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METALLOGENIC SYNTHESIS OF THE PORCUPINE-DESTOR FAULT, ABITIBI SUBPROVINCE

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Silicified and carbonatized brecciated basalt (Nipissing showing). The matrix consists of carbonates and quartz with a zonation from dolomite (beige), in contact with the fragments.

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Québec

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ABSTRACT

The Porcupine-Destor Fault (PDF) is one of the most important metallotects for gold in the Abitibi Subprovince. Studies were conducted along this fault from 2002 to 2004 to complete the regional mapping done in the 1990s and to develop new tools for gold exploration, including the present regional metallogenic synthesis. Through the synthesis, six types of gold mineralization have been identified, each with specific characteristics: 1) quartz + carbonates veins found in deformation zones with strong iron carbonate, sericite and pyrite alteration, characteristic of orogenic deposits; 2) disseminated sulphides associated with a porphyritic intrusion comprising two subtypes differentiated by the composition of the intrusion; 3) epithermal veins with open space crystallization textures and anomalous concentrations of Zn, Pb and Hg typical of neutral epithermal mineralizations; 4) argentiferous extension quartz veins rich in Cu, Sb, Zn and Hg, analogous to Ag-Pb-Zn veins enclosed in clastic metasedimentary rocks; 5) disseminated sulphides associated with leaching present as a massive quartz + pyrite (5-10%) residue reminiscent of acidic epithermal deposits; and 6) volcanogenic massive sulphide showings associated with quartz + pyrite + chalcopyrite replacement in basaltic flow breccia. Isotope geochemistry and electron microprobe analyses have been used to corroborate field classification of the different types of mineralization.

This study shows that gold emplacement has occurred at various depths and at various stages in the area's geological evolution. The definition of the characteristics of the different types of gold mineralization permits a more carefully targeted exploration in the region. In addition, some sectors and contexts have been identified as being prospective for gold-bearing deposits and they deserve special attention. The present study suggests that the Quebec portion of the Porcupine-Destor Fault underwent less erosion than the Ontario part, and that some of its gold potential must therefore lie at depth.

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INTRODUCTION

The Porcupine-Destor Fault (PDF) is one of the most important gold metallotects in the Abitibi Subprovince (Figure 1). This E-W trending fault can be followed over a distance of about 200 km from Timmins, Ontario to the area east of the town of Duparquet. On the Quebec side, the PDF was the site of gold mining from 1933 to 1956 (Beattie, Donchester and Duquesne mines) and from 1983 to 1990 (Duquesne, Yvan-Vézina and Davangus mines; Figure 2 and Table 1). However, very little gold was extracted on the Quebec side (≈46 t Au extracted; Table 1) compared with the situation in Ontario (≈2400 t Au extracted; Atkinson *et al.*, 2005; Meyer *et al.*, 2005). This difference can be explained by a number of socio-economic and geological factors such as the longer mining history of the Timmins sector (gold extraction began in 1910) and the greater extent of the PDF in Ontario.

In 2002, Géologie Québec began a metallogenic study along the PDF in order to complete the regional mapping work done in the 1990s (Lacroix and Landry, 1991; Goutier and Lacroix, 1992; Goutier, 1997). Another goal of the project was to develop new tools for gold exploration through a regional metallogenic synthesis and 3D-modelling (Fallara *et al.*, 2004). The main purpose of the present metallogenic synthesis is to characterize the different gold occurrences and define the chronology and the controls on mineralization. Areas and settings that have barely been explored, but that have potential for the discovery of economic deposits, are also described.

REGIONAL GEOLOGY

The geology of the PDF region (Figures 2a and 3) consists of an Archean volcano-sedimentary assemblage divided into four volcanic groups and two sedimentary groups (Goutier and Lacroix, 1992; Goutier, 1997; Goutier, 2003a and b). Located at the base is the Kinojevis Group, which encompasses two volcanic units. The Deguisier Formation (2718-2722 Ma; Zhang *et al.*, 1993; Barrie, 1999), consisting of ferriferous and magnesian tholeiites, is overlain by the Lanaudière Formation (2718 Ma; Zhang *et al.*, 1993), composed of basalts, andesites, rhyolites and komatiites. The Malartic Group (2714 Ma; Pilote *et al.*, 1998), which is in fault contact with the other units, is composed chiefly of ultramafic rocks, andesites and lapilli tuffs. The Hébécourt Formation (2701-2706 Ma; Corfu and Noble, 1992) consists of ferriferous and magnesian tholeiites characterized by variolitic and glomeroporphyritic textures. The Reneault-Dufresnoy Formation of the Blake River Group (2698 Ma; Mortensen, 1993) conformably overlies the Hébécourt Formation. Its lower part is composed of andesites intercalcated with intermediate pyroclastics. The sedimentary rocks making up the Mont-Brun and Caste formations of the Kewagama Group (2684-2686 Ma; Mortensen, 1993; Davis, 2002) are younger than the volcanic rocks and originated as turbiditic sediments deposited in deep basins. The Duparquet Formation of the Timiskaming Group (< 2682 Ma; Mueller *et al.*, 1996) is the youngest stratigraphic unit in the region. It is composed of polygenetic coarse-grained, poorly sorted sedimentary rocks that were deposited in alluvial and fluvial environments.

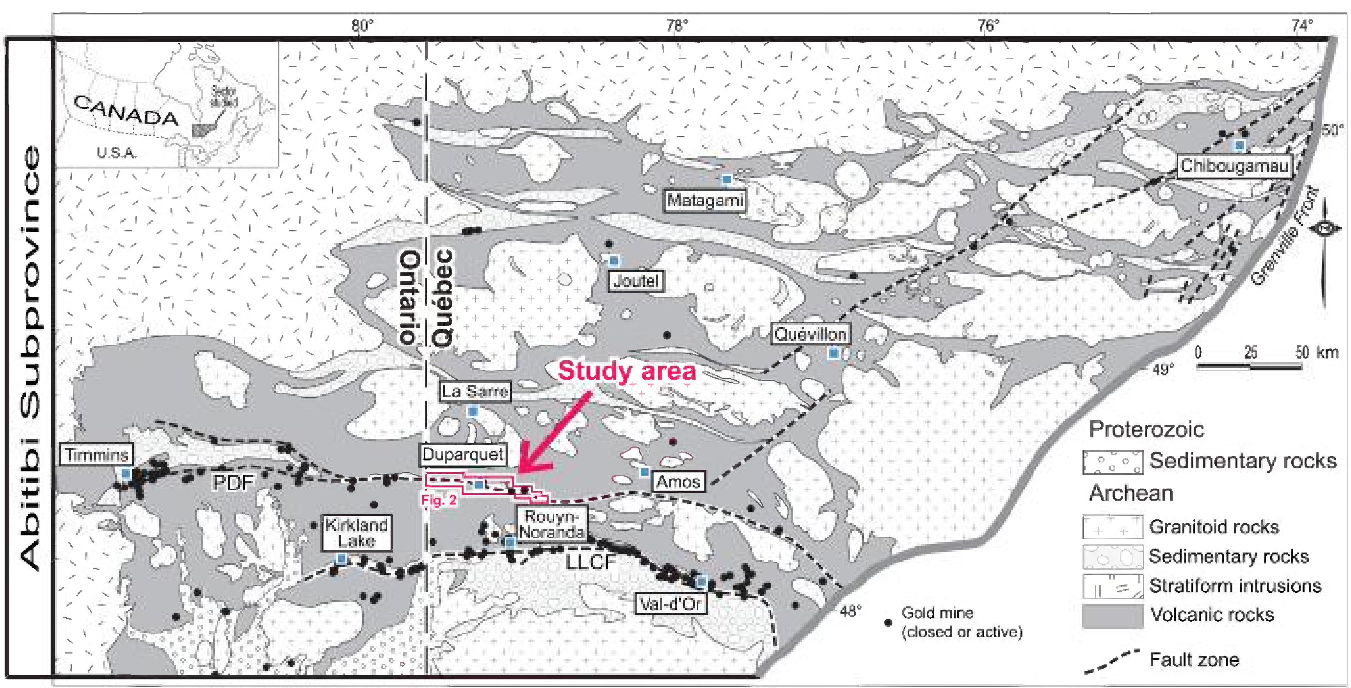

FIGURE 1 - Geological map of the Abitibi Subprovince showing the location of the Porcupine-Destor Fault (PDF). The study region is shown in red. LLCF = Larder Lake-Cadillac Fault.

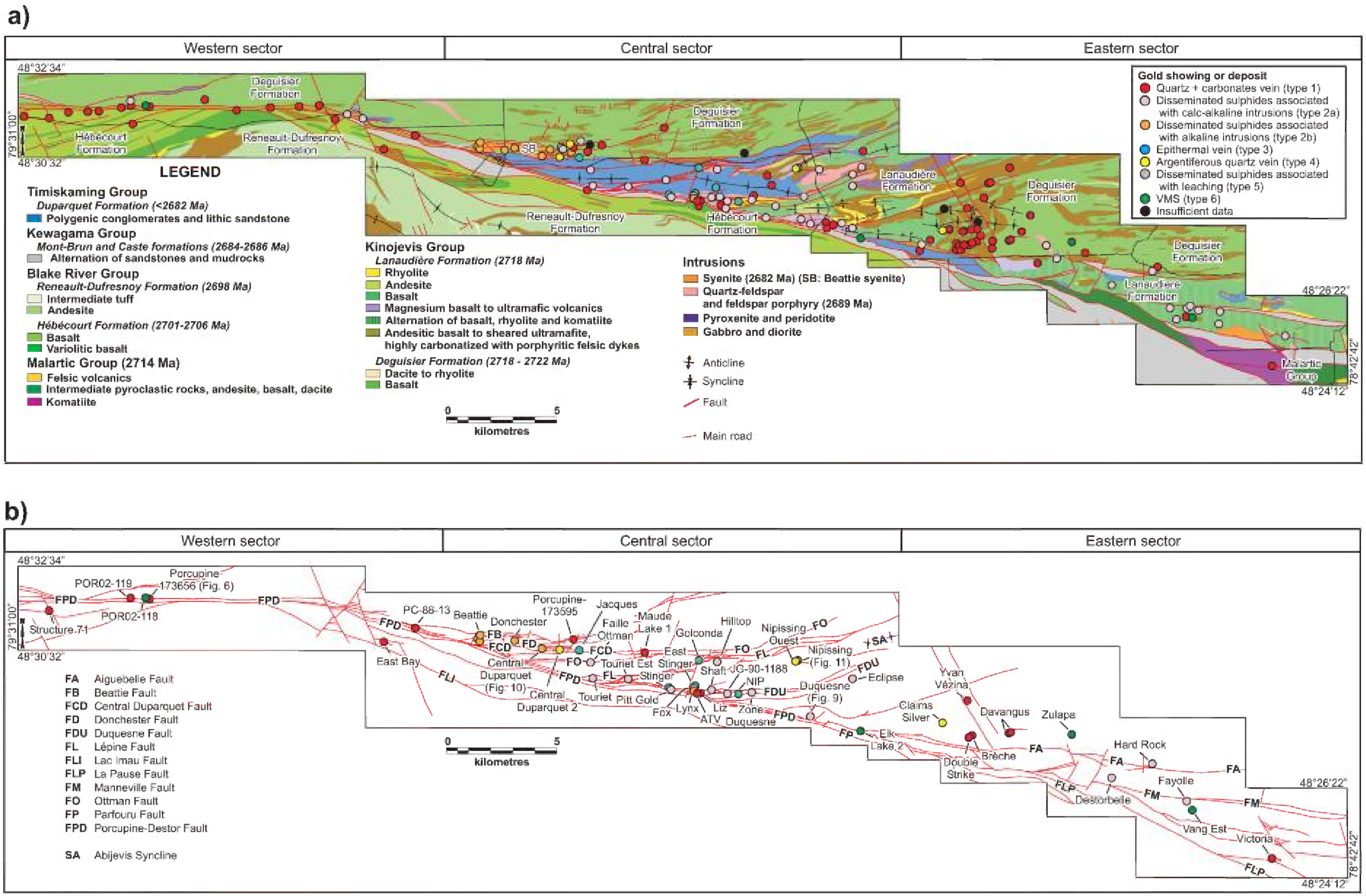

FIGURE 2 - a) Regional geological map of the Porcupine-Destor Fault. The figure draws on SIGEOM maps. See the text for dating references. **b)** Identification of showings and faults mentioned in the text. Different colours are used to illustrate the different types of gold mineralization. The complete list is given in Appendix 1.

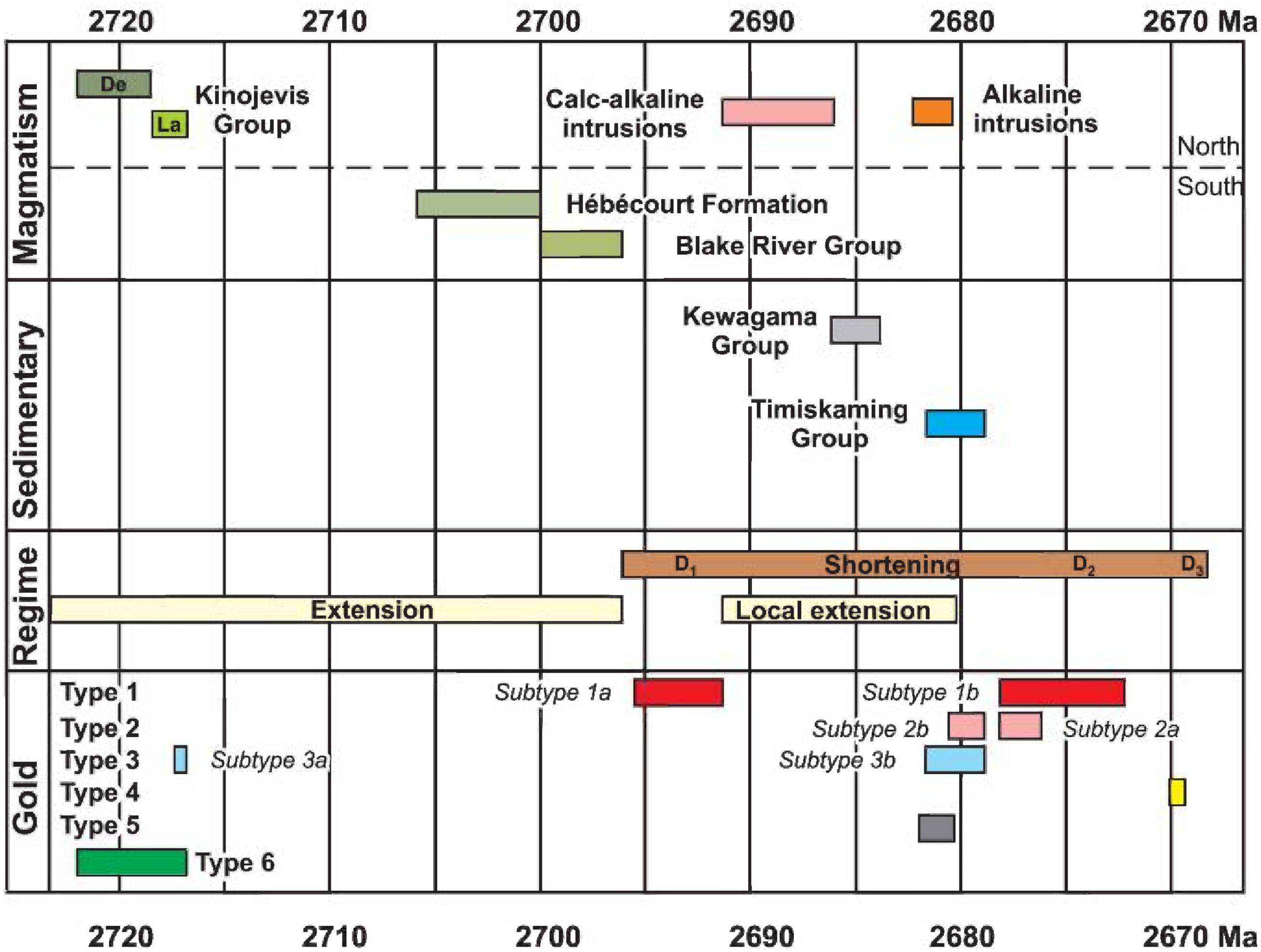

FIGURE 3 - Geological and metallogenic evolution of the study area determined on the basis of U-Pb dating (see text for geochronology references) and the relationships between gold mineralizations and structural elements, porphyritic intrusions and conglomerates of the Duparquet Formation. DE = Deguisier Formation; La = Lanaudière Formation; D_1, D_2 and D_3 = deformation episodes.

TABLE 1 - List of gold mines along the Québec portion of the Porcupine-Destor Fault. Refer to Figure 2 for locations.

Mine	Active	Tonnes extracted	Grade (g/t)	Type	Orientation	References
Beattie[i]	1933-1956	8 404 628	3.52	2b	090°/SV	Graham, 1954; Bevan, 1996; internal reports
Donchester	1943-1956	1 224 712	9.26	2b	090°/SV	Graham, 1954; Bevan, 1996; internal reports
Duquesne[ii]	1949-1952; 1989-1990	99 912	10.31	2a	090°/75°	Internal reports; Radisson, annual report, 1989, 1990
Yvan-Vézina	1983-1988	1 095 191	3.72	1	140°/60°	Goutier, 1997; Faure, 1998
Davangus[iii]	1987-1988	32 120	4.31	1	060°/45° and 090°/45°	Goutier, 1997; Faure, 1998

Type 1 = quartz + carbonates vein; Type 2a = disseminated sulphides associated with calc-alkaline intrusion; Type 2b = disseminated sulphides associated with alkaline intrusion. See Table 2 for the characteristics of these types. SV = subvertical dip (>85°).

i. Data from the Canadian Mines Handbooks give the combined production for the Beattie and Donchester mines. The values given represent our best estimate based on data from several sources. According to Bevan (1996), resources of 2.2 Mt grading 3.99 g/t Au still remain in several zones.

ii. According to Radisson's 1990 annual report, resources of 0.19 Mt grading 8.5 g/t Au still remain in several zones.

iii. The Davangus deposit consists of two mineralized zones, with resources estimated at 0.07 Mt grading 3.55 g/t Au.

In several locations, the Timiskaming Group lies with angular unconformity on deformed volcanics as well as on alkaline and calc-alkalic porphyritic intrusions.

Many ultramafic to felsic and alkaline intrusions cut the rocks found in the region. A number of the mafic to ultramafic intrusions are synvolcanic sills. Quartz + feldspar porphyries (2689 ±3 Ma; Mueller *et al.*, 1996) are observed throughout the region (Figure 2) and are characterized by the presence of phenocrysts of feldspar ± quartz and weak to intense iron carbonate and sericite alteration. These intrusions have an andesitic to rhyodacitic composition and a calc-alkalic affinity, and they exhibit significant fractionation of light rare earth elements (Figure 4). Although in the field, these quartz + feldspar porphyries can be confused with the porphyritic rhyolites of the Lanaudière Formation, the latter are chemically distinguishable by their rhyolitic composition, their transitional affinity and their weak rare earth element fractionation. The alkaline intrusions (2682 ±1 Ma; Mueller *et al.*, 1996) outcrop in two locations: Beattie and Central Duparquet mines (Beattie Syenite) and, to a lesser extent, in the vicinity of the Shaft deposit (Figure 2). Their alkaline nature is illustrated by high alkali levels, high-field-strength elements (for example, Zr, Y, Nb) and light rare earth elements (Figure 4). The Beattie Syenite has been the subject of a more detailed study (Patry *et al.*, 2004).

The PDF region has been divided into three sectors according to the distribution of the different types of gold mineralization: western, central and eastern (Figure 2). The geology of the western sector is simple and characterized by a homoclinal sequence (consisting mainly of basalts of the Deguisier and Hébécourt formations) in fault contact with a few sedimentary rock from the Mont-Brun and Duparquet formations (Goutier, 2003b). Ultramafic volcanics from the Kinojevis Group and felsic and ultramafic intrusions are also wedged within the PDF (Lei, 2000; MRNQ, 2002). There are a few ENE-WSW faults, which are probably subsidiary to the E-W-trending PDF. Intense schistosity parallel to the faults can also be distinguished, but it is not well developed away from the faults.

The central sector is more geologically complex but does not reach as deep structurally (Goutier and Lacroix, 1992; Goutier, 2003a). This factor has favoured the preservation of calc-alkalic and alkaline porphyritic intrusions along with a substantial accumulation of Timiskaming Group conglomerate (Duparquet Formation; Rocheleau, 1980; Mueller *et al.*, 1991). Two generations of folds can be seen in the central sector: those associated with the Lanaudière Formation (D_1) and those affecting the Duparquet Formation (D_2). The first generation folds are associated with the tilting of volcanic layers and predate the deposition of the Duparquet Formation. They are therefore older than the folds associated with the latter unit (Goutier and Lacroix, 1992). A number of E-W faults are present in the central sector; they cross-cut most of the lithologies (for example, the Beattie, Donchester, Central Duparquet, Ottman and Lépine faults). These faults are not necessarily subsidiary structures of the Porcupine-Destor Fault (ESE-WNW orientation), which is associated with D_2. It has been shown (Goutier and Lacroix, 1992) that some of them clearly predate or are contemporaneous with the formation of the Duparquet basin (basin east of the town of Duparquet in which most of the Duparquet Formation was deposited). An intense ENE-WSW to E-W schistosity is associated with the PDF and the E-W trending faults, but it is only locally developed elsewhere in the sector. Two phases of development of subparallel schistosity (D_1 and D_2) are represented in the sector. This interpretation stems from the presence of schistose fragments of volcanic rocks (D_1 schistosity) in the Duparquet conglomerates and in the porphyritic intrusions, which in turn are locally deformed (D_2 schistosity). All of the lithologies and structures are cut by a late network of NNE-SSW and NNW-SSE conjugate faults, with apparent sinistral and dextral displacement, respectively, associated with the D_3 deformation event.

The geology of the eastern sector is relatively simple, characterized by gabbroic sills interdigitated with the basaltic and rhyolitic flows of the Kinojevis Group (Goutier, 1997). In the SE part of the region, the Malartic Group is wedged between the Kinojevis Group and the Mont-Brun Formation. A few occurrences of Davangus Breccia, which represents the base of the Duparquet Formation, can be recognized in some locations. The rocks in the vicinity of Yvan-Vézina mine are affected by open, 'M' shape parasitic folds that are linked to the Abijevis Synclinal whose trace runs north of the mine (Figure 2). These P_1 folds have a general E-W orientation and plunge westward. In addition, the PDF splits into several secondary faults towards the east. The findings of Goutier (1997) suggest, however, that the faults in the eastern portion are superimposed and converge toward the west to form the Porcupine-Destor Fault and therefore are not subsidiary to the latter. They are either associated with the D_1 event or with the opening of the Duparquet basin.

All of these sectors exhibit metamorphism of equal or less intensity than greenschist facies metamorphism (Jolly, 1978; Powell *et al.*, 1995). The regional metamorphism postdates the emplacement of the Duparquet Formation and the PDF, since the metamorphic isograds cross these structures (Powell *et al.*, 1995).

ECONOMIC GEOLOGY AND TYPES OF MINERALIZATION

Anomalous gold zones and lithogeochemical analyses compiled as part of the present project permitted the identification of more than 130 gold mineralization occurrences (>1 g/t Au) in the study area (Figure 2 and Appendix 1). The

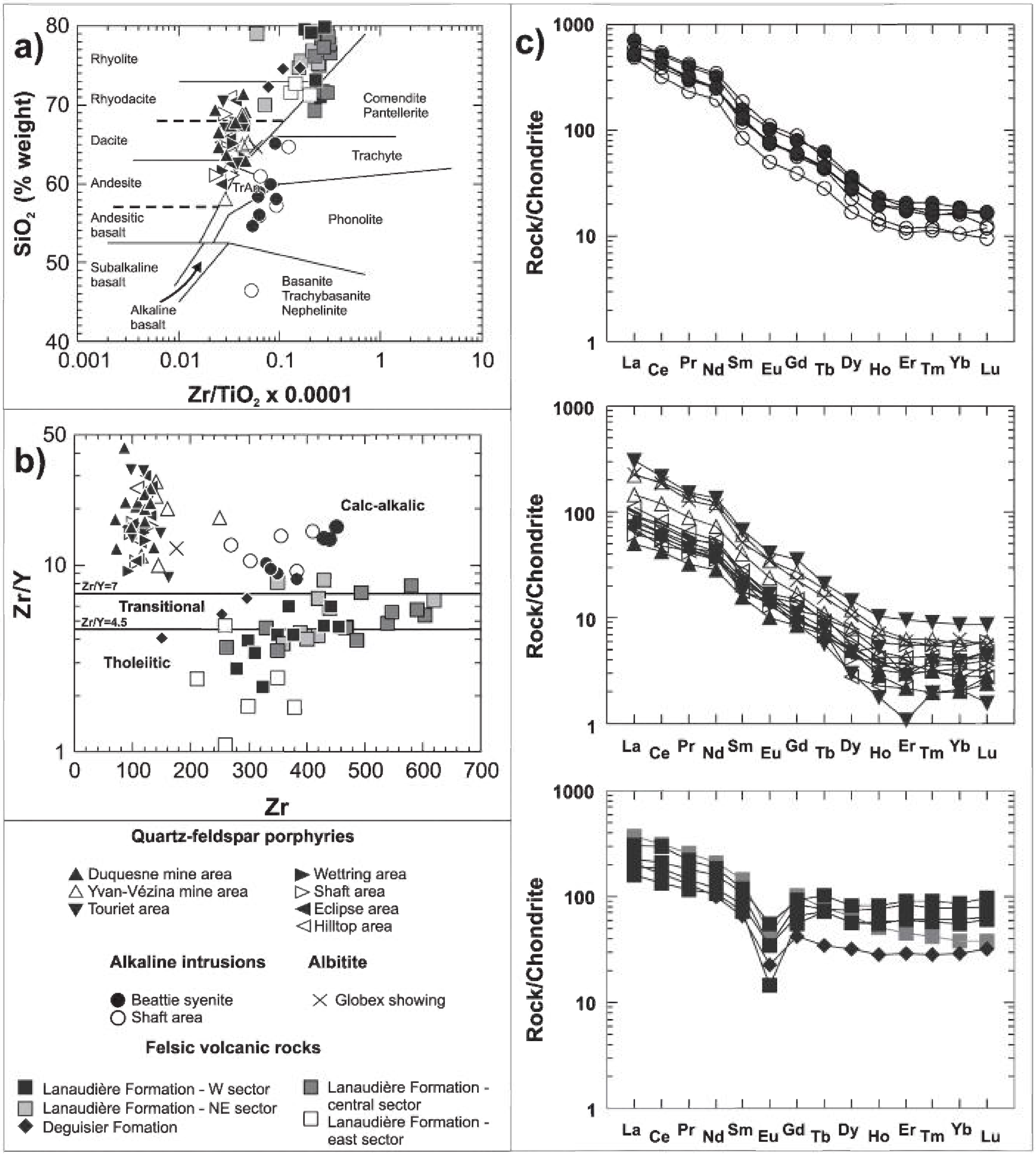

FIGURE 4 - Geochemical diagrams of quartz-feldspar porphyries, alkaline intrusions and felsic volcanic rocks. **a)** SiO_2 vs Zr/TiO_2 classification diagram, fields from Winchester and Floyd (1977). TrAn = trachyandesite. **b)** Zr/Y vs Zr diagram, fields from Barrett and MacLean (1999). **c)** Chondrite-normalized rare earth element (REE) concentrations (Sun and McDonough, 1989). Quartz-feldspar porphyries can be distinguished from alkaline intrusions by their lower REE concentrations, and felsic volcanics by their fractional pattern and absence of negative europium anomaly.

still accessible mineralization zones (outcrops or drill holes) were studied during the summer fieldwork, and those for which sufficient information of suitable quality was available were examined in greater detail. More than 4800 lithogeochemical analyses from SIGEOM, various mining companies (Cambior, Globex, Exploration Tom), statutory work, master's and PhD studies were compiled and used in conjunction with the analyses of the present study to define the distribution of regional alteration. The new compilation data have been incorporated into SIGEOM.

Based on the findings, six types of gold mineralization have been identified. The main characteristics of these mineralization styles are summarized in Table 2, and the relative abundance of gold, silver and base metals are illustrated in Figure 5.

Type 1 - Quartz + carbonates veins

This is the most common type of mineralization, accounting for 50% of the compiled occurrences. In the western sector, this type of mineralization is predominant and spatially related to the PDF (Figure 2). In the central sector, it is found along the southern and northern margins of the Duparquet basin, whereas in the eastern sector, quartz + carbonates vein deposits are generally located around the Yvan-Vézina mine. Type 1 occurrences are typically associated with rectilinear veins or with stockworks of veinlets and pyritized wall rock (Figure 6). The example shown in Figure 6 clearly shows the rectilinear nature of the veins despite the fact that shear veins and tension veins are both present. Iron carbonate and sericite alteration is characteristic, with the latter being more proximal to the mineralized structures. These alterations translate into gains in potassium, carbon and sulphur (Figure 7). Tourmaline is very rare in these veins; it is found in abundance only at the Victoria showing (Appendix 1) and in the deposits of the Timmins area (Hodgson and Troop, 1988). The quartz + carbonates veins are emplaced in primary (PDF), secondary (for example, Duquesne Fault) or tertiary structures (for example, the Brèche showing) (Figure 2).

Grades higher than 20 g/t Au are common and the Au/Ag ratio is generally high (> 3; Figure 5). Arsenic and tungsten are generally more abundant in the western sector than in the other sectors and more frequent in quartz + carbonates veins than in the other types of mineralization (Figure 8).

A number of occurrences do not share these general characteristics. For example, some mineralized samples collected near the Duparquet basin and in the vicinity of Yvan-Vézina mine exhibit Au/Ag ratios < 1 (Figure 5). Some of these mineralized samples are also characterized by the addition of silica instead of the typically observed leaching (Figure 7). The Yvan-Vézina mine area has a large number of mineralized zones in which quartz + carbonates veins form the matrix of hydrothermal breccia. These veins contain angular wall rock fragments that are typically altered and pyritized (the *fluid assisted breccia* of Jébrak, (1997)). Another example of breccia is found in the western sector (POR02-119 showing); however, in this case, the matrix is rich in arsenopyrite-pyrite (6.0 g/t Au over 5.3 m; Caillé *et al.*, 2003). The mineralization of the East Bay showing consists of quartz + carbonates + pyrite veins and quartz + carbonates + chalcopyrite veins; the latter feature high copper values, but low gold values.

The variation in the deformation intensity that affected the veins suggests a syn- to late-regional-deformation (D_1 and D_2) (Figure 3). Some mineralized zones, such as the Yvan-Vézina and Double Strike deposits, have an essentially N-S orientation (Tables 1 and 3), suggesting emplacement in Riedel fractures or in tension fractures that formed during the D_1 deformation event (subtype 1a). They subsequently underwent folding and boudinage by E-W structures compatible with regional D_2 deformation (Beaudoin, 1986; Laflèche and Gilbert, 1987; Fournier, 1992). Furthermore, the presence of quartz vein fragments (one of which assayed 2.6 g/t Au) and native gold in the heavy mineral concentrates (Jean David, pers. comm., 2005) of Duparquet Formation conglomerates indicates that gold mineralization existed prior to sedimentation. However, most of the gold-bearing veins are late regional D_2 deformation, since their orientation is E-W and they are nearly rectilinear and contain structured alteration minerals (subtype 1b). These veins are typically emplaced in shear zones of reverse movement with an oblique component.

The "quartz + carbonates vein" type of mineralization shares all the characteristics of orogenic mineralization as defined by Groves *et al.* (1998). The zones characterized by brecciated facies and Au/Ag ratios < 1 may represent mineralization emplaced under shallower conditions (< 5 km; Groves, 1993).

Type 2 – Disseminated sulphides associated with porphyritic intrusions

Intrusion-associated disseminated sulphide mineralization, accounting for 35% of the compiled occurrences, is commonly found along the PDF and, as its name implies, it is spatially related to porphyritic intrusions. Two areas have a large number of these mineralized zones: the periphery of Duparquet basin and the Fayolle deposit area (Figure 2). Two subtypes, based on intrusion composition, have been identified: disseminated sulphides associated with calc-alkalic intrusions and with alkaline intrusions.

Subtype 2a – Disseminated sulphides associated with calc-alcaline intrusions

Twenty-eight percent of the compiled occurrences are associated with quartz + feldspar porphyritic (QFP) or feldspar porphyritic (FP) intrusions. The mineralized zones of the Duquesne Zone and Eclipse showings, hosted in the rhyolites of the Lanaudière Formation, are also included in this subtype, because they have the same mineralization style. Nearly all of the intrusions mapped at a 1:20,000 scale

TABLE 2 - Characteristics of the six types of gold minerization found along the Porcupine-Destor Fault. See text for explanations.

Type[1]	1	2		3	4	5	6
Subtype	----	2a	2b	----	----	----	----
Number of showings	68	38	9	8	5	4	4
Style	Vein, veinlets	Disseminated sulphides, QZ + CB veinlets	Disseminated sulphides	CQ + QZ + CB veins, veinlets	QZ + CB veins, veinlets	QZ + PY massive residue	Pockets of QZ + CB + SF, disseminated SF
Quartz texture in vein	Heterogranular; banded	Comb; heterogranular	----	Cockade; colloform; crustiform; comb; mosaic	Comb	----	Colloform; crustiform
Alteration	Sericitization, carbonatization, sulphurization	Sericitization, carbonatization, sulphurization	Carbonatization, sericitization, silicification, sulphurization	Silicification, carbonatization, sericitization, sulphurization	Silicification, carbonatization, sulphurization	Sericitization, carbonatization, sulphurization	Carbonatization, silicification, chloritization, sulphurization
Metallic minerals	PY, AS	PY, MO	PY, AS	PY, SP, CP, GL, MO, TH	TH, PY, CP, SP, GL	PY	PY, CP
Gold occurence	Native Au (included in PY, fractures in PY, PY surfaces, free in VN)	Native Au (included in PY, fractures in PY, PY surfaces, free in VN)	Native Au (included in PY)	Native Au/electrum (included in PY), in pyrite structure?	In tetrahedrite structure, native gold (free in vein)	Native Au (included in PY, fractures in PY)	?
Metals	As, W	Ag, Mo	As, Mo	Ag, Zn, Cu, Pb, Mo, Hg, Sb	Ag, Cu, Sb, Zn, Hg	---	Ag, Cu, Zn
Au values [2]	< 25 g/t	< 100 g/t	< 15 g/t	< 100 g/t	< 10 g/t	< 20 g/t	< 5 g/t
Au/Ag [3]	7.4 ±12.7 (75)	3.6 ±2.3 (39)	5.6 ±4.2 (14)	2.4 ±2.8 (61)	0.19 ±0.47 (12)[5]	13.1 ±18.9 (15)	0.09 ±0.06 (3)
Main host [4]	Basalt, komatiite, sandstone, QFP/FP, gabbro	QFP/FP, QFP/FP contact, rhyolite	Syenite, syenite contact	QFP/FP basalt	Gabbro, syenite, basalt	Basalt, intermediate tuff, QFP/FP	Basalt, intermediate tuff
Control	Secondary and tertiary faults, lithological contacts	Rheological, lithological contacts	Secondary faults, lithological contacts	Synvolcanic or sedimentary faults?	Rheological, near E-W shear	Secondary faults (synsedimentary faults?)	Synvolcanic faults
Chronology	Early (D_1, subtype 1a) to late(D_2, subtype 1b) regional deformation	Synregional deformation (D_2)	Synregional deformation (D_2)	Pre-(subtype 3a) to syn-(between D_1 and D_2 - subtype 3b) regional deformation	Late regional deformation (D_3)	Synregional deformation (D_2)	Preregional deformation
Classification	Orogenic deposits	Variation of classic orogenic deposits	Disseminated sulphides associated with syenites	Neutral epithermal deposits	Ag-Pb-Zn veins in clastic metasedimentary rocks	Acidic epithermal deposits	Stockworks associated with VMS deposits
Economic potential	Medium to high	Medium	Medium to high	Medium	Low	Medium	Promising
Examples	Yvan-Vézina, Structure 71, Liz	Duquesne, Fayolle, Touriet	Beattie, Donchester, Central Duparquet 1	Nipissing, East Stinger, Golconda	Nipissing Ouest, Central Duparquet 2, Claims Silver	Fox	Zulapa, Elk Lake 2

AS = arsenopyrite; CB = carbonates; CQ = chalcedony; CP = chalcopyrite; GL = galena; MO = molybdenum; QZ = quartz; PY = pyrite; SF = sulphides; SP = sphalerite; TH = tetrahedrite; VN = vein.

1. Type 1 = Quartz + carbonates vein; Type 2 = Disseminated sulphides associated with a porphyritic intrusion (subtype 2a = Calc-alkaline intrusions; subtype 2b = Alkaline intrusions); Type 3 = Epithermal vein (subtype 3a = synvolcanic; subtype 3b = synsedimentary); Type 4 = Argentiferous quartz vein; Type 5 = Disseminated sulphides associated with leaching; Type 6 = Sulphides associated with VMS.
2. Indicates the generally observed upper limit in selected samples and drill intersections.
3. Mean ± standard deviation (number of analyses).
4. QFP = quartz-feldspar porphyry; FP = feldspar porphyry.
5. 0.04 ±0.10 if one removes the isolated analysis for Central Duparquet 2.

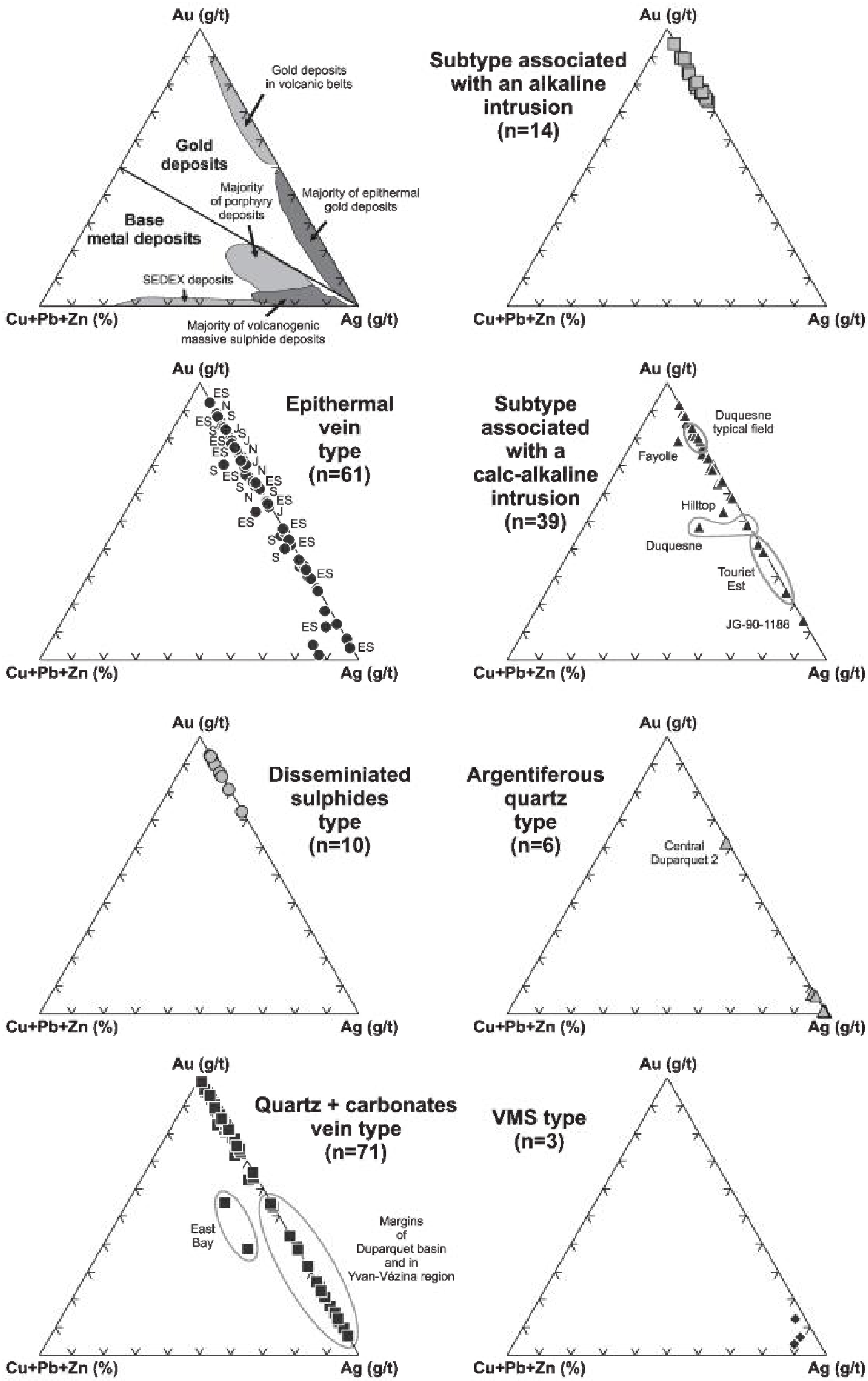

FIGURE 5 - Ternary diagram showing the relative abundance of gold, silver and base metals (Cu+Pb+Zn) for the different types of gold mineralization found along the PDF. The fields of the upper left-hand ternary diagram are taken from Poulsen (1996).
Epithermal vein type: ES = East Stinger; J = Jacques; N = Nipissing; S = Stinger.

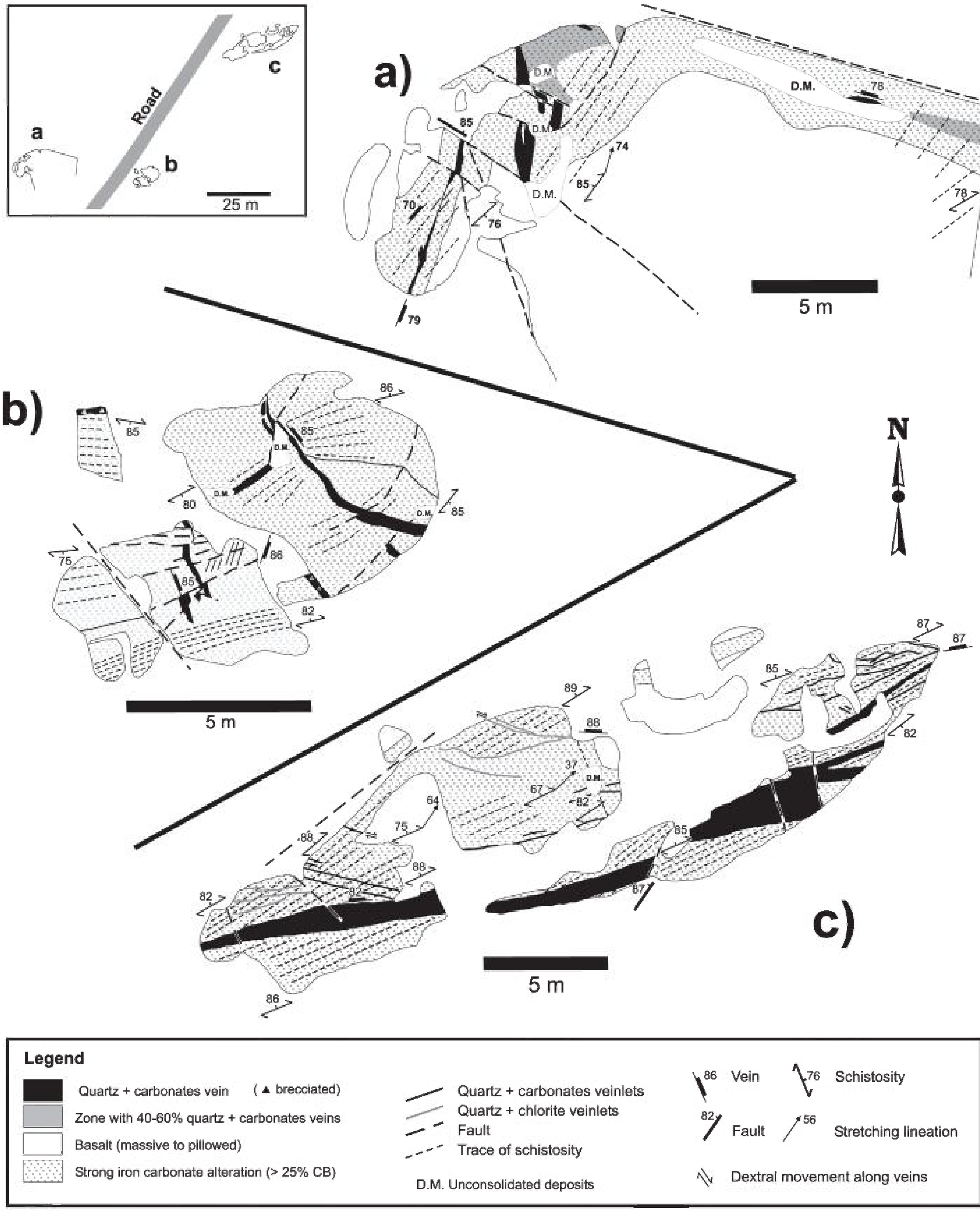

FIGURE 6 - Detailed maps of the Porcupine-173656 showing (quartz + carbonates vein type) located in the western sector of the PDF. The angular relationship between the schistosity and the main vein (outcrop c) is compatible with emplacement during dextral shearing. The gold values obtained in this study are low (<1 g/t Au), and only one value on record is greater than 1 g/t Au (2.23), but its exact location is unknown (Lulin, 1985).

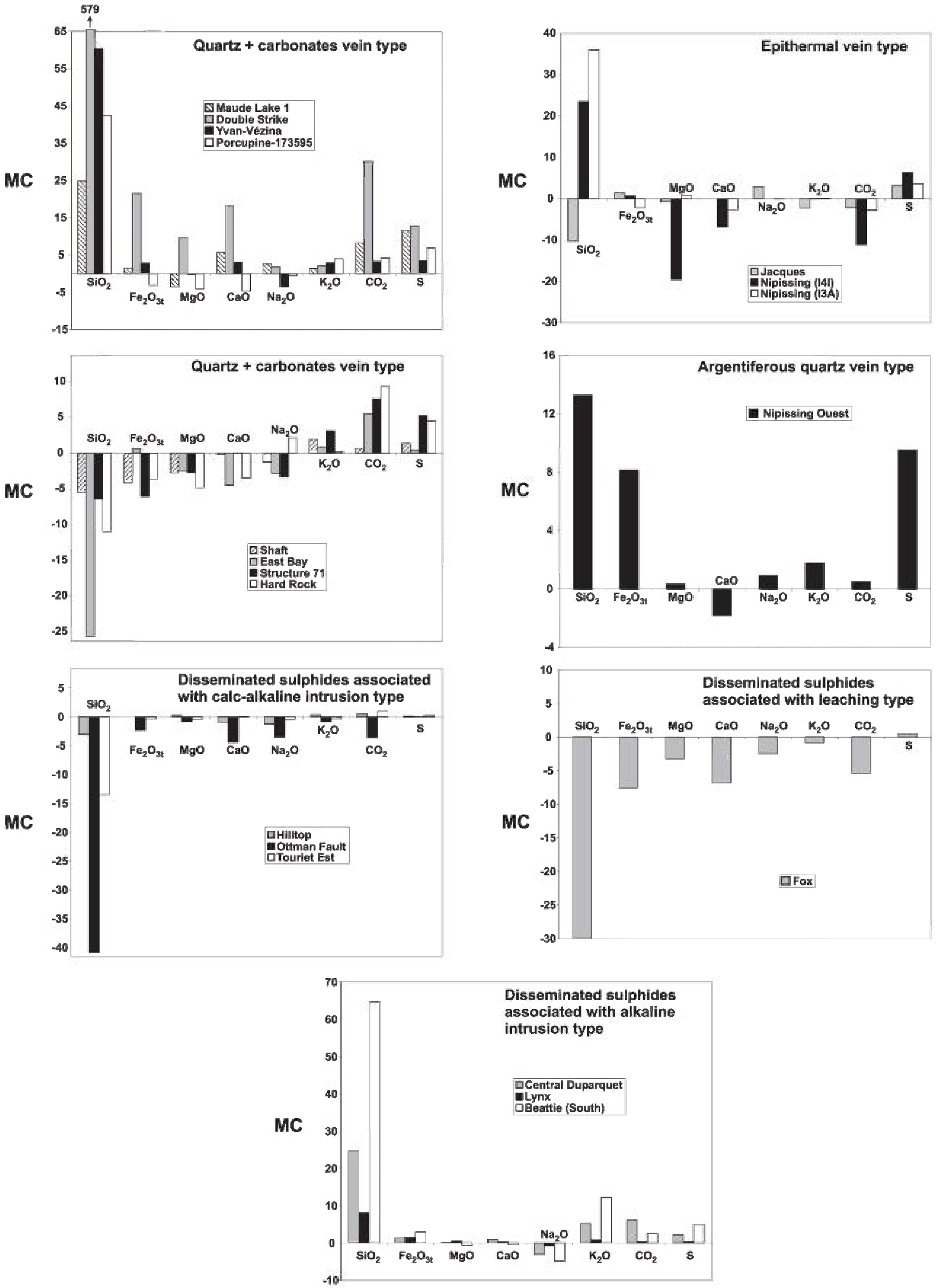

FIGURE 7 - Mass change (MacLean and Kranidiotis, 1987) of the immediate wall rock (A) versus the equivalent fresh rocks (F) for the different types of gold mineralization. The mass change ($MC = ((I^F/I^A) \times X^A) - X^F$) indicates the increase or decrease in X elements relative to an immobile element I. Zirconium was used as an immobile reference in these calculations (exception: aluminum was used for the Yvan-Vézina mine). The analyses are mainly from the present study, and from Beaudoin (1986) and Samson (1998).

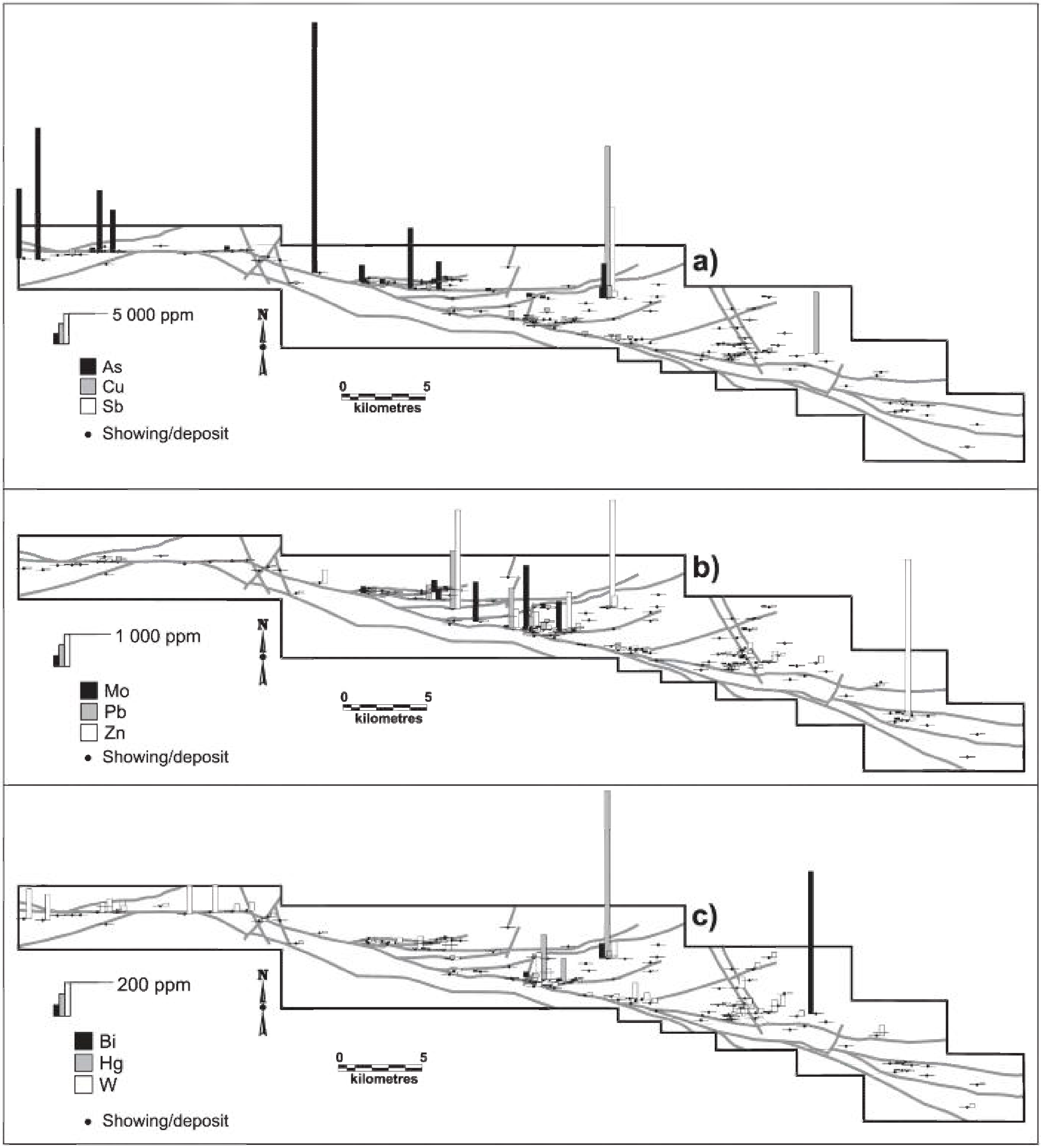

FIGURE 8 - Metal concentrations for the showings/deposits along the Porcupine-Destor Fault: **a)** As-Cu-Sb; **b)** Mo-Pb-Zn; **c)** Bi-Hg-W. The analyses come mainly from the present study. The average grade has been used in cases where more than one analysis is available.

TABLE 3 - List of deposits, with estimated tonnage, located along the Porcupine-Destor Fault. See Figure 2 for locations.

Deposit	Reserves-Resources	Grade (g/t)	Type	Orientation	References
Structure 71	234 358	4.30	1	090°/55°	Gobeil, 1988
Central Duparquet	567 023	5.11	2b	270°/80°	Lochon, 1989
Golconda	362 874	5.83	2a	233°/76°	Tanguay, 1981; Samson, 1998
Stinger	537 666	10.77	3	100°/40°	Press release, 2003, Normabec
Main	175 455	4.46	2a	100°/70°	Press release, 2003, Normabec
Fox	333 232	15.17	5	090°/75°	Londry *et al.*, 2003
East Stinger	188 778	5.06	3	090°/85°	Cunningham-Dunlop, 1997; Londry *et al.*, 2003
Shaft	67 514	7.86	1	090°/75°	Londry *et al.*, 2003
South Shaft	35 341	6.58	1	090°/75°	Londry *et al.*, 2003
Liz	442 168	6.13	1	090°/75°	Londry *et al.*, 2003
Double Strike	201 511	2.32	1	000°/65°	Fournier, 1992; Faure, 1998
Fayolle	799 600	6.19	2a	090°/65°	Laplante, 1997; Gaudreault, 2003

Type 1 = quartz + carbonates vein; Type 2a = disseminated sulphides associated with a calc-alkaline intrusion; Type 2b = disseminated sulphides associated with an alkaline intrusion; Type 3 = epithermal vein; Type 5 = disseminated sulphides associated with leaching. See Table 2 for characteristics of these types.

(Goutier and Lacroix, 1992; Goutier, 1997) include at least one example of this subtype characterized by disseminated pyrite (2-5%) associated with quartz + carbonates + pyrite veinlets. The mineralization is present either within the intrusion, or in the wall rock in contact with the intrusion (Figure 9). The veinlets generally do not have a systematic orientation. However, some showings such as the Faille Ottman and Hilltop veinlets have an essentially E-W to WNW-ESE orientation (Figure 2 and Appendix 1). Sericitization and carbonatization are the most common types of alteration, although they vary greatly in intensity (weak to intense). In some locations, carbonatization is limited to the immediate wall rocks of the veinlets. There is always a very close relationship between sericite and auriferous pyrite. Silica leaching is also generally observed (Figure 7).

This mineralization appears to be synchronous with D_2 and likely represents a variant of classic orogenic deposits (Figure 3). The absence of mineralized QFP fragments in the base conglomerate immediately south of the Hilltop showing suggests that the emplacement of this subtype postdates the Duparquet Formation. Very high grades of gold can be found locally (Figure 9b). The Au/Ag ratio is usually high (>4) and comparable to that of the "quartz + carbonates vein" type of mineralization. At the Hilltop and Touriet Est showings, however, low Au/Ag ratios are associated locally with mineralization zones that are enriched in Zn and Mo, respectively. A few samples from the Duquesne mine (Pilote and Couture, 1989; Couture and Pilote, 1990) also exhibit low Au/Ag ratios, along with higher copper concentrations. The arsenic values are generally low (As <100 ppm).

Subtype 2b – Disseminated sulphides associated with alkaline intrusions

These occurrences are much less common (7% of compiled showings) than those associated with calc-alkalic intrusions (28% of compiled showings). Two areas have mineralized syenitic intrusions: the Beattie Syenite, which is the host unit for most mineralization of this subtype, and the smaller syenites in the vicinity of the Shaft deposit. It is noteworthy that these syenites are located at the intersection of the margins of the Duparquet basin and the PDF (Figure 2). The syenite intrusions located in the eastern part of the study area do not display gold mineralization.

This mineralization subtype is manifested as fine disseminations of pyrite and arsenopyrite (10-20%) in highly silicified E-W trending zones hosted in distal sericite and carbonate alteration zones (Figure 10). It is chemically distinguishable from subtype 2a through the significant contribution of silica, potassium and sulphur (Figure 7). At the Beattie mine, nearly 60% of the production came from silicified breccia located at the northern contact between the syenite and the turbiditic sediments of the Mont-Brun Formation (Banfield, 1940; Graham, 1954). This subtype of mineralization corresponds to the syenite-associated disseminated sulphide deposits described by Robert (2001). It is late relative to the syenite intrusion, but early to synchronous relative to Duparquet Formation sedimentation (Figure 3). This chronology is suggested by the presence of altered syenite fragments in the Duparquet Formation sediments near the unconformity at the Central Duparquet 2

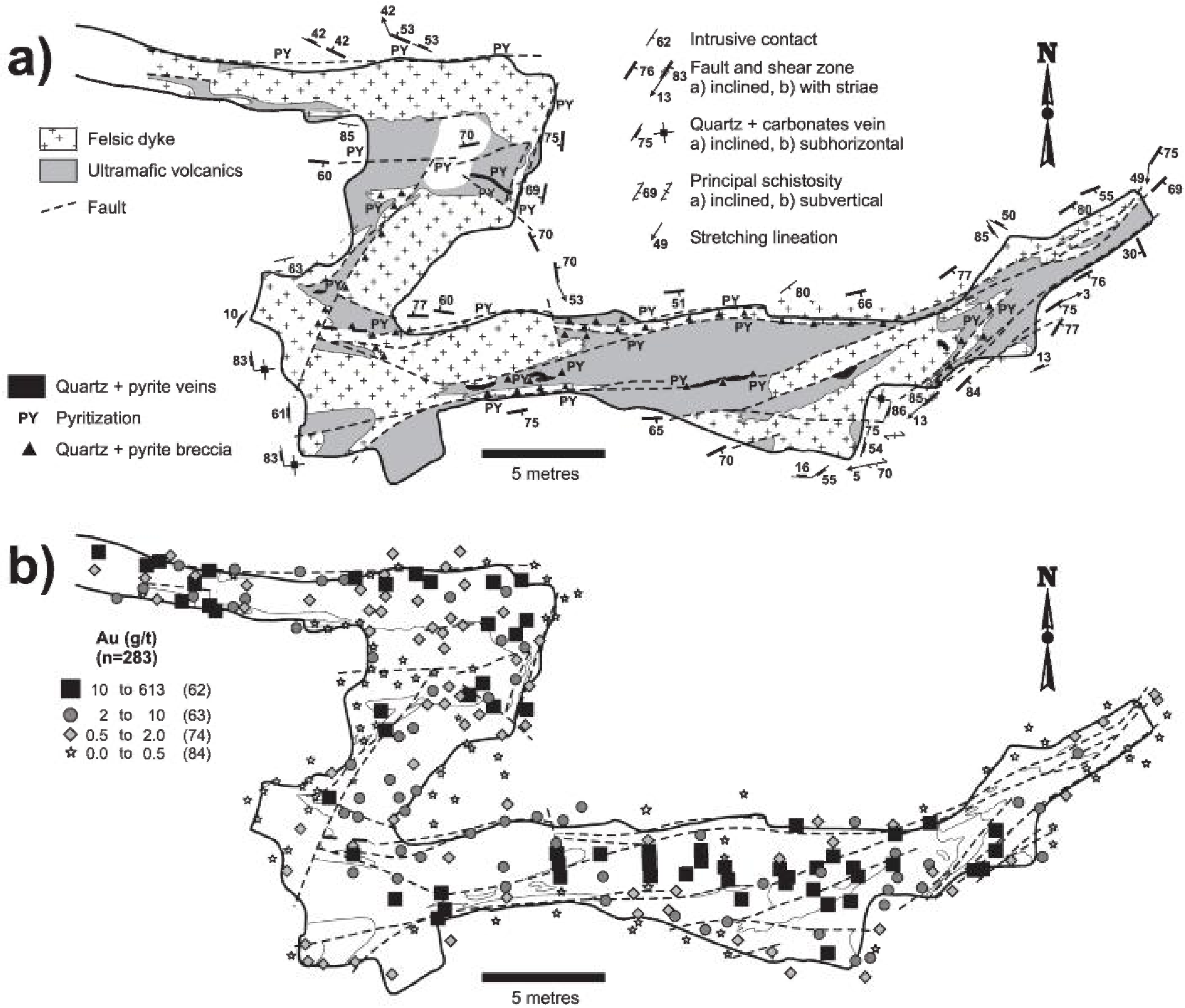

FIGURE 9 - a) Detailed map of sublevel 7-20-3 of the Duquesne mine ("disseminated sulphides associated with calc-alkaline intrusions" subtype), located in the central sector of the PDF. From Couture and Pilote (1990). **b)** Distribution of gold values. Note that high gold values are not necessarily associated with quartz + pyrite veins. The analyses are based on selected samples and definition drill holes; the latter are located mid-interval. Data from Couture and Pilote (1990) and Radisson Mining Resources.

showing. These fragments are not gold-bearing, however. The gold grades of subtype 2b are fairly constant (3 to 10 g/t), with higher values (≈10 to 15 g/t) being found at the Donchester mine (Graham, 1954). The Au/Ag ratio is generally high (>3) and the arsenic values are also elevated (As >300 ppm) (figures 5 and 8). The suite of metals is very similar for all the occurrences of this subtype.

Type 3 – Epithermal veins

This uncommon type of mineralization (5% of compiled showings) occurs only along the margins of the Duparquet basin (Figure 2). On the southern margin of the basin, the epithermal vein type is more proximal to the basin than are the other types. Other epithermal vein deposits may be present in the vicinity of the Hilltop and Shaft showings, given the anomalous concentrations of Zn, Pb and Hg observed there in some locations.

Samson (1998) and Waychison (written communication, 2002) postulated that epithermal vein mineralization might be present in the central sector. These occurrences are characterized by the presence of veins of microgranular quartz or chalcedony in association with carbonates and sulphides. The veins generally have open spaces crystallization textures (colloform, cockade, crustiform and comb textures).

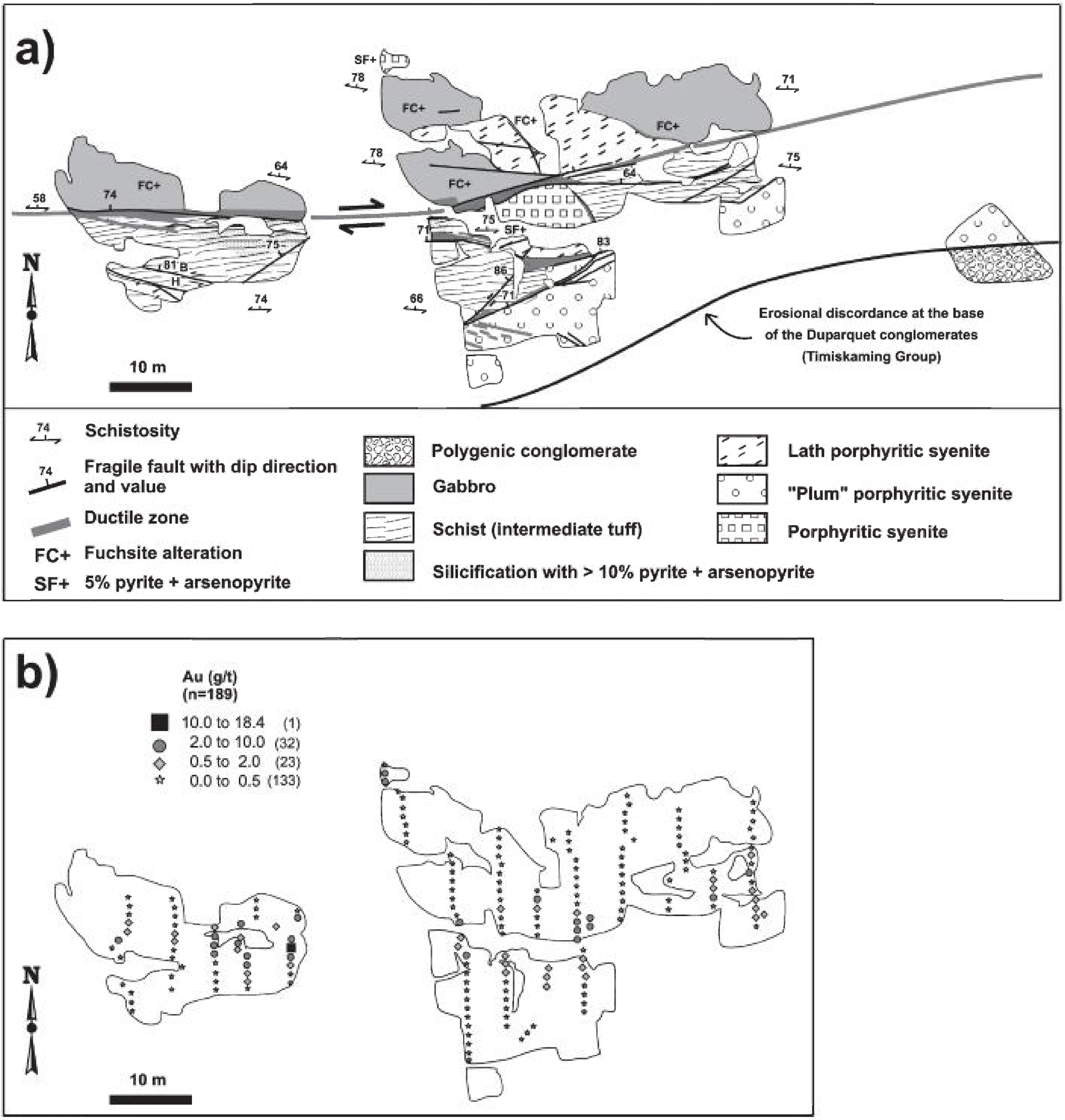

FIGURE 10 - a) Detailed map of stripping of Central Duparquet deposit ("disseminated sulphides associated with alkaline intrusion" type) located in the central sector of the PDF. Modified from Goutier (1996). **b)** Distribution of gold values. Note the association between high gold values and silicified zones. The analyses are based on selected samples (Goutier and Lacroix, 1992; present study) and channel samples (Landry, 1987); the latter are located mid-interval.

Two episodes of epithermal vein mineralization are recognized: synvolcanic and synsedimentary. The Nipissing showing is the only example of synvolcanic epithermal mineralization (subtype 3a). It has been interpreted as contemporaneous with the emplacement of the volcanic rocks of the Lanaudière Formation (2718 Ma; Zhang *et al.*, 1993). This tilted system of veins and breccia is associated with NW-SE trending silicified and carbonatized fractures (Figure 11). The bulk of the mineralization occurs at the contact between a peridotite sill and a gabbro (granular massive basalt?), and is associated with intense silicification and pyritization (Figure 7). Synsedimentary epithermal mineralization (subtype 3b) can be seen mainly in drill holes. These occurrences are late relative to the QFP and FP intrusions that they cut, and they seem to be synchronous with the Duparquet Formation, which unconformably overlies the QFP and FP intrusions. The veins were folded and boudinaged by the D_2 deformation event. The fragments of microcrystalline quartz veins found in the base conglomerate immediately west of the Jacques showing suggest that subtype 3b is, at least partly, synchronous with the opening of the basin and early relative to Timiskaming sedimentation.

In some locations, the gold grades of this type of mineralization are impressive (149 g/t Au over 3.0 m at the Nipissing showing; Chute, 1985). The Au/Ag ratio varies widely (0.1 to > 10; Figure 5) between showings and even within given showings (for example, Stinger and East Stinger). Other showings, such as Nipissing and Jacques, systematically display high ratios (generally > 2). The mineralized zones along the margins of the eastern part of the Duparquet basin exhibit enrichments in Pb-Zn-Hg (±Cu) and Mo-Bi (up to 0.3% Mo and 60 ppm Bi); the latter association points to the infiltration of a magmatic fluid (Kirkham and Sinclair, 1996; Figure 8).

The "epithermal vein" type of mineralization is analogous in several respects to neutral epithermal deposits (Hedenquist *et al.*, 1996). The spatial relationship between mineralization of subtype 3b and the faults that control the geometry of the basin suggests a genetic link (Figure 3).

Type 4 – Argentiferous quartz veins

This type of mineralization is rare (4% of compiled showings), but very distinct from the other types. It occurs in the form of veins about 30 cm thick containing quartz + carbonates + tetrahedrite with comb and cockade textures. The veins are associated with weak wall rock alteration (Figure 7) and their orientation is NW-SE to NNW-SSE. They are found in isotropic rocks (that is, gabbro, syenite) near a NE-SW to E-W trending shear and therefore represent rectilinear tension veins that can be followed over more than 100 metres. They appear to have been emplaced fairly late, since they are not deformed and the alteration minerals are not structured. This episode of mineralization is interpreted to be syn-D_3, synchronous with the formation of NNE and NNW conjugate faults (Figure 3).

The gold grade is generally lower than 10 g/t. One distinctive characteristic is the very low Au/Ag ratio (<0.1; Figure 5) caused by the very high silver concentrations (<454 g/t). Only one sample from the Central Duparquet 2 deposit shows an elevated Au/Ag ratio; it is associated with free gold in the vein. In addition to silver, these veins are enriched in copper, zinc, lead, antimony and mercury (Figure 8). Although chalcopyrite, arsenopyrite, sphalerite and galena are present, some of these elements also occur in solid solution in the tetrahedrite structure (Craig and Vaughan, 1990).

These veins have a number of similarities with the Ag-Pb-Zn veins that occur in clastic metasedimentary rocks, such as in the Cœur d'Alène district of the United States (Beaudoin and Sangster, 1992). The Proterozoic arsenide-silver veins exhibit a metal assemblage (Ruzicka and Thorpe, 1996) differing from that of type 4 veins.

Type 5 – Disseminated sulphides associated with leaching

Mineralization of the "disseminated sulphides associated with leaching " type (3% of compiled showings) has been found at the Fox showing and, possibly, NE of the Central Duparquet 2 deposit. In the latter case, the mineralization is only visible in drill holes, which unfortunately were not examined. This type of mineralization shows a spatial and perhaps temporal association with syenites (Figure 3).

The mineralization occurs as a massive residue of quartz + pyrite (5-10%) in a deformation zone with sericite and carbonate alteration. The residue represents moderately to strongly leached wall rock (Figure 7). These zones have an E-W orientation and could represent acidic epithermal deposits (Hedenquist *et al.*, 1996). The Au/Ag ratio is usually elevated (>3; Figure 5). Other metals are present in low concentrations.

Type 6 – Sulphides associated with VMS

This type of mineralization (3% of compiled showings) is found primarily in the eastern part of the study area and is believed to be contemporaneous with the volcanic rocks of the Kinojevis Group (Figure 2). The Elk Lake 2 and Zulapa showings are associated with quartz + chalcopyrite replacement of the volcanic breccia matrix. The latter showing also has promising gold values (<3.9 g/t Au). The Vang Est showing contains laminated, graded and silicified tuffs, with pyrite in dissemination and in veinlets. Eldor Resources Ltd. has reported a surface sample containing 4.97 g/t Au (Tremblay, 1985), but this value could not be replicated. The POR02-118 showing is associated with very coarse pyrite in a weakly carbonatized and strongly sericitized basalt (9.6 g/t Au over 1.45 m; Caillé *et al.*, 2003).

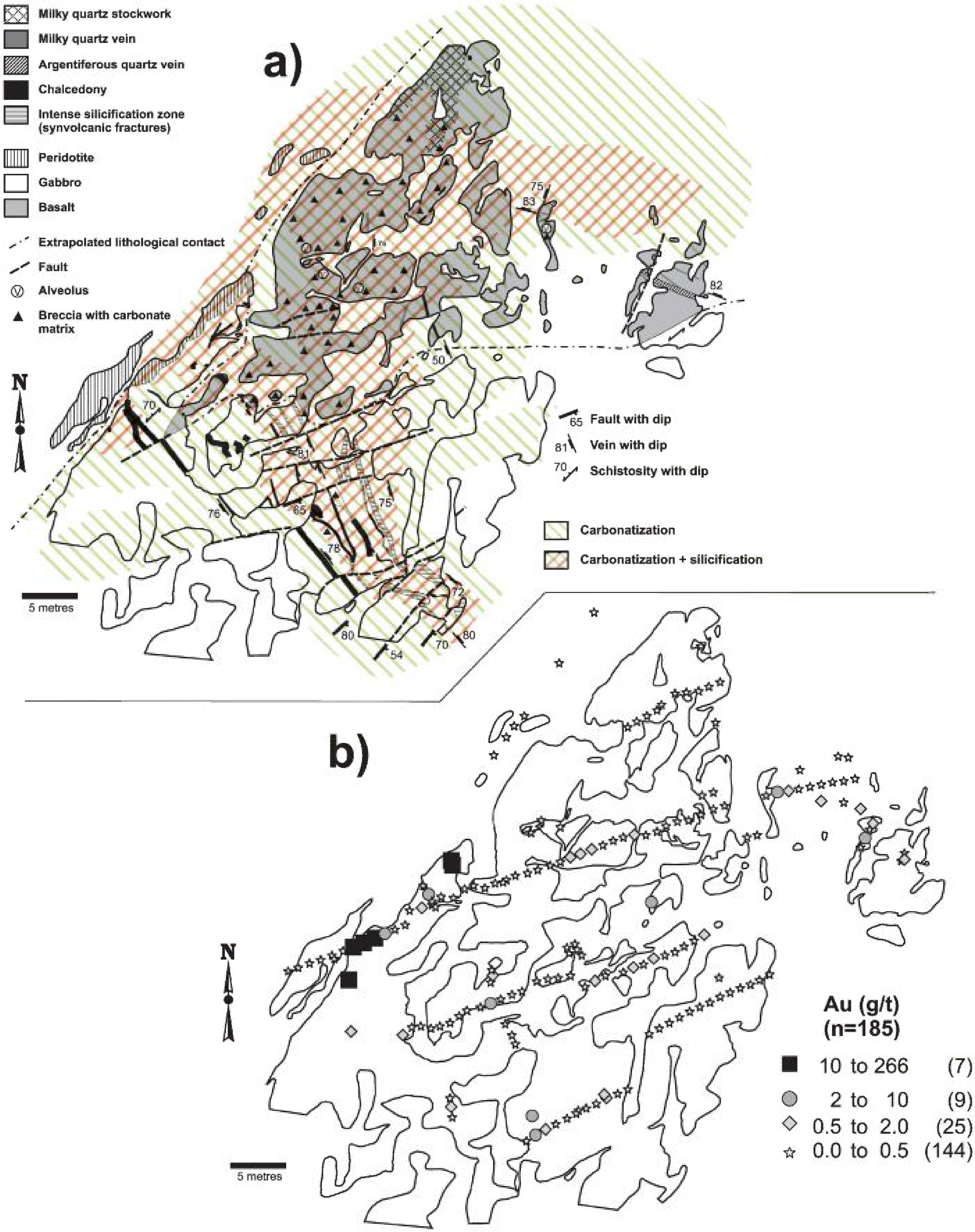

FIGURE 11 - a) Detailed map of the Nipissing showing ("epithermal vein type") situated in the central sector of the PDF. **b)** Distribution of gold values. The highest gold values are associated with the silicified zone at the southern contact with the peridotite. The analyses are based on selected samples (Goutier and Lacroix, 1992; present study) and channel samples (Chute, 1985); the latter are located mid-interval.

ISOTOPE GEOCHEMISTRY

The oxygen isotope composition of quartz and the oxygen and carbon isotope composition of carbonate were determined for various types of gold mineralization (Beaudoin, 2004; Figure 12 and Appendix 2). This exercise was undertaken to determine whether seawater ($\delta^{18}O \approx 0‰$) and/or meteoric ($\delta^{18}O < 0‰$) water were involved in the formation of epithermal type mineralization. Samples from other types of mineralization were also analysed to permit comparison with the compositions of metamorphic ($\delta^{18}O$ = 5-15‰) and magmatic ($\delta^{18}O \approx 8‰$) fluids (McCuaig and Kerrich, 1998). The minerals were separated by hand and examined under a binocular microscope to obtain a pure monomineral ore. The quartz concentrates were analysed for oxygen isotope composition following extraction using bromine pentafluoride (BrF_5) according to the method of Clayton and Mayeda (1963). The carbonate was digested in phosphoric acid to release the CO_2 (McCrea, 1950). The CO_2 was then analysed by mass spectrometry at the Geological Survey of Canada's Delta-Lab to derive the oxygen and carbon isotope composition. The $\delta^{18}O$ and $\delta^{13}C$ values are reported in relation to international standards V-SMOW and V-PDB, respectively. Measurement precision is better than 0.2‰.

The Nipissing showing is an "epithermal vein" type of gold mineralization that is contemporaneous with the volcanics of the Lanaudière Formation. The quartz in these veins has an oxygen isotope composition, $\delta^{18}O$, varying between 13.0‰ and 16.2‰. The quartz can be divided into two types: a drusy quartz considered to be early stage, found along the vein margins, and late stage chalcedony, present in the middle of the veins. Analysis of a drusy quartz sample from crustiform bands gave a $\delta^{18}O$value of 16.2‰. The oxygen isotope composition of the carbonate in the same sample gave a $\delta^{18}O$value of 17.8‰. Assuming that quartz and chalcedony are in isotopic equilibrium, the oxygen fractionation indicates an emplacement temperature of about 200°C (Zheng, 1999). At this temperature, the fluid in equilibrium with quartz and carbonate had a $\delta^{18}O$composition of 4.5‰ (Zheng, 1999), suggesting the circulation of evolved Archean seawater with a long history of fluid-rock interaction. The later stage chalcedony had a lower oxygen isotope composition ($\delta^{18}O$ between 13.0‰ and 13.5‰ with a mean $\delta^{18}O$ of 13.3‰ ± 0.3‰; n=3). This decrease probably does not represent a temperature increase because the chalcedony likely crystallized at a temperature below 200°C (Fournier, 1985). Using this temperature as a limit, the maximum $\delta^{18}O$ for the fluid was determined to be 1.6‰, indicating that the late hydrothermal fluid associated with the precipitation of the chalcedony was almost pure Archean seawater (≈0‰).

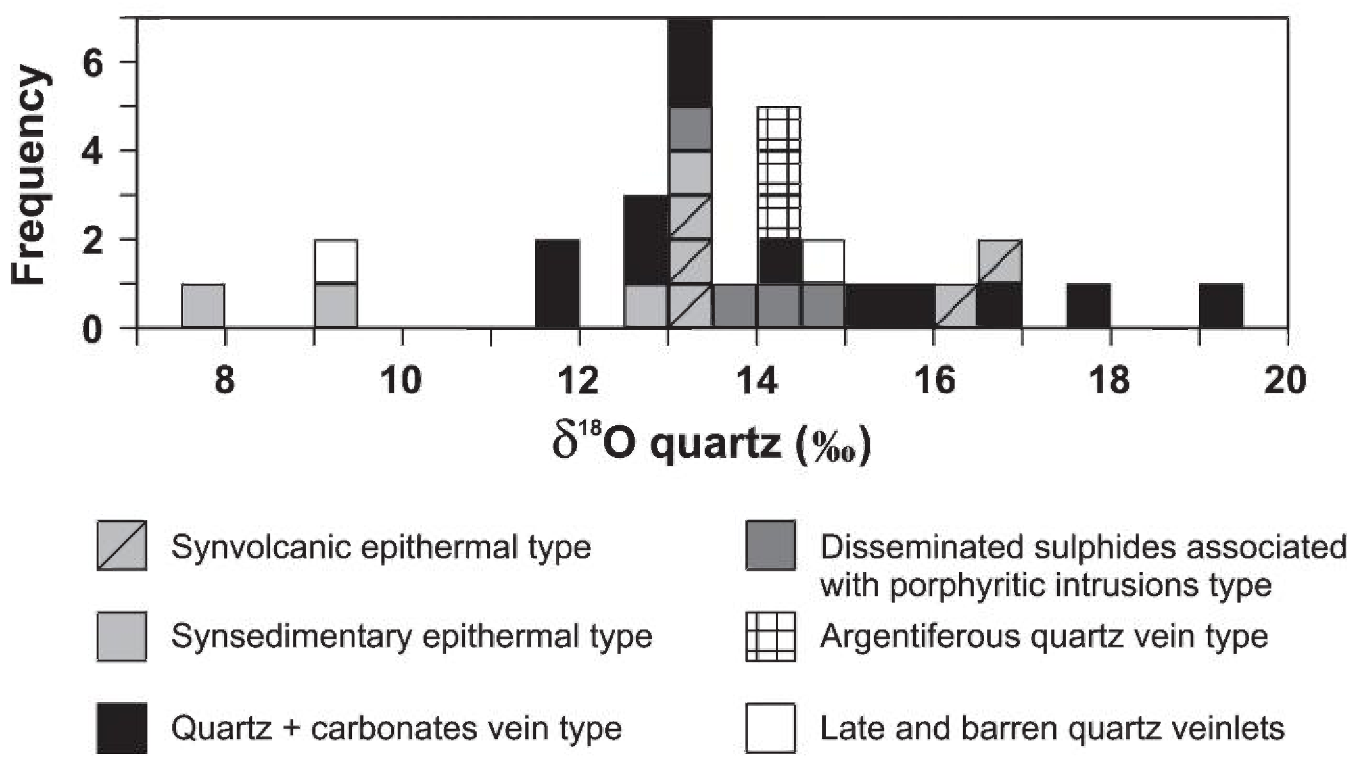

FIGURE 12 - Histogram showing the isotopic composition of quartz according to type of mineralization. Microgranular quartz and chalcedony of the "epithermal vein" type generally show lower $\delta^{18}O$ values than quartz of the "quartz + carbonates vein" type.

These values are similar to the composition of fluids associated with emplacement of Archean volcanogenic massive sulphides (Huston, 1999) and therefore consistent with a submarine epithermal system.

Samples from synsedimentary epithermal veins (NIP, Faille Ottman; Appendix 2) have lower isotopic values for chalcedony and exhibit greater variation (7.9‰ to 13.1‰; n = 4). For a fluid with a temperature of 200°C, this suggests lower $\delta^{18}O$ values (-3.5‰ to +1.5‰) (quartz fractionation factors of Clayton *et al.*, 1972) and therefore a significant meteoric water component. This hypothesis is consistent with these veins being formed during the exhumation and erosion of the volcanic pile in the subaerial Duparquet basin.

Quartz samples from the type 2 occurrences have $\delta^{18}O$ values ranging from 13.2‰ to 14.7‰ (n = 4; Hélène, Hilltop, Ottman, Touriet Est showings) (Appendix 2). Assuming that the quartz and carbonate are in isotopic equilibrium at the Hilltop showing, the oxygen fractionation indicates an emplacement temperature of about 200°C (Zheng, 1999). The quartz from the type 1 deposits displays a wide range of $\delta^{18}O$ values (from 11.5‰ to 19.1‰; n = 12; Casino, Duquesne, East Bay, Lac Duparquet-Ouest, Porcupine-173656, Porcupine-88-72, Shaft, Structure 71 showings) (Appendix 2); this is comparable to the isotope compositions of the quartz veins typifying Val-d'Or orogenic vein networks ($\delta^{18}O$ from 9.9‰ to 13.5‰; Beaudoin and Pitre, 2003) and other orogenic districts of the Superior Province (Kerrich, 1987). The quartz from type 4 deposits has $\delta^{18}O$ values that vary little ($\delta^{18}O$ from 14.0‰ to 14.4‰; n = 3; Central Duparquet 2, Nipissing, Nipissing West showings) (Appendix 2). The carbonate in the veins of the different types of mineralization gives $\delta^{18}O$ values of 6.7‰ to 18.0‰ and $\delta^{13}C$ values of -7.8‰ to -1.0‰, with a more or less linear distribution which is indicative of organic carbon contribution for low $\delta^{13}C$ values.

Most of the quartz and carbonate samples on which oxygen isotope analyses were performed are not in equilibrium, since the oxygen fractionation would give unrealistic values. That is why the temperature of the fluids has not been estimated for such samples.

MICROPROBE ANALYSIS

Quantitative electron microprobe analyses of the silver and gold contents of gold grains were performed on nine grains (Table 4) from the "epithermal vein" type (Nipissing showing) and from the "quartz + carbonates vein" type (ATV showing) (Aucoin, 2004). The results of Giovenazzo and Perrault (1982) and Kesler (1996) are also presented to permit comparison.

The Au/Ag ratios of the gold grains from mineralized veins of the "quartz + carbonates" type are similar to the Au/Ag ratios of the ore, indicating that most of the gold and silver in the rock represents native gold. In addition, these gold grains contain few impurities except for silver (<5% by weight). Furthermore, the gold grains identified in the epithermal vein mineralization samples show Au/Ag ratios lower than that of the ore, suggesting that other gold minerals are present, that the gold is "invisible" or that the gold is present in the pyrite structure, which can accommodate up to 110 g/t (Cook and Chryssoulis, 1990). The grains analysed from epithermal vein mineralization typically have a

TABLE 4 - Microprobe analysis results showing the percent by weight of gold and silver in native gold grains. Data from Aucoin (2004), Kesler (1996) and Giovenazzo and Perrault (1982). Aucoin used the following parameters: 15.0 kV potential difference, 20.0 nA current and count time of 20 seconds (10 seconds at peak). Calibration for gold analyses was performed with a 100% Au standard; for silver analysis, the standard used was 80% Au and 20% Ag.

Sample	Showing	Type[i]	No.[ii]	Au % wt	Ag % wt	Total	Fineness[iii]	Au/Ag[iv]	Au/Ag rock
ML-03-505A	Nipissing	3	1	74.175	13.746	87.921	844	5.396	8.10
ML-03-334	Nipissing	3	2	79.292	11.222	90.514	873-879	7.066	8.10
ML-03-346	ATV	1	4	79.631	17.852	97.483	797-832	4.461	5.12
ML-03-350	ATV	1	2	83.893	14.238	98.131	844-866	5.892	4.97
DQ95-32[v]	Stinger	3	-	> 90 ?	< 10	---	> 900	> 9	5.00
DQ95-43[v]	Stinger	3	-	75-85 ?	15-25	---	750-850	3.0-5.7	0.71
DQ95-47[v]	Stinger	3	-	80-90 ?	10-20	---	800-900	4.5-9.0	3.40
---[vi]	Yvan Vézina	1	-	72-83	17-28	---	720-830	2.6-4.9	0.67

i. 1 = Quartz + carbonates vein; 3 = Epithermal vein.
ii. Number of analyses.
iii. 1000 x Au %/(Au % + Ag %).
iv. Au/Ag ratio in gold grains.
v. The analyses come from an internal report (Kesler, 1996) giving only quantative results for silver.
vi. The analyses come from an internal report (Giovenazzo and Perrault, 1982) giving only quantative results. They are normalized to 100%.

high degree of impurities (up to 19% by weight), possibly reflecting elements that are in solid solution in the gold, such as mercury or copper, or even tiny inclusions (Chapman *et al.*, 2000). This variation in Au/Ag ratios in gold grains versus ore and in the proportion of impurities in gold is typical of orogenic deposits ("quartz + carbonates vein" type) and epithermal deposits ("epithermal vein" type) (Rose and Morrison, 1988; Morrison *et al.*, 1991; Chapman *et al.*, 2000).

METALLOGENIC EVOLUTION

The chronology of the geological events of the Porcupine-Destor Fault (PDF) zone is summarized in Figure 3. The interpretation of the emplacement of the different types of mineralization is based on the relationships between the mineralization and the structural elements, the Timiskaming Group rocks and the porphyritic intrusions.

Showings consisting of "VMS-associated sulphides" mineralization (type 6) and "synvolcanic epithermal veins" (subtype 3a) are spatially associated with the volcanic rocks of the Kinojevis Group. Although the Nipissing showing does not exhibit a metal assemblage typical of a submarine hydrothermal system (Barrie and Hannington, 1999), the geometry of the mineralized system and its alteration envelope suggests that it was emplaced when the strata were subhorizontal and that it is now tilted. Furthermore, volcanic rock fragments cut by chalcedony veinlets have been identified in a conglomerate lens of the Duparquet Formation immediately north of the showing. Similar active mineralized systems, rich in As-Sb-Hg, have been found at depths of over 1,000 m below sea level (Herzig and Hannington, 1995). The fact that only gold is present in economic quantities is thought to be linked to boiling of hydrothermal fluids (Poulsen and Hannington, 1996).

The first mineralization event of the "quartz + carbonates vein" type (subtype 1a) is associated with the folding of the volcanic pile and with the development of the earliest regional schistosity (event D_1). The chronology of this mineralization event is revealed by the presence of auriferous quartz vein fragments in the Duparquet Formation, along with strongly deformed N-S trending veins like those at Yvan-Vézina mine and the Double Strike deposit. Only a few deposits (for example, Maude Lake 1) can be linked to this deformation episode.

A period of local extension (Figure 3) corresponds to the emplacement of calc-alkaline and alkaline porphyritic intrusions and the opening of the sedimentary basins associated with sedimentation of the Duparquet Formation. Mineralization of the "synsedimentary epithermal vein" type (subtype 3b) was probably emplaced during this stage in synsedimentary faults bordering the Duparquet basin. These veins cross-cut the calc-alkaline intrusions and are strongly deformed. The "leaching-associated disseminated sulphides" (type 5) type of mineralization was affected by the D_2 deformation event (folding and boudinage). In light of their spatial association with syenites, these mineralized zones are likely contemporaneous. Mineralized zones representing "disseminated sulphides associated with alkaline intrusions" (subtype 2b) were emplaced after the syenite intrusion, but before sedimentation of the Duparquet Formation. This is suggested by the sulphide-rich fragments occurring in the base conglomerate in discordant contact with syenite.

Two types of mineralization are related to the second phase of deformation (D_2), with which the folding of Duparquet Formation sediments and the development of the PDF and some E-W trending faults are associated (Beattie, Donchester and Central Duparquet faults and portions of the Ottman and Lépine faults), reactivation of the synsedimentary faults (Duquesne fault and portions of the Ottman and Lépine faults) and associated schistosity. Most mineralization of the "quartz + carbonates vein" type (subtype 1b) can be explained using a model of emplacement within shear zones of reverse movement with an oblique component. These veins are usually weakly deformed and cross-cut all lithologies.

Mineralization consisting of "disseminated sulphides associated with calc-alkaline intrusions" (subtype 2a) constitutes a variant of the latter type. During deformation, a marked competency contrast between these intrusions and the host rock (generally ultramafic volcanics) promotes fracturing of the intrusion, thus creating channelways for the transport of hydrothermal fluids. However, these systems were altered significantly during subsequent deformation episodes, giving rise to discontinuous mineralized envelopes.

Mineralization of the "argentiferous quartz vein" type (type 4) was emplaced during the fragile D_3 deformation period, with which the formation of NNE and NNW conjugate faults is associated. These rectilinear veins were disturbed only slightly by late NNE-trending faults.

IMPLICATIONS FOR GOLD EXPLORATION

The compilation of gold showings and deposits indicates that the gold was emplaced at different depths during the geological evolution of the sector. Of the six types of gold mineralization identified, the "quartz + carbonates vein" type and the "disseminated sulphides associated with alkaline intrusions" type have the greatest potential for economic deposits. Although the Duquesne mine is a good example of the mineralization subtype referred to as "disseminated sulphides associated with calc-alkaline intrusions," the values obtained for this subtype are generally too erratic and the zones too discontinuous for it to constitute an economic deposit. At the Duquesne mine, zones characterized by swarms of small dykes were found to have higher gold values than zones with wider or less dense dykes (P. Pilote, pers. comm., 2004). Environments with an abundance of dykes should be preferentially targeted in the search for economic deposits of this type. The "synsedimentary epithermal vein" type of mineralization and the "disseminated sulphides associated with leaching" type could also have some potential, as attested by the Golconda and Fox deposits, respectively (Table 2); however, the complexity of these deposits suggests that they result from the superposition of several types of mineralization. The limited thickness and erratic gold concentrations of the "argentiferous quartz vein" type of mineralization are not prospective for the discovery of economic deposits.

Characterization of the types of gold mineralization permits more targeted exploration at the regional scale. Some sectors remain underexplored; some have a higher potential than others. A brief evaluation of some of these favourable areas is provided here.

In the western part of the study area, gold exploration has been concentrated mainly along the PDF. Some areas of the PDF remain relatively unexplored such as the region west of the Beattie Syenite (Figure 2), which shows gold anomalies in the till and promising alterations (Lei, 2000; Figure 13). Little work has been done on the ENE-WSW, ESE-WNW and E-W subsidiary structures, mainly because of the absence of obvious anomalies in the geophysical and geochemical surveys (Lei, 2000). It must be kept in mind, however, that most of the deposits on the Ontario side of the PDF are located along subsidiary faults (Ayer and Trowell, 1998). In addition, the Holloway deposit, located 17 km west of the Ontario border at a depth of over 300 m, only has sericite and carbonate alteration at the surface (Ropchan *et al.*, 2002). The carbonatization zones associated with the subsidiary faults along the PDF are generally less than 50 to 100 m thick and therefore can easily be overlooked in an investigation. Albitization is an important type of alteration in the Holloway and Holt-McDermott mines in Ontario (Workman, 1986; Ropchan *et al.*, 2002), but it is rare on the Quebec side. Its identification within a carbonate alteration halo could lead to the discovery of similar deposits. Some mineralized zones have been intersected recently in drill holes in the vicinity of the Porcupine-173656 showing (Caillé *et al.*, 2003). One of these differs greatly from the "quartz + carbonates vein" type and is associated with very coarse pyrite in weakly deformed basalt that is weakly carbonatized and sericitized (POR02-118 showing). This zone may be more closely related to the "VMS-associated sulphides" type of mineralization than with the "quartz + carbonates vein" type and may therefore represent a new exploration target for the sector.

A number of areas around the Beattie Syenite deserve to be explored or simply studied more systematically. The margins of the syenite (especially those that are sheared) show promising gold intersections whose extensions have not been properly tested (especially the eastern extensions of the Beattie and Donchester mines; Lochon, 1989; Hallé, 1990; Gadoury, 1995). Other areas show alterations similar to those characterizing the "disseminated sulphides associated with alkaline intrusion" type of mineralization, making them worth investigating (Legault *et al.*, 2004b). The paucity of rocks containing normative quartz around the Beattie Syenite (basalt, gabbro, syenite) means that silicified zones can be quickly detected using the NORMAT software developed by Piché and Jébrak (2004).

The Duparquet basin, in the central sector, should also undergo more detailed study, especially the faulted margins. This sector is characterized by mineralization of the "synsedimentary epithermal vein" type emplaced along synsedimentary faults during the opening of the Duparquet basin. The molybdenum (<0.3%) and bismuth (<60 ppm) enrichment in these occurrences strongly suggests that a magmatic fluid was involved in their genesis. The circular positive magnetic anomaly situated between the Shaft deposit and the Hilltop showing (Legault *et al.*, 2004a) could in fact represent a syenitic intrusion (?) associated with the opening of the sedimentary basin, which could have favoured the emplacement of epithermal veins. Mineralization of the "quartz + carbonates vein" type and the "disseminated sulphides associated with calc-alkaline intrusion" subtype located south of the Duparquet basin may represent a remobilization of epithermal mineralization. This hypothesis could explain the anomalous Hg, Ag and Pb values of some of the mineralized zones. The southern margin of the basin near the Shaft deposit continues to provide promising intersections (Queenston, press release, September 22, 2004), but the eastern portion of the southern margin and most of the northern margin have so far undergone very little exploration. The significant gold values obtained recently at the NIP showing (9.9 g/t Au over 3.5 m; Globex, news release, January 13, 2003) confirm the economic potential of these faults towards the east. The faults are generally highly carbonatized and sericitized (Figure 13), which is indicative of the passage of hydrothermal fluids.

The Lanaudière Formation, which extends between the Shaft deposit and Yvan-Vézina mine, as well as from the Fayolle deposit to the area east of Aiguebelle Provincial Park (off the map), holds potential for VMS-type mineralization. The rhyolites are characterized by a transitional affinity (Zr/Y = 4.6; n = 37), low REE fractionation (La/Yb_N = 4.5; n = 5) and strong negative europium anomaly (Eu/Eu* = 0.38; n = 5) (Figure 4). These characteristics allow them to be classified in the FIIIB type of Lesher *et al.* (1986) and Group I of Barrie *et al.* (1993), which are generally associated with volcanogenic massive sulphide mineralization. It is interesting to note that the Lanaudière Formation has compositional features and a geological setting (interdigitation of basalts, magnesian basalts, ultramafic intrusions and rhyolites) similar to those of the Kidd Creek Mine in Timmins, Ontario, which contains more than 139 Mt grading 2.4 % Cu, 6.5% Zn, 0.2% Pb and 89 g/t Ag (Barrie *et al.*, 1999). In the

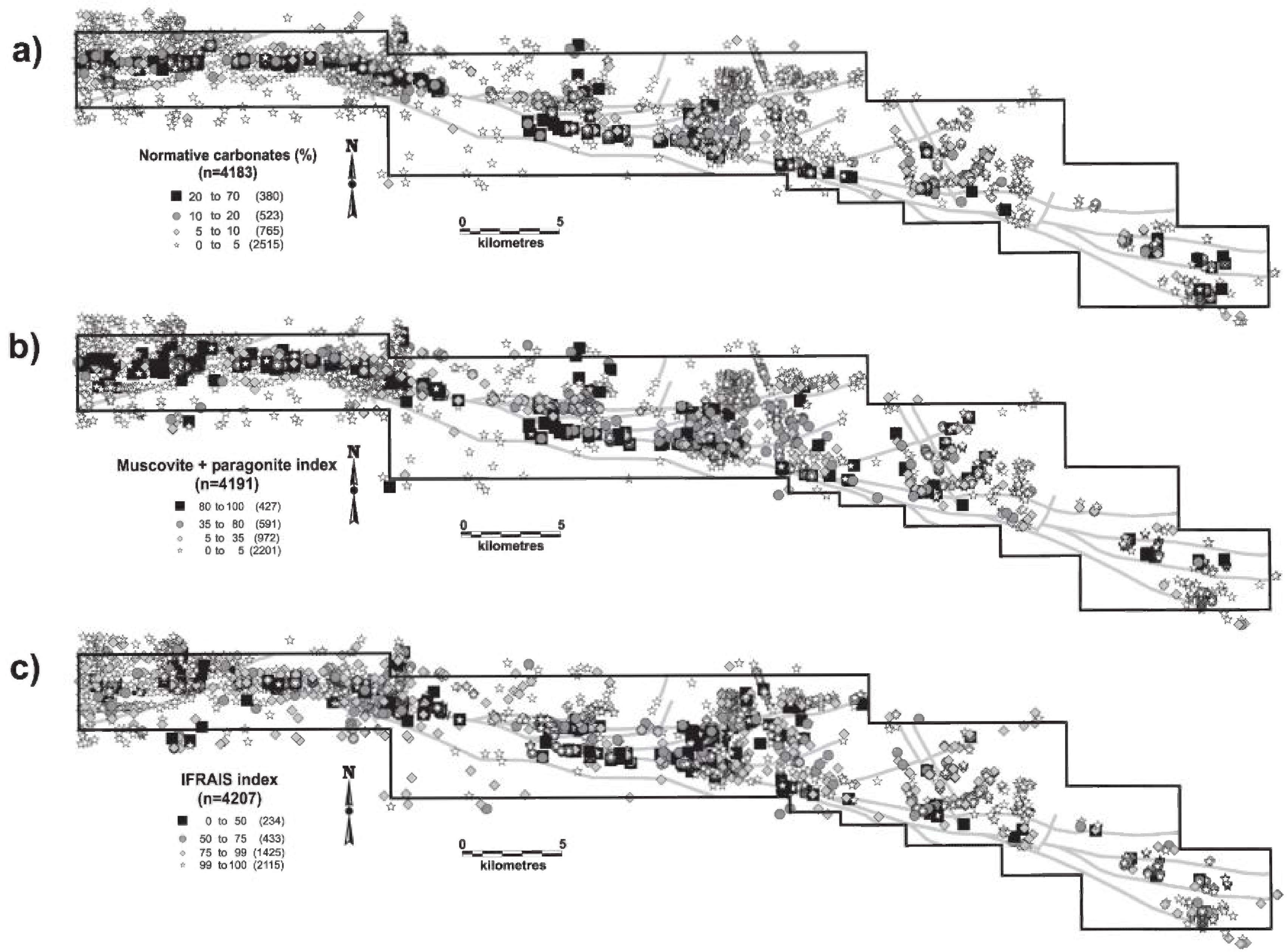

FIGURE 13 - Regional alteration distributions based on a compilation of 4600 lithogeochemical analyses processed using NORMAT software (Piché and Jébrak, 2004): **a)** Carbonates (ankerite + calcite + dolomite + magnesite + siderite); **b)** Muscovite-paragonite index (100x((muscovite + paragonite)/(albite + potash feldspar + muscovite + paragonite)); **c)** IFRAIS index (100x(albite + potash feldspar + anorthite + clinopyroxene)/(chlorite + paragonite + pyrophyllite + albite + potash feldspar + anorthite + clinopyroxene)).

past, exploration companies have studied the region primarily for its gold potential, virtually ignoring its VMS potential. The IFRAIS index of Piché and Jébrak (2004), which measures relative alteration intensity, indicates that the Lanaudière Formation contains highly altered rocks (Figure 13).

In the eastern part of the study area, exploration work has focused mainly on the area of the Yvan-Vézina, Fayolle, Destorbelle and Victoria deposits. Several segments of the major faults (Aiguebelle, Manneville, La Pause) remain essentially unexplored. These structures are generally associated with strong carbonatization (Figure 13), but they are not very exposed, being covered by a thick mantle of unconsolidated deposits of Quaternary age. The area of the Hard Rock showing, among others, holds promise. It is associated with strong carbonatization and intense pyritization in a poorly defined geological context (Morisette, 1994; Morisette and O'Connor, 1996); it is also identified by an induced polarization (IP) anomaly, which can be followed westward over a distance of over a kilometre (Hallof, 1987). The only drill holes, which date back to 1946, provide little information (Hard Rock Gold Mines, 1946). This showing is located in the Aiguebelle Wildlife Reserve, where mineral exploration activities are permitted provided certain rules aimed at minimizing environmental impacts are complied with.

Looking at the study region as a whole, it is clear that exploration work has focused on specific areas. Furthermore, exploration in these areas has primarily consisted in testing the first 500 metres below the surface. This observation is important given that that the Quebec part of the PDF shows a low degree of erosion, which would explain the preservation of epithermal vein-type mineralizations and the low degree of metamorphism. The Ontario part of the fault is distinguished mainly by the presence of "quartz + carbonates vein" mineralization (Berger, 2001) and by greenschist facies metamorphism (Jolly, 1978; Powell *et al.*, 1995), suggesting a higher degree of erosion. As lithostatic pressure increases with depth, orogenic mineralization tends to be confined to shear zones at greater depths and pressures and to more diffuse breccia and stockworks at shallower depths and lower pressures (Groves *et al.*, 1995; McCuaig and Kerrich, 1998). If this is the case, we can expect to find more concentrated gold mineralization, analogous to that observed on the Ontario side at depth, in the Quebec portion of the PDF. This observation is even more relevant in the central sector, where most of the epithermal mineralization is present.

CONCLUSION

Six types of gold mineralization have been identified and characterized through the metallogenic synthesis encompassing the Porcupine-Destor Fault (PDF). The "quartz + carbonates" vein type occurs in deformation zones with strong iron carbonate, sericite and pyrite alteration, which are characteristic of orogenic deposits. The "disseminated sulphides associated with porphyritic intrusion" type can be divided into subtypes based on the composition of the intrusive rock. The subtype associated with alkaline rocks is richer in sulphides and exhibits intense silicification. The calc-alkaline subtype has a limited sulphide content and generally displays strong carbonatization. The latter probably constitutes a variant of classic orogenic deposits. The "epithermal vein" type of mineralization has open spaces crystallization textures (colloform, cockade and crustiform textures) along with anomalous Zn, Pb and Hg concentrations typical of neutral epithermal mineralization. The "argentiferous quartz vein" type is associated with tension veins rich in Cu, Sb, Zn and Hg, analogous to the Ag-Pb-Zn veins hosted in clastic metasedimentary rocks. The "disseminated sulphides associated with leaching" type of mineralization occurs as a massive residue of quartz + pyrite (5-10%) that is reminiscent of acid epithermal deposits. By contrast, the "volcanogenic massive sulphides" type exhibits quartz + pyrite + chalcopyrite replacement in basalt flow breccia. The identification of these various characteristics should help to guide and better target exploration efforts in the sector. This study shows that gold has been emplaced at various depths throughout the region's geological evolution, attesting to a complex history that is not necessarily tied to the PDF. A number of sectors or settings that are prospective for gold are described. The presence of epithermal vein mineralization, porphyry intrusions, a large accumulation of Timiskaming-type sediments and low-grade metamorphic facies attests to the low degree of erosion generally observed along the PDF. This finding, combined with the orogenic mineralization emplacement model (Groves *et al.*, 1998), suggests that the potential of some structures lies at depth where the gold mineralization is likely to be more concentrated.

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Location and description of the different gold mineralizations compiled in the present study.

Showing	Easting	Northing	NTS	Description **	Type	GM (most recent)	Comments
1299-01-02	638676	5372900	32D06	in contact with I1	2a	59046, 60246	Drill intersections; see also drill hole 1299-02-05
20	613130	5375986	32D11	Schist TC-CB-CL-PY	1	6786A	Drill intersection
20-20	641098	5372136	32D06	PY++ CB++	2a	53986, 54723, 54921, MB 96-06	Stripping; drill intersections
85-29	653000	5372090	32D07	[BR] CB CL PY+	1*	42853	Drill intersection
90-5	635150	5374164	32D11	vn QZ [BR] PY++ EP++	1	49711	Two other gold intersections in hole
A-83-9	647497	5373476	32D06	vl QZ PY+++	2a	40928	Drill intersection
AIG97-08	663579	5366408	32D07	PY+ vl QZ CB	2a	55590	Drill intersection
AIG97-15	663632	5366967	32D07	PY+ HM++ CC++	2a	55590	Drill intersection
Aiguebelle A-83-10B	647563	5374197	32D11	vn QZ CB PY+	1	40928	Drill intersection
Aiguebelle A-83-15	645586	5373367	32D06	vl QZ CB PY+	2a	40928	Drill intersection
Aiguebelle-Goldfields	661381	5367125	32D07	PY++ vlQZCBPY HM+++	2a	5752, 37247, 57134	Trenches; intersections in old drill holes
ATV	639922	5372113	32D06	vn QZ CB PY++	1	53986, 54723, 54921	Drill intersections
B86-56	655416	5369141	32D07	vn CB PY+	1 ?	44915	Drill intersection
B87-104	651440	5370680	32D07	vl QZ CB PY++	1	46411	Drill intersection
B87-105	653390	5370140	32D07	vn QZ CB CL PY+	1	46411	Drill intersection
B87-168	655090	5371300	32D07	vn QZ PY PY++ [BR]	1*	46411, 52668	Drill intersection
B87-178	652703	5370691	32D07	vl QZ PY+	1 ?	46411	Drill intersection
B87-98	653370	5369820	32D07	HM+++ CB+++ PY++	1 ?	46411	Drill intersection
Bassique	657560	5369610	32D07	vn QZ ???	1 ?	6071, 11496	Intersections in old drill holes
Beattie - Zone A	630190	5374410	32D11	[BR] QZ+++ PY++ AS++	2b	Internal report	Reserves estimated at 0.418 Mt grading 5.31 g/t Au
Beattie - Zone Nord	630311	5374585	32D11	[BR] QZ+++ PY++ AS++	2b	Internal report	Reserves estimated at 1.39 Mt grading 4.05 g/t Au
Beattie - Zone Sud	630292	5374300	32D11	[BR] QZ+++ PY++ AS++	2b	Internal report	Stripping; reserves estimated at 0.408 Mt grading 3.99 g/t Au
Bocabois	651210	5371600	32D07	???	???	6072A, 43374	Trenches
Bouchard 1	652435	5370658	32D07	vn QZ EP CB	1	38044	Outcrop
Bouchard 2	652050	5370575	32D07	vn QZ EP CL PY	1	38044	Outcrop
Bouchard 4	652839	5370391	32D07	vn QZ EP PY	1	38044, 42853, 43374	Outcrop
Bouchard 5	652726	5371005	32D07	PY++ associated with an enclave	???	38044	Outcrop
Brèche	652466	5370065	32D07	vn QZ [BR] PY++	1*	#	Stripping and channel sampling
Carte 2	651950	5369738	32D07	vl QZ CB PY+ cis	1	52668	Outcrop
Casino	640160	5371737	32D06	vn QZ [BR] PY++	1*	53986, 54723, 54921	Drill intersections
CD-95-96	634404	5374132	32D11	QZ+++ PY++	2b	53555	Drill intersection
CD-95-99	633458	5374265	32D11	QZ+++ PY++	2b	53555	Drill intersection
Central Duparquet 1	633086	5373970	32D11	QZ+++ PY++	2b	MB 96-06; internal report	Stripping; reserves estimated at 0.57 Mt grading 5.1 g/t Au
Central Duparquet 2	633886	5373930	32D11	vn QZ CB CP GL SP PY AS TH	4	MB 96-06; internal report	Exploration shaft; ore still present
Chert noir	642638	5372189	32D06	vl PY in S4D	1 ?	53116	Trench
Claims Silver	651136	5370630	32D07	vl QZ CB PY+	4	9669,11740,46411	Trenches
Concession	652690	5370140	32D07	vn QZ [BR] PY++	1*	6077, 52668	Drill intersections
D-33	647087	5373146	32D06	PY+ in I1	2a	32062	Drill intersection
D-6	635254	5374482	32D11	PY and CP traces in I2I	???	32062	Drill intersection; no information
DAM	646595	5370955	32D06	CB++ QZ++ PY+	2a	43025,56047, PFE Chénard 1990	Stripping
Davangus Est	655810	5369950	32D07	vl QZ PY+	2a	9678, 56676	Drill intersections
Davangus Zone 1	654130	5370170	32D07	[BR] CB QZ PY++	1*	52668	Reserves estimated at 0.24 Mt grading 5.8 g/t Au for zones 1 and 2
Davangus Zone 2	654210	5370200	32D07	[BR] CB QZ PY++	1*	52668	Reserves estimated at 0.24 Mt grading 5.8 g/t Au for zones 1 and 2
Davangus Zone NE	654700	5370570	32D07	[BR] CB QZ PY++	1*	52668	Drill intersections
Destor Nord	651940	5372760	32D07	vn QZ CB HM++ PY++ [BR]	1*	41869, 52668	Drill intersections
Destorbelle	658756	5368155	32D07	PY CP SP brecciated GP+++	2a ?	27, 42414	Trenches; intersections in old drill holes
Double Strike	652321	5369970	32D07	QZ+++ HM++ PY++	1*	37246, 52668, 56047	Reserves estimated at 0.20 Mt grading 2.32 g/t Au
East Bay	625971	5374280	32D11	vn QZ CB PY CP	1	625B, 9878, 39769	Trenches, drill intersections
East Stinger	639994	5372303	32D06	vl QZ CB PY CP GL SP	3	54723, 54921	Reserves estimated at 0.19 Mt grading 5.06 g/t Au
Eastchester	638600	5375242	32D11	vl QZ QZ+++ PY+	1	695A	Drill intersections
Eclipse	647084	5372620	32D06	[BR] PY++ vn QZ?	2a	9677, 40928, PFE Chénard 1990	Trenches
Elk Lake 1	647074	5370728	32D06	vl QZ PY++	2a	43025,56047, PFE Chénard 1990	Stripping; drill intersection
Elk Lake 2	647443	5370263	32D06	Replacement QZ CP	6	10199B	Drill intersection

Some codes used in this table are defined on the last page of Appendix 1.

Location and description of the different gold mineralizations compiled in the present study.

Showing	Easting	Northing	NTS	Description **	Type	GM (most recent)	Comments
FA-95-02	662674	5367022	32D07	SI+++ PY+	2a	53438	Drill intersections
Faille Ottman	635283	5373351	32D06	vn QZ SP GL PY	3	56355, ##	Stripping
Faille Ottman	635283	5373351	32D06	vl QZ PY++	2a	56356, ##	Stripping
Fayolle	662140	5367104	32D07	vl QZ CB PY++	2a	45761, 47439	Stripping; reserves estimated at 0.80 Mt grading 6.2 g/t Au
Fox	639927	5372183	32D06	QZ+++ PY++	5	53986, 54723, 54921, ##	Strippings; reserves estimated at 0.33 Mt grading 10.02 g/t Au
G82-5	634353	5374516	32D11	vn QZ PY	4	40579	Many veins (especially in drill hole G82-1)
G82-7	634839	5374651	32D11	QZ+++ PY++	5 ?	40579	Possibly associated with syenite, ratio of Au/Ag < 1
G83-1	633954	5374353	32D11	QZ+++ PY++	5 ?	40579	Possibly associated with syenite, Au/Ag < 1
G83-2	634033	5374289	32D11	QZ+++ PY++	5 ?	40579	Possibly associated with syenite, Au/Ag < 1
Globex	641142	5371762	32D06	vl QZ CB PY++	1	53986, 54723, 54921	Stripping; drill intersections
Golconda	640161	5373450	32D06	vn QZ CB PY	3	9920, 39275, 55643	Reserves estimated at 0.36 Mt grading 5.83 g/t Au
Hard Rock	660588	5368784	32D07	PY++	2a ?	5753,40370	Flooded trench; intersections in old drill holes
Hélène	631415	5374243	32D11	QZ+++ PY++	2b	MB 92-06	Outcrop JG-90-1027
Hilltop	640982	5373378	32D06	vl QZ CB PY	2a	55643, ##	Stripping; drill intersection
Jackpot Vein	640090	5371953	32D06	vn QZ CB PY	1	53986, 54723, 54921	Drill intersections
Jacques	634772	5373902	32D11	vn QZ PY++	3	MB 92-06	Outcrop JG-94-5042
JG-90-1188	641446	5371949	32D06	vn QZ CB PY+ in I1	2a	MB 92-06	Outcrop JG-90-1188
KA	656280	5369350	32D07	vl QZ SR++ PY+	2a	54167	Drill intersections
L87-52	642212	5374101	32D11	???	???	46977	Drill intersection
Lac Dances-Ouest	611749	5375946	32D11	vn QZ CB PY++	1	6786	Intersections in old drill holes
Lac Duparquet-Ouest	623051	5376255	32D11	vn QZ CB PY+	1	40129, 53164, 57122	Trenches; drill intersections
Lac Hébécourt-Nord	614144	5376154	32D11	vl QZ CB PY+	1	6786, 55797	Intersections in old drill holes
Laplante 2	651743	5369761	32D07	vn QZ PY	1	42853, 43374	Outcrop
Laplante 3	651880	5369918	32D07	vn QZ PY	1	42853, 43374	Stripping
Laplante 3a	651776	5370040	32D07	vn QZ ??	1	6077, 43374	Outcrop
Laplante 4	652106	5369966	32D07	vl PY	1 ?	42853, 43374	Outcrop
Lépine - Zone A	653290	5372780	32D07	M16 SR vl QZ PY++	1	44480, 52668	Outcrop; drill intersection
Lépine - Zone B	653200	5372740	32D07	vn QZ CB PY+ [BR]	1*	44480, 52668	Drill intersection
Lépine NE	654160	5373450	32D07	CB+++ PY++ fault?	1 ?	43375, 52668	Drill intersections
Lépine Sud	645930	5370718	32D06	vl QZ CB PY++	1	53116	Drill intersections
Liz	640238	5371966	32D06	vn QZ CB PY++	1	Rapp. Int.	Reserves estimated at 0.44 Mt grading 6.07 g/t Au
Lynx	639930	5372067	32D06	PY++ in syenite	2b	53986, 54723, 54921	Stripping; drill intersections
Maude Lake 1	637724	5373803	32D11	vl QZ CB PY+++ folded	1	56356; ##	Stripping
Mine Donchester	631856	5374330	32D11	[BR] QZ+++ PY++ AS++	2b	RG 61	Ore still present; deposit depleted?
Mine Duquesne	645185	5370919	32D06	vn QZ CB PY++ CP+ in contact with d'I1	2a	53116, internal report, DV 90-10	Reserves estimated at 0,22 Mt à 7,78 g/t Au
NIP	641942	5371926	32D06	vl QZ CB PY CP SP MO	3	51555	Drill intersection
Nipissing	644623	5373444	32D06	vl QZ CB [BR] PY++	3	42616, 54562#	Stripping; drill intersections
Nipissing	644623	5373444	32D06	vn QZ CB CP PY+	4	42616, 54562#	Stripping
Nipissing Ouest	644517	5373407	32D06	vn QZ CB TH PY++	4	42616, 54562#	Stripping; drill intersections
Orco	666569	5365866	32D07	vn QZ PY++ CB+++	2a	51735	Stripping
Oublié	623773	5375628	32D11	vn QZ CB PY+	1	10758A, 40129	Trenches
Patino	645880	5370990	32D06	vn QZ CB PY++	1	52159,53116	Stripping; drill intersections
PC-88-13	627384	5374902	32D11	vn QZ CB AS	1	48562	Drill intersection
PD 87-04	643616	5371711	32D06	vl QZ PY+ in V1B	2a	42272	Drill intersection
PD 87-06	643439	5372667	32D06	[BR] CC+++ PY+?	1 ?	42272	Drill intersection
PD-87-8B	643239	5373088	32D06	vl CC EP PY+	1	42272	Drill intersection
Peacock	625021	5375655	32D11	CB++ CL++ PY++	2a	30266, 56323, 58080	Trenches now covered by road; drill holes
Pitt Main (et Pitt South)	638911	5372130	32D06	vn QZ CB [BR] PY++	2a	53986, 54724, 54920	Drill intersections
POR02-118	615369	5376236	32D11	PY++ coarse SR+++	6 ?	60023	Drill intersection
POR02-119	614563	5376200	32D11	[BR] AS+++ PY++ SR+++ vl QZCB	1*	60023	Drill intersection
POR-88-76	614653	5375422	32D11	vn QZ CB PY+	1	48775	Drill intersection
POR-95-79	620857	5376155	32D11	vn QZ CB [BR] PY++	1	53164	Drill intersection

Some codes used in this table are defined on the last page of Appendix 1.

Location and description of the different gold mineralizations compiled in the present study.

Showing	Easting	Northing	SNRC	Description **	Type	GM (most recent)	Comments
POR-96-82	612629	5375970	32D11	vn QZ CB PY+	1	54432	Drill intersection
POR-96-84	617898	5376508	32D11	vn QZ CB PY+	1	54432	Drill intersection
POR-97-87	622158	5376210	32D11	vn QZ CB PY+	1	54897	Drill intersection
POR99-110	614553	5376458	32D11	CB++ SR++ PY+	2a	58080	Drill intersection
Porcupine-173595	634511	5374355	32D11	vn QZ CB PY++	1	42537, 49436#	Stripping; Au/Ag < 1
Porcupine-173656	615411	5376205	32D11	vn QZ CB PY+	1	42537#	Stripping; other mineralization styles in drill holes
Porcupine-88-50	609761	5375755	32D12	vn QZ CB PY++ AS+	1	48775	Drill intersection
Porcupine-88-72	619336	5376030	32D11	vl QZ CB PY++	1	48775	Drill intersection
Quebelle	662294	5367219	32D07	vl QZ CB PY++	2a	45761	Outcrop
RAD-93-03	643180	5371196	32D06	vl QZ CB CP PY+ in I1	2a	53116	Stripping
RD96-11	644893	5372152	32D06	PY++ in I1	2a	54562	Drill intersection
Sondage 90-11	635786	5374455	32D11	vn QZ PY++	1	49711	Drill intersection
Stinger	638803	5372227	32D06	vn QZ CB [BR] PY CP GL SP	3	53986, 54724, 54920	Drill intersections
Structure 71	610886	5375680	32D11	vn QZ CB PY++ AS+	1	46481	Reserves estimated at 0.20 Mt grading 5.20 g/t Au
Sylvanit Pit	652101	5370598	32D07	[BR] PY++ vn QZ QB	1*	43374, 52668, 56047	Flooded trench
Tiger Ouest	640924	5372556	32D06	vl QZ CB PY CP GL SP	3	55643	Drill intersection
Tom	660820	5368976	32D07	vl QZ CB CL+++ PY++ [BR]	1 ?	56050	Drill intersection
Touriet	635383	5372636	32D06	vl QZ CB PY+ in I1	2a	47063, 56323	Strippings; drill intersections
Touriet Est	636976	5372603	32D06	vl QZ PY in I1	2a	56515	Drill intersection
Touriet Sud	635125	5372434	32D06	vn QZ CB PY++	1	56323	Drill intersection
Valley Gold	650110	5369710	32D07	QZ+++ PY++	1 ?	971	Intersections in old drill holes
Valley Gold	650200	5369990	32D07	PY++ vl PY	2a	971	Intersections in old drill holes
Valley Gold	650580	5370190	32D07	QZ++ EP++ PY+	1 ?	971	Intersections in old drill holes
Vang	662102	5366727	32D07	vn QZ PY+	1	55590, 57134	Stripping
Vang Est	662390	5366688	32D07	S1/S6 laminated PY++	6	55590, 57134	Outcrops; drill intersections
Vang Ouest	661671	5366610	32D07	PY++ CB+++	2a	40081, 57134	Drill intersections
Victoria	665978	5364516	32D07	vn QZ CB TL CB++ SR++ PY++	1	53124, 55599	Stripping; drill intersections
Wettring	624313	5375853	32D11	VL QZ PY+	2a	6769, 10758A	Intersections in old drill holes
Yvan Vezina	652256	5371630	32D07	vn QZ CB PY++ [BR]	1*	Beaudoin 1986, internal report	Depleted deposit
Zone 20 extension W	644761	5371124	32D06	vn QZ PY++ in contact with I1	2a	53116	Stripping and channel sampling
Zone Faille Duquesne	642542	5372000	32D06	vl QZ CB PY++ in V1B	2a	53116	Stripping; drill intersections
Zone grise	646220	5370870	32D06	QZ+++ CB+++ PY++	1 ?	52159, 53116	Drill intersections
Zone Shaft	640732	5372111	32D06	vn QZ CB PY+ in contact with I1	2a	53986, 54723, 54921	Stripping; reserves estimated at 0.10 Mt grading 7.10 g/t Au
Zone South	641368	5371620	32D06	vn QZ CB PY+ in contact with I1	2a	53986, 54723, 54921	Reserves estimated at 0.18 Mt grading 13.4 g/t Au
Zulapa	656962	5370106	32D07	Replacement QZ CB PY CP	6	11496, 46566, 56676, ##	Trenches; stripping

UTM coordinates = NAD 83, zone 17.

Type 1 = quartz + carbonates vein; **Type 1*** = brecciated quartz + carbonates vein; **Type 2a** = disseminated sulphides associated with a calc-alkaline intrusion;
Type 2b = disseminated sulphides associated with alkaline intrusion; **Type 3** = epithermal vein; **Type 4** = argentiferous quartz vein; **Type 5** = disseminated sulphides associated with leaching;
Type 6 = volcanogenic massive sulphides; **???** = insufficient data.

= stripping mapped by the author; **##** = company's detailed mapping modified by author.

I1 = felsic intrusion (quartz + feldspar or feldspar porphyry).

vn = vein.

vl = veinlets.

[BR] = brecciated.

** = the minerals are identified by SIGEOM codes.

APPENDIX 2: Oxygen and carbon isotopic composition

Oxygen and carbon isotopic composition of quartz (QZ) and carbonate (CB). Data from Beaudoin (2004).

Sample	Showing	Mineralization type	Mineral	$\delta^{18}O$	$\delta^{13}C$	Texture
ML-02-001D	Lac Duparquet-Ouest	Quartz + carbonates vein	QZ	15.4		White quartz vein
ML-02-014	Porcupine-173656	Quartz + carbonates vein	QZ	14.3		Quartz + carbonates vein
ML-02-025	Ottman	Epithermal	QZ	13.1		Microgranular quartz
ML-02-025	Ottman	Epithermal	CB	6.7	-7.8	Microgranular quartz
ML-02-062	Duquesne	Quartz + carbonates vein	QZ	11.5		Quartz veinlets
ML-02-069	Porcupine-88-72	Quartz + carbonates vein	QZ	11.8		White quartz vein
ML-02-073	Structure 71	Quartz + carbonates vein	QZ	13.1		White quartz vein
ML-02-097	Touriet-E	Disseminated sulphides associated with QFP	QZ	14.3		Quartz veinlets
ML-03-245	Hilltop	Disseminated sulphides associated with QFP	QZ	14.7		Quartz + sulphides veinlets
ML-03-245	Hilltop	Disseminated sulphides associated with QFP	CB	16.5	-4.3	Quartz + sulphides veinlets
ML-03-275	Central Duparquet 2	Argentiferous quartz vein	QZ	14.3		White quartz vein
ML-03-281	East Bay	Quartz + carbonates vein	QZ	12.5		White quartz vein
ML-03-288	Shaft	Quartz + carbonates vein	QZ	19.1		Quartz + carbonates vein
ML-03-288	Shaft	Quartz + carbonates vein	QZ	16.7		Quartz + carbonates vein
ML-03-299	Casino	Quartz + carbonates vein	QZ	12.7		Breccia with quartz cement
ML-03-299	Casino	Quartz + carbonates vein	CB	13.4	-5.3	Breccia with quartz cement
ML-03-301	Casino	Quartz + carbonates vein	QZ	17.5		White quartz vein
ML-03-330	Nipissing	Epithermal	QZ	13.3		Chalcedony
ML-03-343	NIP	Epithermal	QZ	12.9		Quartz grains in dolomite
ML-03-501	Porcupine-173656	Quartz + carbonates vein	QZ	15.5		White quartz vein
ML-03-502	Hélène	Disseminated sulphides associated with syenite	QZ	13.6		Quartz + sulphides veinlets
ML-03-503	Ottman	Disseminated sulphides assoc. with QFP	QZ	13.2		White quartz vein
ML-03-504	Ottman	Late quartz vein	QZ	9.2		Quartz + sulphides veinlets
ML-03-506	Nipissing	Epithermal	QZ	13.5		Chalcedony
ML-03-507	Nipissing	Epithermal	QZ2	13.0		Late chalcedony
ML-03-507	Nipissing	Epithermal	QZ1	16.2		Early drusy quartz
ML-03-507	Nipissing	Epithermal	CB	17.8	-1.6	Early drusy quartz
ML-03-508	Nipissing	Carbonates vein (late)	CB	18.0	-3.8	Carbonate
ML-03-509	Nipissing	Geode centre (epithermal)	QZ	16.9		White quartz
ML-03-510	Nipissing	Argentiferous quartz vein	QZ	14.4		Translucent quartz vein
ML-03-511	Nipissing	Quartz + carbonates vein (late)	QZ	14.7		Drusy carbonate followed by quartz
ML-03-511	Nipissing	Quartz + carbonates vein (late)	CB	15.5	-2.4	Drusy carbonate followed by quartz
ML-03-512	Nipissing Ouest	Argentiferous quartz vein	QZ	14.0		Translucent quartz vein
ML-03-513	Faille Railroad	Carbonates vein	CB	13.6	-4.9	Carbonate
ML-03-514	Faille Lépine	Quartz + carbonates vein	CB	16.2	-1.0	Carbonate
ML-03-514	Faille Lépine	Quartz + carbonates vein	QZ	13.2		Quartz + carbonates vein
ML-03-515	NIP	Epithermal	QZ	9.2		Quartz fragments in sulphide matrix
ML-03-515	NIP	Epithermal	QZ	7.9		Quartz fragments in sulphide matrix

ABSTRACT

The Porcupine-Destor Fault (PDF) is one of the most important metallotects for gold in the Abitibi Subprovince. Studies were conducted along this fault from 2002 to 2004 to complete the regional mapping done in the 1990s and to develop new tools for gold exploration, including the present regional metallogenic synthesis. Through the synthesis, six types of gold mineralization have been identified, each with specific characteristics: 1) quartz + carbonates veins found in deformation zones with strong iron carbonate, sericite and pyrite alteration, characteristic of orogenic deposits; 2) disseminated sulphides associated with a porphyritic intrusion comprising two subtypes differentiated by the composition of the intrusion; 3) epithermal veins with crystallization textures in voids and anomalous concentrations of Zn, Pb and Hg typical of neutral epithermal mineralizations; 4) argentiferous quartz veins produced under tension and rich in Cu, Sb, Zn and Hg, analogous to Ag-Pb-Zn veins enclosed in clastic metasedimentary rocks; 5) disseminated sulphides associated with leaching that are present as a massive residue of quartz + pyrite (5-10%) reminiscent of acidic epithermal deposits; and 6) volcanogenic massive sulphide showings associated with quartz + pyrite + chalcopyrite replacement in basaltic flow breccia. Isotope geochemistry and electron microprobe analyses have been used to corroborate field classification of the different types of mineralization.

This study shows that gold emplacement has occurred at various depths and at various stages in the area's geological evolution. Now that the characteristics of the different types of gold mineralization have been defined, more carefully targeted exploration activities can be undertaken in the region. In addition, some sectors and contexts have been identified as being prospective for gold-bearing deposits and they deserve special attention. The present study suggests that the Quebec portion of the Porcupine-Destor Fault underwent less erosion than the Ontario part, and that some of its gold potential must therefore lie at depth.

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