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EXPLORATION FOR PORPHYRE-RELATED MINERAL DEPOSITS IN THE GASPE PENINSULA: NEW PERSPECTIVES

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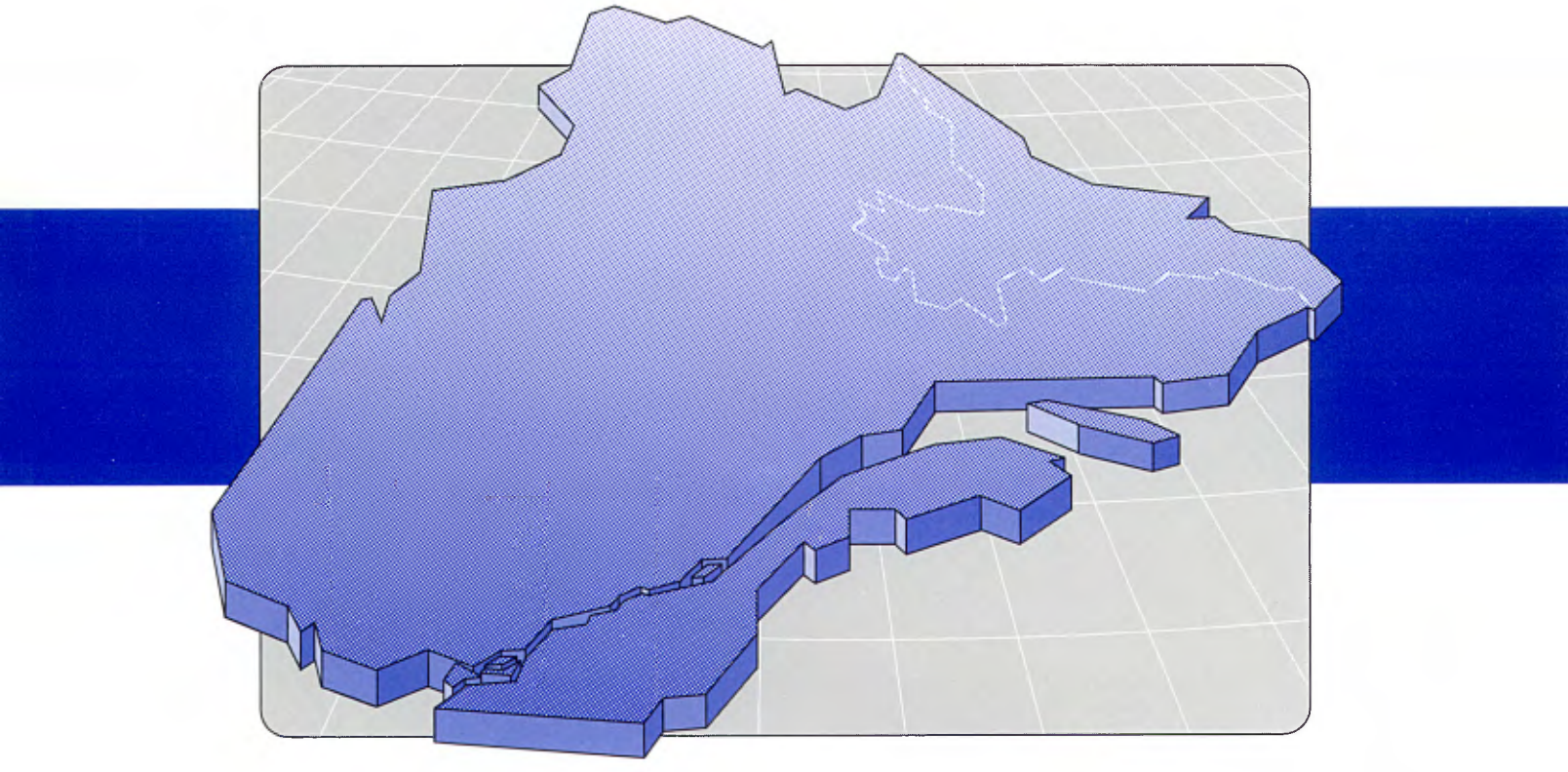
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Exploration for porphyry-related mineral deposits in the Gaspé Peninsula : new perspectives

Martin Doyon

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Introduction

The Gaspé Peninsula is known as a mineral district because of the world-class Murdochville deposits (figure 1), which comprise porphyry coppers, copper-skarns and copper-rich, massive sulphide replacements of marbles. The latter deposit type was only recognized during the 1980's and, despite its economic potential, has not been explored for outside of the mine area. This document presents a review of porphyry-related deposits, in relation to their geologic environment (figure 2), and suggests favorable areas for exploration in the Gaspé Peninsula (figure 1).

Geological Setting

The Gaspé Peninsula is part of the Appalachian orogen, which represents an ancient continental margin of the North-American continent. The central and southern parts of the Peninsula are comprised of mid-Ordovician to mid-Devonian sedimentary rocks belonging to the Gaspé Belt (figure 1 ; Bourque *et al*, in press ; Brisebois and Brun, 1994). The sedimentary rocks are mainly limy sandstone and mudstone ; some units comprise thick limestone horizons favorable for the formation of replacement deposits (Brisebois *et al*., 1991). The Gaspé Belt also comprises a number of Siluro-Devonian volcanic units belonging to a bimodal suite of tholeiitic to alkaline basalts and subalkaline to peralkaline rhyolites (Doyon and Dalpé, 1993). Only the Dalhousie volcanics, in the Chaleurs Bay area, contain abundant andesites. In addition to these volcanic rocks, there are coeval intrusive rocks, including subvolcanic sills and dyke swarms (Doyon and Dalpé, 1993 ; Bédard, 1986), granitic stocks and laccoliths in the north-central part of the Peninsula, and the McGerrigle complex. The mid-Devonian Acadian orogeny deformed strata of the Gaspé Belt into open folds, and caused the development of strike-slip and reverse faults (Malo and Bourque, 1993).

Mineral Deposits

The Gaspé Belt hosts a suite of porphyry-related mineral deposits typical of continental margins like the American Southwest or British Columbia. In such a tectonic setting, three groups of mineral deposits can be distinguished : deposits associated with stocks, peripheral deposits, and deposits associated with volcanic rocks. Figure 2 shows the position of these various deposits in an ideal magmatic and hydrothermal system (see also Panteleyev, 1988). In addition to recognized deposits in the Gaspé Peninsula, a number of potential deposit types are also shown.

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Deposits associated with stocks (C, figure 2)

In the Gaspé Peninsula, this group comprises porphyry coppers, copper skarns and copper-rich massive sulphides replacing marbles. The best documented sites in the area are Murdochville (Wares and Berger, 1995 ; Wares and Bernard, 1993), Sullipek (skarn, Wares, 1988) and Patapedia (porphyry copper, Williams-Jones, 1982). Murdochville deposits comprise : 1) porphyry coppers at Mount Copper (200 Mt at 0,4 % Cu and 0,02 % Mo ; Wares and Bernard, 1993) and Mount Porphyre (discovered in 1994 : 0,9 % Cu over 395 m) ; 2) copper skarns in B and C zones (14 Mt at 1,2 % Cu and 33 Mt at 1,6 % Cu and 0,03 % Mo, respectively ; Wares and Bernard, 1993) ; and 3) massive sulphides replacing marbles in E zone (8,9 Mt at 3,16 % Cu and 14,2 g/t Ag ; Wares and Bernard, 1993).

Deposits associated with stocks are well documented in the American Southwest. In that area, porphyry copper deposits are typically associated with composite plutons 2 km in diameter or less (Titley, 1993a) and copper skarns are associated with stocks 0,5 to 2 km in diameter (Einaudi *et al*, 1981). The porphyritic texture of these intrusions is characteristic and indicates shallow emplacement, between 1,5 and 4 km depth (Guilbert and Park, 1986). Typically monzonites, these intrusions show wide variations in composition (Titley, 1993a ; Meinert, 1993). These stocks, small relative to the volumes of hydrothermally altered rocks, are considered as batholith apophyses (figure 2 ; Sillitoe, 1973 ; Candela and Holland, 1986).

Wall-rock composition is crucial for the development of replacement-type deposits in porphyry systems (Einaudi *et al*, 1981 ; Titley, 1993b). At Murdochville, only units containing over 50 % carbonates host skarns or mantos (Wares and Bernard, 1993 ; Bellehumeur and Valiquette, 1989). In the Gaspé Peninsula, deposits associated with stocks occur within well-developed alteration zones, which cover 6 km^2 at Murdochville and 35 km^2 in the Sullipek area ; these alteration zones show a tendency to be stratiform and can be overlain by unaltered rocks (Wares, 1988 ; Duquette *et al*, 1984).

Peripheral deposits (B,figure 2)

Mineral deposits located around or over porphyry systems include Cordilleran Vein type deposits, Zn-Pb-Ag skarns and high temperature, carbonate-hosted massive sulphides. Cordilleran veins in the Gaspé Peninsula have a quartz and carbonate gangue and show typical district zoning, from Fe-Cu in the center to Cu ± Zn ± Pb ± W

and Zn ± Pb ± Ag in the peripheral parts of the system (Wares, 1988 ; Stevens, 1983 ; Bellehumeur and Valiquette, 1993). These veins are commonly found alongside of felsic or mafic dykes ; they occupy brittle structures and show ubiquitous open-space filling textures. Although they locally show high grades, their economic potential is limited by their usually small tonnage. However, the spatial association of limestone beds and these mineralized veins suggests the possibility of finding Zn ± Pb ± Ag replacement deposits (Titley, 1993b).

Deposits associated with volcanic rocks (A,figure 2)

At subvolcanic to volcanic levels, the only deposits observed in the Gaspé Peninsula are disseminations in sandstones and lavas (Morin and Simard, 1987), which are copper-rich in the mont Alexandre syncline and zinc and lead-bearing in north-central Gaspé (Brodeur, 1992).

Even if volcanic rocks have been little explored, felsic volcanic centers and dyke swarms show potential for epithermal deposits (figure 1 ; Doyon and Dalpé, 1993 ; Bellehumeur and Valiquette, 1993). The occurrence of limy sedimentary rocks is also favorable for Carlin-type deposits (Wares, 1988).

Submarine volcanic rocks of the Gaspé Belt host a volcanogenic deposit in northern New-Brunswick (Olshevsky, 1992). Pyritic cherts at mont Lyall (Doyon and Valiquette, 1991) and altered rhyolites (Lachance, in preparation) suggest a possibility for volcanogenic deposits of Zn-Pb-Cu or Besshi types. This geological environment, along with manganese anomalies in the Upper Gaspé Limestones, are also favorable for Sedex-type deposits (Bellehumeur and Valiquette, 1989, 1993).

Conclusions

Replacement type deposits have the best economic potential. They are found where felsic dyke swarms cut limestones. Figure 1 shows a preliminary compilation of these areas in the Gaspé Peninsula. Moreover, some deposit types have received little attention in this area, such as copper and Zn-Pb-Ag massive sulphide deposits, epithermal and exhalative deposits (volcanogenic and Sedex). For these last deposit types, figure 1 shows the locations of known felsic volcanic centers.

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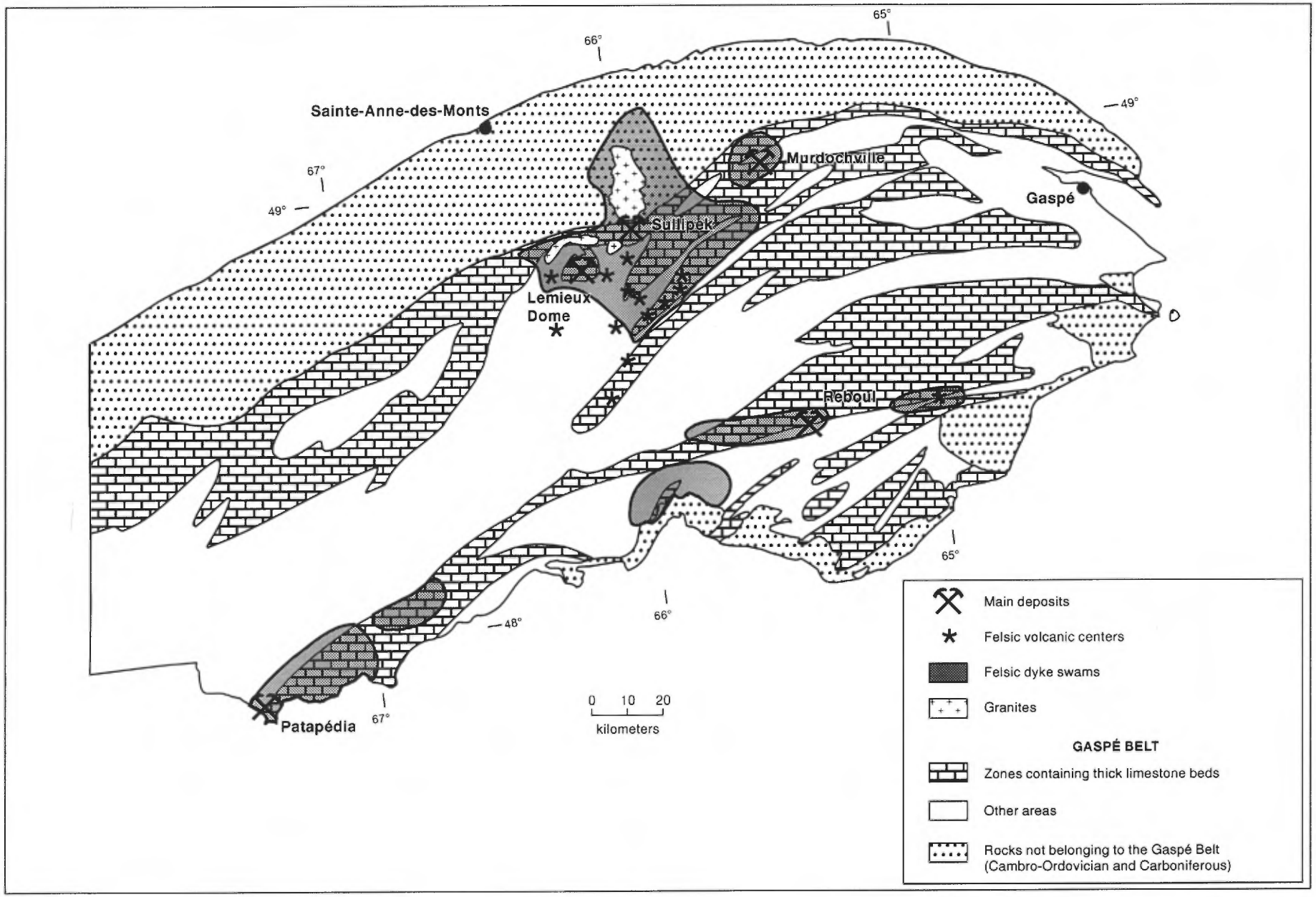
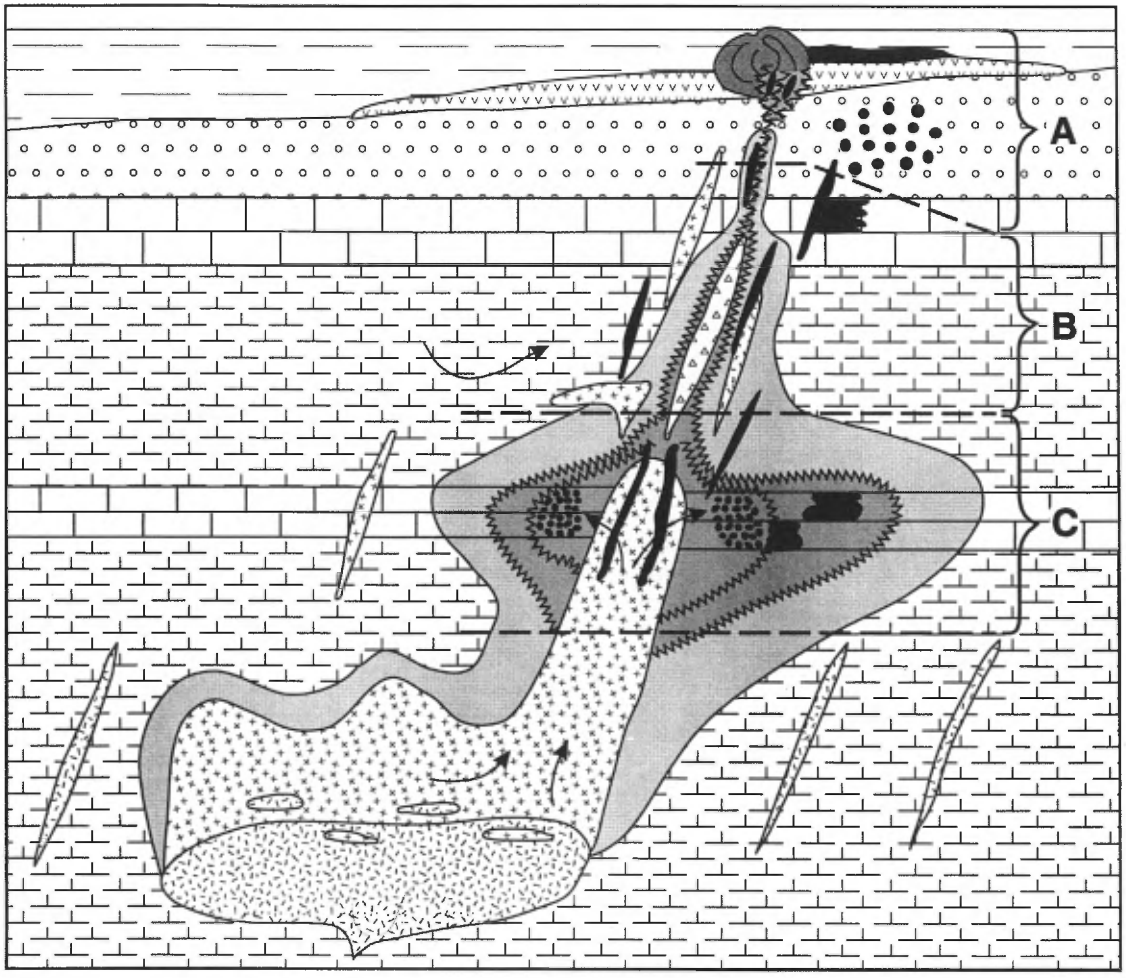
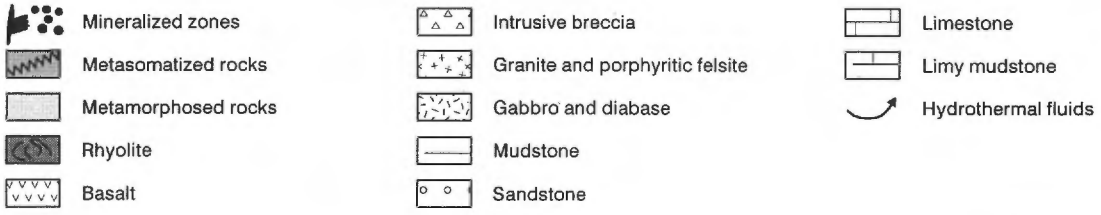


FIGURE 1-Map of the Gaspé Peninsula showing felsic dyke swarms and zones containing thick limestone beds. Data from Brisebois *et al.* (1991) for sedimentary units and from a preliminary geological compilation of the Gaspé Peninsula for felsic dykes.



	DEPOSIT TYPES	EXAMPLES IN THE GASPÉ PENINSULA
A	**Deposits asssociated with volcanic rocks:**	
	Volcanogenic massive sulphides, Zn-Pb-Cu or Besshi	
	Sedex	
	Epithermal deposits	
	Disseminations in sandstones	Mount Alexandre syncline, North-Central part of the Peninsula
B	**Peripheral deposits:**	
	Cordilleran Vein type deposits	Murdochville area, McGerrigle complex area, Lemieux dome
	Zn-Pb-Ag skarns and high-temperature, carbonate-hosted massive sulphides	
C	**Deposits associated with stocks:**	
	Porphyry coppers	Mount Copper Mount Porphyre, Patapédia
	Copper skarns	Murdochville, C Zone, Sullipek
	Copper-rich massive sulphides replacing marbles	Murdochville, E Zone



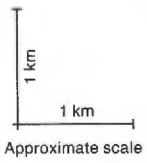


FIGURE 2-Geological environment of mineral deposits related to igneous rocks in the Gaspé Belt.