et des sédiments de lacs dans le Grand-Nord*

Influence of the polyphase glaciation dynamics on the till and lake bottom sediments geochemistry in the Far North

M. Parent (Commission géologique du Canada), M. Beaumier (Géologie Québec), S. Paradis (Commission géologique du Canada)

11 h – 11 h 20 — Évolution tectonomagmatique de la Ceinture volcanosédimentaire de Frotet-Evans (CVFE), sous-province d'Opatica, Québec*

Tectonomagmatic evolution of the Frotet-Evans Volcanosedimentary Belt (FEVB), Opatica sub-province, Québec

M. Boily (firme géo-conseil GÉON), C. Dion (Géologie Québec)

11 h 20 – 13 h 30 — Visite de la salle d'exposition, du pavillon Abitibi 2000 et du Carrefour des technologies d'information géominière

Lunch

Session 2 Geological exploration : programs, systems and tools

Chairman : Daniel Brisebois (Géologie Québec)

13 h 30 – 14 h — Les programmes d'aide à l'exploration : où en sommes-nous ?*

Exploration Assistance Programs : Current situation

P. Rissmann, P. Marcoux (Géologie Québec)

14 h – 14 h 30 — Le SIGÉOM – Internet : un état de la question*

The SIGEOM-Internet : A status report

C. Roy et l'équipe SIGÉOM (Géologie Québec)

14 h 30 – 15 h — Utilisation de la télédétection en cartographie géologique*

Use of remote-sensing in geological mapping

M. Rheault (MIR Télédétection), P. Verpaelst, A. Leclair, J. Goutier, P. Pilote (Géologie Québec)

15 h – 15 h 30 — Système de production des cartes du potentiel minéral (SPCPM) : exemple d'application pour les gisements de sulfures massifs volcanogènes du type Noranda dans les régions de Joutel et Chibougamau*

The mineral potential maps production system (MPMPS) : an example of its application for the Noranda-type volcanogenic massive sulphide deposits in Joutel and Chibougamau areas

D. Lamothe (Géologie Québec)

15 h 30 – 16 h — Poster Session

Visit of the exhibit hall, the *Abitibi 2000* Pavillon and the *Carrefour des technologies d'information géominière*

Golden hammer award ceremony and promotional prizes

16 h with the Minister of Natural Ressources, Mr. Jacques Brassard

17 h 30 — "Beer and sandwiches" reception

Thursday November 23rd

ABITIBI 2000

Session 3 Géological considerations

Chairmen: Phil C. Thurston (OGS) et John Ayers (OGS)

8 h – 8 h 10 Introduction

W.U. Mueller (Université du Québec à Chicoutimi) et R. Marquis (Géologie Québec)

8 h 10 – 8 h 30 La subdivision des ceintures de roches vertes: quelle direction prendre? **

Subdivision of greenstone belts: where do we go from here?

P. C. Thurston (Ontario Geological Survey)

8 h 30 – 8 h 50 Chevauchement, extension et transpression dans la zone volcanique sud de la Sous-province de l'Abitibi*

Thrusting, extension and transpression in the southern volcanic zone of the Abitibi greenstone belt

R. Daigneault, W.U. Mueller, E.H. Chown (Université du Québec à Chicoutimi), P.Pilote (Géologie Québec)

8 h 50 – 9 h 10 Les failles régionales de la ceinture de roches vertes de l'Abitibi, leur influence sur la stratigraphie et sur la distribution des gisements**

Regional faults in the Abitibi greenstone belt and their prolonged control on the distribution of stratigraphy and mineral deposits

J. Ayer, N. Trowell (Ontario Geological Survey), Y. Amelin, S. Kamo (Royal Ontario Museum)

9 h 10 – 9 h 30 Le rôle des intrusions granitoïdes dans l'évolution de l'arc volcanique de l'Abitibi en croûte continentale**

The role of plutonic granitoid intrusions in converting the Abitibi Volcanic arc into Continental Crust

E.H. Chown (Université du Québec à Chicoutimi), A. Moukhsil (Géologie Québec), R. Harrap (Queen's University)

9 h 30 – 9 h 50 Évolution volcanique et géodynamique du terrane Abitibi-Wawa: magmatisme de plume bonninitique et son association avec les andésites-Mg, adakites et basaltes enrichis en Nb**

Volcanic-geodynamic evolution of the Abitibi-Wawa terrane: plume-bonninite magmatism, and the Mg-andesite-adakite-Nb-enriched basalt association

R. Kerrich (University of Saskatchewan), D. Wyman (University of Sydney), A. Polat (Max-Planck Institut)

9 h 50 – 10 h 20 Break

10 h 20 – 10 h 40 Variations temporelles et spatiales dans la géochimie des komatiites à l'échelle de la ceinture de roches vertes de l'Abitibi**

Temporal and spatial variations in komatiite geochemistry in the Abitibi greenstone belt

R. Sproule, C.A Lesher (Laurentian University), J.Ayer, P.C. Thurston (Ontario Geological Survey)

10 h 40 – 11 h Les roches supercool de l'Abitibi: formation de varioles, sphérulites, harissite et spinifex**

Supercool Abitibi rocks: the development of varioles, spherulites, harissite and spinifex

A.D. Fowler (Université d'Ottawa)

11 h – 11 h 20 La géochronologie U-Pb des métasédiments archéens des sous-provinces de Pontiac et de l'Abitibi, Québec: contraintes sur l'âge, l'origine et la tectonique régionale**

U-Pb geochronology of Archean metasediments in the Pontiac and Abitibi subprovinces, Québec: constraints on timing, provenance and regional tectonics

D. W. Davis (Royal Ontario Museum)

11 h 20 – 11 h 40 Contraintes temporelles sur le volcanisme archéen: l'exemple du complexe volcanique de Hunter Mine, dans la ceinture d'Abitibi**

Age constraints on Archean volcanic construction: an example from the Hunter Mine volcanic complex, Abitibi belt

W.U. Mueller (Université du Québec à Chicoutimi) et J.K. Mortensen (British Colombia University)

11 h 40 – 13 h 20 Poster Session

Visit of the exhibit hall, the *Abitibi 2000* Pavillon and the *Carrefour des technologies d'information géominière*

Lunch

Session 4 Métallogénic Consideration

Chairmen: Robert Marquis (Géologie Québec) et E.H Chown (Université du Québec à Chicoutimi)

13 h 20 – 13 h 40 Variations typologiques des minéralisations aurifères le long de la zone de faille de Porcupine-Destor, Ontario, Canada: un guide d'exploration**

Variations in styles of gold mineralization along the Porcupine-Destor Fault zone, in Ontario, Canada: an exploration guide

B. R. Berger (Ontario Geological Survey)

13 h 40 – 14 h L'altération chloriteuse associée aux dépôts de type SMV du district de Noranda**

Chlorite alteration associated with VMS deposits in the Noranda District

F. Santaguida (Carleton University), M. Hannington (Commission géologique du Canada), H. Gibson (Laurentian University), D. Watkinson (Carleton University), A. Galley (GSC), F. Paquette-Mihalasky (Laurentian University), P. Jones (Carleton University)

14 h – 14 h 20	Analyse des patrons d'altérations reliés aux gisements aurifères et de type SMV dans la ceinture de roches vertes de l'Abitibi, Québec* Alteration patterns analysis related to gold and VMS deposits in the Abitibi greenstone belt, Quebec M. Piché (Géologie Québec)
14 h 20 – 14 h 40	Géologie et aspects structuraux du Couloir de déformation de Casa-Berardi* Geology and structural aspects of the casa-Berardi deformation zone P. Pilote et S. Lavoie (Géologie Québec)
14 h 40 – 15 h	Une nouvelle vision du camp minier de Joutel, zone volcanique nord* New insights from the Joutel mining camp, northern volcanic zone M. Legault (Géologie Québec), W. U. Mueller (Université du Québec à Chicoutimi), M. Gauthier, M. Jébrak, F. Baillargeon (Université du Québec à Montréal), R. Daigneault (Université du Québec à Chicoutimi), M. Piché (Géologie Québec)
15 h – 15 h 20	Break
15 h 20 – 15 h 40	Des plumes mantelliques à la subduction : évolution géologique de l'arc de Val-d'Or, à l'extrémité sud-est de la ceinture de roches vertes de l'Abitibi** From mantle plumes to subduction : evolution of the Val d'Or Arc southeast Abitibi Greenstone Belt C.R. Scott, W.U. Mueller (Université du Québec à Chicoutimi). P.Pilote (Géologie Québec), S. Lavoie (Université du Québec à Chicoutimi), R. Marquis (Géologie Québec)
15 h 40 – 16 h	Continuité possible de la Formation de Val-d'Or au sud de la zone tectonique de Cadillac* Possible extension of the Val-d'Or Formation, south of the Cadillac tectonic zone J. Moorhead, L. Vorobiev (Géologie Québec), A. Tremblay (Institut national de la recherche scientifique)
16 h – 16 h 20	Contexte régional et minéralisations porphyriques en or de Launay Taschereau* Regional context and porphyric gold mineralization Launay Taschereau P. Doucet (Géologie Québec) et M. Jébrak (Université du Québec à Chicoutimi)
16 h 20 – 16 h 30	Conclusion R. Marquis (Géologie Québec)
16 h 30	End of Seminar

CONTENTS

CONFERENCES ABSTRACTS

POSTERS ABSTRACTS

Session 1 : 9 h 10 à 9 h 40

Far North Project : New understanding of the regional geology, mineral potential and highlights of the summer 2000 field program

Alain Leclair, Alain Berclaz and Anne-Marie Cadieux, Jean David, Charles Gosselin, Jean-Yves Labbé, Pierre Lacoste, Youcef Larbi, Louis Madore, Martin Parent, Kamal Sharma, Martin Simard, Robert Thériault (Géologie Québec)

Archean rocks of the NE Superior Province (SP) cover a vast territory north of the 55^{th} parallel, corresponding to nearly 1/5 of the total surface area of Québec. The objectives of the Far North Project are to build a geologic framework at a scale of 1:250,000, to determine the nature, origin and tectonic evolution of this part of the SP and to outline the most favourable geologic settings for mining exploration. Within the scope of this project, 11 geological surveys were carried out in 18 NTS sheets (23M, 24D, 24E, 24F, 24L, 24M, 25C, 25D, 25E, 25F, 34A, 34G, 34H, 34I, 34J, 34P, 35A, 35H) along a 700 km N-S axis. This work has outlined several regional stratigraphic units that form complex geological assemblages with diverse origins and ages. The current model supports an amalgamation of six major geological assemblages which attest to a succession of magmatic and tectonic events between *ca.* 2.87 and 2.68 Ga. (1) The oldest recognized geological elements are scattered remnants of ancient rocks, which most likely represent a Middle Archean (3.1-2.9 Ga) tonalitic basement, and juvenile supracrustal sequences (Buet, Trempe, Thury, Hamelin, Tasiaalujuaq, Rivier, Faribault, Leridon, Kakiattukallak, Natuak, Gayot) with ages on the order of 2.86-2.82 Ga. The latter are associated with syntectonic tonalite-trondhjemite-granodiorite (TTG) suites (*ca.* 2.81-2.79 Ga) which appear to be related to an episode of accretion involving older terrains. (2) Juvenile tectonomagmatic activity (*ca.* 2.84-2.77 Ga) then led to the development of a second TTG suite containing volcano-sedimentary units, possibly arc/intra-arc-type rocks, to form a margin/continent association (Duquet, Qalluviartuuq, Payne, Dupire, Vizien, Garault). All these units form the "Faribault-Thury" and "Goudalie-La Grande" assemblages, and possibly represent an orogenic headland against which subsequent tectonic activity developed. Later widespread calc-alkaline magmatic activity, which took place between 2.76 and 2.70 Ga, was marked by: (3) the emplacement of granodiorites, into which the Kogaluc and Pélican-Nantais belts are inserted, and (4) the emplacement of complexes composed of charnockitic rocks (ca. 2.75-2.70 Ga) and mafic to ultramafic rocks, whose high ambient temperature is probably responsible for granulite-facies metamorphism. (5) A major collisional event (*ca.* 2.73-2.68 Ga) is characterized by the syn- to late-tectonic emplacement of important volumes of porphyritic granodiorite-granite, leucogranite, diatexite and pegmatite. It has led to important recycling of older lithologies, and to amphibolite-facies regional metamorphism. (6) Finally, late alkaline magmatism (*ca.* 2.65 to 2.00 Ga) is recorded as nepheline syenite intrusions and several networks of diabase, ultramafic to mafic lamprophyre dykes and carbonatites.

Session 1 : 9 h 40 à 10 h

Far North Project : Discoveries of the 2000 summer season

Jean-Yves Labbé, Pierre Lacoste, Alain Leclair, Martin Parent, Louis Madore, Youcef Larbi, Alain Berclaz, Anne-Marie Cadieux, Charles Gosselin, Martin Simard (Géologie Québec) and Régis Dumont (GSC)

The 2000 summer field campaign resulted not only in the discovery of new interesting mineralized showings, but also in the identification of metallogenic settings conducive to future discoveries.

The best discovery of the summer is undoubtedly the Ni-Cu-Co Qullinaaraaluk showing, announced at the end of August. The mineralization consists of massive, semi-massive and disseminated sulphides hosted in a mafic to ultramafic intrusion. The massive sulphide zone outcrops sporadically over a length of about 25 metres. The zone varies from 1 to 4 metres wide. Massive sulphides mainly consist of pyrrhotite, with pentlandite, chalcopyrite and pyrite. Six samples, taken with a sledgehammer, returned Ni values between 1.71% and 2.60%, Cu between 0.08% and 1.8% and Co from 0.14% to 0.27%. The hosting mafic to ultramafic intrusion is probably post-tectonic ; it cross-cuts a sequence of diatexites and metatexites. This metallogenic environment is quite different from the classic Archean greenstone belt model, and adds a new dimension to the Far North Project by making metamorphic terrains, considered economically uninteresting up until now, much more attractive.

The discovery of the Kimber belt in the Lac Klotz area also represents a highlight of the 2000 summer season. This belt is over 10 kilometres long and may reach up to 4 kilometres wide. It is very well exposed and represents a volcano-sedimentary environment favourable to the development and preservation of porphyry-type and epithermal mineralized systems. Several sulphide zones were observed in this belt, namely in a tonalite, probably subvolcanic in origin, with anomalous gold values (0.34 g/t Au), and along a kilometre-scale fragmental horizon with a massive sulphide matrix, probably exhalative in origin.

Several felsic volcanic horizons were discovered or revisited this past summer. Alteration zones with cordierite, anthophyllite, garnet or sillimanite, probably associated with volcanogenic hydrothermal systems were identified in most of these felsic rocks, namely in the Pélican-Nantais, Chavigny and Tasiaalujjuaq belts. These areas therefore represent prime targets for Cu-Zn-Au VMS exploration.

Session 1 : 10 h à 10 h 20

Ni-Cu-Co-PGE mineralizations, Gayot project, Venus belt, Far North

Michel Chapdelaine and Paul Archer (Virginia Gold Mines)

The Gayot project is located 110 kilometres north of Caniapiscau Reservoir, Far North region, within map sheet NTS 23M. The property, held 100% by Virginia Gold Mines inc., was acquired in 1997 and now consists of six (6) mining exploration licences covering a total surface area of 323 square kilometres.

The Gayot Project area (sheet 23M) marks the junction of the La Grande, Ashuanipi, Minto (Goudalie Domain) and Bienville Archean subprovinces. In the field, units of the La Grande Subprovince appear to be related to those of the Goudalie Domain : they mainly consist of undifferentiated tonalitic and granitic rocks containing several one to ten kilometre-wide volcano-sedimentary belts.

The Gayot project covers the largest of these belts, the Venus belt, which extends over more than 15 km in length by over 5 km in width. On the whole, the Venus belt represents an overturned south and southeast-facing homoclinal sequence. From the base (northwest) upwards (southeastward), the belt comprises a felsic volcano-sedimentary sequence with a synvolcanic tonalitic intrusion, conglomerates and a few mafic flows, a thick (100-600 m) fractionated ultramafic flow, additional felsic volcano-sedimentary rocks, a sulphide-rich exhalative horizon, a 500-m sequence of thin spinifex-textured ultramafic flows overlain by komatiitic basalts and basalts, an oxide-facies iron formation, and finally, a sequence of amphibolites and mafic gneisses.

The stratigraphy is locally repeated as a result of folding or thrust faulting, and is also disturbed by shear zones.

Exploration work performed to date by Virginia Gold Mines has outlined several important showings with Ni-Cu-Co-PGE mineralization, hosted in ultramafic rocks in the Venus belt. These Ni-Cu-Co-PGE showings may be divided into five distinct types :

1. Massive, net-textured or disseminated sulphides at the base of the thick fractionated flow (Gayot, L and Base Line showings) ;
2. Massive, net-textured or disseminated sulphides at the base of the sequence of thin spinifex-textured flows (Gagnon Extension showing) ;
3. Disseminated and blebby sulphides in olivine cumulates within the thick fractionated flow (Nancy, DeChamplain showings) ;
4. Disseminated sulphides within the pyroxenite portion of the fractionated flow (Gagnon, Pyrox showings) ;
5. Type 1 and 2 massive sulphides remobilized in the surrounding host rock.

The abundance and diversity of Ni-Cu-Co-PGE showings hosted in komatiitic rocks of the Venus belt clearly demonstrate the strong potential of this ultramafic sequence, which displays numerous features similar to known mining camps such as Kambalda and Mount Keith in western Australia and Raglan in the Nouveau-Québec region.

Session 1 : 10 h 20 à 10 h 40

Archean volcanism in the NE Superior Province

Charles Maurice and Don Francis (McGill University)

The presence of volcano-sedimentary belts in the NE Superior Province has only been known for a few years, and their study remains marginal. Despite the high degree of deformation and metamorphism, as well as the high volume of felsic intrusives, it is possible to find well-preserved volcanic relics where primary textures are locally recognizable.

Three volcanic belts of the Faribault-Thury amphibolitic Complex were sampled within the scope of a detailed petrogenetic study during the summer of 1999 (Hamelin, Lac Trempe and Lac Buet belts, NTS 24M and 25D). Rocks in these three locations are mafic to ultramafic in composition ; lavas (basalts and komatiites) and associated cumulate rocks (peridotites, pyroxenites and gabbros) are equally represented. The lavas display MgO contents > 7 wt%, and the calculated composition of olivines coexisting with basaltic liquid varies between Fo_{75} and Fo_{85}. An Fe enrichment tholeiitic trend suggests the absence of magnetite fractionation in weakly oxidizing conditions.

In terms of major elements, the Fe content of these volcanic rocks is distinctly higher than modern oceanic ridge basalts (MORBs). Subchondritic Zr/Y ratios are similar to MORBs (Zr/Y = 1.9-2.8) and rare earth patterns are very flat. However, certain incompatible element ratios (Nb/Th = 7-9, Zr/La_{pm} = 0.75-1.5, Th/La_{pm} = 0.7-1.1), similar for basalts and komatiites, are clearly distinct from MORBs (Nb/Th ~ 19, Zr/La_{pm} ~ 1.8 and Th/La_{pm} ~0.4). Furthermore, the trace element content of these volcanic rocks is lower than that of modern equivalents.

Globally, the geochemical similarities between the three sites, the occurrence of Mg-rich lavas, the depleted rare earth patterns and the low trace element contents suggest that the volcanic rocks of the three belts represent the primitive remnants of the base of a single volcanic sequence. Furthermore, the similarity of incompatible element ratios for basalts and komatiites, as well as the fractionation modelling of ultramafic lavas at low pressure suggest a single origin for both komatiites and tholeiites. This interpretation concerning lavas of the Faribault-Thury Complex contrasts with other models which suggest that komatiitic and associated tholeiitic lavas are derived from partial melting at different mantle depths.

The differences between recent and ancient mafic volcanism have important implications on mantle chemistry and evolution. If these volcanic rocks represent Archean equivalents of MORBs, this implies that the upper mantle, from which these lavas are derived, had a primitive composition, and thus had not yet undergone complete extraction of the continental crust.

Session 1 : 10 h 40 à 11 h

Influence of the polyphase glaciation dynamics on till and lake sediment geochemistry in the Far North

Michel Parent (QGC), Marc Beaumier (Géologie Québec) and Serge J. Paradis (QGC)

Studies of glacial flow indicators carried out over the last few years have demonstrated that the dynamics of regional glacial movements in Québec's Far North region is much more complex that that envisioned in classic models. These observations indicate (1) that the last two glacial maxima were characterized by the reorientation, over nearly 90°,of the main glacial divide, and (2) that portions of the ice sheet located near the ocean locally underwent important reorientations due to the development of glacial currents (Hudson Strait, Ungava Bay, James Bay, Gulf of Saint-Lawrence). Thus several phases of glacial transport, most often in different directions, may be recognized in practically all areas of the Far North.

Reconnaissance scale (1/100 km^2) till geochemistry surveys in these areas revealed various types of dispersal trains: banded, composite (= banded and palimpsest) and amoeboid (cf. Parent *et al.*, 1996). Given the selected grain size fraction (< 0.063 mm) and analytical techniques (INAA and ICP-AES), these surveys provide a direct record of the composition of sediments dispersed by glacial transport, all the while minimizing the nugget effect affecting precious metals (Paradis *et al.*, 1996). This type of survey was conducted in four areas of the Far North region (24E, 24I, 33N and 34J), which made it possible to recognize the effects of multiple phases of particle reworking by subglacial transport, and demonstrated that glacial dispersal trains in these areas may easily reach distances on the order of 30 km.

Higher density (1/13 km^2) lake sediment geochemical surveys, available for the entire Far North region, also record these glacial dispersal patterns, whose characteristics may be compared to those outlined by till geochemistry. Given the nature of these lacustrine sediments (diatom organic mud + clastic fraction), their interpretation must take into account three types of processes: (1) glacio-sedimentary dispersal per se, (2) mechanical remobilization in the hydrographic system, and (3) accumulation of compounds derived from the meteoric alteration of Quaternary sediments and bedrock. Examples of lake sediment and till geochemistry will show that it is essential to take into account the local complexities of glacial dynamics, and that the application of broad-based models can easily lead to errors in interpretation.

References:

Paradis, S.J., Beaumier, M. and Kirouac, F., 1996 – Géochimie du till dans la région du lac Surprise (SNRC 32 G/07), Québec, comparaison des fractions <177 et <63 microns du till. *Geological Survey of Canada*, Public File 3285, 230 p.

Parent, M., Paradis, S.J. and Doiron, A., 1996 – Palimpsest glacial dispersal trains and their significance for drift prospecting. *Journal of Geochemical Exploration*, vol. 56, p. 123-140

Session 1 : 11 h à 11 h 20

Tectonomagmatic evolution of the Frotet-Evans Greenstone Belt (FEGB), Opatica sub-Province, Québec

Michel Boily (GÉON) and Claude Dion (Géologie Québec)

The FEGB forms an EW-oriented thrust panel nestled within orthogneissic sheets which constitute the bulk of the Opatica sub-Province. The FEGB is divided into four lithotectonic segments. The volcanic-dominated Frotet-Troilus and Evans-Ouagama segments define the eastern and western ends of the belt, whilst the centre is composed of volcanosedimentary assemblages (Storm-Evans and Assinica segments).

The Storm-Evans segment contains calc-alkalic basaltic to rhyodacitic tufs and lavas (Evans Group) showing fractionated LREE-normalized profiles ($[La/Sm]_N$=2,3-6,0, depletions in HFSE but enrichment in LILE, LREE and Th in primordial mantle-normalized (PM) spidergrams which are typical of subduction-generated volcanics. Sequences of basaltic flows that predominate in the Rabbit Formation (Evans Group; Storm-Evans and Evans-Ouagama segment) and the Assinica Group (Assinica segment) extends eastward within the Troilus Group (Frotet-Troilus segment). They contain flows of boninitic affinity (BON) exhibiting low HFSE contents (Zr=20-78 ppm and TiO_2 = 0,23-0,73 wt.%), U-shaped REE-normalized patterns (($[La/Sm]_N$=1,4-2,1 and $[Gd/Lu]_N$=0,64-1,1) and PM-normalized positive Zr and Hf anomalies; a distinctive chemical signature of Cenozoic boninites. Fractionated Ti-rich tholeiites (FT), with $[La/Sm]_N$ >1 (1,2-2,1) and trace element signatures intermediate between N-MORBs and island arc tholeiites are interstratified with the BON. The latter are presumably overlain by magnesian tholeiites (MT) and rare ferrotholeiites (FTO; FeO_T >12 and TiO_2 >1,2 wt.%) presenting unfractionated REE patterns ([La/Sm]=1,2-2,1) and no HFSE depletions in PM-normalised spidergrams which are compatible with a N or E-type MORB affinity. The BON, FT, MT and FT lavas are related to forearc splitting and the development of a marginal oceanic basin. The Frotet-Troilus segment differs somewhat from the other segments by the occurrence of oceanic plateau sequences showing an interstratification of TM and FTO lavas and the presence of calc-alkaline Sr-rich (150-900 ppm) aluminous andesitic to dacitic pyroclastic rocks having sufficiently high $[La/Yb]_N$ (18-33) and Sr/Y (5-130) to suggest an adakitic affinity.

We propose a tectonomagmatic model in which the central and western segments of the FEGB represent the development of a forearc oceanic basin and the resurgence of a mature oceanic arc. The eastern Frotet-Troilus segment would define the distal portion of the forerac basin near a submerged adakitic arc which underwent collision with oceanic plateau fragments.

Session 2 : 13 h 30 à 14 h

Exploration assistance programs : current situation

Patrick Rissmann and Pierre Marcoux (Géologie Québec)

For the 2000-2001 fiscal year, two new measures have been added to existing programs. A $5M credit was granted for the implementation of a program designed to support junior exploration companies experiencing difficulties, and another amount of $5M was set aside for the mining region of Abitibi. The latter amount is divided into $4M for financial assistance to exploration companies, managed under the Québec Mineral Exploration Assistance Program, and $1M for the gathering of geoscience data. Thus, the total annual budget for mining exploration assistance will amount to $12.65M.

The assistance program for junior exploration companies more specifically targets companies whose head office is located in Québec, and who perform most of their activities on its territory. To be eligible, companies must have expended a minimum of $500,000 in exploration work in Québec, and have a working capital below $500,000. Financial assistance for these companies may reach a total of $500,000, including a maximum contribution of $150,000 to the company's working capital, and a reimbursement of 80% of expenses incurred for exploration projects, up to a maximum of $350,000. Thus, of the 22 companies who submitted applications amounting to $8.7M, 14 of these will receive a total assistance of $5M.

The Québec Mineral Exploration Assistance Program (MEAP) ($7.65M) underwent several modifications this year. The previous Near North Program was integrated, in addition to the $4M financial assistance measure for the Abitibi geological Subprovince. The MEAP is still designed for the same clientele, namely : prospectors, mining exploration companies, regional exploration funds, and native funds. In the division "Financial assistance for individual prospectors – grassroots prospecting", an additional amount of $1,000 per project is granted to cover the costs of travel by floatplane for projects inaccessible via ground travel. Financial assistance related to the division "Assistance to exploration companies" was modified for certain regions. It still consists of a reimbursement of 50% of incurred expenses up to a maximum of $50,000 per project for southern regions, but the maximum amount for work carried out in the Near North and Far North regions has been harmonized, and may now reach up to $75,000 per project.

Prospectors will share a budget of $750,000 for the realization of about 100 projects. In the "companies" division outside of the Abitibi region, over 60 projects have been accepted for a budget of $1.85M. The five regional exploration funds will share a total amount of $1.1M. The Nunavik mining exploration fund has access to $300,000, and the new fund implemented with the Natashquan community can count on an amount of $50,000. The $4M budget devoted to the Abitibi is divided into three sections : one dedicated to deep drilling, a second for advanced exploration, and a third section which basically corresponds to the "Assistance program for exploration companies".

Session 2 : 14 h à 14 h 30

SIGÉOM-Internet : A status report

Charles Roy (Géologie Québec)

Géologie Québec entered the Internet realm in early 1998, by introducing its Examine bibliographic database, soon followed by the first general portal for Géologie Québec, then in November 1999 with the introduction of two new geoscience applications (Atlas of GIS data, and List of Products) complete with imagery and electronic commerce, which allows the use of credit cards. The 2000 vintage will add the first functions related to "SIGÉOM à la carte", and a new integrated version of Examine. To signal the arrival of its newborn, Géologie Québec has redesigned its product interface.

"SIGÉOM à la carte" represents an entirely new approach to SIGÉOM. It invites the customer to use a search engine based on textual or geometric elements, to download the results, if desired, by specifying the map projection (UTM, MTM, geographic coordinates), and by specifying the format (MicroStation, MapInfo, ArcView, AutoCad). All the geometric data included in SIGÉOM (folds, faults, diamond drillholes, Examine survey locations, etc) is targeted by this new application. The user will be able to select his choice of downloading the data or purchasing a CD-ROM to obtain the results of his query.

Another novelty of "SIGÉOM à la carte" is that the data will not be symbolized, and the customer will therefore be able to select the desired parameters (colours, cells, etc.) to apply to the various geometric elements, based or not on textual elements.

The integration of Examine into "SIGÉOM à la carte" will include a transition period during which the previous interface will be maintained in order to provide a harmonious transition to the new interface. New downloading functions (document base imagery, downloading of geometric data) and English translation will only be available in the SIGÉOM version of Examine.

Géologie Québec is currently considering the possibility of imaging geoscience maps in SIGÉOM. These images would be viewed in the Atlas of GIS data, and would provide an efficient way to consult information from SIGÉOM, without the barriers arising from the data format of current products.

Subscriptions are currently under study, in order to provide for an initial period of unlimited access to data in "SIGÉOM à la carte", then a second phase providing access to the remaining available data including documents in the documentation database and SIGÉOM products and images. Consultation of this information within Géologie Québec applications will remain free of charge.

The FTP (File Transfer Protocol) site should allow in the near future to download purchased reports and data, and to substantially reduce the handling of information by both users and Géologie Québec. Needless to say that Géologie Québec will maintain the availability of CD-ROMs and hard copies of maps and written documents.

Session 2 : 14 h 30 à 15 h

Use of remote sensing in geological mapping

Michel Rheault (MIR Télédétection), Pierre Verpaelst, Alain Leclair, Jean Goutier, Pierre Pilote (Géologie Québec)

Within the framework of the Canada-Québec Agreement on RADARSAT Data Development, MIR Télédétection completed a project dealing with the integration of remote sensing within the process of geological map production. Various value-added products responding to the needs of Géologie Québec were generated for three locations:

- Québec's Far North (sheet 34I) for a 1:250,000 scale mapping project;
- James Bay (sheet 33F16) for a 1:50,000 scale mapping project;
- Abitibi (southeast part of sheet 32C4) for a geoscience study at a scale of 1:20,000.

For these three sites, RADARSAT and optical (Landsat, SPOT, IKONOS) images were integrated with magnetic, geochemical and topographic data. Various remote sensing and geophysical products were generated at scales of 1:250,000, 1:50,000 and 1:20,000 respectively for the Far North, James Bay and Abitibi regions. In each case, these products were used by the mapping crews to interpret a first level of geological information and to plan upcoming field work. The same products were also used after the field season to produce the final geological maps.

A plan to integrate remote sensing in the activities of Géologie Québec has finally been established. It includes a user's manual on remote sensing data allowing geologists to identify, as soon as a geological mapping project is under way, useful value-added products with regards to the scale of mapping, the climate, the physiography and the structural trend of the area.

Remote sensing data supplies very detailed surface information revealing the structural trend or the mineral composition of geological bodies. For any organization planning to conduct geological mapping surveys, they are therefore very useful in extracting a first level of lithostructural information, in orienting field efforts, and in producing better geological maps.

Session 2 : 15 h à 15 h 30

The mineral potential map production system (MPMPS): An example of its application for Noranda-type volcanogenic massive sulphide deposits in the Joutel (32E) and Chibougamau (32G) areas

by D. Lamothe and C. Dion (Géologie Québec)

As early as 1986, the Mines Sector recognized the importance of including mineral potential assessment to its list of principal activities in geological research. After an initial phase of assessment and conceptualization in 1989 and 1995, the MPMPS has now entered the production phase. The system produces mineral potential maps derived from the application of parameters arising from a detailed metallogenic model. Produced at a scale of 1:250,000, these maps illustrate via a colour code the level of response to the model for each 250 m cell forming the matrix of the study area.

The MPMPS is a system that combines both: 1) the ability of the GQL (Andyne) graphics gateway adapted to SIGÉOM to query and extract data from Oracle databases, and 2) the spatial and statistical analysis techniques of the MGE software (Intergraph) applied to GIS-type matrix files derived or not from SIGÉOM. In the first case, the system helps integrate the results of GQL queries corresponding to the parameters of the selected metallogenic model. In the second case, the system makes it possible to apply a vast range of spatial analysis tools to geological elements relevant to the model (lithological contacts, drillholes, lithochemical analyses or secondary environment analyses, magnetic signature, satellite imagery lineaments, etc.).

The Joutel (32E) and Chibougamau (32G) areas were selected to test the MPMPS with the volcanogenic massive sulphide (VMS) ore deposit model. This model essentially rests on four criteria:

1. high heat flow necessary to maintain hydrothermal activity;
2. the presence of conduits allowing fluid circulation;
3. stratigraphic control marked by pauses in volcanic activity; and
4. the presence of mineralizing fluids.

The first three criteria are examples of the use of zonation and overlap in spatial analysis. The last criteria helps illustrate the processing abilities in MGE of databases imported from SIGÉOM. The combination of various intermediate products results in the final mineral potential map, on which targets deemed to be the most promising by the author are identified and commented on.

The VMS model will soon be applied to map sheet 32F, and will eventually cover all of the Abitibi. Two other metallogenic models are currently being developed by Géologie Québec, namely 1) a model outlining the potential for kimberlite and lamproite discoveries (J.-Y. Labbé), and 2) an Olympic Dam-type model, adapted to the Grenville Province of the Lower North Shore (D. Lamothe).

Session 3 : 8 h 10 à 8 h 30

Subdivision of greenstone belts : Where do we go from here ?

P.C. Thurston, (OGS)

Models for greenstone belt development have changed over the last 30 years from ensimatic models to the suspect alloch-thonous terrane model based on the plate tectonic paradigm. However, within the plate tectonic model, it is difficult to reconcile the secular variation seen throughout much of the Superior Province. Alloch-thonous terranes should be essen-tially random in their occurrence rather than exhibiting secular order, therefore we ought to examine our models. What we see is a progression from early platforms through oceanic plain, to arc sequences, and ultimately to late pull-apart basins. That progression is marked by early quartz-carbonate metasedi-mentary rocks, representing platform sedimentation, unconfor-mably overlying previously cratonized crust consisting of granitic rocks and/or earlier greenstone belts . The platform sedimentary rocks are followed by komatiite-tholeiite volca-nism suggesting subsequent continental break-up. Subsequent greenstone belts then include oceanic plain and/or arc volcanic rocks amalgamated against early platforms and then cut by strike-slip shear zones with associated unconformably overlying pull-apart basins.

The allochthonous terrane model is challenged by the presence of a major 2.9–2.7 Ga unconformity in the Red Lake greenstone belt, subtle, within sequence unconformities in the Pilbara and Tikshozero (Baltic shield) greenstone belts, and unconformity bounded 2.9, 2.8, and 2.7 Ga sequences in the Confederation greenstone and the Michipicoten greenstone belts. These examples tend to demonstrate that greenstone belts can be characterized as including unconformity-bounded sequences as well as accreted allochthonous terranes.

Within the Abitibi greenstone belt there are challenges to the allochthonous, suspect terrane model. The Swayze green-stone belt is, based upon stratigraphic and isotopic evidence, seen as an orderly autochthonous sequence built up ensiali-cally. The Abitibi greenstone belt does not have any evidence for early platform sequences. Unconformities between pull-apart basin sequences and the underlying volcanic rocks are numerous. However, the presence of four plume-related major sequences in the western Abitibi over a 50 Ma span suggests that important internal unconformities must be present. Some sequences are characterized by an upper unit representing pelagic sedimentation (e.g., iron assemblages) which may represent large time intervals lacking volcanic activity. Other subtle unconformities may be present as minor horizons of feldspar destructive alteration, or the addition of Fe or Mg leading to the presence of minor garnet, or weathered chromite altered to fuschitic spots.

Refinement of our greenstone belt models will lead us to the realization that many greenstone sequences are not alloch-thonous random collages but rather unconformity bounded sequences responding to large scale phenomena such as eusta-tic sea level changes or global scale catastrophic convective overturn of the Earth's mantle. At this point we can then conceive of stratigraphic correlation between isolated belts based upon unconformity surfaces as is the case in modern stratigraphic analysis.

Session 3 : 8 h 30 à 8 h 50

Thrusting, extension, and transpression in the southern volcanic zone of the Abitibi Greenstone Belt

Réal Daigneault, Wulf Mueller et Edward H. Chown
(UQAC) et Pierre Pilote (Géologie Québec)

The Abitibi Subprovince (ASP) is divided into a northern (NVZ) and southern volcanic zones (SVZ ; Chown et al. 1992). The SVZ is limited to the north by the Destor-Porcupine-Manneville Fault Zone (DPMFZ) and to the south by the Cadillac Larder Lake Fault Zone (CLLFZ). Several deformational events affected the ASP but only those relevant to the SVZ are considered. They are related to crustal shortening, crustal exhumation and dextral transcurrent motion. The NVZ is a composite but intact volcano-sedimentary sequence (2730-2710 Ma) with well-defined stratigraphic correlations across fault systems. In contrast, the SVZ is composed of the Malartic Block (2714-2702 Ma), a complex arc assemblage associated with komatiites, and the Blake River Block (2703-2698 Ma), a bimodal volcanic sequence. Mantle-plumes attenuated the arc-ocean floor crust causing extension, and the formation of early crustal fractures, considered precursors to the DPMFZ and the CLLFZ.

The ASP is characterized by a progressively southward migrating deformation. In the NVZ, regional folds and thrusts occurred between 2705 – 2700 Ma and culminated with dextral transpression (2700 – 2690 Ma). During NVZ transpression, the NVZ and SVZ collided (E1) and major N-dipping thrust faults produced interarc and foreland sedimentary basins bordering the SVZ. The Caste and Pontiac sedimentary rocks were the locus of the Manneville and the Cadillac thrust faults, respectively.

After terrane docking (E1), dextral transcurrent movement occurred (E2), forming fluvial-dominated strike-slip basins. The Duparquet basin of the DPMFZ formed between 2690-2680 Ma, whereas the Granada basin of the CLLFZ is younger, forming between 2680-2670 Ma. Renewed shortening (i.e. folding and thrusting) recurred in the SVZ (E3 ; 2670-2660 Ma). Subsequently, a 2660-2640 Ma. extensional phase (E4) along the DPMFZ and the CLLFZ facilitated exhumation of the Malartic Block and the Pontiac sediments, respectively. Evidence of exhumation is given by 1) normal shear-sense indicators (south-side down) along faults, 2) juxtaposition of greenschist metamorphism north of both faults with amphibolite metamorphism south of the faults, and 3) emplacement of 2-mica monzogranite plutons. Final deformation (E5) in the SVZ (<2640 Ma) featured folding and shearing associated with a dextral transpression. Dextral shearing was prominent especially along the CLLFZ. SE-trending fault segments of major E-trending systems display large-scale asymmetric Z-fold geometry, (i.e. Malartic and the Marbridge areas). The various events, recorded in the DPMFZ and CLLFZ, span early plume- and subduction-related processes to final dextral transpression and can be integrated as successive responses to an oblique collision.

Reference

Chown, E.H., Daigneault R., Mueller, W., and Mortensen, J. 1992 – Tectonic evolution of the Northern Volcanic Zone, Abitibi Belt, Québec : Can. J. Earth Sci., 29, 2211-2225.

Session 3 : 8 h 50 à 9 h 10

Regional Faults in the Abitibi Greenstone Belt and their Prolonged Control on the Distribution of Stratigraphy and Mineral Deposits

J. Ayer, N. Trowell (OGS), Y. Amelin and S. Kamo (ROM)

New mapping and U-Pb zircon geochronological results in the Abitibi greenstone belt (AGB) in Ontario support a largely autochthonous stratigraphy rather than the collage of allochthonous terranes suggested in recent publications. Nine distinct assemblages have been identified on the basis of lithological and geochronological criteria. The 7 oldest assemblages are predominantly volcanic and represent semi-continuous volcanism from 2745 to 2698 Ma. The geochronology supports coherent, upward-facing stratigraphic sections which have been subsequently modified by regional deformation. About 20% of the samples also contain inherited zircons with ages similar to those of the underlying units. The 2 youngest assemblages are dominantly sedimentary and were unconformably deposited on the older assemblages. The first consists of distal turbidities deposited from 2696 to 2692 Ma, followed by a second assemblage consisting of more proximal subaerial conglomerate, sandstone and volcanic rocks of alkalic affinity deposited from 2685 to 2675 Ma. These late sedimentary assemblages occur in elongate units spatially associated with regional faults. The faults also controlled the distribution of some of the volcanic assemblages, indicating movement histories dating back to at least 2725 Ma. Understanding the control on the distribution of assemblages is economically important because Cu-Zn and Ni-Cu deposits are confined to 4 out of the 7 volcanic assemblages. In addition, epigenetic gold deposits have a close spatial relationship to the regional faults and the sedimentary assemblages and were contemporaneous with, and/or closely followed by, the late sedimentation and alkaline magmatism.

By analogy with modern-day plate tectonic environments, the chemical patterns of tholeiitic and komatiitic rocks imply plume-dominated, ensimatic oceanic rift environments while the calc-alkaline rocks suggest subduction environments. However, autochthonous repetition of the different geodynamic environments over the almost 50 million years of volcanic activity with 5 dominantly mafic (±ultramafic) assemblages and 2 dominantly calc-alkaline assemblages, as well as the extensive intermingling of these different rock series in many of the assemblages, has not been documented in modern plate tectonic environments.

Session 3 : 9 h 10 à 9 h 30

The role of plutonic granitoid intrusions in converting the Abitibi Volcanic arc into Continental Crust

E.H.Chown (UQAC), Abdelali Mouhksil (Géologie Québec) and R. Harrap (Queen's University)

The Abitibi greenstone belt, Canada, constitutes a segment of a broad oceanic volcanic arc that experienced three distinct periods of volcanic activity peaking at 2730-2725Ma, 2718-2714Ma and 2705-2700 Ma, respectively. During all three volcanic phases, which were generated by subduction-related processes, prominent mantle plume komatiitic volcanism affected the composite Abitibi arc. The komatiitic plume volcanism facilitated regional extension, and helped determine the locus of the large, crustal E-W trending Abitibi faults. North-to-south shortening produced thrusting, and folding, followed by SE-trending dextral strike-slip faulting between 2700-2692 Ma. Subsequent E-W dextral strike-slip faulting, limited to the major faults, continued to 2690-2680 Ma (Destor-Porcupine) and even to 2680-2670 Ma (Cadillac-Larder). Extensional structures resulting from the thickened crust developed around 2660 Ma.

Granitoid intrusions are associated with all the volcanic and deformational phases, and have been used to date many of these events. Their role in stabilizing, and adding to, the volcanic crust is perhaps less well appreciated.

Large tonalite-dominated intrusions of the tonalite-trondhjemite-granodiorite (TTG) suite are documented for all three major periods of volcanic activity, and are genetically related to the volcanism. These occur both as high-level, flat, cauldron subsidence complexes and as batholithic masses at the base of the oceanic crust. Tonalite gneiss, dated from 2714 to 2703Ma, occurring in structural highs, is considered to be arc-underplated material related to the 2718Ma plutonism. The gneiss crystallized at depth, and, in contrast to the other tonalites, does not appear to have intruded volcanic rocks.

Numerous arc-derived intrusions of both the TTG and tonalite-granodiorite-granite-monzodiorite (TGGM) suites form stocks and small plutons associated with the late phases of major deformation. These are more numerous than voluminous, and most of the tonalite end members of the suites probably intruded at depth, retarded by the now-thickened crust. Large tonalite intrusions dominate the adjacent uplifted sections of the Abitibi belt in the Kapuskasing and Grenville Parautochthon, and presumably make up much of the deeper parts of the Abitibi belt observed in Lithoprobe seismic profiles.

Small stocks and dyke complexes characterize the late localized strike-slip deformational phase. Intrusions of crustal derivation were emplaced in the final period of extensional activity around 2660 Ma.

Thus, plutonic rocks are a major over-all component of the Abitibi Belt.

Session 3 : 9 h 30 à 9 h 50

Volcanic-geodynamic evolution of the Abitibi-Wawa terrane : plume-boninite magmatism, and the Mg-andesite-adakite-Nb-enriched basalt association

R. Kerrich (University of Saskatchewan), D. Wyman (University of Sydney) and A. Polat (Max-Planck Institut)

Recent thermodynamic models have suggested that direct interaction between mantle plumes and island arcs will enhance long-term arc buoyancy and therefore contribute disproportionately to the crustal record. Studies in the Abitibi-Wawa orogen, provide insights into how this stabilization process occurred in the world's largest preserved greenstone belt. Volcanic sequences of the late Archaean Abitibi-Wawa orogen are dominated by (1) 2750 to 2720 Ma arc-type assemblages ; (2) ~2725 to 2700 Ma komatiite tholeiite assemblages ; and (3) post-2716 Ma tholeiite-to-calc alkalic arc-type assemblages. Field evidence demonstrates these diverse volcanic sequences were spatially associated at the time of eruption and do not correspond to a conventional plateau accretion scenario. Evidence for komatiite flooding of an early Abitibi arc (Dostal & Mueller, 1997) and a later transition from hotspot/plateau volcanism to arc-type volcanism in the Kidd Volcanic Centre provide fundamental constraints on tectonic models for the belt. The distribution of proto-arc related depleted boninitic tholeiites ($TiO_2 <$ 0.5 wt% ; Al_2O_3/TiO_2 ratios to 65, subchondritic Zr/Y ratios and fractionated HREE) across the length of the central Abitibi belt requires plate re-arrangement and the probable initiation of a new subduction zone in response to plume impingement on an existing arc. The stepback of subduction across the plume allowed for the coupling of Archean refractory mantle lithosphere keel to imbricated plume/arc crust and the long-term preservation of an unusually large greenstone belt.

Plume impingement under the arc may have caused flattening of the slab subduction angle and promoted the coexistence of i) basalts derived from a mantle wedge metasomatised by slab dehydration and ii) adakitic rocks derived from slab melts. As a result, plume- and proto-arc-related lithologies are closely associated with magnesian andesites (SiO_2=56-64 wt.%, Mg # 0.64-0.50, with Cr = 531-106 ppm, and Ni = 230-21 ppm), Niobium-enriched basalts-andesites (Nb=7-16 ppm), and more typical tholeiitic to calc-alkaline basalt-andesite suites across the Abitibi-Wawa Orogen. Geochemical data from oceanic plateau sequences, bimodal volcanic arc sequences, siliciclastic turbidites, and plutonic TTG lithologies of the Abitibi-Wawa Orogen suggest the continental crust formed by physical and chemical mixture of approximately 6-12 percent oceanic plateau component with a 88-94 percent complementary subduction component (granitoids and tholeiitic to calc-alkaline bimodal arc volcanic rocks and trench turbidites).

Session 3 : 10 h 20 à 10 h 40

Temporal and Spatial Variations in Komatiite Geochemistry in the Abitibi Greenstone Belt

R.A. Sproule, and C.M. Lesher, (Laurentian University) J.A. Ayer and P.C. Thurston (OGS)

The ~2.7 Ga Abitibi Greenstone Belt (AGB) contains several lithologically-distinct volcano-sedimentary assemblages that may be subdivided into stratigraphically and structurally distinct terranes. The relationships between terranes is ambiguous and the greenstone belt may represent 1) a collage of allochthonous terranes, each representing a single lithotectonic assemblage formed in possibly originally widely separated tectonic settings ; 2) a single autochthonous terrane representing a series of assemblages formed along a stratigraphically and tectonically complex and structurally-deformed convergent margin, or 3) a combination of these two models. Based on an extensive database of U-Pb zircon dating, the western part of the AGB has recently been subdivided into 9 chronologically distinct tectono-stratigraphic assemblages. Komatiites, ultramafic volcanic rocks interpreted to be derived from mantle plumes, occur in 4 of the assemblages : the Pacaud, the Stoughton Roquemaure (S-R), the Kidd Munro (K-M), and the Tisdale. Examination of an extensive komatiite geochemical database (>2000 samples) for the four assemblages for systematic changes in geochemical signatures with time and location will aid in testing the various tectonic models.

The komatiites in the western AGB are distributed on a scale comparable to Phanerozoic plumes and spatially disparate komatiite sequences of similar age possess similar geochemistry, suggesting similar sources and therefore a single plume. However, we observe secular variation in komatiite geochemistry that transgresses former allochthonous terrane boundaries, supporting an autochthonous model. These variations are also consistent with decreasing influence of garnet in the source with time. This implies either 1) a decrease in the amount of magma derived from the plume axis relative to that derived from the plume head, thus a secular change in plume morphology through flattening against the base of the lithosphere, or 2) a change in the depth of magma-source equilibration, representing incremental extraction from a plume ascending through the garnet stability field into the spinel stability field during the formation of the western AGB.

	Pacaud	S-R	K-M	Tisdale
Magma	AEK	ADK>AUK	AUK>>ADK	AUK
Source	g-rich l/h	g-l/g-h	g-l/g-h	g-l/g-h
Residue	h/d	g-l /g-h	h/d	h/d
Origin?	P head	P tail	P head	P head

h=harzburgite ; d= dunite ; g=garnet ; l=lherzolite ; p=plume

Session 3 : 10 h 40 à 11 h

Supercool Abitibi Rocks: The development of varioles, spherulites, harrisite and spinifex

A.D. Fowler, (Ottawa Carleton Geoscience Centre and University of Ottawa)

The term variole has often been misused as it has been applied to a variety of different textures e.g., spherulites, ocelli, amygdules and even phenocrysts. Strictly they are spherulites in mafic rock, though current usage is vague, and would probably consider them as leucocratic, generally spherical, roughly cm-sized globules in mafic volcanic rocks. Spherulites are arrays of tiny acicular crystals (generally plagioclase) that emanate from a common point, each having a unique crystallographic orientation. Most often Archean varioles turn out to be spherulites. Variolites (rocks containing varioles) are associated with numerous gold deposits within the Abitibi. The link here is that the variolitic rocks, although extremely altered, can in some cases be unambiguously classified as spherulitic Fe-rich tholeiitic rocks. The high Fe content of these rocks makes them ideal hosts to react with hydrothermal fluids forming pyrite, and scavenging gold. The aphyric basalts were superheated, and then supercooled on eruption, so that cm-sized spherulites formed.

Spinifex olivine occurs as sheaves of platy crystals that fan out from within dms of komatiite flow tops. The size of the platy crystals (dm) and the sheaves (m) is much greater than those of any other igneous rock, pointing to rather unusual conditions for their formation. Heat loss was largely focussed through the tops of the flows and initially would have caused the formation of a thin crust opaque to radiative heat transfer and thermally non-conductive. Ingress of water into the thickening crust allowed for hydrothermal convection and therefore significant heat-transfer from the flow. Below the crust, olivine crystals (Fo_{94}) nucleated. These Mg-rich olivines grew by thermally constrained crystallization, wherein they transferred heat by radiation and conduction more efficiently that the surrounding melt. Thus the crystals cooled the melt from which they grew and were self-propagating.

Harrisite, a large scale branching and bladed olivine texture of plutonic rocks is found within the upper portions of the Centre Hill layered complex. The branching textures (forsterite) grew in a differentiated crystal mush in response to a sharp thermal gradient caused by injection of new magma into the sill. The patterns can be modeled as having formed due to diffusion limited conditions over a steep thermal gradient.

I appreciate the work of former students Murray Jones, Robert Thériault and Mark Shore, without whom this report would not have been possible.

Session 3 : 11 h à 11 h 20

U-Pb geochronology of Archean metasediments in the Pontiac and Abitibi subprovinces, Québec, constraints on timing, provenance and regional tectonics

D. W. Davis, (ROM)

U-Pb isotopic ages of detrital zircons have been obtained from sandstones in the Pontiac subprovince and from the Cadillac Group, Kewagama and Caste Formations within the southern Abitibi greenstone belt. Youngest detrital zircon ages from each sequence are 2685 Ma, 2686 Ma, 2687 Ma, and 2693 Ma, respectively. The Lac Fournière pluton, which crosscuts the Pontiac metasediments, is 2682 ± 1 Ma old. A similar age was measured on a pluton cutting the Kewagama Group. Deposition of greywackes in the Pontiac and Abitibi subprovinces was therefore at 2685 ± 3 Ma. The Timiskaming Group seems distinctly younger, since its youngest detrital zircon is 2678 Ma, while the age of a crosscutting pluton is 2672 ± 1 Ma.

The normalized probability distributions of detrital zircon ages from the Pontiac and Abitibi metasediments, and of dated igneous rocks from the southern Abitibi subprovince, all show their major source activity in the age range 2685-2710 Ma. The distributions for Abitibi turbidites and dated igneous rocks are very similar, suggesting that these sediments were mostly derived from the surrounding granite-greenstone terrain. The peak of the Pontiac distribution is a few m.y. younger than that from the Abitibi metasediments but both groups show similar age ranges for older, pre-Abitibi components (2750-2850 Ma and 3020-3030 Ma).

Deposition of the ca. 2685 Ma sediments was virtually syntectonic. Based on previous field, geochemical and isotopic studies, as well as age data, the Pontiac Group is suggested to have been deposited within an active subduction zone but derived from a southward advancing nappe complex largely comprised of an uplifted extinct continental arc to the north. This was mostly eroded into the sediment basin and perhaps tectonically overridden by its back-arc basin, now partly preserved as the southern volcanic zone of the Abitibi subprovince. Metaturbidites exposed between metavolcanic assemblages within the greenstone belt may represent overturned unconformities at the structural base of the greenstones. These were brought up by high angle faults, which also localized deposition of non-marine (Timiskaming-type) sediments. It is tentatively suggested that Pontiac-type metasediments extend most of the way beneath the Abitibi subprovince, the oldest part of the accretionary prism emerging as the Quetico metasediments in the western.

Session 3 : 11 h 20 à 11 h 40

Age constraints on Archean volcanic construction : an example from the Hunter Mine volcanic complex, Abitibi Belt

W.U. Mueller, (UAQC) and J.K. Mortensen, (UBC)

The Hunter Mine Group (HMG) of the Northern Volcanic Zone, Abitibi belt is an integral constituent of volcanic cycle 1 (2730-2720 Ma). The south-facing, steeply-dipping, 4-5 km-thick HMG represents a deep-marine volcanic complex with a central cauldron structure that was subsequently flooded by mafic-ultramafic flows of the Stoughton-Roquemaure Group (SRG). This volcanic structure is composed of (1) an extensive 1.5 km felsic dyke system traceable for 2.5 km up-section, (2) pyroclastic deposits resulting from deep-water fire-fountaining eruptions as well as tuff turbidite and banded iron-formation units, (3) massive felsic flows and domes associated with autoclastic debris, (4) syn-HMG basaltic to andesitic dykes, and (5) inferred SRG gabbro intrusions, collectively up to 2 km thick which inflate the HMG volcanic pile. Numerous felsic dyke generations display columnar jointing and multiple rows of columnar joints within the same intrusive phase, indicating numerous magma pulses. Dyke phases were identified based on cross-cutting relationships, and phenocryst content, size and abundance. The observed felsic flow sequence is comparable.

The 3-4 km-thick, felsic-dominated sequence represents the basal to medial part of the HMG, whereas diverse lithological units characterize the summital, 0.5-1 km-thick, tran-sition zone. Eakins (1972) suggested that sill-like gabbros intruded the HMG sequence. A quartz-feldspar-phyric volcanic rock near the base of the succession and previously interpreted as a feeder dyke, yielded an U-Pb zircon age of 2729.6± 1.4 (Mortensen, 1993) which establishes incipient HMG evolution. Additional sampling, constrained by rigorous facies mapping, was initiated to determine the duration of HMG felsic volcanism. A QFP flow (WPP-3) with 1-2 mm size quartz (10-25%), as well as a distinct QFP-dyke (HMG-3-90) with up to 1 cm-large quartz phenocrysts, both in the medial part of the HMG, gave comparable ages of ~2724 Ma and 2725.4+4.5/-3.5 Ma, respectively. A QFP unit with up to 0.1-1 cm-size quartz phenocrysts (10-25%) was sampled near the contact with the SRG. The cross-cutting relationship with massive sulfides suggests it is a dyke and is probably related to petrographically similar dykes that intrude gabbro sills lower in the succession. An age of 2704.3±1.7 Ma (HMG-4-90) supports this interpretation. Many similar dykes are therefore not related to initial volcanic construction. The coarse-grained quartz-hornblende pods in the gabbro were sampled to constrain the upper limit HMG development, but an age of 2731.8+2.2/-2.0 Ma (WPP-99-1) indicates that some gabbro sills are coeval with early edifice construction rather than SRG volcanism. U-Pb dating of samples taken near the top of the volcanic sequence is in progress to provide an upper limit for HMG edifice construction. Only with detailed facies mapping, can stratigraphic sampling be conducted in volcanic centres and the documented wide age ranges attest to the complexity of volcanic edifice construction.

References

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Session 4 : 13 h 20 à 13 h 40

Variation in Styles of Gold Mineralization along the Porcupine – Destor Fault zone in Ontario, Canada : an exploration guide

Ben R. Berger (OGS)

The Porcupine–Destor fault zone (PDFZ) is a regional gold–bearing structure that transects over 450 km of the Abitibi greenstone belt. Gold deposits display a variety of distinctive mineralization styles in different segments of the PDFZ occurring from Timmins to the Quebec border.

In the Timmins segment (approximately 19 km), the major gold deposits occur in splay faults north of the PDFZ and are associated with calc-alkalic quartz-feldspar porphyry intrusions. Gold in free form, or in pyrite, occurs in large quartz veins and stockworks in strongly carbonatized mafic and ultramafic metavolcanic rocks.

The Pamour segment (27 km long) is characterised by gold deposits hosted in mafic metavolcanic and metasedimentary rocks north of the PDFZ. Calc-alkalic intrusions are rare or absent. Free form gold or in pyrite occurs in quartz – carbonate veins and stockworks within an intense but spatially restricted carbonate, sericite alteration halo.

In the Nighthawk-Matheson segment (37 km), gold deposits occur within the PDFZ, are hosted by carbonatized and green mica altered ultramafic and mafic metavolcanic rocks and are associated with apatite-bearing alkalic albitite dikes. Gold occurs principally in free form and with pyrite in the albitite dikes. Quartz stockwork and pervasive silicification are common ; carbonatization is intense but is typically more localised than in the Timmins segment.

In the Hislop-Michaud segment (27 km) the PDFZ branches into several subparallel faults separated by metavolcanic and metasedimentary rocks intruded by mafic to felsic alkalic plutons. Gold deposits are associated with faults transecting the alkalic intrusions and metasedimentary rocks. Gold occurs with disseminated and vein pyrite in pervasively albitized and silicified zones with abundant hematite. Carbonate is locally abundant, but is typically minor in most of the deposits.

The PDFZ becomes more tightly focused in the Harker – Holloway segment (29 km) extending to the Québec border. Gold deposits occur within the fault zone and along splay faults to the south. The deposits are hosted in strongly albitized, silicified and hematized mafic metavolcanic rocks. Gold occurs within pyrite and intense carbonatization is restricted to the immediate vicinity of the deposits.

Knowledge of mineralization styles can help gold explorationists tailor their programs for specific deposit types along the different segments of the PDFZ. While we can only speculate why these differences occur at present, it is hoped that ongoing Ontario Geological Survey mapping and research will help better understand the fundamental reasons for these differences.

Session 4 : 13 h 40 à 14 h

Chlorite Alteration Associated with VMS deposits in the Noranda District

F. Santaguida (Carleton University), M. Hannington (GSC), H. Gibson (Laurentian University), D. Watkinson (Carleton University, A. Galley (GSC), F. Paquette-Mihalasky (Laurentian University) and P. Jones (Carleton University)

Chlorite is ubiquitous throughout the Noranda Volcanic Complex (NVC) and demonstrates a complex hydrothermal and metamorphic paragenesis. Textures, mode of occurrence and unique mineral compositions define two main types of hydrothermal chlorite.

"Background" chlorite is developed as groundmass replacement of volcanic glass and spherulites as well as open-space infilling of vesicles, interpillow hyaloclastite, and flow-top breccia in both mafic and felsic volcanic rocks. Concentrations of background chlorite are up to 30% in the Noranda Mine. Sequence where most VMS deposits occur and commonly coincide with whole-rock ^{18}O depletion. Compositions of background chlorite in the Mine Sequence are Fe-rich ($Fe/Fe+Mg \geq 0.5$) compared to elsewhere in the NVC, but typically still reflect the Fe-Mg range of the least altered volcanic rocks and suggest background chloritization does not involve extensive metasomatism.

"Discordant" chlorite occurs in cross-stratal zones up to 2 km in surface extent. These zones typically contain over 30% chlorite and approach "chloritite" concentrations (> 70%) within mineralized areas. The most intensely chloritized rocks are developed along synvolcanic faults and feeder volcanic dykes in both mafic and felsic eruptive centres that characterize the "pipe-shaped" alteration zones at most of the VMS deposits. Discordant chloritization also overprints semi-conformable alteration such as silicification and epidote-quartz alteration. Several discordant chloritic alteration zones envelope massive sulphide mineralization at Ansil, Corbet, Horne, Quemont and Delbridge. These zones are recognizable by widespread Ca, Na, Sr, and Rb depletion and Fe, Mg, Mn, Cu, and Zn enrichment in whole-rock geochemical analyses. Chlorite compositions range between Fe- and Mg-endmembers in chloritite and contain elevated Mn, Cu, and Zn. Chloritic alteration associated with relatively small stringer sulphide deposits such as at the Bedford and Inmont deposits demonstrates whole-rock geochemical signatures similar to chloritites, but the chlorite compositions reflect only moderate Fe-enrichment, comparable to background chlorite.

Formation of Fe-rich chlorite requires high temperature (> 300 °C) fluids that were prevalent throughout the Noranda Mine Sequence. Development of endmember Fe-chlorite simultaneous with massive sulphide mineralization suggests chloritites also involve prolonged fluid:rock interaction at these high temperatures. Endmember Mg-chlorite within the chloritites represents later, lower temperature hydrothermal activity that is only prominent where permeability has been enhanced by previous fluid conduits. The distinction between chlorite compositions in massive sulphide deposits versus both stringer sulphide systems and background alteration assemblages is a useful evaluation tool of a hydrothermal systems' potential for productivity and is applicable for Noranda Camp VMS exploration and perhaps elsewhere.

Session 4 : 14 h à 14 h 20

Analysis of alteration patterns associated with gold and VMS deposits of the Abitibi greenstone belt

Mathieu Piché (Géologie Québec)

Two factors contributed to allow a regional-scale characterization of alteration zones associated with gold and VMS deposits of the Abitibi greenstone belt.

1- The Québec portion of the Abitibi greenstone belt contains a large amount of available numerical lithogeochemical data. The SIGÉOM database contains 15 000 rock analysis. The Jean Descarreaux's database contains 75,700 analyses. The available data compiled under current Géologie Québec projects adds up to a total of **134,000** rock analyses in the Québec portion of the Abitibi greenstone belt.
Whole rock geochemistry is the most efficient tool to characterize and quantify hydrothermal alteration associated with mineralization. It is used as a prospection tool for hidden deposits.
2- The greenschist facies normative mineral ratios technique allows to obtain an absolute hydrothermal alteration quantification from whole rock geochemical data. The original rock composition does not affect the calculated alteration intensity value. This eliminates the need of establishing the protolith composition for each rock type in the alteration quantification. The *indices d'altération* calculated by this technique from the large amount of available whole rock analysis can be integrated into a GIS database to outline alteration zones associated to gold and VMS deposits at a regional scale.

The 1999 Joutel area pilot project allowed to characterize the alteration zones of the VMS deposits of this area using the ISER and ICHLO normative *indices d'altération*. The altera-tion zones associated with the gold deposits were successfully delineated by the IPAF normative index as well as with the normative siderite.

Following these positive results, the LITHOGÉOCHIMIE project was initiated by Géologie Québec. This project aims at integrating all the available whole rock analysis in the SIGÉOM database. The different types and intensities of alterations are to be compiled on numerical maps that will be published in order to promote mineral exploration in areas of high discovery potential which constitute the alteration zones.

Session 4 : 14 h 20 à 14 h 40

Geology and structural aspects of the Casa-Berardi deformation zone

Pierre Pilote and Sébastien Lavoie (Géologie Québec)

This project consists of a study conducted in partnership with the MRNQ and mining companies active in the townships of Dieppe, Casa-Berardi, Estrées and Estrades (south part of sheets 32E/11 and 32E/10). The objectives are (1) to determine the tectono-stratigraphic and structural settings which led to the development of the Casa-Berardi deformation zone (CBDZ), oriented E-W and extending over 200 km strike-length, (2) to define the geometry of the Taïbi Group and adjacent volcano-sedimentary assemblages, and (3) to place gold and volcanogenic massive sulphide (VMS) mineralizations in their respective settings.

The major geological assemblages identified in the area are the Joutel-Raymond Arc, the Dieppe hills Domain and the Taïbi Group. In Casa-Berardi Township, the Joutel-Raymond Arc is composed of calc-alcaline affinity intermediate to felsic volcanic rocks striking NNW to NNE and facing west. The company Cancor holds a VMS deposit in this assemblage. The zinc sulphide body in Zone B contains an indicated resource of 668,940 tonnes at 6.75% Zn, 0.45% Cu, 0.58% Pb, 114.3 g/t Ag and 1.75 g/t Au, and an inferred resource of 622,715 tonnes at 2.98% Zn, 0.71% Cu, 0.43% Pb, 60.6 g/t Ag and 1.26% Au. The volcanic sequence is truncated to the east by the Mistaouac synvolcanic pluton (2726 ± 2 Ma). To the west, this felsic volcanic sequence is in faulted contact with a thin band of sedimentary rocks (turbidites), commonly rich in pyrite and graphite. In Estrées Township, E-W oriented rhyolites of transitional to calc-alkaline affinity have been observed in the stratigraphic extension of this arc.

In Dieppe and Casa-Berardi Township, the thin sedimentary band described previously is conformably overlain by tholeiitic basalts of the Dieppe hills Domain. These mafic lavas, striking N-S to NW-SE and facing west, contain numerous interdigitations of oxide-facies banded iron formation and cherty sediments. These lithologies are truncated by the CBDZ, which hosts the volcano-sedimentary Taïbi Group. The CBDZ thereby juxtaposes compositionally and geometrically distinct lithological assemblages with locally opposite facing directions.

The Taïbi Group, 4 to 6 km wide over a distance in excess of 100 kilometres in an E-W direction, consists of a coherent series of mafic to locally felsic volcanic rocks of tholeiitic to calc-alkaline affinity, and sedimentary rocks (greywacke, argillite, banded iron formation, conglomerate). Gold ore deposits at Casa-Berardi West (measured and indicated resource of 6.9 Mt at 6.7 g/t Au or 1.5 M ounces Au – September 2000) and East (0.46 Mt at 6.67 g/t Au) are contained within the Taïbi Group. The Estrades VMS deposit (2.17 Mt @ 7.72% Zn, 1.02% Cu, 3.75 g/t Au and 112 g/t Ag) could also be hosted within the Taïbi Group, depending on the presumed location of the southern limit of the CBDZ.

These observations indicate that the CBDZ represents a volcano-sedimentary arc which developed early in the evolution of the NW part of the Abitibi belt. Furthermore, a conglomeratic sandstone yielded a U-Pb zircon age of 2696 Ma, which indicates that pre- to syntectonic plutons contributed during various periods to the supply of certain portions of the basin, thus attesting to the long-lived nature of the CBDZ.

Session 4 : 14 h 40 à 15 h

New insights on the Joutel mining camp, northern volcanic zone

Marc Legault (Géologie Québec), Wulf U. Mueller (UQAC), Michel Gauthier, Michel Jébrak et François Baillargeon (UQAM), Réal Daigneault (UQAC) et Mathieu Piché (Géologie Québec)

The Joutel mining camp is located in the western part of the northern volcanic zone 75 km southwest of the town of Matagami. In total more than 12 millions Tm of copper, 7 millions Tm of zinc and 1 million ounces of gold have been extracted from the mining camp from 1966 to 1993. This study is a result of a joint effort implicating Géologie Québec, UQAM and UQAC.

The Poirier Member is host to three polymetallic deposits. It is principally composed of rhyolitic to dacitic flows with some volcaniclastic horizons. The identification of flow banding, spherulites, autoclastic breccia and hyaloclastites suggests lobe-hyaloclastite type flows. Fragments of stromatolites in the volcaniclastic deposits above the Poirier Member indicate that the volcanic edifice was near the ocean surface. A study of the alteration within the Poirier Member shows several highly chloritized zones outside the VMS deposits. These zones probably represent hydrothermal conduits (synvolcanic faults). Within the deposits a strong chlorite-talc alteration is present. Furthermore a carbonate alteration is also found at the Explo-Zinc deposit. The Poirier and Joutel Copper deposits occupy the same stratigraphic horizon, whereas the Explo-Zinc deposit is found much higher in the stratigraphy.

Geochemical data indicate a wide range in affinities from tholeiitic to calc-alcaline for volcanic rocks of the sector. This is the result of the duality of volcanic magmatism during deposition. Tholeiitic mid-ocean ridge-type basalts and calc-alcaline oceanic arc-type rhyolites represent the extreme cases. Certain assemblages show evidence of contamination which could account for the diversity of chemical affinities.

Gold mineralisation at the Eagle-Telbel deposit is stratiform and was emplaced during sedimentation. Observations such as colloform and alveolar textures and the presence of chalcedony suggest an epizonal mineralization. The existence of a chalcedony-siderite-ferriferous dolomite stockwork southeast of the Telbel mine has been recognized in the underlying bedrock and is associated to an alteration pipe stringer zone. The presence of a vast carbonate alteration zone conformable with the base of the sedimentary bassin and the zonality of the carbonates (ankerite – ferriferous dolomite – siderite) suggest a similarity between the Eagle-Telbel deposit and Mattabi-type VMS deposits.

Session 4 : 15 h 20 à 15 h 40

From mantle plumes to subduction : Evolution of the Val d'Or Arc, south-west Abitibi Greenstone Belt

Craig R. Scott, Wulf U. Mueller (UQAC), Pierre Pilote (Géologie Québec), Sébastien Lavoie (UQAC), and Robert Marquis (Géologie Québec)

The Malartic Block (MB) within the Southern Volcanic Zone of the Abitibi Greenstone Belt is a complex assemblage of volcano-sedimentary rocks interleaved with syn- to post-tectonic plutonic suites. The MB can be broken into two groups based on regional tectonics and volcano-sedimentary stratigraphy : the basal Malartic Group (MG), composed of the La Motte-Vassan, Dubuisson and Jacola Formations (JF), and the upper Louvicourt Group (LG), containing the Val d'Or (VDF) and Héva (HF) Formations. The MG represents a Archean oceanic floor controlled by extensional mantle plume tectonics and is characterized by effusive komatiites and basalts, and intrusive dykes and sills. Although plume processes are still operating, the LG signals the change to subduction-related processes featuring a deep-marine volcanic arc. This complex volcano-sedimentary sequence evolved between 2714 ± 2 Ma and 2702 ± 2 Ma. U-Pb age determinations of 2706 ± 1 Ma for the VDF and 2702 ± 2 Ma for the HF constrain the age of the 5-7 km-thick Val d'Or Arc to ca. 5 Ma.

The contact between the mafic-ultramafic JF and VDF is gradational and indicated by andesitic volcaniclastic debris deposited via mass flow processes. The 3-5 km-thick VDF is a complex subaqueous volcano-sedimentary sequence with rapid lateral and vertical changes of volcaniclastic deposits and associated andesitic to rhyolitic lavas. The 1-50 m thick volcaniclastic deposits are normal- to reverse-graded beds composed tuff- to angular to subrounded, breccia-sized clasts, that locally have a vesicularity index between 15-35%. The 1-100 m thick massive, pillowed/ lobate and brecciated lava flows are variably vesicular (1-30%). In addition, numerous small felsic-dominated volcanic centers of limited extent, containing massive sulfide deposits define the Val d'Or Arc. Effusive eruptions and their autoclastic to hydroclastic counterparts form these centers. The 2-3 km-thick tholeiitic HF is defined by effusive mafic and felsic volcanism with local volcaniclastic deposits. A basal spherulitic dacite unit traceable for 20 km along strike serves as the marker horizon for the Val d'Or Arc. Up section, massive to pillowed mafic flows with gabbroic dykes and sills are dominant, suggesting more fissural-type volcanism. Local tuff turbidites and reworked scoriaous pyroclastic deposits attest to explosive eruption(s).

The JF represents a deep marine ridge-like oceanic setting controlled by mantle plume volcanism. Andesitic volcaniclastic rocks and lavas at the base of the VDF indicate subduction-related volcanism. Fragment-dominated calc-alkaline volcanism of the VDF marks arc construction forming numerous small and overlapping subaqueous volcanic centers. The tholeiitic HF indicates a return to an extensional regime with fissure-type volcanism during arc dissection. The Val d'Or Arc forms a homoclinal, south-facing volcano-sedimentary succession evolving from plume-related volcanism.

Session 4 : 15 h 40 à 16 h

Possible extension of the Val-d'Or Formation south of the Cadillac Tectonic Zone : Vauquelin and Villebon township area

James Moorhead, Lev Voroviev (Géologie Québec) and Aiain Tremblay (INRS)

The area surrounding Vauquelin and Villebon townships is located in the SE part of the volcano-plutonic Abitibi Subprovince, at the contact with the sedimentary-plutonic Pontiac Subprovince, near the Grenville Front. More specifically, this area is located in the eastern extension of the volcano-sedimentary sequence which hosts the volcanogenic massive sulphide (VMS) deposits of the Val d'Or mining camp.

Although the Vauquelin Township sector is relatively well-studied, no VMS-type showings have been reported to date east of the town of Louvicourt, despite the presence of volcanic rocks belonging to the same unit, the Val d'Or Formation. The absence of VMS-type showings east of Louvicourt may be explained by facies changes in the Val d'Or Formation, which suggests the presence of a synvolcanic fault centred on Lac Simon. West of Louvicourt, the Val d'Or Formation mainly comprises transitional to calc-alkaline affinity intermediate to felsic volcanic rocks. East of town, the Val d'Or Formation consists of a tholeiitic to transitional sequence of mafic and locally intermediate volcanic rocks.

We carried out reconnaissance work south of the Cadillac Tectonic Zone (CTZ) in the volcanic belt in Villebon Township to establish the nature of certain contacts and to determine if this belt could be correlated with volcanic rocks north of the CTZ. The Villebon Group is separated from the sandy/pelitic assemblage of the Pontiac Group by a shear zone which displays a steeply-plunging stretching lineation. Kinematic indicators show that the Villebon is thrust upon the Pontiac from north to south. The Villebon Group is mainly composed of tholeiitic basalt flows and intercalated ultramafic flows. South of Lac Villebon, a massive rhyolitic lava horizon of transitional to calc-alkaline affinity, 400 m wide by 2.5 km long, is intercalated in the mafic/ultramafic lava sequence. Locally, the felsic lavas are sericitized and slightly pyritized. U-Pb zircon dating of this felsic unit yielded an age of 2703±1 Ma. This is nearly identical to ages obtained in the Val d'Or Formation (2704-2705 Ma). Thus, the Villebon Group could represent a structural slice containing mafic volcanic rocks of the Dubuisson or Jacola Formation and a felsic lava horizon of the Val d'Or Formation, which were detached and thrust southward onto younger (2686 Ma) sedimentary rocks of the Pontiac Group. The felsic unit of the Villebon Group represents an area of interest for VMS-type mineralization.

Session 4 : 16 h à 16 h 20

Regional context and porphyry gold mineralization, Launay Taschereau

Pierre Doucet (Géologie Québec) and Michel Jébrak (UQAM)

The Taschereau area is located in the northwest part of the northern volcanic zone of the Abitibi Subprovince. It is bounded to the south by the Macamic fault, which constitutes a block margin outlined by gravimetric data. The zone comprises a north-dipping upright assemblage of plutonic and volcanic rocks at the greenschist facies. Four major assemblages are identified:

1- Mafic volcanic rocks emplaced at about 2730 Ma, including the Amos and lower Figuery Groups, with thick differentiated ultrabasic sills such as the Dumont sill. These units attest to the emplacement of an immature volcanic arc;
2- Transitional and calc-alcaline volcanic rocks of the Lac Arthur and upper Figuery Groups, which probably represent the products of isolated intermediate to felsic centres, emplaced at about 2714 Ma. The Taschereau intrusion was emplaced in the core of one of these complexes (2718 Ma);
3- Rocks of the Hunter Mine Group;
4- Dominantly mafic volcanic rocks of calc-alkaline affinity of the Kinojevis Group.

The area displays base metal potential for volcanogenic sulphide bodies, and for nickel-copper mineralization.

The zone is intruded by several granodioritic to tonalitic plutons. The Taschereau pluton forms an assemblage of tonalitic sills and dykes. Its margins are locally defined by a more mafic phase. It is cross-cut by a weakly-rooted subvolcanic sheet of granodioritic porphyry (Launay pluton). Gold-molybdenum porphyry mineralization is present along the contacts of the Launay pluton. The zone is outlined by an early phase of intense sodic alteration, overprinted by potassic metasomatism and associated magnetite. Episyenites are locally developed in the potassic phase. The mineralization occurs in the form of disseminations in hydrothermalized zones, and along a north-south shear zone, partly contemporaneous with the emplacement of the Launay porphyry. This unusual mineralization displays features commonly observed in Archean porphyries identified elsewhere in the Abitibi and in the Yilgarn Block, and could be related to the remelting of an island arc.

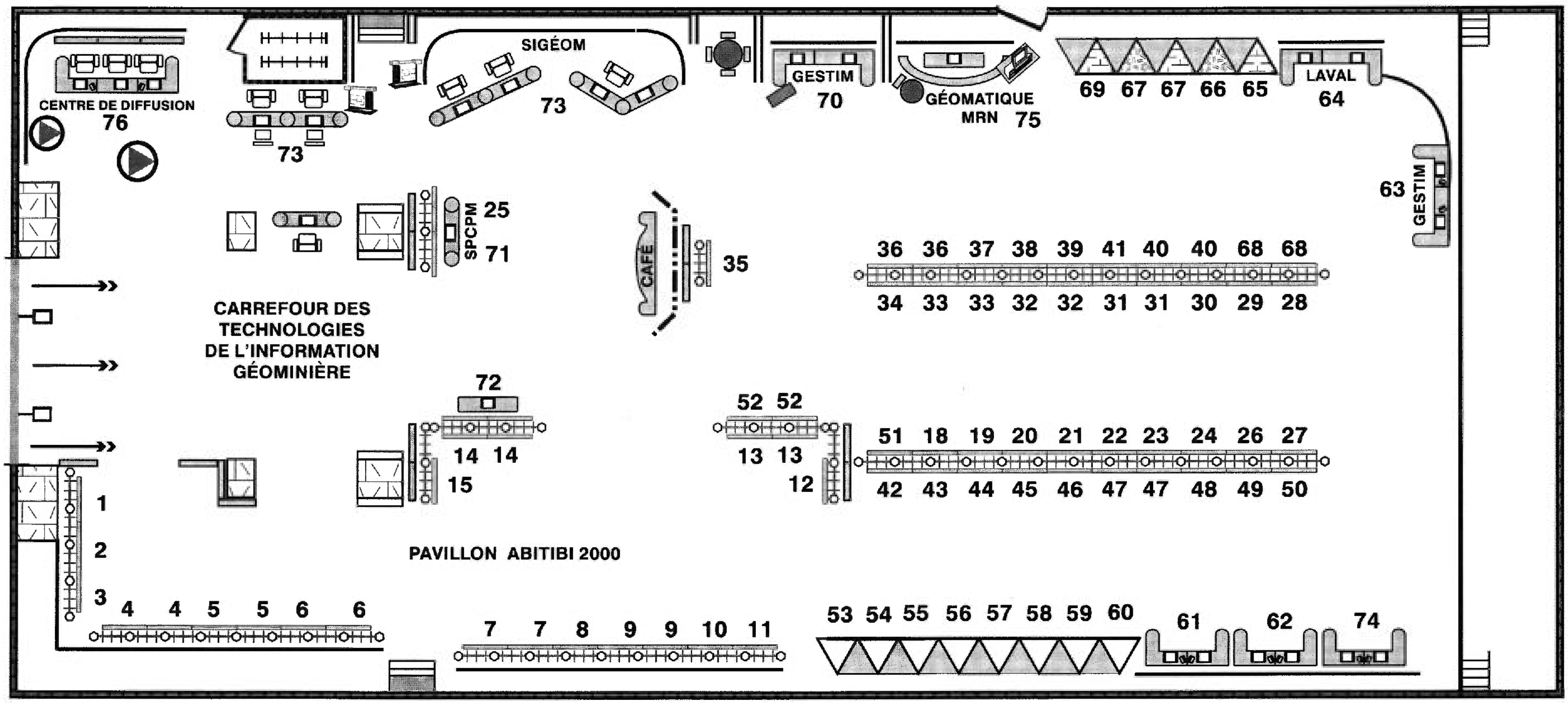

FIGURE 1 – Poster locations in the Ballroom of the Château Frontenac.

Poster presentations
Abitibi 2000

1	Géologie, assemblages et potentiel minéral du secteur de Shining Tree, ceinture de roches vertes de l'Abitibi, Ontario *Geology, Assemblages and Mineral Potential of the Shining Tree Area, Abitibi Greenstone Belt, Ontario* **G. W. Johns (OGS)**
2	Lithogéochimie et pétrogénèse des roches volcaniques archéennes dans le secteur de Shining Tree, Ontario *The lithogeochemistry and petrogenesis of Archaean volcanic rocks in the Shining Tree area, Ontario* **H. S. Oliver (University of Portsmouth), G. W. Johns (OGS)**
3	Résultats du projet sur la géochimie des morts-terrains épais de la ceinture argileuse de l'Abitibi, Commission géologique de l'Ontario *Results from the Ontario Geological Survey Thick Overburden Geochemistry Initiative in the Abitibi Clay Belt* **S. M. Hamilton, C. Vaillancourt (OGS)**
4	Géologie et aspects structuraux du Couloir de déformation de Casa-Berardi *Geology and structural aspects of the Casa-Berardi deformation zone* **P. Pilote, S. Lavoie (Géologie Québec)**
5	Géologie et métallogénie du camp minier de Joutel, sous-province de l'Abitibi (Phase II) *Geology and metallogeny of the Joutel mining camp, Abitibi Subprovince (Phase II)* **M. Legault (Géologie Québec), F. Baillargeon, M. Gauthier, M. Jébrak (UQAM)**
6	Géologie et métallogénie de la ceinture volcano-sédimentaire Urban-Barry, Abitibi (phase I) *Geology and metallogeny of the Urban-Barry volcano-sedimentary belt, Abitibi (phase I)* **D. Bandyayera, L.Théberge (Géologie Québec), F. Fallara (URSTM-UQAT)**
7	Synthèse du camp minier de Doyon-Bousquet-LaRonde *Synthesis of the Doyon-Bousquet-LaRonde mining camp* **J. Moorhead, B. Lafrance, Y. Lei, P. Pilote (Géologie Québec), B. Dubé, M. D. Hannington, A. G. Galley, P. Mercier-Langevin (GSC), W. U. Mueller (UQAC)**
8	Projet LITHOGÉOCHIMIE 2000, résumé des activités *LITHOGEOCHEMISTRY Project 2000, Summary of activities* **M. Piché (Géologie Québec)**
9	Volcanologie physique et cyclicité des coulées komatiitiques: conduits à coussins et conduits principaux, Groupe de Stoughton-Roquemaure, Québec, Canada *Cyclicity and physical volcanology of komatiitic flows: pillow tubes and master tubes, Stoughton-Roquemaure Group, Québec, Canada* **E Gauthier J. Laberge, W. U. Mueller (UQAC), J. Goutier (Géologie Québec)**
10	Brèches hydrothermales néo-archéennes formées à faible profondeur antérieures à la minéralisation dans le camp aurifère de Porcupine, Timmins, Ontario *Neoarchean high level pre-mineralisation hydrothermal breccias in the Porcupine Gold Camp at Timmins, Ontario* **D. Brisbin (Cameco Corporation)**

Poster presentations
Abitibi 2000

11	Géochimie des roches volcaniques d'affinité boninitique de la Ceinture volcanosédimentaire de Frotet-Evans (CVFE) et leur rôle dans l'évolution tectono-magmatique des ceintures volcanosédimentaires archéennes *Geochemistry of boninitic volcanic rocks in the Frotet-Evans volcano-sedimentary belt (FEVB), and their role in the tectono-magmatic evolution of Archean volcano-sedimentary belts* **M. Boily (GÉON), C. Dion (Géologie Québec)**
12	Cartes de compilation géologique au 1: 100 000, région de Kirkland Lake, ceinture de roches vertes de l'Abitibi, Ontario *1:100,000 scale Geological Compilation of the Kirkland Lake area, Abitibi Greenstone Belt, Ontario* **J. Ayer, N. Trowell, L. Valade, E. Amyotte, Z. Madon (OGS)**
13	Cartes de compilation de l'Abitibi au 1: 250 000, depuis l'Ontario jusqu'au front du Grenville *1:250,000 scale compilation maps of the Abitibi, from the Ontario border to the Grenville Front* **J. Goutier (Géologie Québec) C. Beausoleil (URSTM) M. Grant, N. Leblond, P. Doucet, M. Chumova and the compilation map digitization team (Géologie Québec)**
14	L'Abitibi: un centenaire d'exploration et de succès minier *The Abitibi: One hundred years of exploration and mining success* **P. Doucet, J. Goutier, M. Melançon, L. Ste-Croix (Géologie Québec)**
15	Volcanologie physique et métallogénie des roches komatiitiques de la ceinture de roches vertes de l'Abitibi, Ontario-Québec *Physical volcanology and metallogeny of komatiitic rocks in the Abitibi Greenstone Belt, Ontario-Québec* **M. Houlé, C. M. Lesher, R. A. Sproule (Laurentian University), J. Ayer (OGS)**

Poster presentations
Far North, Near North and other regions

18	Projet Grand-Nord : Géologie et potentiel minéral de la région du lac Pélican (SNRC 34P) *Far North Project: Geology and mineral potential of the Lac Pélican area (NTS 34P)* A.-M. Cadieux, A. Berclaz, R. Thériault, J. Nadeau (Géologie Québec), F. Blondeau (U. Laval), G. Lemieux (UQAM), G. Machado (U. of Ottawa)
19	Géologie des régions du lac Klotz et du Cratère du Nouveau-Québec : Nord de la Péninsule de l'Ungava *Geology of the Lac Klotz and Cratère du Nouveau-Québec areas: Northern Ungava Peninsula* Y. Larbi, L. Madore, K.N.M. Sharma, J.-Y. Labbé, P. Lacoste, J. David, K. Brousseau (Géologie Québec)
20	Compilation et synthèse géochronologique du secteur Québec-Baffin de l'orogène trans-hudsonien : une étude préliminaire *Geochronological compilation and synthesis of the Quebec-Baffin segment of the Trans-Hudson Orogen: a preliminary study* N. Wodicka, S. McMullen (GSC)
21	Les nappes paléoprotérozoïques de la Fosse de l'Ungava et du Labrador : corrélations stratigraphiques et structurales *The Ungava and Labrador Trough Early Proterozoic nappes: stratigraphic and structural correlations* P. Ferron, N. Goulet (UQAM), L. Madore, Y. Larbi (Géologie Québec)
22	Contextes métallogéniques de la région du lac Klotz, Projet Grand-Nord *Metallogenic settings in the Lac Klotz area, Far North Project* J.-Y. Labbé, P. Lacoste, L. Madore, Y. Larbi (Géologie Québec)

23	L'indice de Ni-Cu-Co de Qullinaaraaluk : un nouveau type de minéralisation dans les roches archéennes du Grand-Nord. *The Qullinaaraaluk Ni-Cu-Co showing: a new type of mineralization in the Archean rocks of the Far North* J.-Y. Labbé, P. Lacoste, A. Leclair, M. Parent, J. Davy (Géologie Québec), R. Dumont (GSC)
24	Géologie de la région des lacs Vernon (34J) et Minto (34G), Grand-Nord *Geology of the Lac Vernon (34J) and Lac Minto (34G) areas, Far North* M. Parent, A. Leclair, P. Lacoste, J.-Y. Labbé (Géologie Québec)
25	Le système de production des cartes de potentiel minéral (SPCPM) : kimberlites et lamproïtes dans le Grand-Nord *The mineral potential map production system (MPMPS): Kimberlites and lamproites in the Far North* J.-Y. Labbé, P. Lacoste, D. Lamothe, M. Beaumier (Géologie Québec)
26	Le volcanisme archéen dans le nord-est de la Province du Supérieur *Archean volcanism in the NE Superior Province* C. Maurice, D. Francis (McGill University)
27	Mouvements glaciaires régionaux et prospection glacio-sédimentaire dans le centre-ouest de l'Ungava *Regional glacial movements and glacio-sedimentary prospecting in west-central Ungava* M. Parent (CGQ), S.J. Paradis (CGQ), M. Beaumier (Géologie Québec)

Poster presentations
Far North, Near North and other regions

28	Cartographie détaillée 2.5D (1: 250 000) des formations superficielles de la région de la rivière Koroc (24 I) dans le Grand-Nord québécois *Detailed mapping (1:250,000) of surficial deposits in the Koroc River area (24I) in Québec's Far North region* S.J. Paradis, M. Parent (CGQ) Boutin, M., Boivin, R., Larocque, H.
29	Découverte d'un complexe morainique frontal à l'ouest du lac Chavigny (Lac Vernon, 34 J) dans le Centre-Nord du Québec *Discovery of a frontal moraine complex west of Lac Chavigny (Lac Vernon area, 34J) in north-central Québec* S.J. Paradis, M. Parent (CGQ)
30	Les suites tonalitiques du Bloc de Minto; implications magmatiques et tectoniques des variations pétrographiques et géochimiques *Tonalitic suites in the Minto Block: Magmatic and tectonic significance of petrographic and geochemical variations* J. Bédard (CGQ)
31	Géologie de la région de la Basse-Eastmain: phase II – secteur de la rivière Miskimatao, Chute Talking, lac Elmer et lac Duxbury *Geology of the Lower Eastmain area: Phase II – Miskimatao River, Talking Falls, Lac Elmer and Lac Duxbury sectors* A. Moukhsil, C. Dion (Géologie Québec), G. Voicu (UQAM)
32	Géologie de la région du lac des Loups Marins *Geology of the Lac des Loups Marins area* C. Gosselin, M. Simard, M.-J. Mailhot (Géologie Québec)

33	Géologie de la région du lac Hulot (22K/03) et de la demie est du lac Praslin (22K/04) *Geology of the Lac Hulot area (22K/03) and the eastern half of the Lac Praslin area (22K/04)* A. Gobeil, C. Hébert, T. Clark, S. Perreault, J. Doyon, J. Gauthier (Géologie Québec)
34	Synthèse de la région du réservoir Pipmuacan (22E) *Synthesis of the Pipmuacan Reservoir area (22E)* C. Hébert (Géologie Québec)
35	Études pétrologiques, structurales et économiques (Ni-Cu, Fe-Ti-P) de la région du Lac-à-Paul (22E/15), Suite anorthositique du Lac-Saint-Jean, Province de Grenville *Petrologic, structural and economic (Ni-Cu, Fe-Ti-P) studies in the Lac-à-Paul area (22E/15), Lac-Saint-Jean anorthositic Suite, Grenville Province* J. Fredette, L. Huss, S. Turcotte, S.-J. Barnes, R. Daigneault, M. Higgins (CERM – UQAC), C. Hébert (Géologie Québec)
36	Nouvelles observations sur la géologie et les relations structurales du Groupe de Wakeham dans les secteurs du Lac Musquaro et de la Baie Johan-Beetz, Province de Grenville *New observations on the geology and structural setting of the Wakeham Group in the Lac Musquaro and Baie-Johan-Beetz sectors, Grenville Province* L. Corriveau, L. Nadeau, A.-L. Bonnet (INRS-Géoressources), A. Laamrani (Université of Alberta) G. Scherrer (INRS-Géoressources)
37	Géologie de la région du lac Dieppe, Province de Grenville *Geology of the Lac Dieppe area, Grenville Province* S. Nantel, H. Pintson, L. Langlais, E. N'Dah (Géologie Québec)

Poster presentations
Far North, Near North and other regions

38	Géologie de la région du lac Adams (NTS 22A/16-200-0202) *Geology of the Lac Adams area (NTS 22A/16-200-0202)* S. Lachance (Géologie Québec)
39	Le synclinorium de Connecticut Valley-Gaspé dans l'ouest de la Gaspésie *The Connecticut Valley-Gaspé Synclinorium in the western Gaspé area* D. Brisebois, S. Chevé, C. Beausoleil, C. Morin (Géologie Québec)
40	Architecture de la plate-forme et du bassin avant-pays des Appalaches au Québec, Nouveau-Brunswick et Terre-Neuve : Rapport de progrès des Ponts Géologiques de l'Est du Canada *Appalachian foreland and platform architectures in Québec, New Brunswick and Newfoundland: Progress report on the Geological Bridges in Eastern Canada* D. Lavoie, D. Lebel, D. Brisebois, S.R. McCutcheon, S. Colman-Sadd, S. Castonguay, M. Malo, A. Tremblay, M. Parent, and the Geological Bridges team

51	Datations U-Pb récentes dans le secteur de la Baie-James *Recent U-Pb age dating in the James Bay area* C. Dion, J. David, J. Goutier, A. Moukshil, D. Bandyayera, M. Parent (Géologie Québec), D. W. Davis (ROM)
52	Géologie et métallogénie de la région du lac Guyer, Baie-James *Geology and metallogeny of the Lac Guyer area, James Bay* J. Goutier, C. Dion (Géologie Québec), M.-C. Ouellet, S. Turcotte, O. Rabeau (URSTM-UQAT), J. David (Géologie Québec), D. W. Davis (ROM)
43	Tectonostratigraphie de la région de Rivière-du-Loup et de Matane, Zone de Humber externe, Québec *Tectonostratigraphy of the Rivière-du-Loup and Matane areas, External Humber Zone, Québec* J. Gagnon, D. Lavoie, A. Tremblay (CGQ)

Poster presentations
Geodata, industrial minerals, assistance programs

44	Inventaire des ressources en granulats de la région de Scotstown : 22/E11 *Inventory of aggregate resources in the Scotstown area : 21E/11* André Brazeau (Géologie Québec)
45	Les glaciations au service de l'exploration *Glaciations at the service of exploration* Ghismond Martineau, Cathy Lapointe (Géologie Québec)
46	Potentiel en minéraux industriels dans les MRC de Rouyn-Noranda et de la Vallée-de-l'Or *Industrial mineral potential in the regional county municipalities of Rouyn-Noranda and Vallée-de-l'Or* Henri-Louis Jacob, Pierre Buteau, Yves Bellemare (Géologie Québec)
47	Potentiel minéral de la région de Tadoussac – Forestville (feuillet SNRC 22C) *Mineral potential of the Tadoussac – Forestville area (NTS sheet 22C)* Serge Perreault, Henri-Louis Jacob (Géologie Québec)
48	Aide financière aux prospecteurs et aux fonds d'exploration *Financial assistance to prospectors and exploration funds* M. Bergeron, R. Boivin, J. Choinière, J. Henry, P. Marcoux (Géologie Québec)
49	Aide financière aux entreprises : "travaux d'exploration de surface et soutien aux sociétés juniors" *Financial assistance to companies : "surface exploration work and assistance to junior companies"* M. Bergeron, R. Boivin, J. Choinière, J. Henry, P. Marcoux (Géologie Québec)
50	Aide financière pour la sous-province de l'Abitibi *Financial assistance for the Abitibi Subprovince* M. Bergeron, R. Boivin, J. Choinière, J. Henry, P. Marcoux (Géologie Québec)
71	Le système de production des cartes de potentiel minéral (SPCPM) : exemple d'application pour les gisements de sulfures massifs volcanogènes du type Noranda dans les régions de Joutel (32 E) et Chibougamau (32 G) *The mineral potential map production system (MPMPS) : an example of its application for Noranda-type volcanogenic massive sulphide deposits in the Joutel (32E) and Chibougamau (32G) areas* D. Lamothe, C. Dion (Géologie Québec)
72	Projet de numérisation des cartes de compilation géologique dans le SIGÉOM *Digitization of geological compilation maps for integration into SIGÉOM* Christine Beausoleil (URSTM-UQAT), Chantal Bilodeau, Martina Chumova, Stéphane Dufour, Maureen Grant, Edith Jobin, Joanne Nadeau, Ian O'Gallagher, Réal Samuel and the digitization team (Géologie Québec)
73	Le carrefour des nouvelles technologies de l'information géominère (SIGÉOM) *The geomining information technology centre (SIGÉOM)*
76	Centre de diffusion de géologie Québec *Géologie Québec's resource centre*

Poster presentations
Universities and MRNQ

63	Université du Québec à Chicoutimi UQAC	**67**	Sciences de la Terre et des Planètes à McGill *Earth and Planetary Sciences at McGill* Sandy Archibal, John Stix
64	Département de géologie et génie géologique Université Laval	**68**	École Polytechnique, Génie Géologique
65	MEDEF : Département de géologie et de génie géologique Université Laval	**70**	GESTIM
69	Les programmes interuniversitaires de maîtrise et de doctorat en sciences de la Terre Conjointement avec l'Université Laval	**41**	Levé géophysique de sismique réflexion, Val-Brillant : Sismostratigraphie, structures géologiques, failles majeures Shickshock Sud – Causapscal – Ste-Florence (données brutes) *Seismic reflection geophysical survey – Val-Brillant: Seismostratigraphy, geological structures, Shickshock South – Causapscal – Ste-Florence major faults (raw data)* Claude Morin, Jean-Yves Laliberté, Daniel Deschênes, Louise Lévesque (Direction du gaz et du pétrole, MRN)
66	UQAM : Département des sciences de la Terre et de l'Atmosphère	**75**	Géomatique (MRN)
42	Un nouvel outil au service de l'exploration : le Laboratoire multidisciplinaire de scannographie de Québec (LMSQ) *A new exploration tool: the Québec Multidisciplinary Scannography Laboratory (LMSQ)* Bernard Long, Jean-François Crémer, Alfonso Rivera		

Poster presentations
Associations and mining funds

53	Fonds d'exploration minérale Estrie/ Chaudière-Appalaches (FEMECA)
54	Potentiel minéral au Saguenay – Lac St-Jean *Mineral potential of the Saguenay – Lac-St-Jean area* Fonds minier du Saguenay Lac St-Jean Christian Tremblay
55	Projets de prospection minière réalisés sur la Côte-Nord en l'an 2000 *Mineral prospecting projects carried out in 2000 in the North Shore area* Fonds régional d'exploration minière de la Côte-Nord Louis Caron
56	Potentiel minéral de la région Gaspésie et des Iles-de-la-Madeleine *Mineral potential of the Gaspésie/Îles-de-la-Madeleine area* Fonds régional d'Assistance à la prospection minière de la Gaspésie et des îles-de-la-Madeleine (FRAPMGIM) J.P. Barette
57	Potentiel géologique enfin accessible par route *Geological potential finally accessible by road* Association des Prospecteurs de la Manicouagan
58	Fonds d'exploration minière du Nunavik *Nunavik mineral exploration fund*

59	Fonds d'Exploration Minière du Bas-Saint-Laurent
60	Association Professionnelle des Géologues et Géophysiciens du Québec APGGQ
61	Association minière du Québec inc
62	Commission Géologique du Canada – Québec *Geological Survey of Canada – Québec*
74	Institut Canadien des Mines (ICM) *Canadian Institute of Mining (CIM)*

1 – Geology, Assemblages and Mineral Potential of the Shining Tree area, Abitibi Greenstone Belt, Ontario

Glen W. Johns (OGS)

The Shining Tree area can be subdivided into four assemblages: the Pacaud Assemblage (2741 Ma) an ultramafic to mafic volcanic sequence; the Deloro Assemblage (2726 Ma), a mafic and felsic volcanic sequence capped by chemical sediment; the Kidd-Munro Assemblage (2716 Ma), a mafic, ultramafic and felsic volcanic sequence; and the Tisdale Assemblage (2707 Ma), a mafic and felsic volcanic sequence. Timiskaming-type rocks (2687 Ma), clastic sediments and intermediate and felsic volcanics unconformably overlie all assemblages.

The rock types and ages for the assemblages recognized in the Shining Tree area are similar to those in other parts of the Abitibi Greenstone Belt. Mineral potential can also be assumed to be similar. In other part of the Abitibi, the Deloro Assemblage has VMS associated with FII felsic volcanics and synvolcanic intrusions, an example being found in Normetal, Québec. Base metals associated with sulphide facies iron formation occur in the Swayze area to the west. The Kidd-Munro Assemblage has VMS associated with FIII rhyolite at Kidd Creek and with mafic to ultramafic volcanics at the Potter Mine. The Kidd-Munro Assemblage also has Cu-Ni potential associated with the ultramafic rocks. The Tisdale Assemblage contains the Kamiskotia deposits, mineralization in Sheraton Township and magmatic Cu-Ni in the Shaw Dome area and Bannockburn Township.

Similar assemblages in the Shining Tree area also have potential to host VMS. The Deloro Assemblage in Macmurchy Township is characterized by FII rhyolite found in the Bigfour Lake area, which is associated with chlorite, sericite and silica alteration. Disseminated and blebby chalcopyrite are found in quartz veins. Silicate facies chemical sediments contains minor sulphides. The Kidd-Munro Assemblage has a thick, interbedded, mafic and ultramafic sequence that has potential to host magmatic Cu-Ni. There are minor Ni occurrences within this sequence. The Tisdale Assemblage has minor Cu occurrences associated with felsic volcanics and sediments. The ultramafic rocks of this assemblage have minor Cu, Zn and Pb within graphitic interflow sediments. The potential for gold is excellent where Timiskaming-age alkalic intrusions are associated with deformation zones. Several gold occurrences are found with this association. Late Archean and Proterozoic age mafic to ultramafic intrusions are also host to Ni-Cu mineralization and have as yet untested potential for platinum group element mineralization.

2 – The lithogeochemistry and petrogenesis of Archaean volcanic rocks in the Shining Tree area, Ontario

H. S. Oliver, D. J. Hughes, R. P. Hall (University of Portsmouth) and Glen W. Johns (OGS)

The Shining Tree greenstone belt, of the Abitibi Subprovince, Ontario, contains a variety of volcanic rocks spanning ~54 million years. The stratigraphy in the Shining Tree area is complex and does not constitute a simple evolutionary magmatic sequence. Five lithotectonic assemblages are defined within the area. These are: i) the Pacaud assemblage (2741 Ma), comprising N-MORB type basalts with minor komatiites; ii) the Deloro assemblage (2726 Ma), dominated by calc-alkaline felsic volcanic rocks, often capped by chemical sediments; iii) the Kidd-Munro assemblage (2716 Ma), a varied assemblage dominated by tholeiitic basalts and komatiites, with minor felsic volcanic rocks; iv) the Tisdale assemblage (2707 Ma), basalts with minor komatiites and intermediate to felsic pyroclastics, and v) the Timiskaming assemblage (2687 Ma) which unconformably overlies the other assemblages and consists of volcaniclastic and sedimentary rocks.

In this work it is shown that across the assemblages there are two main geochemical groups, one comprises tholeiitic basalts ($(La/Lu)_N = 1.02 - 1.58$) with associated komatiites which generally display light rare earth element (LREE) and Th depletion ($(La/Lu)_N = 0.43 - 0.75$) and the other is calc-alkalic basalts to rhyolites characterised by prominent negative Nb, Ta and Ti anomalies and LREE enrichment ($(La/Lu)_N = 6.21 - 24.18$; $(Ti/Gd)_N = 0.40 - 0.55$; $(Nb/La)_N = 0.18 - 0.48$). These groups came from two distinct magma sources. The unconformable Timiskaming assemblage comprises rocks which have an alkalic signature but which also have the negative Nb, Ta and Ti anomalies characteristic of an arc-influenced tectonic environment. Distinct variations can be seen between the komatiites of the Pacaud and Kidd-Munro assemblages. Compared to the komatiites of the Kidd-Munro assemblage, the komatiites of the Pacaud assemblage have noticeably higher MgO and Cr, are enriched in Al ($Al_2O_3/TiO_2 = 21.47 - 28.09$) and are depleted in the Light Rare Earth Elements (LREE) ($(La/Sm)_N = 0.43 - 0.56$). The komatiites from the younger Kidd-Munro assemblage have variably flat to enriched LREE distribution patterns ($(La/Sm)_N = 0.53 - 2.12$) which may be the result of crustal contamination and have average Al values for Archaean komatiites ($Al_2O_3/TiO_2 = 13.67 - 23.75$). Partial melting modelling suggests that the tholeiitic basalts across the area formed by moderately high degrees of partial melting in a partially enriched spinel lherzolite mantle. This enrichment may be due to invasion by upwelling plume material, or metasomatism of the mantle during arc volcanism, however at 2.7 Ga the upper mantle may not have achieved the level of depletion observed today.

3 – Results from the Ontario Geological Survey Thick Overburden Geochemistry Initiative in the Abitibi Clay Belt

Stewart M. Hamilton, Christine Vaillancourt (OGS)

The Abitibi greenstone belt is Ontario's highest mineral potential area. However, it is unfortunately overlain by the Abitibi clay belt – a thick sequence of glaciolacustrine clays, silts and sands that makes mineral exploration difficult. Despite geophysics, most of the important mines and mineral deposits in the region are located in areas where overburden thickness does not exceed 20 m. An important long-term objective of the Ontario Geological Survey is to develop geochemical techniques capable of penetrating thick overburden and detecting mineralisation and other bedrock features in the Abitibi clay belt.

There are three aspects to the OGS' "thick overburden initiative" as it currently stands and each of these has different industry partners. The first component is concerned with developing and refining electrochemical tools that can be used for mineral exploration in areas of thick overburden. This was considered to be important because the OGS theory for the development of geochemical anomalies in areas of thick overburden predicts that a reduced (i.e. negatively charged) "column" should exist in overburden above mineralisation. The second component is investigating selective leach geochemical methods in thick overburden environments at 3 known mineral occurrences (Cross Lake and Halfmoon Lake base metal deposits in Sheraton and Robb townships respectively, and the Marsh Zone gold deposit in Hislop Township). The third component involves the investigation of the electrochemical and geochemical character of a number of "forest rings", which are large circular features in boreal forests that are now known to be centred on geological sources of negative charge.

The outcome of the methods development studies has so far been the development of a number of techniques that, under the right conditions, can quantitatively detect chemically reduced zones in earth materials. The outcome of the studies at the mineral deposit sites has shown quite conclusively that geochemistry can detect the presence of mineralisation through at least 20 m of fully saturated, unfractured glaciolacustrine clay. Also, it has shown that reduced areas exist over some sulphidic mineral deposits, as the theory suggests they should. Although previous theories as to the origin of forest rings had already been disproved, the work on the forest-ring sites has been the first to demonstrate their true origin, i.e. as chemically reduced areas in overburden and, as such, the physical manifestation of electrochemical cells.

4 – Geology and structural aspects of the Casa-Berardi deformation zone

Pierre Pilote and Sébastien Lavoie (Géologie Québec)

This project consists of a study conducted in partnership with the MRNQ and mining companies active in the townships of Dieppe, Casa-Berardi, Estrées and Estrades (south part of sheets 32E/11 and 32E/10). The objectives are (1) to determine the tectono-stratigraphic and structural settings which led to the development of the Casa-Berardi deformation zone (CBDZ), oriented E-W and extending over 200 km strike-length, (2) to define the geometry of the Taïbi Group and adjacent volcano-sedimentary assemblages, and (3) to place gold and volcanogenic massive sulphide (VMS) mineralizations in their respective settings.

The major geological assemblages identified in the area are the Joutel-Raymond Arc, the Dieppe hills Domain and the Taïbi Group. In Casa-Berardi Township, the Joutel-Raymond Arc is composed of calc-alcaline affinity intermediate to felsic volcanic rocks striking NNW to NNE and facing west. The company Cancor holds a VMS deposit in this assemblage. The zinc sulphide body in Zone B contains an indicated resource of 668,940 tonnes at 6.75% Zn, 0.45% Cu, 0.58% Pb, 114.3 g/t Ag and 1.75 g/t Au, and an inferred resource of 622,715 tonnes at 2.98% Zn, 0.71% Cu, 0.43% Pb, 60.6 g/t Ag and 1.26% Au. The volcanic sequence is truncated to the east by the Mistaouac synvolcanic pluton (2726 ± 2 Ma). To the west, this felsic volcanic sequence is in faulted contact with a thin band of sedimentary rocks (turbidites), commonly rich in pyrite and graphite. In Estrées Township, E-W oriented rhyolites of transitional to calc-alkaline affinity have been observed in the stratigraphic extension of this arc.

In Dieppe and Casa-Berardi Township, the thin sedimentary band described previously is conformably overlain by tholeiitic basalts of the Dieppe hills Domain. These mafic lavas, striking N-S to NW-SE and facing west, contain numerous interdigitations of oxide-facies banded iron formation and cherty sediments. These lithologies are truncated by the CBDZ, which hosts the volcano-sedimentary Taïbi Group. The CBDZ thereby juxtaposes compositionally and geometrically distinct lithological assemblages with locally opposite facing directions.

The Taïbi Group, 4 to 6 km wide over a distance in excess of 100 kilometres in an E-W direction, consists of a coherent series of mafic to locally felsic volcanic rocks of tholeiitic to calc-alkaline affinity, and sedimentary rocks (greywacke, argillite, banded iron formation, conglomerate). Gold ore deposits at Casa-Berardi West (measured and indicated resource of 6.9 Mt at 6.7 g/t Au or 1.5 M ounces Au – September 2000) and East (0.46 Mt at 6.67 g/t Au) are contained within the Taïbi Group. The Estrades VMS deposit (2.17 Mt @ 7.72% Zn, 1.02% Cu, 3.75 g/t Au and 112 g/t Ag) could also be hosted within the Taïbi Group, depending on the presumed location of the southern limit of the CBDZ.

These observations indicate that the CBDZ represents a volcano-sedimentary arc which developed early in the evolution of the NW part of the Abitibi belt. Furthermore, a conglomeratic sandstone yielded a U-Pb zircon age of 2696 Ma, which indicates that pre- to syntectonic plutons contributed during various periods to the supply of certain portions of the basin, thus attesting to the long-lived nature of the CBDZ.

5 – Geology and metallogeny of the Joutel mining camp, Abitibi sub-province (Phase II)

Marc Legault (GÉOLOGIE QUÉBEC), François Baillargeon, Michel Gauthier et Michel Jébrak (UQAM)

The Joutel mining camp is host to three polymetallic deposits (Poirier and Joutel Copper mines, Explo Zinc deposit) and a gold deposit (Eagle and Telbel mines, Eagle West open pit). This work presents the final phase of a joint study implicating GÉOLOGIE QUÉBEC, UQAM and UQAC. Our goals for summer 2000 were to (1) characterize the geological environment around the mining camp; (2) document the VMS mineralisation; and (3) determine the genesis of the gold mineralisation at the Eagle-Telbel deposit.

Mapping was done at the 1:20 000 scale on the south and northwest extensions of the Joutel mining camp. In the southern part the extension of the Poirier Member was not observed. However an important calc-alcaline volcanic center of andesitic to dacitic composition was recognized. Of a thickness of about 4 km in its center, it was mapped for more than 12 km on strike. The northwestern part presents the continuation of the Valrennes Formation, the Eagle Member and the Harricana Group. Rocks of the Eagle Member and Harricana Group are highly affected by the Harricana deformation zone and show important chlorite, sericite and iron carbonate alterations. These two units pinch towards the northwest. Mapping during the summer did not allow the discovery of any new showing. However the identification of a dacitic diatreme with disseminated pyrrhotite proves to be an interesting context eventhough concentrations of precious and base metals are low.

The metallogenic study on the VMS deposits of Poirier and Joutel Copper has allowed the identification of associations and mineral textures indicating a mineralizing process in multiple stages. The extension of the observations on a regional scale suggests that the two deposits occupy the same stratigraphic level. A study on the mineralogy and geochemistry of the sulfides should allow us to verify this hypothesis.

Preliminary observations of the Eagle-Telbel gold deposit indicates the presence of a chalcedony-siderite-ferriferous dolomite stockwork mineralisation southeast of the Telbel mine. Although this mineralisation is similar to that of the Eagle-Telbel deposit, the stockwork lies in the underlying bedrock (Eagle Member). On the other hand the Eagle-Telbel deposit is stratiform and is found in the basal facies of the Harricana Group. This type of alteration pipe stringer zone mineralisation could become a new exploration target. The presence of a vast carbonate alteration zone conformable with the base of the Harricana Group and the zonality of the carbonates (ankerite – ferriferous dolomite – siderite) suggest a similarity between the Eagle-Telbel deposit and Mattabi-type VMS deposits.

6 – Geology and metallogeny of the Urban-Barry volcano-sedimentary belt, Abitibi (phase I)

Daniel Bandyayera and Luc Théberge (Géologie Québec) and Francine Fallara (URSTM-UQAT)

The Urban-Barry volcano-sedimentary belt is located in the eastern part of the Abitibi Subprovince, 120 km east of the town of Lebel-sur-Quévillon. The area was the focus of 1:63,360 scale mapping in the 1940s, and 1:50,000 scale mapping in 1990. This work outlined an important greenstone belt, the Urban-Barry belt, which extends over 135 km long in an east-west direction, by 6 to 20 km wide. Newly-built logging roads in previously inaccessible areas, and the confirmation of the sector's strong mineral potential, highlighted by the recent discovery of important gold showings, led the Ministère des Ressources naturelles to review the geology and metallogeny of the Urban-Barry belt. The main objectives of the project are: 1) to map at a scale of 1:50,000 the Lac Picquet (NTS 32G04) and Lac Mesplet (NTS 32B13) areas, 2) to define the importance of felsic volcanism in the area, and 3) to characterize the metallogenic setting of the area.

The Urban-Barry volcano-sedimentary belt is bounded to the north by the Hébert intrusive Suite and the Father pluton, and to the south by the Attic Complex. The intrusive masses are mainly tonalitic, granodioritic and dioritic in composition. Several intrusions in the Attic Complex are metamorphosed to the upper amphibolite facies, and display gneissic textures. New data gathered in NTS sheets 32G04 and 32B13 during the 2000 field season have allowed us to define the following lithological assemblages: a) in the north part, units essentially consist of massive to pillowed flows that generally contain 5 to 60% plagioclase phenocrysts and glomerocrysts, similar to flows observed in the Obatogamau Formation in the Chibougamau area; b) the central part (Lac Windfall sector) is characterized by several felsic volcanic units that extend for several kilometres, comprising lapilli and block tuffs, crystal tuffs, and fine cherty tuffs; the entire sequence is cut by numerous felsic to mafic dykes, and c) the south sector is dominated by mafic volcanic rocks with a few horizons of felsic, and locally ultramafic, horizons.

The north and central parts are characterized by south and south-east facing stratigraphy. The Lac Rouleau sector (south part of the belt) on the other hand, indicates north-facing directions, suggesting the presence of a major regional-scale synclinal structure thereby implying a possible correlation of northern and southern volcanic rocks.

Types of mineralization encountered in the study area are as follows: a) gold-bearing volcanogenic massive sulphides associated with felsic tuffs in the central part (trench ***J & B***, Lac Windfall), b) Cu-Au±Ag volcanogenic massive sulphides hosted in mafic volcanic rocks (***Jackwood*** showing), c) volcanogenic auriferous veins, either CB-QZ-SR-TL-PY±PO±CP (***Debris Flow*** showing) or QZ-SR-PY±CP±TL (***Alto*** showing), d) Au-Cu±Zn tourmalinized felsic horizons (***Sauder*** and ***Nubar*** showings), e) auriferous shear zones with vein-type (QZ-CB-SF; ***Gold Hawk*** and ***Barry IV*** showings) or disseminated (CB-PY-PO-AS; ***Lac Rouleau*** showing) mineralization, f) Mo associated with felsic intrusions or pegmatite dykes (area SW of Lac aux Loutres).

7 – Synthesis of the Doyon-Bousquet-LaRonde mining camp

James Moorhead, Benoît Lafrance, Yueshi Lei, Pierre Pilote (GÉOLOGIE QUÉBEC) ; Benoît Dubé, Mark D. Hannington, Allan G. Galley, Patrick Mercier-Langevin (GSC) ; Wulf U. Mueller (UQAC)

A synthesis of the Doyon-Bousquet-LaRonde mining camp, involving mining companies Cambior, Barrick Gold, Agnico-Eagle and Yorbeau Resources, Géologie Québec, the Geological Survey of Canada and the Université du Québec à Chicoutimi, was undertaken this summer. This mining camp contains 4 mines currently in production. These are, from west to east : the Mouska mine (Au), the Doyon mine (Au), the Bousquet 2 mine (Au-Ag-Cu) and the LaRonde mine (Au-Ag-Cu-Zn). This poster presents results of the first year of the synthesis project. The project includes the integration of all the detailed work and lithogeochemical data of the four mining companies, the production of a geological map at a scale of 1:10,000, detailed volcanology studies as well as several ore deposit studies on the various mineralized bodies.

The volcanic sequence is part of the Blake River Group, and comprises four phases of volcanic construction, each composed of one or several lithological units. Phase 1 is characterized by tholeiitic mafic volcanism. Phase 2 is marked by dykes and sills of quartz and feldspar-phyric rhyolite of tholeiitic affinity. Phase 3 is represented by tholeiitic to transitional andesitic and dacitic volcanism with a high volatile content, dominated by volcaniclastic rocks. Phase 4 consists of transitional to calc-alkaline felsic flows, domes and volcaniclastic rocks, with limited lateral extent.

In the vicinity of the Doyon and Mouska mines, the Mooshla pluton contains differentiated phases that vary from gabbro to tonalite, located in the core of a large sub-seafloor-type volcanogenic hydrothermal alteration zone, to which the early Cu-Au mineralization at Mouska is related. Doyon-type quartz-pyrite-gold veins represent a distinct hydrothermal phase, spatially related to a late trondhjemite cross-cutting the south part of the Mooshla pluton. The Bousquet orebody is formed of massive and semi-massive pyrite lenses mineralized in Au-Ag-Cu, located within a semi-conformable aluminous alteration zone. This alteration zone is characterized by a quartz-sericite-andalusite schist in felsic units, and a garnet-chloritoid±chlorite assemblage in intermediate and mafic rocks. The LaRonde ore deposit is composed of several polymetallic lenses, stacked from north to south in a felsic volcanic sequence. The main lens (20N) is mineralized in Zn-Au-Ag-Cu-Pb and is stratigraphically overlain by a Au-Zn-Ag-Cu-Pb lens (20S), and stratigraphically overlies Au-Ag-Cu-Zn lenses (6 and 7). A garnet-chlorite-chloritoid-sericite zone and a pyrite-pyrrhotite-sericite-hematite and green mica zone constitute the respective footwalls of lenses 20N and 20S. Lens 20N laterally grades into an aluminous zone with kyanite/andalusite-pyrite-sericite-quartz which hosts important Au-Ag-Cu mineralization (lens 5 and Bousquet 2).

8 – Lithogeochemistry Project 2000 : Summary of activities

Mathieu Piché (Géologie Québec)

PART 1 MRNQ Rouyn-Noranda and Chibougamau core libraries sampling.

<u>Rouyn-Noranda core library</u>	
Number of samples	713
Samples with location	477
Samples analysed	288
<u>Chibougamau core library</u>	
Number of samples	415
Échantillons localisés	415
Samples with location	415
<u>SUB TOTAL</u>	
Number of samples	1128
Samples with location	892
Samples analysed	703

PART 2A Acquisition of historical lithogeochemical data from academic publications

Documents consulted	640
Documents with analysis	200
Analysis compiled	18,896
Analysis with location	16,226

PART 2B Data from mining companies

Donation from mining companies	10,400

SUMMARY OF LITHOGEOCHEMISTRY 2000 PROJECT	
Samples from core libraries (786 analysed)	1,128
Samples from academic publications (numerization in progress)	16,226
Donations from mining companies (probable)	10,400
GRAND TOTAL	27,754

<u>Rock chemical analysis in Québec Abitibi.</u>

Theses new chemical analysis will be integrated to the SIGEOM as well as the Jean Descarreaux database. It is believed that this new information will allow to outline new mining exploration targets.

9 – Cyclicity and physical volcanology of komatiitic flows: pillow tubes and master tubes, Stoughton-Roquemaure Group, Quebec, Canada

E. Gauthier, J. Laberge, Wulf U. Mueller (UQAC) et
Jean Goutier (Géologie Québec)

The 0.2-2 km-thick Stoughton Roquemaure Group (SRG), straddling the southern boundary of the Northern Volcanic Zone in the Abitibi greenstone belt, is a mafic-ultramafic cycle 1 volcanic sequence. Lithological mapping by Goutier (2000) showed that the SRG is composed of two 50-400 m-thick komatiitic units alternating with 100-1000 m-thick tholeiitic basalt flows. Detailed facies mapping was conducted on two large outcrop zones in the basal komatiite unit. The generally south-facing and steeply-dipping, volcanic succession represents a deep-marine setting in which effusive, plume-generated, ultramafic flows drowned the large subduction-related, calc alkaline volcanic complex of the Hunter Mine Group. The geochemistry documents the association of depleted (Al_2O_3/TiO_2~10) and undepleted (Al_2O_3/TiO_2~20) komatiitic flows (Dostal and Mueller, 1997), indicating a similar magma source but different mantle depths. The depleted flows possibly derived from the stem of a mantle plume (>400 km), and undepleted flows originating from the upper head of the plume (>200 km).

The SRG ultramafic flows, subjected to subgreenschist metamorphism, display delicate primary volcanic textures as well as excellent surface flow characteristics preserved in local 3-D exposures. An up-section flow organization and stacking was identified in the komatiitic basalts and komatiites. Flow facies include (1) principal master tubes, >20m wide, (2) secondary master tubes, 5-20 m wide, (3) pillows and pillow tubes <5 m wide, (4) pillow fragment breccia, and (5) pillow rind breccia. A complete up-section and lateral effusive flow sequence, 50-150 m-thick, is composed of facies 1-2-3-4 or 1-2-3-5, suggestive of pulsating magma supply from fissures or restricted vents. Master tubes (i.e. Corky's flow) are internally complex flow units that locally display central columnar joint arrangements perpendicular to the cooling front, abundant polygonal joints and thermal contraction fractures that were altered by percolating seawater, and marginal pillowed tubes indicative of budding and branching. The absence of classical spinifex textures remains puzzling. Surface features on pillowed tubes and their terminations, including (1) longitudinal and transverse spreading cracks that enabling budding, (2) half-moon surface swells and ridges giving flow direction, (3) longitudinal corrugations, and (4) thermal contraction polygons, are strikingly similar to more viscous basalt flows. Multiple chilled rinds on pillow tubes represent the precursors to pillow rind breccia, which may grade laterally and up-section into pillow fragment breccia because of continued fragmentation during flow of the pillow tube. Flow organization of the komatiites, surface features, and the cyclic nature of flow form and size, are important exploration tools used in identifying younging direction, flow direction, and relative vent proximity.

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10 – Neoarchean high level pre-mineralisation hydrothermal breccias in the Porcupine Gold Camp at Timmins, Ontario.

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Over 1,892 tonnes (61 million ounces) of gold have been produced from Neoarchean vein deposits in the world class Porcupine Gold Camp (PGC) in the Abitibi greenstone belt at Timmins, Ontario. Hydrothermal heterolithic breccias that are Archean analogues to breccia dykes common in Cenezoic porphyry Cu Au and epithermal Au-Ag environments are closely associated with epizonal felsic intrusions in major mineralised centres in the camp.

Two types of breccia occur; of which heterolithic breccias are the most common. Almost all are intimately associated with 2690 Ma porphyry stocks and, through analogy with younger examples, they are interpreted to have developed through explosive devolatilisation of the porphyry magma during emplacement into the top 4 kilometres of the crust. Tourmalinised breccias are texturally identical to heterolithic breccias but are characterised by a dark grey to black tourmaline-rich groundmass. They also developed through high level explosive hydrothermal processes. Relative timing of heterolithic and tourmalinised breccias is not well constrained. Tourmalinised breccias are interpreted to be younger and to have closely preceded gold mineralisation based on their association with tourmaline fracture stockworks and tourmaline-rich early barren vein phases.

The spatial association of heterolithic and tourmalinised breccias, porphyry intrusions, 2673 Ma albitite dykes, fracture stockworks, alteration, and gold-bearing veins at Timmins is interpreted to result from hydrothermal activity during intrusion of the porphyries and albitite dykes in two distinct events. The comparable nature of the breccias and fracture stockworks developed during both events suggests that both occurred at high levels even though albitite dykes and subsequent auriferous quartz-carbonate veins post-dated the porphyries by at least 17 Ma. The widespread occurrence of hydrothermal breccias and fracture stockworks is incompatible with development of penetrative fabrics under greenschist facies conditions at depths of 10 to 12 kilometres in the crust. Thus the association of heterolithic breccias with porphyry intrusions is inconsistent with the emplacement of the porphyries into active shear zones. Indeed, the breccias, intrusions and hydrothermal fracture stockworks were deformed during this late Kenoran deformation that affected the whole of the Superior Province.

Although all known breccias at Timmins are pre-ore, they are comparable to inter-mineral breccias at other significant gold deposits in the Superior Province (Springpole Lake and Hemlo deposits in Ontario, and the Troilus and Kiena deposits in Quebec). These breccias are indicative of energetic hydrothermal processes at high crustal levels and should be regarded as positive indications of potential for intrusion-related Au !Cu deposits during exploration.

11 – Geochemistry of boninitic volcanic rocks in the Frotet-Evans volcano-sedimentary belt (FEVB), and their role in the tectono-magmatic evolution of Archean volcano-sedimentary belts

Michel Boily (GÉON) and Claude Dion (Géologie Québec)

The Frotet-Evans volcano-sedimentary belt (FEVB; 2755-2783 Ma) constitutes an E-W oriented thrust sheet in an assemblage of orthogneiss sheets that form the core of the Opatica Subprovince. The FEVB contains the oldest basaltic to andesitic volcanic rocks of boninitic affinity (BON) in the Superior Province. BONs outcrop within a sequence of pillowed basaltic rocks that extends over a distance of 200 km, in the Rabbit Formation and the Assinica and Troilus Groups. These comprise calc-alkaline basalts (CAB), fractionated tholeiites (FRT), magnesian tholeiites (MT) and iron tholeiites (FT), but are characterized by the absence of komatiitic lavas. This belt overlies and is overlain by calc-alkaline basaltic to rhyodacitic lavas and pyroclastic rocks of the Storm and Le Gardeur formations.

BONs form a siliceous (SiO_2=49.0-59.8 weight%) and magnesian (MgO=4.5-13.6 weight%) suite with moderate FeO_T values (5.1-12.7 weight%), which results in high Mg# values (0.56-0.72). Aluminous (Al_2O_3=12.7-19.6 weight%) BONS are characterized by depleted TiO_2 values (0.35-0.67 weight%) and other HFSE (Zr=20-78 ppm and Ta=0.07-0.18 ppm), combined with relatively high LREE (La=2.2-2.9 ppm), LILE (Ba=7-63 ppm), Th (0.46-0.8 ppm), Ni (28-260 ppm) and Cr (153-1022 ppm). Although BONs in the FEVB do not always strictly comply with the definition of boninites established by Crawford *et al.* (1989) (i.e. SiO_2 > 53 weight% and Mg# > 60), they display U-shaped normalized REE patterns ($[La/Sm]_N$ =1.4-2.1 and $[Gd/Lu]_N$ =0.67-1.1), positive Zr and Hf anomalies in multi-element diagrams normalized to the primitive mantle (PM), and Al_2O_3/TiO_2 ratios (20-47) characteristic of Cenozoic boninites.

To explain the interstratification of BONs in the Abitibi Subprovince with komatiites and primitive island arc tholeiites, Wyman (1999) advocates the development of a proto-arc pursuant to the stepback of subduction arising from the interaction of the previous arc with a mantle plume. Our model, which is closer to those proposed for Phanerozoic boninitic suites, suggests that BONs in the FEVB as well as interstratified basaltic rocks form a succession of volcanic outpourings associated with the separation, opening and expansion of an oceanic fore-arc basin. Thus, the underlying calc-alkaline Le Gardeur Formation would represent the fragments of the dissected arc, and the overlying Storm Formation the resurgence of an emerging mature island arc.

12 – 1:100 000 scale Geological Compilation of the Kirkland Lake area, Abitibi Greenstone Belt, Ontario

John Ayer, N. Trowell, L. Valade, E. Amyotte, and Zoran Madon (OGS)

The Kirkland Lake sheet is the most recent product of an ongoing multi-year project to produce a series of 1:100 000 scale geological compilation maps covering the Abitibi greenstone belt in Ontario. From a mineral deposit perspective, the Abitibi is the most valuable piece of geological real estate in Ontario, but finding new deposits in this extensively explored and poorly exposed area is not an easy task. The new compilation of the bedrock geology and mineral resources provides a valuable aid to exploration at a variety of scales. This initiative is also our first attempt at integrating Geographic Information System technology to the map compilation process and will help to meet the increasing needs of our clients.

Three maps have been produced to date including the Timmins (1998), Lake Abitibi (1999) and Kirkland Lake (2000) sheets. The products include both hardcopy maps and attributed digital maps with lithological, structural and mineral occurrence data derived from published geological maps and assessment files as well as from geological maps, diamond drill hole and lithogeochemical data donated from the private files of a number of mining companies. The new geological interpretation is augmented by magnetic and electromagnetic data from high resolution Ontario Geological Survey aeromagnetic surveys, Digital Elevation Models and satellite images including Landsat Thematic Mapper (TM) and recently acquired RADARSAT radar data. An ongoing program of lithogeochemical and geochronological sampling over the course of the project will provide additional data for a final 1:250 000 scale lithostratigraphic and tectonic interpretation map upon completion of the 1:100 000 lithological maps.

13 – 1:250,000 scale compilation maps of the Abitibi, from the Ontario border to the Grenville Front

Jean Goutier (Géologie Québec), Christine Beausoleil (URSTM), Maureen Grant, Nelson Leblond, Pierre Doucet, Martina Chumova and the compilation map digitization team (Géologie Québec)

New geological compilation maps at a scale of 1:250,000 are now available in SIGÉOM for sheets 31M, 32C, 32D, 32E and 32L. These maps mainly cover the Archean Abitibi and Pontiac subprovinces, along the Ontario border and along the axis of the Cadillac fault. They were produced from compilation maps already digitized at 1:20,000 and 1:50,000, and include recent geological data that was integrated whenever possible.

One of the most difficult tasks in this work consisted in creating a legend that would take into account the numerous stratigraphic and lithological elements present. These maps comprise several major geological assemblages that are very different from one another. For example, map sheet 31M includes numerous units of the Pontiac Subprovince, several distinct Proterozoic dyke swarms, Proterozoic sedimentary rocks (Cobalt Group), part of the Grenville Front, and even Paleozoic rocks.

These maps will help establish, in collaboration with the OGS, a new synthesis of the entire Abitibi greenstone belt. They will also be useful for the production of the next geological map of Québec.

14 – The Abitibi : one hundred years of exploration and mining success

Pierre Doucet, Jean Goutier, Mario Melançon and Lucie Ste-Croix (Géologie Québec)

The Abitibi Subprovince is world-renowned for the large number and high grade of its polymetallic and precious metal orebodies. Since the beginning of the 20th century, over 310 base or precious metal mines and industrial mineral quarries have been discovered and mined in the Abitibi in Québec and Ontario. The production derived from mines in Québec since 1927 amounts to 5.6 million tonnes of copper, 6.2 million tonnes of zinc, 1,860 tonnes or 54 million ounces of gold and 5,500 tonnes of silver. Mines in Ontario have produced in excess of 103.4 million ounces or 3,562 tonnes of gold since 1910. The location of these mines, illustrated on a geological map at a scale of 1:500,000, outlines the fact that several regions contain a large concentration of orebodies. The Rouyn-Noranda – Bousquet/Cadillac – Val d'Or axis, and the Matagami and Chapais-Chibougamau sectors in Québec, as well as the sectors of Timmins, Matheson and the Kirkland Lake – Larder Lake axis in Ontario, contain the vast majority of mines in operation in the Abitibi during the 20th century.

The history of mining exploration in northwestern Québec begins much earlier than the discovery made by Edmund Horne in 1922. In 1686, the Chevalier de Troyes collected samples from a lead showing along the shores of Lake Temiskaming. This deposit was forgotten for 200 years, but was eventually mined in the 1890s. Despite the discovery of gold at Lac Fortune in 1906, the origins of the Rouyn-Noranda camp are linked to the discovery of the Horne orebody, and to the incorporation of Noranda Mines Ltd a few months later. The discovery set off a rush that peaked in 1925. In the Val d'Or area, the discovery of the Sullivan gold orebody in 1911 was the starting point of the mining camp, whereas the Lamaque and Sigma mines ensured its growth. Activities began in 1924 in the Bousquet-Cadillac area. Exploration in the Chibougamau area began at the turn of the century, but the area's mining history began in earnest in 1953, with the opening of the Springer mine in Chapais. The Matagami, Joutel, Casa-Berardi and Selbaie mining camps in northwestern Abitibi are more recent.

Exploration in NE Ontario is closely linked to the construction of the Temiskaming and Northern Ontario railway from North Bay at the end of the 19th century. The Cobalt mining camp, where spectacular silver showings were discovered in 1903-1904, was already fully established in 1907. Attracted by the potential of northern areas, prospectors made an initial gold discovery on the shores of Nighthawk Lake east of Timmins in 1907. A small rush ensued, and another discovery took place SW of Lake Porcupine in 1909, which would eventually become the Dome mine. The year 1909 also marks the discovery further west of a showing which would become the Hollinger mine. The Kirkland Lake – Larder Lake axis also attracted its share of prospectors migrating north after the discovery of silver mineralization in Cobalt. The first claim in Larder Lake was staked in 1906, and the first mine to go into production in the camp was the Toburn mine in 1912.

15 – Physical Volcanology and Metallogeny of Komatiitic Rocks in the Abitibi Greenstone Belt, Ontario-Québec.

Michel Houlé (Laurentian University, University of Ottawa), C.M. Lesher and Rebecca A. Sproule (Laurentian University), John Ayer (OGS)

Volcanological processes are critical in the genesis of komatiite-hosted Ni-Cu-(PGE) sulphide deposits. However, the precise volcanological processes within komatiites are not well understood, and represent an important area of research. Komatiitic lavas form a variety of textural facies, including massive, differentiated, pillowed, and volcaniclastic flows. Several different schemes have been used to classify these facies. The lithofacies classification scheme subdivides komatiitic lavas into different facies as a function of olivine enrichment (fractional accumulation) and differentiation (fractional crystallization), yielding four end-members: (1) undifferentiated noncumulate (UN) flows, (2) differentiated cumulate (DN) flows, (3) undifferentiated cumulate (UC) flows, and (4) differentiated cumulate (DC) flows. UN flows may be massive, pillowed, or volcaniclastic, and may be further subdivided on the basis of flow morphology, pillow shape, and volcaniclastic textures. For example, less magnesian lavas form smaller, more smoothly rounded pillows, whereas more magnesian lavas form larger, more flattened pillows/tubes. Volcaniclastic/pyroclastic komatiites appear to be uncommon, except in Norway and Finland, but many komatiites possess autoclastic flow-top breccias. Komatiites occur in a wide range of volcanic facies including: vent facies, pyroclastic/epiclastic facies, lava lobe facies, lava pond facies, sheet flow facies, channelized sheet flow facies, channel-flow facies, and lava channel with overbank facies. Each facies may include multiple lithofacies and textural facies within a single cooling unit. Volcanic facies mapping is particularly important as it facilitates recognition of favourable volcanic sequences that may host magmatic Ni-Cu-(PGE) sulphide mineralization, thus aiding exploration for these deposits. However, many of the present facies models are based on basalt facies, and may not necessarily be appropriate, as komatiites: i) were much hotter, ii) had much lower viscosities, iii) crystallised over much wider temperature ranges, iv) had much higher heat content, and v) appear to have erupted into deep water onto relatively shallow slopes. A better understanding of the physical volcanology of komatiites will provide critical information about the nature of volcanism on the young Earth, the stratigraphy and structure of Archean and Proterozoic greenstone belts, and the genesis of komatiite-associated Ni-Cu-(PGE) deposits.

18 – Far North Project: Geology and mineral potential of the Lac Pélican area (NTS 34P)

Anne-Marie Cadieux, Alain Berclaz, Robert Thériault and Joanne Nadeau (Géologie Québec), Frédéric Blondeau (U. Laval), Gabriële Lemieux (UQAM) and Gabriel Machado (U. of Ottawa)

This new survey, carried out at a scale of 1:250,000, is located 250 km east of Puvirnituq. It is bounded to the east, south and north by NTS sheets 24M, 34I and 35A, respectively mapped in 1998, 1999 and 2000.

The oldest elements are represented by the Suluppaugalik Suite in the southwesternmost part of the area, and the Faribault-Thury Complex (FTC) in the east, which consist of a TTG suite (dated at *ca* 2.8 Ga) dominated by strongly foliated to gneissic bo±hb tonalites and trondhjemites. In the FTC, remnants of volcano-sedimentary rocks are abundant, and form discontinuous belts up to 20 km long by 5 km wide. These are mainly composed of hb-pg±cx±ox±gr metabasalts, but also contain ultramafic, intermediate and felsic volcanic rocks, paragneiss and iron formation.

In the NW part of the area, the Pélican volcano-sedimentary Complex extends along a < 10-km wide N-S axis. It is dominated by migmatitic paragneisses, with felsic tuffs (*ca* 2.742 Ga), andesites and metabasalts.

All these units are intruded by a "charnockitic"-type TTG suite, dominated by bo-ox±cx±hb enderbites and opdalites (ca *2.723 Ga), associated with minor proportions of pyroxenites, gabbronorites and ox-bearing diorites. These units form intrusive complexes, outlined by a positive magnetic signature and granulite-facies metamorphism. Laterally, charnockitic units make way to hb±bo granodiorites – tonalites* (ca *2.720 Ga), diatexites* (ca *2.719 Ga) and white granitic pegmatites.*

The SW part of the area is dominated by bo-phyric granodiorite to monzogranite intrusions, which grade laterally to homogeneous bo-hb leucogranites. These units appear to be respectively related to the La Chevrotière Suite (*ca* 2.732 Ga) and the La Potherie Suite (*ca* 2.723 Ga), recognized further south in NTS sheet 34I.

An important network of late diabase and gabbro to gabbronorite dykes, preferentially oriented WNW-ESE, cross-cuts all other lithologies.

Sites of economic interest may be divided into five types: 1) volcano-sedimentary rocks of the FTC host: *i)* qz veins with <10% py±po±cp; *ii)* disseminated po±py±cp±mc±bn in basalts, and *iii)* iron formation units. 2) The Pélican belt hosts: *i)* py-rich siliceous horizons in paragneisses; *ii)* iron formations with < 15% py±as±sp; and *iii)* disseminated sulphides in felsic tuffs and at the basalt/paragneiss interface. 3) Po-cp-bearing ultramafic and mafic intrusions offer good potential for Ni-Cu-Co-PGE mineralization. 4) Late-tectonic granites and pegmatites contain mo±gl±mg veinlets and disseminations. 5) Finally, late fault zones characterized by qz-ep-hm-cl alteration are rich in py±gl.

19 – Geology of the Lac Klotz and Cratère du Nouveau-Québec areas: Northern Ungava Peninsula

Youcef Larbi, Louis Madore, Kamal N.M. Sharma, Jean-Yves Labbé, Pierre Lacoste, Jean David and Karine Brousseau (Géologie Québec)

This new geological survey, located in the north part of the Ungava Peninsula, covers the Lac Klotz map sheet (NTS 35A) and the south part of the Cratère du Nouveau-Québec map sheet (NTS 35H). This project was undertaken within the framework of the Far North mapping program covering the NE Superior Province.

The geological survey at a scale of 1:250,000 represents a surface area of about 18,000 km^2. It is underlain, from west to east, by Archean rocks including the Nantais volcano-sedimentary belt, the Lepelle Domain, a sequence of rocks equivalent to the Faribault-Thury Complex and the western portion of the Qimussinguat Complex. The map area is bounded to the north by the Early Proterozoic supracrustal sequences of the Ungava Trough.

The Nantais belt consists of mafic and felsic lavas, sediments or volcaniclastic rocks, conglomerates and paragneisses. These supracrustal rocks are metamorphosed to the middle amphibolite facies or to the granulite facies. They are surrounded by tonalitic and granodioritic rocks.

The Lepelle Domain is mainly composed of tonalite and granodiorite, locally with two pyroxenes and containing mafic enclaves. These rocks are cut by late porphyritic monzonitic and granitic intrusions.

The lithological assemblage equivalent to the Faribault-Thury Complex is composed of tonalite, and contains remnants of amphibolite-facies volcano-sedimentary rocks. These remnants, one to several kilometres in size, are distributed along a N-S axis over a distance exceeding 100 km. It is in this setting that a new particularly interesting volcano-sedimentary belt was uncovered. The Kimber belt is formed of mafic and intermediate lavas, ultramafic lavas and sills, marbles, calc-silicate rocks, paragneisses and iron formations. This belt reaches up to 4 km wide and extends over more than 10 km in length.

The Qimussinguat Complex is composed of gneissic and strongly migmatized enderbite and tonalite. It contains minor quantities of granodiorite and monzonite. The Qimussinguat Complex is characterized by granulite-facies metamorphism.

Cordierite, anthophyllite and garnet-bearing horizons most likely representing alteration zones associated with volcanogenic systems were identified in the volcanic rocks of the Nantais belt. In the Kimber belt, a fragmental horizon 1 to 2 metres thick with a massive sulphide matrix, probably exhalative in origin, was traced within a dominantly mafic volcano-sedimentary sequence over a strike-length of several hundred metres. The volcano-sedimentary sequence appears to be cut by a tonalitic intrusion with disseminated sulphide mineralization and locally remobilized massive sulphides.

20 – Geochronological compilation and synthesis of the Quebec-Baffin segment of the Trans-Hudson Orogen: a preliminary study

Natasha Wodicka and Sarah McMullen (Geological Survey of Canada)

A new project funded by the Targeted Geoscience Initiative (TGI) was initiated in July 2000 with the primary goal of refining our understanding of the tectonostratigraphic, magmatic, and metallogenic evolution of the eastern Trans-Hudson Orogen and its bounding Archean margins in northern Québec and Baffin Island. One specific theme targeted by this project is an attempt to elucidate the relationship between Ni-Cu-Co-PGE mineralisation and the multiple Paleoproterozoic rifting events (2.10, 1.92, 1.89 and 1.87 Ga) and resulting mafic/ultramafic magmatism that occurred at the margin between the Superior Province and the Trans-Hudson Orogen in the Cape Smith Belt and Labrador Trough. A precise temporal context for the Raglan Ni-Cu-Co-PGE deposit and other mafic-ultramafic intrusions in the Cape Smith Belt, Labrador Trough, and Baffin Island areas will be established. Precise, U-Pb age-dating of mineralized bodies will not only provide a test to determine if economic deposits are found in one or more temporal suites of mafic-ultramafic sills, but will also aid in the selection of future potential exploration targets.

The new U-Pb ages generated in this study will be integrated into a compilation and synthesis of all existing isotopic ages from northern Québec and Baffin Island. The compilation includes basic information on the sources of data as well as on the geological description, geographic location, and age (with interpretation) of dated samples. To date, isotopic systems used to derive ages for rocks and minerals from these areas include U/Pb, K/Ar, $^{40}Ar/^{39}Ar$, Rb/Sr, Sm/Nd, and Pb/Pb. The database is being prepared in a form that will facilitate easy access to the data using different commercially available spreadsheet, Geographic Information System (GIS) or database programs. A first version of the geochronological compilation will be released in CD-ROM format in March 2001. Overall, the geochronological compilation and synthesis of the Quebec-Baffin segment of the Trans-Hudson Orogen will be essential to the establishement of regional tectonostratigraphic correlations and will provide a rigid geotemporal context for metallotects.

21 – The Ungava and Labrador Trough Early Proterozoic nappes : stratigraphic and structural correlations

Philippe Ferron, Normand Goulet (UQAM)
Louis Madore, Youcef Larbi (Géologie Québec)

The study area is located in the Ungava Peninsula, and includes the SE limit of the Ungava Trough (Cape Smith Belt) and the northern tip of the Labrador Trough (Early Proterozoic New Québec Orogen).

A detailed examination of Early Proterozoic units was carried out with the purpose of understanding the stratigraphic, structural and metamorphic evolution involving these two allochthonous belts.

The allochthonous nature of the Ungava Trough, described by St-Onge *et al.* (1988), is suggested by the presence of a basal decollement located between the Early Proterozoic sequences and the Archean basement represented by the Minto Subprovince (Superior Province).

Stratigraphic units of the Povungnituk Group (south part of Cape Smith Belt) seem to correspond to the basal units (iron, carbonate, and pelitic sequence) of the northern Labrador Trough. Furthermore, the volcanic sequences of the Povungnituk Group appear to be equivalent to volcanic sequences located south of Lac Roberts (Labrador Trough).

The supracrustal rocks have undergone several phases of folding (polyphase tectonics). Numerous kinematic indicators, mainly observed in the mylonitic schists at the base of the sequence, reveal a tectonic transport direction from north to south with regards to the southern margin of the Cape Smith Belt and from the northwest to the southeast for the northernmost Labrador Trough.

Numerous small Early Proterozoic klippes, observed between the two belts, help establish a correlation of the regional tectonic movement towards the southeast, and provide for an estimate of the minimal distance of transport of 100 km. The constant direction of tectonic transport, and the important distance traveled lead us to propose that the Cape Smith Belt and the northern Labrador Trough are derived from the same nappe.

This D1 nappe was refolded by a D2 deformation event, with axial planes oriented E-W to NE-SW. This folding created undulations in the nappe, the synforms being preferentially preserved. The intensity of deformation decreases in the northern Labrador Trough. In this area, a D3 deformation is well-developed and forms folds overturned to the west or southwest, with axial planes oriented NW-SE. The latter deformation, also observed in the Cape Smith Belt, would have been caused by the collision of the Diana structural Complex (Rae Province ?) in the northeast with the Faribault-Thury Complex in the southwest.

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22 – Metallogenic settings in the Lac Klotz area, Far North Project

Jean-Yves Labbé, Pierre Lacoste, Louis Madore and
Youcef Larbi (Géologie Québec)

Field work carried out during the 2000 summer season in the Lac Klotz area outlined two volcano-sedimentary belts with interesting metallogenic settings.

In the Pélican-Nantais belt, Percival *et al.* (1997) identified a few bands of supracrustal rocks, mainly comprised of paragneiss and mafic metavolcanic rocks. Intermediate to felsic volcanic units were also outlined in the Lac Pélican area, and represent a favourable environment for volcanogenic mineralization. New felsic volcanic horizons were identified in the Pélican-Nantais belt during our 2000 field survey. These felsic units are aphanitic and relatively deformed ; they probably represent fine tuffs and/or rhyolitic flows. A few horizons of polygenic lapilli and block tuff, or conglomerate, were also observed. These rocks are in contact with metabasalts. The contact zone itself is characterized by the presence of cordierite, anthophyllite, garnet, and locally, sillimanite or sericite. These minerals are typical of alteration zones associated with volcanogenic mineralizing fluids. This sector therefore represents a favourable environment for the discovery of Cu-Zn-Au VMS-type mineralization.

The Kimber belt, outlined during our field survey this past summer, also represents a favourable environment for the discovery of polymetallic mineralization. This belt may reach up to 4 kilometres wide in certain parts, and extends over more than 10 kilometres. It mainly consists of mafic to intermediate volcanic rocks, with a few horizons of paragneiss and ultramafic rocks. Several sulphide zones were observed, namely in the south part of the belt, where a few massive to semi-massive sulphide horizons are present. In this sector, the belt is composed, from west to east, of a fine to medium-grained tonalite, aphanitic basalts and a sequence of intermediate to mafic lavas including several marble horizons (carbonate sediments), iron formation and calc-silicate rocks. The tonalite displays an important disseminated sulphide content, as well as a few massive layers of recrystallized pyrite. At the interface between the aphanitic basalt and the mafic sequence with carbonate horizons, a sulphide-rich unit 1 to 2 metres thick was traced over a distance exceeding one kilometre. It consists of a brecciated rock with angular to rounded quartz fragments in a massive sulphide matrix (pyrrhotite and pyrite with minor chalcopyrite). This environment appears particularly interesting for porphyry-type or epithermal polymetallic mineralization.

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23 – The Qullinaaraaluk Ni-Cu-Co showing: a new type of mineralization in the Archean rocks of the Far North

Jean-Yves Labbé, Pierre Lacoste, Alain Leclair, Martin Parent, Julien Davy (Géologie Québec) and Régis Dumont (GSC)

The Qullinaaraaluk showing was discovered in August 2000, during 1:250,000 scale mapping of the Lac Vernon and Lac Minto areas. It is located about 170 km NE of the village of Umiujaq and 120 km from the coast of Hudson Bay. The ministère des Ressources naturelles announced the discovery in a press release dated August 31st, 2000.

The mineralization consists of massive, semi-massive and disseminated sulphides hosted in a mafic to ultramafic intrusion. The massive sulphide zone outcrops sporadically over about 25 metres. The zone varies from 1 to 4 metres in width. Massive sulphides mainly consist of pyrrhotite, with pentlandite, chalcopyrite and pyrite. Six samples, collected with a sledgehammer, yielded Ni values between 1.71% and 2.60%, Cu between 0.08% and 1.80% and Co between 0.14% and 0.27%. No channel samples were collected.

Disseminated mineralization is present throughout the intrusion, but particularly to the northeast of the massive sulphide zone, where the host rock is more mafic and probably corresponds to a pyroxenite. Interstitial sulphides may reach up to 20%, and the rock is particularly rusty. The gossan zone extends over about 250 metres by 100 metres. Analytical results of these rocks are still pending.

The intrusion hosting the mineralization is irregularly shaped. It extends over about 750 metres by 200 metres along an ENE-WSW axis, perpendicular to the regional foliation. The intrusion consists of massive, medium-grained melanocratic gabbro and pyroxenite, which appear to be undeformed. It cross-cuts a sequence of strongly deformed diatexites and metatexites, and therefore seems to be post-tectonic. Pegmatitic injections are observed both in the diatexite and in the gabbro.

Other mafic to ultramafic intrusions, probably similar in origin, were identified in the map area. These rocks therefore represent a new ore deposit setting in the Far North, where similar metamorphic environments are present.

An airborne magnetic survey is currently under way (end of September), in the Lac Qullinaaraaluk area. Preliminary results will be presented at the Information Seminar, and will prove to be useful in identifying other similar intrusions.

24 – Geology of the Lac Vernon (34J) and Lac Minto (34G) areas, Far North

Martin Parent, Alain Leclair, Pierre Lacoste and Jean-Yves Labbé (Géologie Québec)

Geological mapping of the Lac Vernon (NTS 34J) and Lac Minto (NTS 34G) areas was carried out within the framework of Far North mapping project. The centre of the map area is located 185 km east of Inukjuak and 260 km southeast of Puvirnituq. The main objectives of the survey are: 1) to produce a geological map at a scale of 1:250,000, 2) to provide a regional geological framework, and 3) to highlight the geological settings most favourable to the discovery of new showings.

Aeromagnetic data from the Lac Vernon and Lac Minto areas broadly illustrates the various geological settings. Weak and uniform magnetic signatures reflect the presence of tonalitic rocks hosting volcano-sedimentary sequences. Three sectors (Chavigny, Bush and Kogaluc) are identified for their supracrustal rock content. The best-preserved rocks are found within the Chavigny belt, about 2 km wide by over 30 km long. As opposed to most volcano-sedimentary belts already inventoried in the NE Superior, the Chavigny belt is dominated by felsic volcanic rocks. Sericite schists, lapilli tuffs, polygenic conglomerates, metabasalts, iron formations and paragneisses are also present. The Lac Bush sector is characterized by the presence of pillowed basalts and an important marble sequence. In several locations within the map area, tonalites hosting the volcanic rocks are affected by a granitization phenomenon. Linear magnetic signatures, outlined by a succession of N-S oriented positive and negative anomalies, illustrate the presence of alternating BO-GR-CD diatexites, paragneisses and charnockitic and granitic-type rocks. These units rarely exceed a few kilometres in width. More intense and uniform magnetic signatures reflect the presence of voluminous homogeneous intrusions of granodiorite and opdalite.

The economic potential of the area was increased by the discovery of the Qullinaaraaluk Ni-Cu-Co showing north of the lake bearing the same name. It consists of metre-scale massive and semi-massive sulphide pods, hosted in a late melanogabbro and pyroxenite intrusion. Grab samples yielded grades of up to 2.6% Ni, 1.8% Cu and 0.27% Co (see Labbé *et al.*, this volume). Several gabbro intrusions were mapped in the area. A study is currently under way in order to identify gabbros similar to the one hosting the Qullinaaraaluk showing. Elsewhere, the Chavigny belt displays anthophyllite and cordierite zones associated with felsic volcanic rocks, and interpreted as metamorphosed volcanogenic alteration zones. Since 1994, work by Soquem, Virginia Gold Mines and Cambiex has demonstrated the gold potential of the area, namely in the Kogaluc iron formation (5.99 g/t Au over 3 metres) and the Narsaaluk iron formation (7.9 g/t Au).

25 – The mineral potential map production system (MPMPS): Kimberlites and lamproites in the Far North

Jean-Yves Labbé, Pierre Lacoste, Daniel Lamothe and Marc Beaumier (Géologie Québec)

The mineral potential map production system (MPMPS) is an extension of SIGÉOM that allows to superpose various types of data, from SIGÉOM or other sources, in order to produce mineral potential maps. These maps highlight sectors favourable to the discovery of a particular type of ore deposit or substance, based on a specific geological model. A theoretical mineral potential assessment model is generated, then applied to an area to obtain the mineral potential map for the type of ore deposit or substance being sought. The scale used for the MPMPS is 1:250,000.

The MPMPS is used here to assess the discovery potential of kimberlite and lamproite pipes in Québec's Far North region, more specifically in the Minto Subprovince, which represents the northeasternmost part of the Archean Superior craton. A theoretical model was generated using recent data available in the literature. This model was then applied to the Lac Aigneau area (NTS 24E), a sector mapped in 1999 which attracted much interest for diamond exploration given the abundance of alkaline intrusions.

The model for kimberlite and lamproite pipes is based on three principal criteria, or sub-models, which are:

— Major regional lineaments: kimberlite fields generally occur along major deep structures rooted at the base of the crust. These crustal lineaments are identified at a regional scale (1:1,000,000) with the help of aeromagnetic and gravity maps, satellite images and regional geological maps. Data relevant to the study area are then extracted and converted to a scale of 1:250,000 to be integrated into the MPMPS.

— Local structural control: kimberlite pipes are often found along brittle faults which served as conduits for kimberlitic magmas. These generally late faults are interpreted from aeromagnetic maps and satellite images at a scale of 1:250,000, or are extracted from the recent geological map.

— Signs of kimberlitic volcanism: despite the fact that kimberlites nearly never outcrop at surface, they may nevertheless be detected through their geophysical signature (isolated anomalies), geochemical signature (anomalies in lake sediments or till), or topographic signature (small deep circular lakes). The presence of indicator minerals in till is also used where available.

The poster presents the preliminary potential map for map sheet 24E (Lac Aigneau), as well as the theoretical model and the regional map showing major crustal lineaments.

26 – Archean volcanism in the NE Superior Province

Charles Maurice and Don Francis (Université McGill)

The presence of volcano-sedimentary belts in the NE Superior Province has only been known for a few years, and their study remains marginal. Despite the high degree of deformation and metamorphism, as well as the high volume of felsic intrusives, it is possible to find well-preserved volcanic relics where primary textures are locally recognizable.

Three volcanic belts of the Faribault-Thury amphibolitic Complex were sampled within the scope of a detailed petrogenetic study during the summer of 1999 (Hamelin, Lac Trempe and Lac Buet belts, NTS 24M and 25D). Rocks in these three locations are mafic to ultramafic in composition; lavas (basalts and komatiites) and associated cumulate rocks (peridotites, pyroxenites and gabbros) are equally represented. The lavas display MgO contents > 7 wt%, and the calculated composition of olivines coexisting with basaltic liquid varies between Fo_{75} and Fo_{85}. An Fe enrichment tholeiitic trend suggests the absence of magnetite fractionation in weakly oxidizing conditions.

In terms of major elements, the Fe content of these volcanic rocks is distinctly higher than modern oceanic ridge basalts (MORBs). Subchondritic Zr/Y ratios are similar to MORBs (Zr/Y = 1.9-2.8) and rare earth patterns are very flat. However, certain incompatible element ratios (Nb/Th = 7-9, Zr/La_{pm} = 0.75-1.5, Th/La_{pm} = 0.7-1.1), similar for basalts and komatiites, are clearly distinct from MORBs (Nb/Th ~ 19, Zr/La_{pm} ~ 1.8 and Th/La_{pm} ~0.4). Furthermore, the trace element content of these volcanic rocks is lower than that of modern equivalents.

Globally, the geochemical similarities between the three sites, the occurrence of Mg-rich lavas, the depleted rare earth patterns and the low trace element contents suggest that the volcanic rocks of the three belts represent the primitive remnants of the base of a single volcanic sequence. Furthermore, the similarity of incompatible element ratios for basalts and komatiites, as well as the fractionation modelling of ultramafic lavas at low pressure suggest a single origin for both komatiites and tholeiites. This interpretation concerning lavas of the Faribault-Thury Complex contrasts with other models which suggest that komatiitic and associated tholeiitic lavas are derived from partial melting at different mantle depths.

The differences between recent and ancient mafic volcanism have important implications on mantle chemistry and evolution. If these volcanic rocks represent Archean equivalents of MORBs, this implies that the upper mantle, from which these lavas are derived, had a primitive composition, and thus had not yet undergone complete extraction of the continental crust.

27 – Regional glacial movements and glacio-sedimentary prospecting in west-central Ungava

Michel Parent (CGQ), Serge J. Paradis (CGQ) and Marc Beaumier (Géologie Québec)

Quaternary geology studies carried out during the 2000 summer season in the west-central part of the Ungava Peninsula focussed on the Lac Vernon map sheet (34J) and also touched the adjoining half of adjacent map sheets (34I west and 34K east). Several types of surveys were conducted: (1) glacial striation measurements on some 200 rock outcrops, (2) till geochemistry, (3) indicator minerals for diamond in till, and (4) mapping of surficial deposits.

In this area located west of the central Ungava glacial divide, our surveys helped identify three successive systems of glacial movement:

1. Early SW movement: This early movement, observed on the protected surfaces of a restricted number of rock outcrops (about 15%), is oriented roughly 210° to 240°, and mainly affected the western part of the study area. This SW movement appears to be the counterpart of an early ESE movement observed in the east-central part of the peninsula (sheets 24E, 24L and 24M; Parent and Paradis, 1999).
2. Intermediate NW movement: Generally oriented at 295° to 335° and locally 350°, this movement was observed on the protected surfaces of a large number of outcrops (about 60%) throughout the area except for the west part of 34I. This system obviously corresponds to the early NNW movement observed in previous studies east of Hudson Bay (Parent *et al.*, 1995). In terms of relative timing, this system appears to be correlated with the NNE movement observed in the east-central part of the Ungava Peninsula.
3. Principal W movement: Oriented in a restricted range between 255° and 280°, this movement is dominant on outcrops in the west-central part of the peninsula, all the way to the coast of Hudson Bay where it is slightly deflected to the WSW. Although the results of till geochemistry and mineralogy surveys are not yet available, the lake sediment survey suggests that this movement is responsible for overall glacial transport in the area, as is the case in areas further south (Parent *et al.*, 1995, 1996).

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28 – Detailed mapping (1:250,000) of surficial deposits in the Koroc River area (24I) in Québec's Far North region

Paradis, Serge J., Parent, Michel, (CGQ) Boutin, Marco, Boivin, Ruth, Larocque, Hugo

A mapping survey at a scale of 1:250,000 was carried out in the summer of 1998 in the Koroc River map sheet (24I). This survey made it possible to inventory and characterize surficial deposits in the area. Based on the method described by Paradis and Boutin (2000), 169 conventional black and white aerial photographs at a scale of 1:40,000 were digitized then compiled in monoscopic view using the Digital Video Plotter (DVP) software. In the second phase, pursuant to the procedure described by Paradis *et al.* (1999), a digital field model at a scale of 1:250,000 with artificial shadow effects was generated from contour lines and the corrected hydrographic network taken from the National Topographic Database (NTD). The final map product of the Koroc River area is the result of the superposition of the thematic map of surficial deposits in HSV images (Hue, Saturation, Value) and the digital field model. The methodology used makes the 1:250,000 scale map of the Koroc River area (24I) an avant-garde product both in terms of conceptualization and presentation. Digital videoplotting is a rapid and accurate method of transferring data. It is also a privileged tool for the presentation of multi-layered maps for educational purposes.

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29 – Discovery of a frontal moraine complex west of Lac Chavigny (Lac Vernon area, 34J) in north-central Québec

Paradis, Serge J., Parent, Michel (CGQ)

A surficial deposit mapping survey at a scale of 1:250,000 was carried out during the 2000 summer season in the Lac Vernon map sheet (34J). The latter resulted in the identification of an arcuate frontal moraine complex extending roughly north-south between Lac Kakiatuk in the south (58 03 N – 75 08 W), through the Qaqqaluapik Siqinirsik, Qarqaluapik and Qaqqaluapik Tarrasik hills northward past Lac Farineau (58 27 N – 75 20 W). This complex extends over a distance of nearly 50 kilometres, and is composed of several segments more or less defined in terms of topographic features. One of the characteristic morphological features is the presence of multiple ridges that form several of these segments. In addition to this multi-ridge feature, the moraine complex is composed of at least 2 major branches : the first and most extensive is located west of Lac Chavigny (58 10 N – 75 10 W) whereas the second, much less obvious, is located east of the same lake. A brief review of the literature (Lauriol, 1982, and references therein) reveals no mention of the presence of minor or major moraine deposits west or east of Lac Chavigny. The identification of this complex may thus be considered as a discovery. To date, the following interpretations may be proposed : firstly, the location and distribution of the various moraine segments with average altitudes of 180-200 metres make it a morphological phenomenon whose emplacement would not be directly related to the presence of the marine limit, which would rather be located at about 160-165 metres for the area west of Lac Chavigny (Lauriol, 1982). Secondly, the age of the Lac Chavigny moraine complex falls within the 7500 to 6000 years BP range ; this age may be defined more accurately in future studies.

Reference

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30 – Tonalitic suites in the Minto Block : Magmatic and tectonic significance of petrographic and geochemical variations

Jean Bédard (QGC)

Archean granodioritic-granitic plutonic terrains of the Minto Block formed in a limited time interval, and are typically interpreted as the roots of continental or oceanic arcs. One of the most common plutonic assemblages is the Rivière-aux-Feuilles Suite, dominated by granites and granodiorites. Tonalitic (biotite + hornblende + epidote + titanite + oxydes) and enderbitic (pyroxenes + red biotite + magnetite) suites are generally slightly older, but may be contemporaneous with the granites. Trace element modelling requires the presence of garnet in the tonalite source, which implies that these magmas are derived from the melting of metabasites at about 20-25 km depths. Several tonalite samples display beautiful idiomorphic muscovite plates intergrown with biotite, and containing idiomorphic inclusions of seemingly igneous epidote+allanite. The margins of these muscovites are partially resorbed where they have outgrown their biotite shield. These muscovites display high TiO_2 contents (0.5-1.5%), suggesting an igneous origin. Experimental data suggests that igneous muscovite is not stable at pressures below 7-11 km. The presence of muscovite therefore supports the model indicated by epidote : onset of crystallization at high pressure, followed by upwelling in a magmatic state of a crystal mush + liquid. Trace element models suggest that the fractionation of accessory phases (allanite, epidote, titanite, apatite) controlled trace element variations during the fractionation of tonalites to trondhjemites. Thermometry data indicates a relatively high temperature for plagioclase-hornblende equilibration (710-826 °C), beyond the stability of the amphibolite facies, thus confirming the interpretation of the magmatic nature of the ferromagnesian assemblage in hornblende tonalites. However, pyroxenes (Fe-Mg : 667-740 °C) and feldspars (plagioclase-alkali feldspar : 300-600 °C) record lower exsolution temperatures. The absence of deformation in feldspar exsolutions implies a post-kinematic period of static re-equilibration. The Al-in-hornblende barometer indicates pressures between 3 and 6 kb. Enderbites contain micas with lower Al and Mg than in hornblende tonalites, suggesting higher activity of silica and ferric iron. Since the deformation is syn-magmatic, the presence of a north-south regional fabric with subvertical lineations cannot be due to the collision of independent terranes, as it is unlikely that all these terranes would be synchronous. I suggest that these fabrics are the result of crustal-scale partial convection related to the sagduction of supracrustal belts in a partially molten tonalitic substratum.

31 – Geology of the Lower Eastmain area: Phase II – Miskimatao River, Talking Falls, Lac Elmer and Lac Duxbury sectors

Abdelali Moukhsil and Claude Dion (MRN) and Gabriel Voicu (UQÀM)

The map area (33C/03, 33C/04, 33C/05 and 33C/06) constitutes phase II of the Lower Eastmain Project, initiated in the summer of 1999. Its objectives are to review the geological interpretation of this area and to study mineralized showings.

Mapped lithological units belong to the Archean Lower Eastmain Group, comprising four volcano-sedimentary formations and ultramafic to felsic intrusive rocks. At the base of the sequence, the Komo and Kauputauch Formations are essentially composed of basalts, amphibolitized basalts and amphibolites accompanied by andesitic, dacitic and rhyolitic lavas and/or felsic to intermediate tuffs. The overlying Wabamisk Formation consists of pyroclastic rocks, conglomerates and oxide-facies iron formation. The top of the sequence is represented by the Auclair Formation, mainly composed of paragneiss. Intrusions which vary from monzonitic to monzogranitic in composition are present throughout the region, as well as mafic to ultramafic intrusions. Feldspar-phyric tonalite and diorite intrusions and dykes are also observed cross-cutting the volcanic units. Proterozoic diabase dykes cross-cut all previously described lithologies.

The regional metamorphism varies from the greenschist facies to the upper amphibolite facies. The principal planar fabric (S1) strikes E-W overall, and is generally steeply north-dipping. A second NE-SW oriented planar fabric, interpreted as S2, is also visible locally. Several major faults and shear zones (ex. Opinaca fault) were mapped in the area.

The map area reveals significant mineral potential, as several sectors contain gold (up to 120 g/t), silver (up to 47 g/t), copper (up to 8%) and zinc (up to 8.10%) showings. The main mineralized zones include the Lac Elmer deposit and the Kali, Lidge and Gorge Clouston showings. The metallogenic characteristics of these mineralizations suggest the presence of a large-scale porphyry-epithermal system, probably related to the emplacement of feldspar porphyry-type subvolcanic intrusions. This mineralization is associated with porphyry-type alteration zones (potassic, phyllic and propylitic). The mineralization was subsequently remobilized and recrystallized in deformation zones (Lac Elmer horizon) under the influence of regional metamorphism and deformation. Recrystallized sulphides are associated with metamorphosed aluminous alteration zones which are outlined by the presence of garnet, andalusite, staurolite and cordierite. These are then cross-cut by orogenic quartz-tourmaline-ankerite veins.

32 – Geology of the Lac des Loups Marins area

Charles Gosselin, Martin Simard and Marie-Josée Mailhot (Géologie Québec)

A geological survey was carried out during the summer of 2000 at a scale of 1:250,000 in the Lac des Loups Marins area (NTS sheet 34A), located about 400 km NE of Radisson. This work was carried out within the framework of the Far North Project, and corresponds to the western extension of surveys conducted in 1998 (Gayot area, 23M) and 1999 (Maricourt area, 24D).

Based on the broad subdivisions of the NE Superior Province, most of the area should be underlain by rocks of the Bienville Subprovince, except the NE corner, represented by the Minto Subprovince. However, our work reveals that the entire area is mainly composed of lithological units comparable to those described further north in the Minto Subprovince.

The area is essentially composed of granitoid rocks of tonalitic to granitic composition, that vary from massive to strongly foliated or gneissic. Tonalitic rocks are largely predominant. They are represented by units of tonalitic gneiss, biotite trondhjemite-tonalite and hornblende tonalite. These rocks are affected by late, more or less intense migmatization, which translates into the presence of granodioritic ribbons and irregular injections, giving the rock a very heterogeneous aspect. A homogeneous granodiorite unit observed in a few locations could represent the ultimate phase of migmatization of the tonalitic units. Also present in minor quantities are horizons of mafic volcanic rocks, diorites, paragneisses and mafic to ultramafic intrusions. Late granite and porphyritic granodiorite intrusions cross-cut older units.

The regional metamorphism varies from the amphibolite facies to the granulite facies. The gradual increase in metamorphic grade towards the central part of high-grade zones suggests that the vast majority of granulitic rocks correspond to metamorphosed equivalents of the various units in the area. Enderbitic intrusions are also found locally in these sectors.

The regional structural trend is represented by a principal NW-striking foliation of variable intensity. Regional faults belong to two systems: the first NW-oriented system is particularly well-developed. The second includes a few E-W faults that reorient structures parallel to the main fault plane.

The principal sites of economic interest are found in two geological settings:

— Silicified, carbonatized and sulphide-rich zones contained within shear zones related to a regional NW-SE oriented fault.

— Sulphide zones associated with gabbroic intrusions intruded within NW fault zones.

A few sulphide zones and iron formations were also observed in association with horizons of volcanic amphibolite and paragneiss.

33 – Geology of the Lac Hulot area (22K/03) and the eastern half of the Lac Praslin area (22K/04)

André Gobeil, Claude Hébert, Thomas Clark, Julie Doyon and Julie Gauthier (Géologie Québec)

The area mapped at a scale of 1:50,000 during the 2000 summer season covers a surface area of about 1,490 km^2, the centre of which is located 140 km NNW of Baie-Comeau. The eastern part of the area is occupied by the Outardes 4 Reservoir. This survey constitutes the first phase of a project designed to provide a link with the work of C. Hébert further west in the Pipmuacan Reservoir and Saguenay – Lac-Saint-Jean areas, and in particular with the Lac-Saint-Jean anorthositic Suite. It is paired with a metallogenic study discussing the economic features of this area (Clark *et al.*, this volume).

All the rocks in the area are included in the Allochthonous Polycyclic Belt of the Grenville Province. They have been divided into three major assemblages:

- the first consists of compositionally variable intrusions, from monzonites to granites or their charnockitic equivalents. These rocks were emplaced before or during the last episode of regional deformation, marked by a tectonic signature characterized by shortening and thrusting. These rocks pierced through a cover of supracrustal rocks, of which only a few small-scale remnants remain, represented by diverse gneisses, aluminous paragneisses and calc-silicate rocks. All these rocks are foliated or gneissic, and metamorphosed to the amphibolite or granulite facies.
- the second assemblage groups rocks of the De La Blache mafic plutonic Suite. This suite consists of two geographically and lithologically distinct assemblages; the core of the batholith is composed of coarse-grained anorthosite, leucotroctolite or leuconorite; it forms an east-plunging antiform. This assemblage is surrounded by a fringe of fine- to medium-grained rocks mainly comprised of gabbronorite, leuconorite and local peridotite and pyroxenite.
- the third assemblage groups rocks of diverse compositions emplaced after the regional deformation. They comprise gabbronorites, gabbros, mangerites or granites. They form small bodies and dykes that cross-cut the first two assemblages.

Important structural elements other than regional folding and thrusting are represented by the numerous mylonite zones with subhorizontal lineations affecting the gabbronorite fringe of the De La Blache mafic plutonic Suite. These deformation zones most likely constitute the NE extension of the Pipmuacan deformation zone (Hébert, 1991, 1999). NNE-SSW oriented mylonite zones are also observed, and represent late deformation events relative to E-W mylonites.

From an economic standpoint, the De La Blache Suite appears to be a good target for copper-nickel or iron-titanium exploration. A few bands of ultramafic-mafic rocks host disseminated and rarely semi-massive sulphides, and finally, supracrustal remnants contain minor sulphides and graphite.

33 – Ore deposit study of the Lac Hulot (22K/03) and Lac Praslin (22K/04) areas, Grenville Province

Thomas Clark, André Gobeil, Claude Hébert, Serge Perreault (Géologie Québec)

An inventory of the various mineral occurrences in the Lac Hulot (22K/03) and Lac Praslin (22K/04) areas was undertaken in order to classify these based on their physical and chemical characteristics and their mode of origin. This work was carried out within the framework of a geological survey undertaken in the area in 2000 (see Gobeil *et al.*, this volume). The area contains several Fe-Ti and Cu-Ni mineral occurrences associated with the La Blache plutonic Suite (anorthositic intrusion with a mafic-ultramafic envelope). Several Fe-Ti showings were discovered in these rocks in the 1950s; these were the focus of exploration campaigns including drilling up to the 1980s. Mineral occurrences form 10-metre thick horizons of massive titaniferous magnetite, lodged in a sequence of anorthosite, orthopyroxene-bearing anorthosite, leuconorite and leucotroctolite. The Cu-Ni potential of the mafic-ultramafic envelope surrounding the anorthositic massif was only recognized in the early 1990s. Several types of sulphide mineralization were identified: 1) disseminated to semi-massive sulphides associated with plagioclase peridotite layers one to several hundred metres thick; 2) disseminated sulphides in a 100-metre thick band of troctolite, leucotroctolite and norite; 3) disseminated sulphides in norite and/or gabbronorite horizons; and 4) disseminated sulphides in 10-metre thick magnetitite beds intercalated in the mafic rocks. Furthermore, small mafic to ultramafic intrusions injected in the gneissic terrains and the few paragneiss remnants identified in the area are locally mineralized with disseminated sulphides.

34 – Synthesis of the Pipmuacan Reservoir area (22E)

Claude Hébert (Géologie Québec)

The decision to update the geological map of NTS sheet 22E (Pipmuacan Reservoir) came after the completion of several geological mapping programs by the MRN between 1989 and 1999. A geochronological study was also integrated to the project.

Rocks of the Lac-Saint-Jean anorthositic Suite and part of the Labrieville Anorthosite cover nearly 2/3 of the surface area of the region. The country rocks hosting these anorthositic suites consist of gneisses, primarily igneous in origin. Several felsic to intermediate plutons cross-cut both the anorthositic rocks and the gneisses. The geochronological study is mainly focussed on the gneisses and the felsic to intermediate plutons. The ages obtained should help us find out more about the country rocks hosting the anorthositic suites, to link certain plutons to AMCG suites and to establish the history of other studied plutonic bodies.

The relative timing of emplacement of the various anorthositic, felsic and/or intermediate intrusive bodies was strongly influenced by the presence of major regional structures. The Pipmuacan deformation zone (Hébert, 1991), which transects the area in a NE-SW direction, is particularly important. Several episodes of thrusting and shortening must also be taken into account, along with a regional system of NNE-SSW oriented shear zones. Finally, NW-SE lineaments, generally associated with the formation of the Saguenay Graben, represent structural elements which played a role in the emplacement of late alkaline plutons.

Previous geochronological data, combined with data from this study help establish the age of certain mineral occurrences, namely the wollastonite deposit (over 50 million tonnes) discovered in 1989 by the MRN in Saint-Onge Township (Hébert, 1989). This is also the case for Ni-Cu and Fe-Ti-P showings in the Chute-des-Passes, Lac-à-Paul and Lac-Mélonèze areas (Hébert, 1998), and for Fe-Ti-P mineralization in the La Hache monzonite and the Gouin mangerite, located along the south-central and east-central margins of the area.

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35 – Petrologic, structural and economic (Ni-Cu, Fe-Ti-P) studies in the Lac-à-Paul area (22E/15), Lac-Saint-Jean anorthositic Suite, Grenville Province

Julie Fredette, Laurence Huss, Sophie Turcotte, Sarah-Jane Barnes, Réal Daigneault and Michael Higgins (CERM – UQAC) and Claude Hébert (Géologie Québec)

Pursuant to mapping by the MRN (RG 99-05), in 1998, of the Lac-à-Paul area (NTS 22E/15), located in the north part of the Lac-Saint-Jean anorthositic Suite (LSJAS), three studies were undertaken on : 1) the petrology of anorthositic, mafic and ultramafic rocks of the anorthositic suite and their potential for Fe-Ti-P mineralization, 2) the characterization of various types of Ni-Cu sulphide showings, and 3) the structural events that affected the LSJAS and the surrounding gneisses.

The anorthositic suite consists of anorthosite, leuconorite, norite, gabbro, gabbronorite, olivine gabbro, pyroxenite, peridotite, dunite and Fe-Ti-P oxide-rich rocks. All these facies display variable Fe-Ti-P enrichment. Rocks offering the best Ti potential are massive Fe-Ti oxide-rich rocks, which may contain 15-30% TiO_2 as ilmenite. For apatite, the most enriched facies are the peridotites and dunites (10-25% apatite), characterized by an olivine±pyroxene cumulate in a groundmass of magnetite and ilmenite. Apatite is disseminated in the cumulate and the groundmass.

Analysis of the geochemical behaviour of noble and precious metals in the Ni-Cu showings of Manouane, Nourricier, Paul and Lac Houlière indicates early sulphide segregation. Massive sulphides would have undergone important fractionation of mono-sulphide solid solution. Disseminated mineralization features higher metal contents than massive and semi-massive mineralization, which may be explained by the prolonged contact of sulphide droplets with silicate magma. Massive mineralization in the Manouane and Nourricier A areas shows Pt and Au fractionation, attributable to MSS fractionation. Metal profiles in the Paul showing area however, indicate that the massive sulphides did not undergo fractionation, and that the concentration of disseminated sulphides in the area are the lowest observed throughout the Lac-à-Paul region.

The LSJAS is characterized by shallow east-dipping primary layering (S_0). An S_1 fabric parallel to subparallel to S_0 is observed throughout the LSJAS. This S_1 fabric is associated with a shallow SE-plunging stretching lineation. This signature is compatible with NW-directed transport. A vertical S_2 fabric, oriented WNW-ESE, is observed within deformation zones; the most important one is located at the contact with the gneisses. NNE-SSW thrust faults represent continued NW-verging thrust movement. Gneissic country rocks display an older gneissocity, completely folded and transposed by a N-S foliation contemporaneous with the S_1 fabric in the LSJAS. Finally, a late dextral deformation zone striking NNE affects all the lithological units present in the eastern part of the area.

36 – New observations on the geology and structural setting of the Wakeham Group in the Lac Musquaro and Baie-Johan-Beetz sectors, Grenville Province

Louise Corriveau, Léopold Nadeau, Anne-Laure Bonnet, Ahmed Laamrani, Guy Scherrer and Pierre Brouillette

Studies undertaken in the 2000 summer season by the GSC in partnership with the Service géologique de Québec (MRNQ) and the Geological Survey of Newfoundland (GSNL) are conducted within the framework of a Labrador-Québec transect, aimed at improving our understanding of the nature and extension of the Labradorian (1.7-1.6 Ga), Pinwarian (1.55-1.4 Ga) and Grenvilian (<1.25 Ga) orogens/terrains in the eastern Grenville Province.

Supracrustal rocks belonging to or related to the Wakeham Group constitute a distinctive lithological element and a structural marker for these terrains. New observations in the sectors of Lac Musquaro – d'Auteuil helped establish important distinctive features within the granitic gneisses, and led namely to the identification of felsic volcanic rocks, presumably belonging to the Wakeham Group. Moreover, the outstanding zone of outcrop along the coast in the Baie-Johan-Beetz sector made it possible to identify at least three regional ductile deformation events followed by a phase of ductile-brittle deformation focussed along certain zones such as the Watshishou – Lac Caron zone.

Granitic gneiss units along the shores of Lac d'Auteuil and Lac Musquaro, which had previously been interpreted as arkoses, correspond in fact to lapilli tuffs intercalated with massive or banded felsic gneiss and nodular gneiss of unknown origin. These tuffs leave no doubt as to the presence of felsic volcanism in the Wakeham Group. Variably-oriented lapilli tuffs injected with finely banded material and irregular dykes suggest the proximity of the volcanic edifice, and a certain degree of hydromagmatism. Surrounding granites also display 10-m wide screens of coticules and garnetites with yellowish to pinkish garnets associated with hornblendites. These supracrustal rocks are in intrusive contact with adjacent granitoids and their gneissic equivalents.

Metasediments in the Baie-Johan-Beetz area display structures which indicate the partial preservation of primary bedding, in this case, cross-bedding. We can however demonstrate that these structures were locally affected by a first phase of folding, with the development of submetric folds with frequently sheared hinges, giving rise to pseudo-cross-bedding. The transposition of metasediments – metagabbros and the development of the dominant foliation are attributed to a second event at the amphibolite facies. A third event, also at the amphibolite facies, accompanied the structural emplacement of surrounding major plutonic complexes. The deformation finally became more focussed, producing ultramylonite zones, and evolved from a ductile regime at the greenschist facies to a brittle regime.

37 – Geology of the Lac Dieppe area, Grenville Province

Suzie Nantel, Hillar Pintson, Louise Langlais, Ehouman N'Dah (Géologie Québec)

This mapping survey at a scale of 1:50,000 of the Lac Dieppe area (sheet 31O/03) forms the continuation of mapping in sheets 31J/10, 31J/11, 31J/14 and 31J/15 conducted between 1996 and 1999 in the Mont-Laurier area. This work was carried out within the scope of an economic potential assessment of areas favourable to the presence of zinc, as well as industrial minerals and building stone.

The area falls within the Mont-Laurier terrain of the Grenville Province. It is divided into three lithotectonometamorphic domains. The first represents the extension of the Caïn Domain, originally defined in map sheet 31J/14. In sheet 31J/15, this domain consists of a series of metapelites, quartzites, calc-silicate gneisses and calcitic marbles cross-cut by gabbros with orthopyroxene-bearing mobilizate, tonalites, charnockites and porphyritic monzonites. Based on the presence of interference patterns, these rocks were affected by two phases of folding: the first with E-W axes and the second with SE-NW axes. In the western part of the domain, lineations are variably oriented, but in the eastern part, they consistently trend 210-240°.

The second domain corresponds to the Baker Domain, previously defined in sheet 31J/14. The typical lithology is a pink fine-grained monzogranite combined with pink pegmatite. These facies are massively injected into biotite-feldspar paragneisses (typical of the Ascension metamorphic Suite), calc-silicate gneisses, calcitic and dolomitic marbles, quartzites and a few fibrolite-muscovite paragneisses. Stretching lineations observed in the Baker Domain in the NW part of the map area are oriented NE.

The abundance of outcrops with recent brittle structures outlined by the presence of breccias, striations, quartz geodes as well as epidote, chlorite and hematite alteration is remarkable. These recent faults followed the path of older deformation zones such as the Lièvre thrust zone that marks the boundary between the Caïn and Baker domains. In sheet 31J/15, numerous kinematic indicators have confirmed a direction of movement from the SW to the NE along this zone.

The third Bressani Domain contains the oldest rocks in the area, namely tonalites that are either homogeneous, or banded with diorites. Numerous recent faults such as those described above, separate this domain from the other two domains. No lineation was observed in the Bressani Domain.

An area of about 1 km^2 located in the core of a brown-red porphyritic monzonite intrusion merits further attention in the search for potential sites of architectural granite production.

38 – Geology of the Lac Adams area (NTS 22A/13-200-0202)

Serge Lachance (Géologie Québec)

This project is part of a process undertaken to upgrade the geology at a scale of 1:20,000 in certain parts of the north-central Gaspé area in order to better define geological settings favourable to the presence of ore deposits. The Lac Adams area corresponds to topographic sheet 22A/13-200-0202. During the summer of 2000, we carried out traverses along logging roads in sectors previously not covered in our 1993 and 1994 surveys. We also reviewed this previous work and transferred the data along with the new 2000 data into SIGÉOM.

The study area is mainly underlain by the north limb of the Connecticut Valley-Gaspé Synclinorium, a major tectono-stratigraphic element of the Appalachian geological Province. Exceptionally, lithologies of the Québec Supergroup are observed in the northwest corner. The stratigraphic sequence for the entire area extends from the lower Cambrian to the lower Devonian, and mainly consists of sedimentary rocks. Lithostratigraphic units forming this sequence are, from the oldest to the youngest: the Orignal Formation, the undifferentiated Trois-Pistoles Group and the Romieu and Rivière-Ouelle formations of the Québec Supergroup; the Sources Formation of the Matapédia Group; the Val-Brillant, Sayabec, Gascons, West Point and Indian Point formations of the Chaleurs Group; the three formations of the upper Gaspé Limestones: Forillon, Shiphead Indian Cove, and the two lower formations of the Gaspé Sandstones: York Lake and York River. The Lemieux intrusive Suite, which extends from the Silurian to the middle Devonian completes the sequence. In the area, the suite is represented by mafic and felsic dykes and sills.

Taconian (NW part of the map area) and Acadian orogenic phases deformed this sedimentary sequence into a series of folded and faulted strata.

Folds are oriented NE-ENE with shallow to moderate NE-ENE or SW-WSW plunges, and the regional cleavage is steeply-dipping to the NW-NNW or occasionally towards the SE-SSE. Regional longitudinal faults and transverse faults have also been observed or assumed.

Zones of contact metamorphism or hydrothermal metamorphism of variable dimensions have been observed in the vicinity of certain intrusive bodies. The most important alteration zone is located in the northeast part of the map area. This zone, represented by marbles, porcellanites, and horfels, represents the host rock of the copper orebodies at Mines Gaspé (Noranda inc.), which ceased mining operations permanently on October 14th, 1999 after 45 years of production, due to the depletion of mineable ore reserves.

39 – The Connecticut Valley-Gaspé Synclinorium in the western Gaspé area

Daniel Brisebois, Serge Chevé, Christine Beausoleil (Géologie Québec) and Claude Morin (DGP – MRN)

The Connecticut Valley-Gaspé Synclinorium (CVGS) is one of three tectono-stratigraphic units in the Gaspé Belt, a successor basin of Acadian sedimentary and volcanic rocks in the northern Appalachians. The two other units are the Aroostook-Percé Anticlinorium (APA), south of the CVGS, and the Baie-des-Chaleurs Synclinorium, south of the anticlinorium. The CVGS comprises two stratigraphic sub-units: the Gaspé fold belt in the north and the Gaspé trough in the south. The fold belt is composed of rocks of the Chaleurs Group (Awantjish, Val-Brillant, Sayabec and Saint-Léon formations), the upper Gaspé Limestones (Forillon, Shiphead and Indian Cove formations) and the Gaspé Sandstones (York Lake, York River and Battery Point formations). The contact between these rocks and the underlying Cambro-Ordovician (Québec Supergroup, Shickshock Group, Ruisseau Isabelle Melange or Redemption Complex) consists of an erosional unconformity, or of the Schickshock South normal fault. The Gaspé trough is formed of the Fortin Group bounded to the north by the Sainte-Florence reverse fault, and to the south by the Grand Pabos strike-slip fault or the Chaleurs Group, which is conformably overlain by the Fortin Group.

Mafic dykes of the Lemieux intrusive Suite cross-cut the Saint-Léon and the upper Gaspé Limestones in the south part of the fold belt. Moreover, magnetic surveys suggest the presence of deep-seated granitic intrusions in several parts of the eastern study area.

Epithermal and vein-type auriferous mineralization at Sainte-Marguerite constitutes the principal economic interest in the area. Numerous Cu mineral occurrences in the Schickshock Group outline this unit's potential for stratiform Cu or volcanogenic massive sulphide mineralization. Chromitite bodies in the Redemption Complex (with PGE potential) and Cambro-Ordovician argillites of the Orignal Formation (sedimentary stratiform Cu) constitute assemblages whose mineral potential merits further evaluation. Siliceous deposits in the Val-Brillant Formation, limestone and dolomite in the Sayabec and Saint-Léon formations, and a slate potential in the Fortin Group represent potentially interesting sources of industrial minerals. The oil-bearing potential of Siluro-Devonian rocks in the northern part of the synclinorium is currently being assessed.

40 – Appalachian foreland and platform architectures in Québec, New Brunswick and Newfoundland : Progress report on the Geological Bridges in Eastern Canada

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The Geological Bridges in Eastern Canada is a five-year multi-agency geoscientific initiative. The *Bridges* span geological segments critical to our understanding of southeastern Québec, northwestern New Brunswick and western Newfoundland. The *Bridges* project plans to use five narrow geological corridors to fill existing gaps in the coverage of the Saint-Lawrence platform, the thrust fold belt of the Appalachian foreland basin (Humber zone), and the successor basins. The program includes the production of maps showing the bedrock and surficial deposits performed in conjunction with provincial geological mapping projects, as well as a series of thematic studies aimed at improving the economic potential assessment of these areas. During the 2000 summer season, over 40 individuals were at work in the various tectono-stratigraphic domains in the transects of Montreal-Appalachians (#1), Québec-Appalachians (#2), Matane-New Brunswick (#3), Anticosti-Gaspésie (#4), and western Newfoundland (#5).

New geological maps of the bedrock and surficial deposits at 1:50,000 and 1:20,000 were produced for the Humber zone in Québec and Newfoundland (transects #2 and #5), as well as for Paleozoic and Quaternary successor basins in Québec and New Brunswick (transects #2, #3 and #4). Thematic studies were conducted on A) the stratigraphy and diagenesis of the Paleozoic autochthonous platform (transects #1 and #4) in order to initiate regional correlations and define its hydrocarbon potential, B) the tectono-stratigraphic and diagenetic evolution of the Humber zone (the five transects) aimed at proposing regional correlations and a structural history, C) the tectono-stratigraphic evolution of post-Taconian successor basins (transects #2, #3 and #4), in order to correlate Devonian units along the orogen, and Late Ordovician-Early Silurian units on either side of the Québec-New Brunswick border, and D) the stratigraphy of Quaternary basins (transects #1, #2 and #3), in order to build a paleogeographic framework and propose a 3D architecture for these deposits. Finally a SWATH scan bathymetric survey was carried out along the eastern coast of the Gaspé area (#4), detailed magnetic susceptibility data was collected for successions in the northeast Gaspé area (#4) and seismic lines for transects #1, #2 and #4 were reprocessed. The objective of this work is to reconstruct the 3D architecture of the continental margin and to help recognize the nature of contacts between tectonostratigraphic domains. Preliminary results of these studies will be presented.

41 – Seismic reflection geophysical survey – Val-Brillant: Seismostratigraphy, geological structures, Shickshock South – Causapscal – Ste-Florence major faults (raw data)

Claude Morin, Jean-Yves Laliberté, Daniel Deschênes, Louise Levesque (MRN, Secteur Énergie, Direction du gaz et du pétrole)

Despite a history of 140 years of sporadic exploration for oil in the Gaspé area, the region is still known for its oil-bearing potential. Recently, significant oil showings were discovered in the Val-Brillant area. In the summer of 1999 and 2000, Géologie-Québec and the Energy Sector (DGP) completed the geological mapping of the western part of the Gaspé area. With this new geological compilation in hand, and in order to visualize geological structures in 3 dimensions, 9 geophysical seismic reflection transects totalling 118 kilometres were acquired last October by the Energy Sector. This new basic geoscience data will help establish a global picture and a better understanding of the subsurface, namely concerning the orientation of the major Shickshock South fault, which was intersected in 6 different locations, and the Causapscal and Ste-Florence faults, intersected once each.

This 3D view will lead to a better understanding of the regional geology and will help recognize the relative importance of geological structures and the emplacement mechanism of the dynamic hydrocarbon system. Consequently, this acquisition of geoscience data will provide a new impetus for the exploration of all mineral resources (oil, gas and metals) in the western Gaspé area, and will favour additional private investments in these fields of activity.

42 – A new exploration tool : the Québec multidisciplinary scannography laboratory (LMSQ)

Bernard F LONG, Jean-François KRÉMER and Alfonso RIVERA (CGQ)

INRS-Géoressources, in association with various research centres, is creating a Multidisciplinary Scannography Laboratory, for the purpose of developing scannography applications outside of the medical field, primarily in the natural resources and engineerings fields.

In geology, this laboratory, which uses a non-destructive high-speed method of sample analysis (eight sections per second) and image reconstruction, will be developed for 3D studies of sedimentary structures and fracture patterns, analyses of solution cavities and accretion zones, calculations of porosity, fluid migration, density variations for both hard rocks and unconsolidated sediments from core samples.

This infrastructure, unique in Canada, will make it possible to study hard rocks and unconsolidated sediments, from core or grab samples, in order to develop models for exploration or mining of mineral and hydraulic resources. It will be particularly useful for :

— The 3D characterization of sedimentary and organic structures to determine the internal structure of detrital bodies
— The identification of micro-fissures in fractured and consolidated rocks
— The direct measurement of matrix diffusion in order to assess the transport mechanisms of polluting agents through fractured rocks
— The characterization and rehabilitation of contaminated sites
— The calculation of the reservoir potential of sedimentary rocks

This laboratory will serve both to develop experimental techniques and as an assessment tool for industrial projects. It will invite very widespread collaboration with individuals and agencies from various branches of the earth sciences.

44 – Inventory of aggregate resources in the Scotstown area : 21E/11

André Brazeau (Géologie Québec)

During the 2000 summer season, an inventory of aggregate resources was undertaken in the Scotstown area. This work, at a scale of 1:50,000, covered NTS sheet 21E/11. Results of this survey will help locate and characterize sources of aggregate in the area, and assess their importance.

Field activities mainly consisted in the visit of sand and gravel pits (a total of 79) as well as the examination of numerous natural cross-sections and road cuts. Furthermore, 19 sand and gravel samples were collected and shipped to the laboratory to determine their physico-mechanical properties.

The region is characterized by very uneven topography, and is part of the Appalachian Highlands physiographic unit. The latter namely comprises the Scotstown hills, the Weedon hills and the Saint-François River valley.

The bedrock is part of the Appalachian geological Province. A wide variety of sedimentary, volcanic and intrusive rocks are present. These rocks have been deformed to differing degrees, and often display an important schistosity.

Deposits which may represent sources of aggregate are mainly glacial in origin. They were generally emplaced during the last deglaciation, about 12,500 years ago. Ice-contact and fluvio-glacial deposits constitute the best sources for sand and gravel. These deposits are often confined in valleys. In the area, most of these deposits have a restricted extent and only contain a small quantity of material. Furthermore, several of these have been intensively mined, and are today almost completely depleted. Some glacio-lacustrine and fluviatile deposits may also contain aggregate resources.

The quality of aggregates in the area appears to be quite variable. This material, which was extracted from the bedrock through the action of glaciers, reflects the wide variety of underlying rocks.

The main sources of aggregate in the study area are: deposit no. 2, near Fontainebleau, deposits 5 and 6, located on either side of the Saint-François River south of Weedon, deposit 18 southwest of Scotstown, and deposit 31 north of Milan.

45 – Glaciations at the service of exploration

Ghismond Martineau, Cathy Lapointe (Géologie Québec)

The first copies of a new SIGÉOM product focussed on glacial geology are now available. In this product, entitled *"Glacial Transport"*, we have grouped indicator and erratic boulders, as well as glacial erosion micro-features. Erratic boulders and indicator boulders are represented by dots accompanied by a short mineralogical or lithological description. Areas of boulder counts carried out within the scope of glacial dispersion studies are represented by crosses. Near the latter, the proportion of boulders of each lithology inventoried is indicated by a percentage. A particular symbol identifies boulders displaced through floating ice processes, within marine or glacio-lacustrine limits. Outcrops exhibiting glacial erosion micro-features are represented by the usual symbol for striations, oriented in the direction of glacial flow. When several striation symbols are present on a single outcrop, the relative timing of movement is indicated by a number near the striation symbol.

The consultation of *Glacial Transport* map sheets therefore makes it possible to establish the orientation and relative timing of the various ice flow events, and to estimate the importance of transport associated with these processes for the entire land surface of Québec. These elements of information were grouped together to offer an additional tool to mining exploration. This tool may prove particularly useful when attempting to locate the source of mineralized erratic boulders, namely in regions where numerous ice flow events took place.

46 – Industrial mineral potential in the regional county municipalities of Rouyn-Noranda and Vallée-de-l'Or

Henri-Louis Jacob, Pierre Buteau and Yves Bellemare (Géologie Québec)

The objective of this project is to assess the potential for industrial minerals, peat and architectural stone within the regional county municipalities (MRC) of Rouyn-Noranda and Vallée-de-l'Or. This project was undertaken following a request formulated by members of the "Comité Zone Active" of the MRC Vallée-de-l'Or in the fall of 1999, seeking to diversify the economic activities in this part of northwestern Québec. Work conducted in the summer of 2000 consisted in an overview of the various geological settings present in this territory.

The only **industrial minerals** inventoried within the large volcanic belts are asbestos and talc, locally associated with metavolcanic or plutonic ultramafic rocks, as well as pyrophyllite associated with altered felsic volcanic rocks in Carpentier Township north of Senneterre. Certain metasedimentary rocks in the Pontiac Group contain alumino-silicates such as andalusite, sillimanite or staurolite, whereas spodumene-rich pegmatite dykes are associated with peraluminous monzogranitic plutons that cross-cut metasedimentary and metavolcanic rocks. These plutons also contain granitic pegmatite dykes and lenses which may represent potential sources for feldspar, quartz and muscovite.

Our field work has allowed us to identify 5 **peat bogs** that fulfil in part or in whole, the selection criteria that we developed for the production of peat blocks (surface area, thickness of strata, nature and breakdown index of geobotanical assemblages forming peat horizons, colour, exfoliation potential, drainage, road and railway infrastructure). These are the Champneuf (850,143), Uniake (830,041), Belcourt (830,030), Tiblemont (830,052), Louvicourt (830,106) and Lac Blouin (830,073) peat bogs (Buteau, 1989). Although several of the peat bogs studied in the Abitibi did not meet our minimum established criteria, our results lead us to believe that several other targets could be very promising, namely south of Val d'Or and along the Senneterre – La Sarre axis.

Potential assessment of lithological units for the production of **architectural stone** requires two phases of evaluation, namely: one for dimension stone, and one for building stone, decorative stone and monument stone.

Our review of lithological units led to the conclusion that the potential for dimension stone is low. The large number of fractures in the rock, combined with the presence of various undesirable elements such as sulphides, quartz or carbonate veinlets, all types of enclaves and dykes, make it impossible in many cases to produce standard blocks (12 m^3), that may be used in this type of industry. Furthermore, the relative paucity of rock outcrops, and the low relief of hills limit the search for potential sites for dimension stone to very restricted sectors. However, certain lithologies feature interesting textures and colours very likely to attract small-scale production for building stone, decorative stone or monument stone.

Reference

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47 – Mineral potential of the Tadoussac – Forestville area (NTS sheet 22C)

Serge Perreault and Henri-Louis Jacob (Géologie Québec)

The objective of this project is to update mineral deposit files in NTS sheet 22C between Tadoussac and Forestville. Field work conducted during the 2000 summer season included the visit and description of industrial mineral showings and former producers, as well as sulphide showings.

Metasedimentary rocks in this portion of the Grenville Province contain conformable lenses of granitic pegmatite locally enriched in muscovite. Some of these lenses, all located in Bergeronnes Township, were mined sporadically for sheet mica between 1892 and 1946 (Greig, 1952). Mined deposits, which reportedly supplied high-quality muscovite, are too small to offer economic interest today.

The metasedimentary rocks that extend north of Les Escoumins host relatively muscovite-rich (up to 30%) horizons. These rocks were recently the object of prospecting work seeking a source of ground mica. North of Forestville, metasedimentary rocks contain pure quartzite horizons (99% SiO_2 and more). Certain quartzite horizons were the focus of exploration and assessment studies as a potential source of high-purity silica. The thickest and purest horizons are found south of Lac Trompeur (sheet 22F/3) and east of Lac Croche (sheet 22C/14).

Other industrial mineral resources in the area include small ocher deposits associated with peat bogs near Les Escoumins and Saint-Paul-du-Nord, along the Romaine River. The latter have attracted small-scale mining in the past as a source of mineral pigment. In the Tadoussac area (Grande Anse), a pure calcite vein infilling late fractures cross-cutting Precambrian rocks was mined for lime in the early 1900s. Other similar veins were the focus of exploration work in the Petites Bergeronnes area between 1993 and 1994.

In the Grandes Bergeronnes and Les Escoumins area, several copper and copper-gold showings were the focus of exploration work between 1979 and 1994. The Boudrias, Pylone 300 and Projet Bleu showings are the most promising. Mineralization consists of disseminated to semi-massive sulphide lenses comprising chalcocite, bornite and chalcopyrite, with epidote, hornblende, plagioclase, biotite, quartz and sporadically scapolite. These lenses are hosted in a hornblende gneiss associated with amphibolite horizons.

48-49-50 – Financial assistance for prospectors, exploration funds and mining exploration compagnies

R. Boivin, J. Choinière, J. Henry, P. Marcoux, M. Bergeron

The MRN will allocate a budget of $12.65M to support mining exploration activities in Québec for the 2000-2001 fiscal year. This budget includes: an amount of $3.65M for the continuation of the Québec Mineral Exploration Assistance Program; an amount of $5M for the implementation of a program to support junior exploration companies experiencing difficulties, and another $4M devoted to the mining region of Abitibi.

The Québec Mineral Exploration Assistance Program (MEAP) underwent several modifications this year. The previous Near North Program was integrated, in addition to the $4M financial assistance measure for the Abitibi geological Subprovince. The MEAP is still designed for the same clientele, namely: prospectors, mining exploration companies, regional exploration funds, and native funds.

Prospectors will share a budget of $750,000 for the realization of nearly 100 projects. An amount of $1.85M has been granted to companies for over sixty surface exploration projects conducted outside of the Abitibi region. The five regional exploration funds will share a total amount of $1.1M. The Nunavik mining exploration fund has access to $300,000, and the new fund implemented with the Natashquan community can count on an amount of $50,000. The $4M budget devoted to the Abitibi Subprovince comprises three assistance measures for companies conducting surface exploration work, deep drilling and advanced exploration work.

The assistance program for junior exploration companies more specifically targets companies whose head office is located in Québec, and who perform most of their activities on its territory. To be eligible, companies must have expended a minimum of $500,000 in exploration work in Québec since 1997, and have access to a working capital below $500,000. Financial assistance for these companies may reach a total of $500,000, including a maximum contribution of $150,000 to the company's working capital, and of $350,000 for exploration work. Thus, 14 junior companies will receive a total assistance of $5M within the scope of this program.

51 – Recent U-Pb age dating in the James Bay area

Claude Dion, Jean David, Jean Goutier, Abdelali Moukhsil, Daniel Bandyayera, Martin Parent (MRN), Donald W. Davis (ROM)

Within the framework of the Near North Project, the MRN carried out U-Pb age dating on several lithological units in the James Bay area in order to better define the geological setting. The objective of this contribution is to present certain recent and in many cases previously unpublished data arising from this work.

The geochronological data is derived from three principal sectors, namely the La Grande and the Middle and Lower Eastmain greenstone belts (La Grande Subprovince), and the Frotet-Evans belt, in the Opatica Subprovince.

La Grande Belt:

La Grande Sud Tonalite (33F/10): this intrusion constitutes the host rock for numerous gold showings and deposits, namely Zone 32, held by Virginia Gold Mines. Zircons yielded a crystallization age of 2734 ± 2 Ma, which suggests synvolcanic emplacement.

A foliated tonalite (33G/06) represents one of the oldest lithologies in the area. Zircons yielded a crystallization age of 2881 ± 2 Ma. A titanite fraction yielded an age of 2602 ± 3 Ma, attributed to the last episode of regional metamorphism.

Middle and Lower Eastmain Belts:

A rhyolite in the Natel Formation (33B/04) yielded a volcanic age of 2739 ± 5 Ma.

A tonalite from the Village batholith (33B/03) displays several generations of zircons. The age of the oldest fraction (2720 ± 2 Ma) probably corresponds to the age of crystallization of the intrusion. This is the oldest known intrusion in the Eastmain River area.

A tonalite from the Le Caron batholith (33C/01) yielded a crystallization age of 2705.9 ± 0.9 Ma, which suggests syntectonic emplacement.

Frotet-Evans Belt:

Rhyolite, Storm Formation (32K/16): This unit forms the upper portion of the Evans Group in the central part of the belt. Zircons yielded an age of 2755.5 ± 0.9 Ma.

Lac Rocher intrusion (32K/09): This layered mafic-ultramafic intrusion represents the host rock for the Nuinsco Ni-Cu deposit. Zircons derived from a gabbro yielded an age of crystallization of 2703 +7/-4 Ma, indicating late-tectonic emplacement.

Parker pluton (32O/01): This granodiorite is located about 200 m SE of the Troilus mine, in the northeasternmost part of the belt. Magmatic titanites indicate a crystallization age of 2698 Ma, confirming observations pointing to late-tectonic emplacement. The Parker pluton is therefore not related to the emplacement of mineralization at the Troilus mine, which pre-dates the injection of felsic dykes dated at 2782 Ma.

In conclusion, it appears that rocks of the Frotet-Evans belt, and the Opatica Subprovince in general are older than units in the Abitibi (south) and La Grande (north) subprovinces, thereby suggesting the accretion of a micro-continent.

52 – Geology and metallogeny of the Lac Guyer area, James Bay

Jean Goutier, Claude Dion (MRN), Marie-Claude Ouellet, Sophie Turcotte, Olivier Rabeau (URSTM-UQAT), Jean David (MRN), Donald W. Davis (ROM)

During the 2000 summer season, three map sheets (33G/05, 33G/06 and 33G/11) were mapped at 1:50,000 scale in order to compare volcanic rocks with those in the Lac Yasinski area further west, and to study mineral occurrences. This area is underlain by Archean rocks of the La Grande and Opinaca subprovinces, as well as NW Proterozoic dykes. The Langelier Complex represents the dominant unit of the La Grande Subprovince in the area. It consists of a series of foliated and granoblastic tonalites cross-cut by numerous dykes of pegmatitic granite. Gneisses are rare, except in the central part of 33G/11. A tonalite in map sheet 33G/06, dated at 2881 ± 2 Ma, indicates the presence of tonalites older than the Langelier Complex (2788-2794 Ma), and probably represents a new unit. Volcano-sedimentary rocks are represented by the Yasinski and Guyer groups. The Yasinski Group contains banded amphibolites, metamorphosed intermediate rocks and iron formations, whereas the Guyer Group is composed of komatiites, basalts, ultramafic and sedimentary rocks and felsic pyroclastic rocks. The two groups are separated by tonalites and fault zones. A few weakly deformed plutons of tonalite and granodiorite intrude these rocks. The Opinaca Subprovince (south half of the area) is separated from the La Grande by a fault zone. It constitutes a homogeneous series essentially composed of biotite paragneiss (Laguiche Group) injected with tonalite and pegmatitic granite. Several peridotite and pyroxenite intrusions, 10 to 100 metres thick, are also present in the area. Preliminary work suggests the presence of two distinct generations of ultramafic rocks (syn-Guyer and post-Laguiche). The Bezier pluton, composed of porphyritic granodiorite and quartz monzodiorite, represents one of the youngest intrusions, as it is injected at the contact between the two subprovinces. The entire area is metamorphosed to the amphibolite facies.

Data collected to date allows us to subdivide observed mineral occurrences into 6 principal types: 1) Algoma-type oxide-facies iron formation; 2) sulphide-facies iron formation with base and precious metal potential; 3) Cu-Ni mineralization associated with komatiitic flows and associated ultramafic sills; 4) base and precious metal volcanogenic mineralization; 5) gold mineralization in quartz-sulphide veins and veinlets; 6) auriferous disseminated sulphides associated with deformation zones. The most promising occurrences are associated with silicate and oxide-facies iron formations with pyrrhotite and arsenopyrite mineralization, located at the contact between mafic volcanic rocks and paragneiss. Virginia Gold Mines discovered on its Poste LeMoyne Extension property a gold-bearing iron formation (Orfé showing), which yielded 82.21 g/t Au in a grab sample, 21.56 g/t Au over 5 m in a channel sample and 6.14 g/t Au over 5 m in drillhole PLE-98-02.

71 – The mineral potential map production system (MPMPS); An example of its application for Noranda-type volcanogenic massive sulphide deposits in the Joutel (32E) and Chibougamau (32G) areas

by D. Lamothe and C. Dion (Géologie Québec)

The MPMPS produces mineral potential maps derived from the application of parameters arising from a detailed metallogenic model. Produced at a scale of 1:250,000, these maps illustrate via a colour code the level of response to the model for each 250 m cell forming the matrix of the study area.

The MPMPS is a system that combines both: 1) the ability of the GQL (Andyne) graphics gateway adapted to SIGÉOM to query and extract data from Oracle databases, and 2) the spatial and statistical analysis techniques of the MGE software (Intergraph) applied to GIS-type matrix files derived from SIGÉOM or other sources. In the first case, the system helps integrate the results of GQL queries corresponding to the parameters of the selected metallogenic model. In the second case, the system makes it possible to apply a vast range of spatial analysis tools to geological elements relevant to the model (lithological contacts, drillholes, lithochemical analyses or secondary environment analyses, magnetic signature, satellite imagery lineaments, etc.).

The Noranda-type volcanogenic massive sulphide (VMS) ore deposit model is the first model to be processed by the MPMPS. This model essentially rests on the spatial analysis of about thirty parameters derived from the following criteria:

1. high heat flow necessary to maintain hydrothermal activity;
2. the presence of conduits allowing fluid circulation;
3. stratigraphic control marked by pauses in volcanic activity; and
4. the presence of mineralizing fluids.

The Joutel (32E) and Chibougamau (32G) areas were selected to test the application of the VMS model. Mineral potential maps indicate the presence of eleven (11) medium to high-potential sectors for the Joutel area, and ten (10) sectors for the Chibougamau area. Areas 32F and 32D are currently being processed using the same metallogenic model.

Two other models are being developed, namely: 1) a model outlining the potential for kimberlites and lamproites, and 2) an Olympic Dam-type model adapted to the Grenville.

72 – Digitization of geological compilation maps for integration into SIGÉOM

Christine Beausoleil (URSTM-UQAT), Chantal Bilodeau, Martina Chumova, Stéphane Dufour, Maureen Grant, Édith Jobin, Joanne Nadeau, Ian O'Gallagher, Réal Samuel and the digitization team (Géologie Québec)

The objective of the first phase of this project consists in building a digital geological base map for all of Québec, available in at least of the scales used in SIGÉOM, for December 31st, 2000.

A total of 1,670 NTS sheets cover the land surface of Québec at the various scales available in SIGÉOM (1:250,000, 1:50,000 and 1:20,000). The Service géologique du Nord-Ouest (SGNO) and the Service géologique de Québec (SGQ) are responsible for the production of base maps covering their respective territories.

The following list includes data compiled as of September 29th, 2000.

SGNO

Chibougamau District

This district is covered by 305 maps. Four maps are available at 1:250,000, 122 at 1:50,000 and 108 at 1:20,000.

Val d'Or District

This district counts 218 maps. Two 1:250,000 scale maps are available, 57 1:50,000 scale maps and 81 1:20,000 scale maps.

Rouyn-Noranda District

This district totals 226 maps. There are currently 4 maps available at 1:250,000, 80 maps are available at 1:50,000 and 123 maps at 1:20,000.

SGQ

The Service géologique de Québec is responsible for the production of 921 maps. To date, 127 of 131 maps at a scale of 1:20,000 are available; 580 of the 677 maps at 1:50,000 are available, and 51 of the 113 maps at 1:250,000 are available.

Status report

In the last few months before the deadline of the first phase of this project, it is realistic to expect the successful completion of the base map both in qualitative and quantitative terms. The digitization process has constantly improved over the years, and map production objectives have been met and even exceeded in the last two years.

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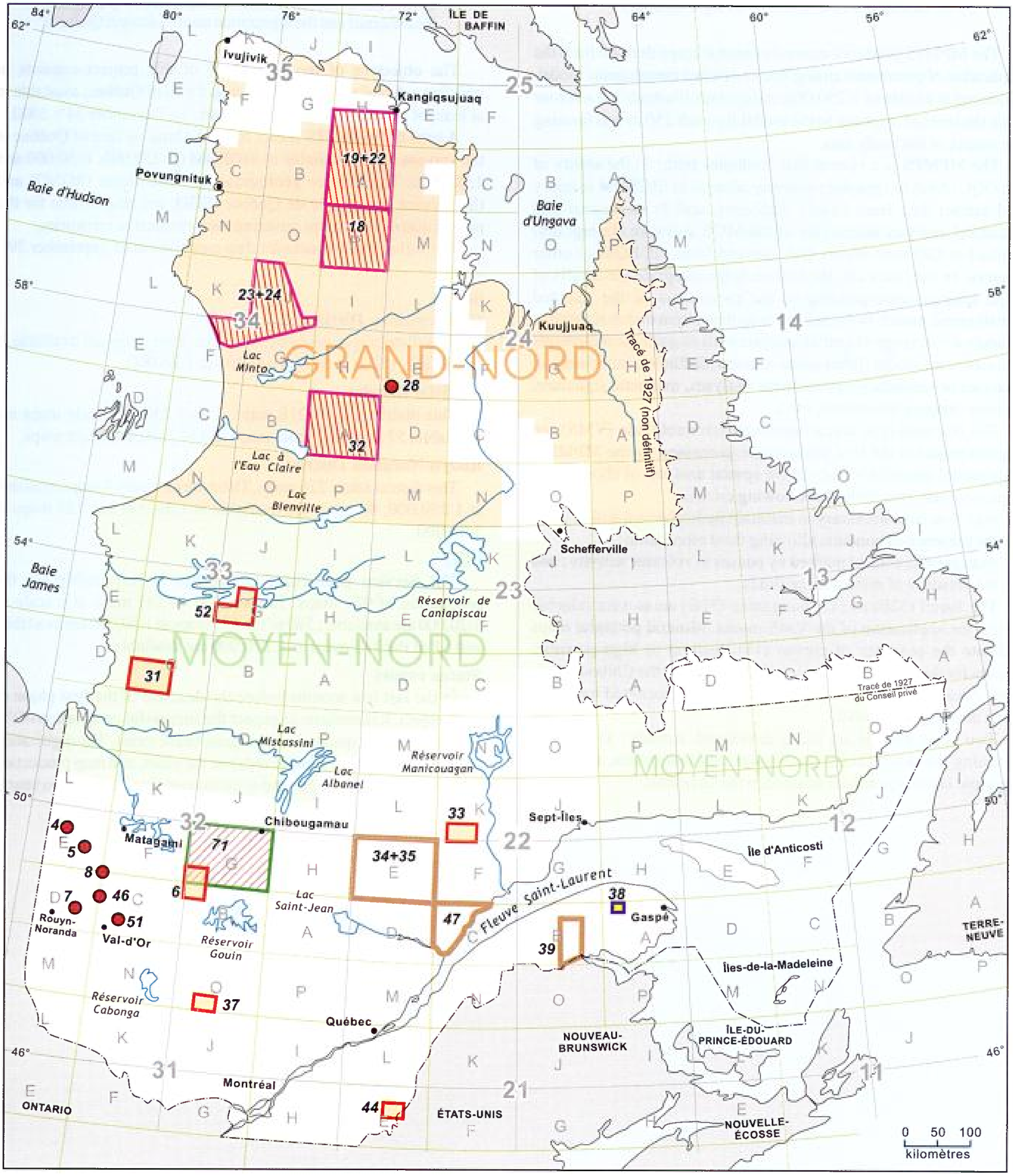

Location of field projects 2000-2001

The numbers refer to the poster abstracts for the mapping and research projects carried out during the summer of 2000 by Géologie Québec

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