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AN OVERVIEW OF THE NI-CU-CO-PGE POTENTIAL OF THE GRENVILLE PROVINCE OF QUEBEC

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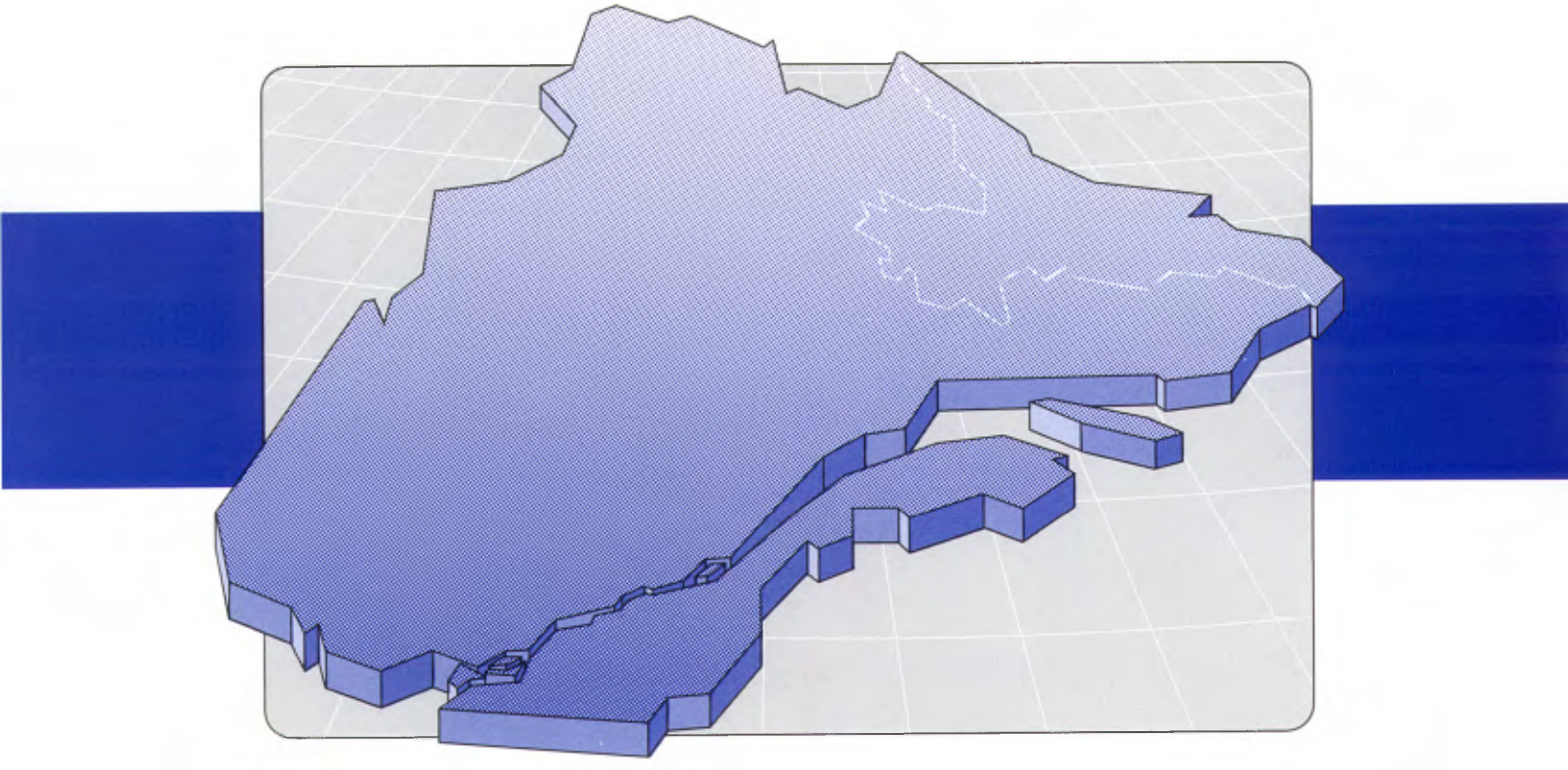
Énergie et Ressources naturelles
Québec

Canada
Québec
Travaux réalisés dans le cadre de l'Entente auxiliaire Canada-Québec sur le développement minéral

An overview of the Ni-Cu±Co±PGE potential of the Grenville Province in Québec

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PRO 98-02



1998

Québec

PRO 98-02 : An overview of the Ni-Cu±Co±PGE potential of the Grenville Province in Québec

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Introduction

More than 100 mineral showings of nickel-copper or nickel, with variable cobalt and platinum-group elements (PGE), are registered in the bank « COGÎTE » at the Ministère des Ressources naturelles du Québec (MRNQ) for the Québec part of the Grenville Province (Figure 1). Numerous additional showings are also shown in the figure. The exploration interest for Ni-Cu in the Québec Grenville has increased considerably since the discovery in 1994 of the Voisey's Bay (Labrador) deposit associated with a troctolitic intrusion (Ryan *et al.*, 1995). It has been spurred on by the MRNQ's discovery in 1996 of massive sulfides at Volant Lake (Perreault *et al.*, 1997). Note that Cu-Ni deposits were mined in the Grenville Province at Renzy Lake and Édouard Lake during the 1970's.

Distribution of sulfide showings

Ni-Cu±Co±PGE sulfide mineralizations in the Grenville Province are mainly associated with mafic and ultramafic rocks, which have a wide range of ages and occur in various tectonic settings (see, for example, the tectonic and geochronologic framework for the eastern Grenville Province by Gower, 1996). An evaluation of the PGE potential of about 16 sulfide deposits in the Québec Grenville was carried out by Barnes and Therrien (1996). The potential of the mafic intrusive rocks in Labrador for PGE deposits was studied by Wardle (1987). For many deposits in the Grenville Province, the age and setting of the host rocks to the mineralizations are not well known. For the purpose of this selective overview, the deposits have been grouped mainly geographically and arranged chronologically (excepting the last two on the list), as follows :

- on the Manicouagan Plateau (E of the Manicouagan Reservoir);
- associated with the Shabogamo Gabbro (**SG**, SE of Fermont);
- associated with mafic dikes cutting the Matamec Complex (**MC**, NE of Sept-Îles);
- associated with mafic-ultramafic intrusions cutting La Bostonnais Complex (**LBC**) and Montauban Group rocks (Portneuf-Mauricie area);
- associated with anorthositic massifs and with marginal mafic and ultramafic rocks (Grenville, in general);
- associated with other mafic-ultramafic intrusions (Grenville, in general).

1. MRN, Service géologique de Québec

Manicouagan Plateau (E of the Manicouagan Reservoir)

The Manicouagan Plateau is underlain by > 1.51 Ga (Gobeil *et al.*, 1996a) sills of gabbronorite and minor pyroxenite, felsic intrusions, and intercalated metasediments, metamorphosed to granulite facies. These rocks are intruded by several mafic-ultramafic and felsic intrusions. The numerous Ni-Cu±Co±PGE showings in the area can be subdivided into 2 types : (1) mineralizations in the older granulitic gabbronorite; (2) mineralizations in the younger, often coronitic, mafic-ultramafic intrusions.

Mineralizations of the first type (e.g. **2EZ**, **lac 108** located about 10 km S of 2EZ, **lac Uniforme** located about 35 km SW of 2EZ) are composed of disseminated sulfides and local veins of semi-massive and massive sulfides (Plante, 1985; Danis and Clark, 1991; Gobeil and Clark, 1993; Clark and Gobeil, 1997). The disseminated sulfides appear to have formed as a result of local contamination of mafic magma by reaction with enclaves or with intercalated horizons of sedimentary rock; in places, they have been affected by hydrothermal remobilization. The disseminated sulfides generally grade < 0.4 % Ni, < 0.3 % Cu, and < 0.05 % Co *(analyses mentioned in this article are those of the author unless otherwise indicated).* Vein sulfides reach grades of 1.5 % Ni, 2.1 % Cu and 0.15 % Co. PGE and gold contents of veins are low, < 30 ppb and < 6 ppb, respectively.

Layered or massive, mafic and ultramafic intrusions were emplaced into the granulitic gabbronorite sills and metasediments (Gobeil, 1995). They are composed of varied assemblages of leucogabbronorite, gabbronorite, anorthosite, olivine gabbronorite, pyroxenite, olivine-plagioclase pyroxenite, and plagioclase peridotite. Olivine-bearing rocks are coronitic. Sulfides are generally disseminated, but vein-like sulfides occur in places. Sulfides locally give elevated values in PGE and Au. In the **lac Mitaine** showing, for example, grab samples of olivine gabbronorite with disseminated sulfides reach 0.34 % Ni, 0.36 % Cu, 0.02 % Co, 1.3 ppm Pt, 0.5 ppm Pd and 0.6 ppm Au (Clark and Gobeil, 1997). Four mineralized zones have been discovered in the layered, 1.51 Ga **Reservoir intrusion (RI)** composed mainly of gabbronorite, leucogabbronorite, pyroxenite, and anorthosite (Gobeil and Clark, 1994; Gobeil *et al.*, 1996a). Layered gabbronorite contains disseminated sulfides grading up to 0.17 % Ni, 0.09 % Cu and 0.01 % Co. Semi-massive

and massive sulfides associated with small, late-stage, comagmatic pyroxenite bodies intruding the layered rocks grade up to 1.43 % Ni, 3.13 % Cu, 0.18 % Co, 76 ppb Pd and 130 ppb Au (in various samples). Other showings of this type have been discovered near **lac 108** and in **Villeray township** (20 km to the SE of 2EZ).

Shabogamo Gabbro (SG, SE of Fermont)

The Shabogamo Gabbro (~1.45 Ga; James, 1994) includes sills, locally layered and generally coronitic, of olivine gabbro and gabbro, along with a little pyroxenite and peridotite; these rocks are chemically similar to within-plate tholeiites (Gower *et al.*, 1990). Near Fermont, the sills intrude metapelites and granitic gneisses (Indarès, 1993). Bodies of peridotite-pyroxenite-melagabbro, which perhaps are fragments of dismembered Shabogamo sills, contain disseminated sulfides with low Ni/Cu ratios and in places relatively high PGE grades. The **lac Pegma** showing has maximum grades of 0.20 % Ni, 1.67 % Cu, and 0.3 % Co (Gleeson, 1956). The **lac Edgar** showing (35 km SE of Pegma Lake) grades up to 0.04 % Ni, 2.15 % Cu, 125 ppb Pt and 113 ppb Pd (Indarès, 1993).

Mafic dikes including the Matamec Complex (MC, NE of Sept-Îles)

The discovery of Ni-Cu-Co sulfides near **Volant Lake** in 1996 provoked a staking rush and gave new life to Ni-Cu exploration in the Grenville (Perreault *et al.*, 1997). Disseminated and massive sulfides occur within and adjacent to a 20 m wide dike of gabbronorite (~1.35 Ga) intruding granulitic gabbronorite of the Matamec Complex (**MC,** ≥ 1.37 Ga; Gobeil *et al.*, 1997). The dike, formed by multiple intrusions of magma (presence of igneous breccias), is chemically similar to Matamec gabbronorite and to contaminated, primitive tholeiite (Nabil *et al.*, 1997). The average grade of the massive sulfides was estimated at 2 % Ni, 2.3 % Cu and 0.1 % Co (Perreault *et al.*, 1997). In massive sulfides, Pd contents are typically 200-350 ppb, Pt grades are ≤ 65 ppb, and Au concentrations are erratic, ranging from < 10 ppb to 800 ppb (Perreault *et al.*, 1997); note that Nabil *et al.* (1997) reported higher but erratic grades for Pt. Drilling by SOQUEM has indicated only limited vertical thickness for the massive sulfides of the original discovery, but further exploration has revealed disseminated sulfides in the newly discovered northeasterly extension of the dike (Raymond, 1997). Mineralized mafic dikes have been discovered elsewhere in the Matamec Complex (e.g. Clark *et al.*, 1997a; press releases by Virginia Gold Mines, 21 October, 1997, and Fancamp Resources, 24 September, 1997). These discoveries suggest high exploration potential for the area underlain by the Matamec gabbronorite and for dikes similar to the Volant Lake dike elsewhere in the eastern Grenville.

Mafic-ultramafic intrusions cutting La Bostonnais Complex and Montauban Group rocks (Portneuf-Mauricie area)

The La Bostonnais Complex (**LBC**, ~1.4 Ga; Nadeau and van Breemen, 1994) is composed of a suite of calcalcalic, dioritic to granitic intrusions; it is closely associated with metasediments and felsic metatuffs of the Montauban Group. The assemblage probably formed in a magmatic arc environment (Gautier, 1993; MacLean *et al.*, 1982). These rocks are intruded by differentiated sills and plutons of gabbro-peridotite-pyroxenite composition, one of which is 1.07 Ga in age (Nadeau *et al.*, 1992). The mafic-ultramafic intrusions host several deposits of massive and disseminated sulfides, associated mainly with the most mafic rocks. The **lac Édouard** deposit, mined briefly during the 1970's, contained 160,000 tonnes grading 1.5 % Ni and 0.5 % Cu (Poirier, 1988); PGE and Au grades were low. Grab samples from the **lac Nadeau** showing, noted for its high PGE and Au grades, analyzed up to 0.5 % Ni, 0.4 % Cu, 0.5 ppm Pt, 1.1 ppm Pd, and 0.4 ppm Au (Poirier, 1988). A drill hole returned 0.6 ppm Pt and 0.6 ppm Pd over 1.5 m. Recently, Troymin Resources (press releases, 28 October and 19 November, 1997) announced the discovery of disseminated to semi-massive sulfides in a layered mafic-ultramafic intrusion in the **La Tuque** area (22 km SW of the lac Edouard deposit); grab samples returned up to 4.8 % Ni, 0.5 % Cu and 0.17 % Co, but further exploration on the site failed to reveal a significant volume of mineralization.

Anorthosite massifs and marginal mafic-ultramafic rocks (Grenville, in general)

Anorthosite massifs are part of the anorthosite-mangerite-charnockite-granite (AMCG) suite. They are composed mainly of anorthosite, leucotroctolite, leuconorite, and leucogabbronorite, along with subordinate mafic and ultramafic rocks such as troctolite, norite, gabbronorite, and pyroxenite (Emslie *et al.*, 1994). Charnockite, mangerite, and granite form envelopes around the massifs. Layered or unlayered mafic-ultramafic intrusions occur near the massifs or intrude their marginal zones. Numerous sulfide showings have been discovered in the Morin (**MA**), Shawinigan, Lake Saint-Jean (**LSJA**), Vaillant Lake (**LVA**), Rivière-Pentecôte (**RPA**), Berté Lake (**BEA**), Havre-Saint-Pierre (**HSPA**), and other massifs in the Grenville Province, and in the Harp Lake (**HLA**) and Michikamau (**MIA**) massifs in the adjacent Churchill Province of Labrador. Disseminated and massive sulfide mineraliza-

tions are most commonly located near the margins of the massifs. In many cases, the sulfides occur in bands of pyroxenite intercalated with the more leucocratic rocks; in other cases, they occur in assemblages, often layered, of mafic and ultramafic rocks including gabbro, olivine gabbro, troctolite, pyroxenite, and peridotite.

At the **Notre-Dame-de-la-Merci** showing in the Morin massif (1.16 Ga for associated pyroxene quartz monzonite; Emslie and Hunt, 1990), grades are typically 0.2 % Ni, 0.2 % Cu, 0.04 % Co, < 20 ppb Pt, < 20 ppb Pd, < 30 ppb Au (Poirier, 1988). The **McNickel** deposit, near the western margin of the Lake Saint-Jean massif (**LSJA**, ~1.15 Ga; Higgins and van Breemen, 1992), was evaluated at 5.8 Mt at 0.2 % Ni, 0.1 % Cu and 0.03 % Co (Mountain, 1990). The massive sulfides, perhaps mainly veins, grade up to 1.0 % Ni, 1.5 % Cu and 0.8 % Co; the disseminated sulfides are generally associated with pyroxenite bands (Clark and Hébert, in press). Alteration and sulfide remobilization are important features at McNickel. In the **Chute-des-Passes** area in the northern part of the Lake Saint-Jean massif, several significant showings with semi-massive and net-textured sulfides have recently been discovered in olivine-bearing mafic and ultramafic rocks (including troctolite, dunite, peridotite, and pyroxenite) (Hébert, 1997). Grab samples yielded on analysis up to 1.3 % Ni, 4.3 % Cu and 0.3 % Co (press release, Virginia Gold Mines, 4 November, 1997). The envelope of the **De La Blache Lake** massif (**LBA**)consists mainly of gabbro, along with bands of peridotite, olivine gabbro, and melagabbro (Lemery, 1992). These rocks form part of a differentiated mafic-ultramafic intrusion probably originating from multiple injections of magma. Several zones of disseminated sulfides occur in the most highly mafic rocks. The best grades obtained were 0.66 % Ni and 0.36 % Cu; grades for Co, PGE, and Au were low. Exploration by Tiomin Resources/SOQUEM resulted in the discovery of sulfide mineralizations near the contact of the **Berté Lake** anorthosite (**BEA**); samples gave grades up to 1.5 % Ni, 0.9 % Cu and 0.1 % Co (press release, September 4, 1996). Freewest Resources has reported the discovery of several disseminated to massive sulfide showings associated with small, elongated anorthosite bodies near **Perdu Lake** (NW of De La Blache Lake); samples from bands of mineralized pyroxenite in the anorthosite returned values up to 0.9 % Ni, 2.3 % Cu, and 0.18 % Co, as well as local anomalous concentrations of Ag and Au (press release, 27 August, 1996). Mapping by the MRNQ in 1996 in the Manitou Lake area (Gobeil *et al.*, 1996b; Clark *et al.*, 1997b) resulted in the discovery of several Ni-Cu-Co showings in pyroxenite bands in the marginal zone of the northwest lobe of the **Havre-Saint-Pierre massif** (**HSPA**, 1.06 Ga for the southwest lobe; van Breemen and Higgins, 1993). Recent exploration in this area has revealed several other showings of disseminated and massive sulfides; grades have reached 1.0 % Ni, 5.1 % Cu, 0.2 % Co, and 390 ppb Au (press release, Geonova Explorations, 12 November, 1997). The **B20** and **Coro** showings in the marginal mafic zone of the Rivière-Pentecôte massif (**RPA**, 1.35 Ga; Nantel and Martignole, 1991) returned up to 1.3 and 0.6 % Ni, 1.9 and 1.6 % Cu, and 0.2 and 0.2 % Co, respectively (press releases, Birchwood Ventures Ltd., 8 January and 23 October, 1996).

Other mafic-ultramafic intrusions (Grenville, in general)

The **Renzy Lake** Ni-Cu deposit, mined between 1969 and 1972, contained ~2 million tonnes of ore grading 0.7 % Ni and 0.7 % Cu (Poirier, 1988). The deposit is hosted by a folded ultramafic sill intruded into biotite-hornblende paragneisses. The sill consists of an amphibolitic border zone and an internal layered zone composed of pyroxenite and peridotite (Johnson, 1972). The mineralization (massive, disseminated, and vein sulfides) occurs in two lenses near the base of the intrusion. A bulk sample taken by the company graded 0.80 % Ni, 0.83 % Cu, 0.05 % Co, 0.1 ppm Pt, 0.1 ppm Pd, 0.1 ppm Rh, 0.32 ppm Au and 4.8 ppm Ag (Poirier, 1988). A grab sample rich in pyrrhotite graded 2.3 % Ni, 0.1 % Cu, 35 ppb Pt, 180 ppb Pd, 180 ppb Au; a sample rich in chalcopyrite returned 0.4 % Ni, 23.8 % Cu, 25 ppb Pt, 65 ppb Pd, 2120 ppb Au (Poirier, 1988).

The **Sainte-Véronique** deposit is hosted in a differentiated sill composed of gabbro, pyroxenite, and olivine pyroxenite with coronitic textures. The sill intrudes Grenville Supergroup paragneisses, about 1 km east of the Sainte-Véronique alcalic intrusion. The deposit consists of a disseminated sulfide zone about 10 m thick in olivine pyroxenite at the contact with paragneisses (Rive, 1976). A remobilized vein-type mineralization is also present. The disseminated mineralization, considered to be of magmatic origin, gave grades reaching 0.5 % Ni, 0.5 % Cu, 1.0 ppm Pt, 0.2 ppm Pd, and 0.9 ppm Au (Poirier, 1988).

The **Réservoir Taureau** showing is associated with a gabbro body intruding biotite gneisses. The mineralization occurs in the gabbro and in the wallrock gneisses. This showing is noteworthy for its Ni-Co arsenides. A bulk sample analyzed 0.46 % Ni, 0.51 % Cu, 0.014 % Co, 0.86 ppm Pt, 0.16 ppm Au, and 5.8 ppm Ag (Poirier, 1988). Poirier (*op. cit.*) considered that the sulfides resemble the vein-type mineralizations near Cobalt (Ontario). Note that more recent analyses gave about 100 ppb Pt, 100 ppb Pd, and no anomalous gold (S. Nantel, personal communication, 1996).

Several sulfide showings have been reported in the Manic 3 dam area (N of the lac Vaillant anorthosite, **LVA**). The **Lac Louis** showing occurs in a differentiated, multiphase pluton composed of gabbronorite and pyroxenite (Clark, 1991). Disseminated sulfides returned values up to 0.7 % Ni and 0.4 % Cu, while veins of massive sulfides graded up to 0.8 % Ni, 2 % Cu, 0.11 % Co, and

284 ppb Au. The disseminated sulfides are thought to be of magmatic origin, while the veins may represent remobilizations of primary sulfides.

On the Lower North Shore, several showings of massive, disseminated, and vein-type sulfides show evidence of hydrothermal remobilization. The **Lobster Bay** showing occurs in a gabbroic body intruding gneisses and grades < 0.5 % Ni and < 0.5 % Cu.

Discussion

Based on available descriptions, many of the Ni-Cu±Co±PGE showings in the Grenville Province are of magmatic origin. The distribution of known showings suggests that the margins of intrusions and the bases of differentiated sills and plutons are preferred sites for mineralization. The most favorable rocks are the most highly mafic, such as peridotites, pyroxenites, and olivine gabbros; the presence of olivine is therefore a positive factor. Tectonic and/or hydrothermal remobilization of primary sulfides is common. Massive sulfides commonly occur in close proximity to zones of probably magmatic, disseminated sulfides. However, it is possible that in some cases deformation has caused massive sulfides to move away from their place of origin.

As work progresses in the Grenville, it is becoming clear that Ni-Cu±Co±PGE sulfide mineralization can occur in a variety of tectonic environments, in rocks of widely varying ages, and in several lithological contexts, as noted above. Host mafic and ultramafic intrusive rocks include (1) layered and unlayered intrusions associated with anorthosite massifs, (2) massive and differentiated sills and plutons intruded into supracrustal sequences with no evident anorthosite association, and (3) dikes representing feeder conduits to crustal magma chambers or volcanic sequences. Given that the **Voisey's Bay** (Labrador) deposit is situated at the junction of a feeder dike and a large mafic intrusion (Naldrett *et al.*, 1996), settings such as that at **Volant Lake** are particularly interesting. In many areas in the Grenville, showings occur in intrusive rocks in close proximity to paragneisses, many of which are sulfide-bearing. Such an association is considered an important factor in the genesis of magmatic Ni-Cu deposits.

Mafic-ultramafic intrusions are numerous and relatively large in the NE part of the Grenville Province, indicating that great volumes of mafic magma were generated there (Figure 1). This suggests a relatively high Ni-Cu potential for this area and a wide scope for exploration. The Matamec Complex **(MC)** is one of the largest assemblages of mafic rocks in the Québec Grenville, and hosts several mineralized mafic dikes, including the Volant Lake dike. These mafic rocks may be related to the intermittent extensional tectonics that characterized the eastern Grenville Province in the period 1.45-1.23 Ga (Gower, 1996). During this time span, many large mafic bodies, anorthosite massifs, and mafic dike swarms were emplaced. Note that in the Matamec Complex, there is also evidence of high grade metamorphism and ductile deformation between 1.37 and 1.35 Ga, just before the emplacement of the lac Volant dike (Gobeil *et al.*, 1997). In the southwestern part of the Grenville, whose importance for exploration has been noted by Sharma *et al.* (1995), the mafic-ultramafic intrusions are smaller, and several showings consist of remobilized sulfides. Nevertheless, large volumes of sulfides have previously been discovered in that area (e.g. the **Renzy Lake** deposit).

An indication of the potential of Ni-Cu showings of magmatic origin (and for which data are sufficient) may be obtained from the composition of the sulfides, recalculated to 100 % sulfides. Relatively high values of Ni and Cu when normalized to 100 % sulfides suggest that conditions in the magma conduit or chamber were appropriate for metal enrichment. Significant metal enrichment (especially of the PGE's) occurs when the volume of silicate magma is high relative to the volume of sulfide liquid (large R factor; Naldrett, 1989). The Cu/Pd ratio can indicate whether or not a particular magma had previously been depleted in PGE, thus reducing its ability to produce Ni-Cu sulfides with appreciable amounts of PGE; this can happen, for example, if sulfides were segregated at an early stage (Barnes *et al.*, 1993; Barnes and Therrien, 1996). Thus Cu/Pd ratios close to mantle values ($\sim 10^3$-10^4) suggest that no sulfides were lost from the magma en route to the site of emplacement, and/or that sulfide formation involved high values of R. Based on these criteria, some of the showings associated with late-stage mafic-ultramafic bodies intruding the La Bostonnais Complex **(LBC)**or located on the Manicouagan Plateau may be promising, if sufficient volumes of sulfides were to be found. In these showings, the sulfides are relatively enriched in Ni, Cu, Pt, Pd, and Au, and they have Cu/Pd ratios close to mantle values. The showings in the Shabogamo Gabbro **(SG)** have relatively low Cu/Pd ratios, but the data are insufficient to evaluate the metal enrichment of the sulfides. Note that most Grenville Ni-Cu showings for which data are sufficient have very high Cu/Pd ratios; these mineralizations are not likely to have appreciable PGE. This is particularly evident in the case of deposits associated with anorthosite massifs (Barnes and Therrien, 1996). The **Volant Lake, Renzy Lake,** and **Édouard Lake** deposits contain mineralizations that show moderate Ni-Cu enrichments and high values of Cu/Pd; however, the characteristics of the magmatic plumbing systems allowed the accumulation of relatively large volumes of sulfides.

Thus, the search for an economic deposit of Ni-Cu±Co±PGE should be focussed on magmatic settings that allow the sulfides to become sufficiently enriched in metals and to accumulate in large volumes. Dy-

namic magma systems with abundant flow (allowing mixing of sulfide and silicate liquids) and entry points of magma into magma chambers are favored targets. Magma systems associated with major crustal-scale fractures or faults that penetrate sequences of sulfidic metasediments are most favorable. It has been suggested (Hamlyn *et al.*, 1985) that regions of the upper mantle depleted by a previous melting event may, when melted again, give rise to low-Ti mafic magmas that are relatively PGE-enriched. A remelting mechanism might explain why some late-stage intrusions in areas of abundant earlier mafic magmatism (e.g. Manicouagan Plateau) contain sulfides that are relatively enriched in PGE.

Acknowledgements

The author thanks his colleagues A. Gobeil et S. Chevé for their comments on the manuscript, and G. Soucy and P. Brouillette for the preparation of Figure 1.

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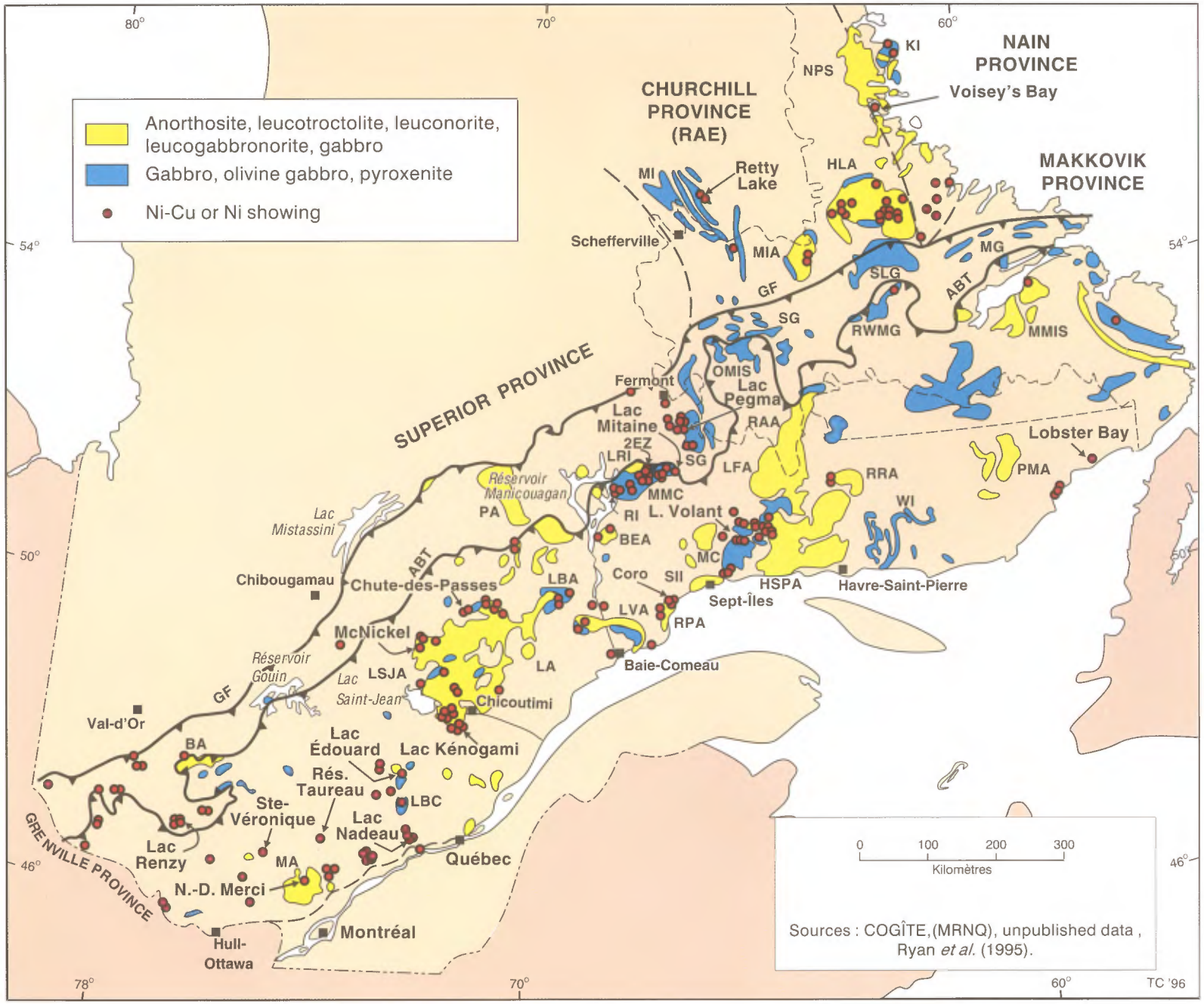


FIGURE 1 - Locations of Ni-Cu and Ni showings in the Québec Grenville and adjacent areas, from the COGÎTE bank of the MRNQ, unpublished data, and Ryan *et al.* (1995). **ABT**, Allochthon Boundary Thrust; **BA**, Bouchette Anorthosite; **BEA**, Berté Anorthosite; **GF,** Grenville Front; **HLA**, Harp Lake Anorthosite; **HSPA**, Havre-Saint-Pierre (Allard) Anorthosite; **KI**, Kiglapait Intrusion; **LA**, Labrieville Anorthosite; **LBA**, De La Blache Anorthosite; **LBC**, intrusions associated with La Bostonnais Complex; **LFA**, Lac Fournier Anorthosite; **LRI,** Lac Raudot Intrusion; **LSJA**, Lac Saint-Jean Anorthosite; **LVA**, Lac Vaillant Anorthosite; **MA**, Morin Anorthosite; **MC**, Matamec Complex; **MG**, Michael Gabbro; **MI**, Montagnais intrusions; **MIA**, Michikamau Anorthosite; **MMC**, Manicouagan metamorphic complex; **MMIS**, Mealy Mountains Intrusive Suite; **NPS**, Nain Plutonic Suite; **OMIS**, Ossok Mountains Intrusive Suite; **PA**, Pambrun Anorthosite; **PMA**, Petit Mécatina Anorthosite; **RAA**, Rivière Atikonak Anorthosite; **RI,** Reservoir Intrusion; **RPA**, Rivière-Pentecôte Anorthosite; **RRA**, Rivière Romaine Anorthosite; **RWMG**, Red Wine Mountains Gabbro; **SG,** Shabogamo Gabbro; **SII**, Sept-Îles Intrusion; **SLG**, Seal Lake Group; **WI**, Wakeham mafic intrusions.

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SERVICE GÉOLOGIQUE DE QUÉBEC
Chef: A. Simard

Accepté pour publication le 98/02/09

Éditeur
J.-P. Lalonde

Dessin assisté par ordinateur
G. Soucy

Supervision technique
A. Beaulé

Préparé par la Division de l'Édition (Service de la Géoinformation, DG)

FÉVRIER 1998

Gouvernement du Québec
Ministère des Ressources naturelles
Secteur des mines