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Geology of the eastern Superior Province, James Bay and Bienville subprovinces, Quebec

A. Ciesielski

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A. Ciesielski
Continental Geoscience Division

Introduction

The accompanying geological map was constructed from the 1:1 500 000 scale Quebec geological compilation map (Avramtchev, 1985) and 1:1 000 000 scale shaded relief aeromagnetic maps (Geological Survey of Canada, unpublished) with additional information from Card and Ciesielski (1986) and Ciesielski (1989). The eastern Superior Province is divided into 5 subprovinces: (1) Minto, (2) Bienville, (3) Ashuanipi, (4) James Bay, and (5) Abitibi. The modifications proposed to the subdivisions of Card and Ciesielski (1986) are based on the following criteria: - the number of subprovinces should be maintained at a minimum and their size should represent between 10 and 20% of the province surface, - the subdivisions should be based on lithological or structural considerations and the boundaries should reflect as much as possible lithological or structural changes. The order of classification should be : province, subprovince, terrane and belt or basin.

The Abitibi/James Bay boundary is located along the contact between metavolcanic rocks and orthogneiss; the James Bay/Bienville boundary is the northern limit of the La Grande Volcanic Belt (LGVB); the Bienville/Minto boundary north of Lac à l'Eau Claire (LEC), and Bienville/Ashuanipi boundary east of Brézolles Volcanic Belt (BVB) are based on aeromagnetic contrasts and anomalies, and reflect metamorphic facies variation more than lithologic boundaries (Ciesielski and Plante, 1990). Recent work by Percival et al. (1991) in the southern Minto Subprovince established the Minto/Bienville boundary at the NNW-striking granodiorite/diatexite contact. The Grenville Front and the region to the southeast indicating the extent of the Archean orthogneisses of the Superior Province (PAO) and the Proterozoic sedimentary rocks of the Labrador Trough (PEP) in the Grenville Province, is also shown (Ciesielski 1991).

James Bay Subprovince

Regional Geological Context

The James Bay Subprovince is composed of (1) two large (meta) sedimentary basins (Opinaca Basin [OB] and Nemiscau Basin [NB]) showing polyphase deformation and metamorphism at upper amphibolite and granulite grade (Remick,

1977; Ciesielski, 1978); (2) three greenschist to middle amphibolite grade metavolcanic/metasedimentary belts: from south to north, the Frotet-Evans (FEVB), Eastmain (EVB) and La Grande (LGVB) volcanic belts; and (3) three gneissic and plutonic belts. No names are given to these belts on the map but from N to S, they could be referred to as La Grande, Eastmain and Frotet-Evans gneissic/plutonic belts. Recently, Sawyer et al., (1991) used Opatica and Quetico subprovinces to designate the region north of the Abitibi greenstone belt. Although the name Opatica is a valid alternative to Frotet-Evans, it should be followed by " gneissic belt " rather than " subprovince " given its relatively small size. On the other hand, the Quetico subprovince of Sawyer et al. (1991) is the southern part of the Nemiscau Basin; its western continuation with the Quetico Subprovince of Card and Ciesielski (1986) is yet to be demonstrated given the presence of the Kapuskasing deformation zone separating the two.

East of LG3[1], metabasalts of the La Grande Volcanic Belt, at lower amphibolite grade, overlie a biotite-garnet-sillimanite paragneiss sequence of the Opinaca basin; the contact zone contains a thin layer of polymictic metaconglomerate (Ciesielski, 1984b). The sedimentary basins are separated by large plutonic and orthogneissic belts composed of tonalitic to granodioritic orthogneiss, quartz diorite, quartz monzonite, granodiorite (+/- K feldspar phenocrysts), granite, diatexite and metatexite (reworked equivalents and partial melts of the paragneiss of the sedimentary basins) and pegmatite (Dubé, 1978; Card and Ciesielski, 1986). Parts of the La Grande, Eastmain and Frotet-Evans volcanic belts are bounded by NE and NW faults. More generally, the shape of some of the supracrustal belts and parts of the sedimentary basins of the James Bay Subprovince are controlled by NE and NW-trending faults associated with the 2140 Ma Preissac and ~2200 Ma Mistassini dyke swarms. Consequently, it is suggested that the present shapes of some of the supracrustal belts of the James Bay Subprovince were acquired in Early Proterozoic times. Sawyer et al. (1991) indicated dextral shearing along SE-trending faults in the Frotet-Evans Volcanic Belt, but suggested an early age for it and do not make the association with the NW-SE-trending Mistassini dyke swarm.

Geochronology

The plutonic rocks associated with the LGVB and those lying between the Opinaca Basin and the Bienville Plutonic Belt (BPB in the southern part of the Bienville Subprovince) are composed mainly of tonalitic orthogneiss; 25 km east of LG2,

[1]: LG2 and LG3 refer to La Grande 2 and 3, the hydro-electric power plants built on La Grande River in the mid-seventies by Hydro-Québec.

tonalitic gneiss yields a U/Pb zircon concordia age of 2811 +/-2.4 Ma (Mortensen and Ciesielski, 1987). In eastern LGVB, porphyritic granodiorite from within the belt and quartz monzodioritic gneiss outside the belt yield U/Pb zircon discordia ages of 2674 +/-12 Ma and 2743 +/-33 Ma respectively; in western LGVB, a porphyritic granodiorite outside the belt yields a U/Pb zircon discordia age of 2738 +/-24 Ma (St.Seymour et al., 1989). Immediately north of the EVB a tonalite/granodiorite complex (the Duxbury massif) yields a Rb/Sr whole-rock isochron of 2500 +/-85 Ma for the granodiorite border and an Rb/Sr errorchron of 3060 +/-180 Ma for the tonalite core (Verpaelst et al., 1980); the same rocks gave U/Pb zircon ages of 2709 +/-2 Ma for the tonalite core, 2708 +/-13 Ma for the granodioritic border and 2728 +/-3 Ma for tonalitic gneissic inclusions in the complex core (Gauthier et al., 1982). In the Lake Troilus area, east of the FEVB, a syn-volcanic tonalitic pluton yields a discordant U/Pb zircon age of 2734 +/-30 Ma, a minimum for the volcanic succession of the Troilus Group. A volcaniclastic rock from the base of the Troilus Group gave a 2750 +/-28 Ma minimum age, as well as 2780 +/-28 Ma and 3003 +/-28 Ma ages which are considered as evidence for a sialic terrane that pre-dates the Troilus Group (Thibault, 1985).

Bienville Subprovince

The Bienville Subprovince is composed mainly of orthogneiss, porphyritic granodiorite, metasedimentary rocks, greenstone belt remnants and associated tonalitic orthogneiss, granulite grade orthogneiss and outliers of Proterozoic sedimentary rocks (Eade, 1966; Ciesielski, 1983). General structural trends are EW and WNW; a major set of NE-trending faults, the Bienville Fault System (BFS) was interpreted from abrupt, linear aeromagnetic contrasts. The relationship between the BFS and the NE dyke trends in the James Bay Subprovince is yet to be established. The southern part of the Bienville Subprovince is dominated by the Bienville Plutonic Belt (BPB). It is characterized by a weakly foliated biotite-hornblende granodiorite showing zoned K-feldspar phenocrysts, which crosscuts the LGVB and the Bienville orthogneiss; it yields a U/Pb zircon age of 2712 +3.2/-2.3 Ma (Mortensen and Ciesielski, 1987). The ENE distribution of this unit is partly inferred from 1:1 000 000 scale aeromagnetic maps. In the western part of the subprovince, north of the BPB, the main orthogneissic constituent (the Bienville orthogneiss) contains amphibolite, ultramafic and metasedimentary inclusions; it shows variable deformation and K-feldspar-rich in situ neosome locally related to fractures. The orthogneiss is heterogeneous at both outcrop and regional scale; it has variable amounts of microcline phenocrysts, biotite and hornblende and varies northeastward from James Bay to Lac à l'Eau Claire (LEC) from tonalite to granite without breaks or lithologic

contacts (Ciesielski, 1984a; Ciesielski and Plante, 1990). Preliminary U/Pb zircon discordia ages obtained from a composite sample, located immediately north of the BPB on James Bay, range from 2797 to 2819 Ma (Mortensen and Ciesielski, 1987).

Pyroxene-bearing orthogneiss and metasedimentary rocks occur southwest of the Bienville Subprovince; on the shaded relief aeromagnetic map, these appear as a magnetically high, oval domain surrounded by regions of lower contrast which have NW-trending linear features (GSC 1:1 000 000 aeromagnetic maps NN17; NN18). The granulites are transected by NW-trending mylonites on the shore of James Bay but the relationship between deformation and metamorphism was not established. The pyroxene-bearing biotite paragneiss is thought to be a granulite-grade equivalent of the Opinaca sedimentary basin; granulite-grade metasedimentary rocks mapped in the eastern Bienville Subprovince and in the Ashuanipi Subprovince (Sharma and Dubé, 1980; Percival, 1987; Percival and Girard, 1988) are also considered to be part of an eastern extension of the Opinaca sedimentary basin. Contrasting with the regional fabric, structural complexity in the eastern Ashuanipi Subprovince was outlined by detailed mapping (Percival, 1990). Similar complexity also exists in the western Opinaca Basin (Remick, 1977). Small greenstone belt remnants were mapped in the western and eastern parts of the Bienville Subprovince north of the BPB (Sabourin, 1961). Detailed mapping of the Fagnant Volcanic Belt (FVB) revealed an important iron ore deposit (Scofield 1960) in a coaxially polyphase north-trending synclinal structure composed of metasandstone, metaconglomerate, iron formation and metabasalt (Mercier, 1981; Mercier and Ciesielski, 1983). Metamorphism reached middle amphibolite grade at the base of the sequence and decreases upward to greenschist facies (Mercier, 1981). The greenstone belt is discordant to the generally WNW structural trends of the Bienville orthogneiss and is intruded by pegmatite that gave a K/Ar muscovite age of 2625 Ma (Lowdon, 1960). The Brézolles Volcanic Belt (BVB) at the eastern end of the Bienville Subprovince, is composed of mafic volcanic and pyroclastic rocks with minor metasedimentary rocks. It is more intensely deformed and transposed than the FVB to the west, and the metamorphism reached middle amphibolite grade. The belt is associated with tonalitic orthogneisses and is bounded to the south by a NE-trending fault of the Bienville Fault System (BFS).

Diabase Swarms

5 dyke swarms are present in the map area. These are (1), a NS dykes in the west, believed to be part of the Matachewan swarm; (2), the Mistassini dykes (MD, ~2200 Ma); (3), the Preissac dykes (PD, 2140 Ma); (4), the Abitibi dyke (AD, 1140 Ma); and (5), the Grenville Front dykes (GFD) (Ciesielski, 1988), previously called Gabbro Island

dykes in the Chibougamau area (Chown, 1984). The Mistassini dykes do not cut across the Mistassini Basin (SE of the James Bay Sp. along the Grenville Front); their locations are inferred from aeromagnetic anomalies that show through the Early Proterozoic sedimentary rocks. NNW- and NE-trending swarms transect the Otish Group and are genetically related to the 1900 Ma Otish gabbro sills (Chown and Archambault, 1987). In the LG3 area, a normal and dextral offset of 500 m was calculated along a well developed NW-trending fault parallel to the Mistassini dyke swarm (Grenon et al., 1977).

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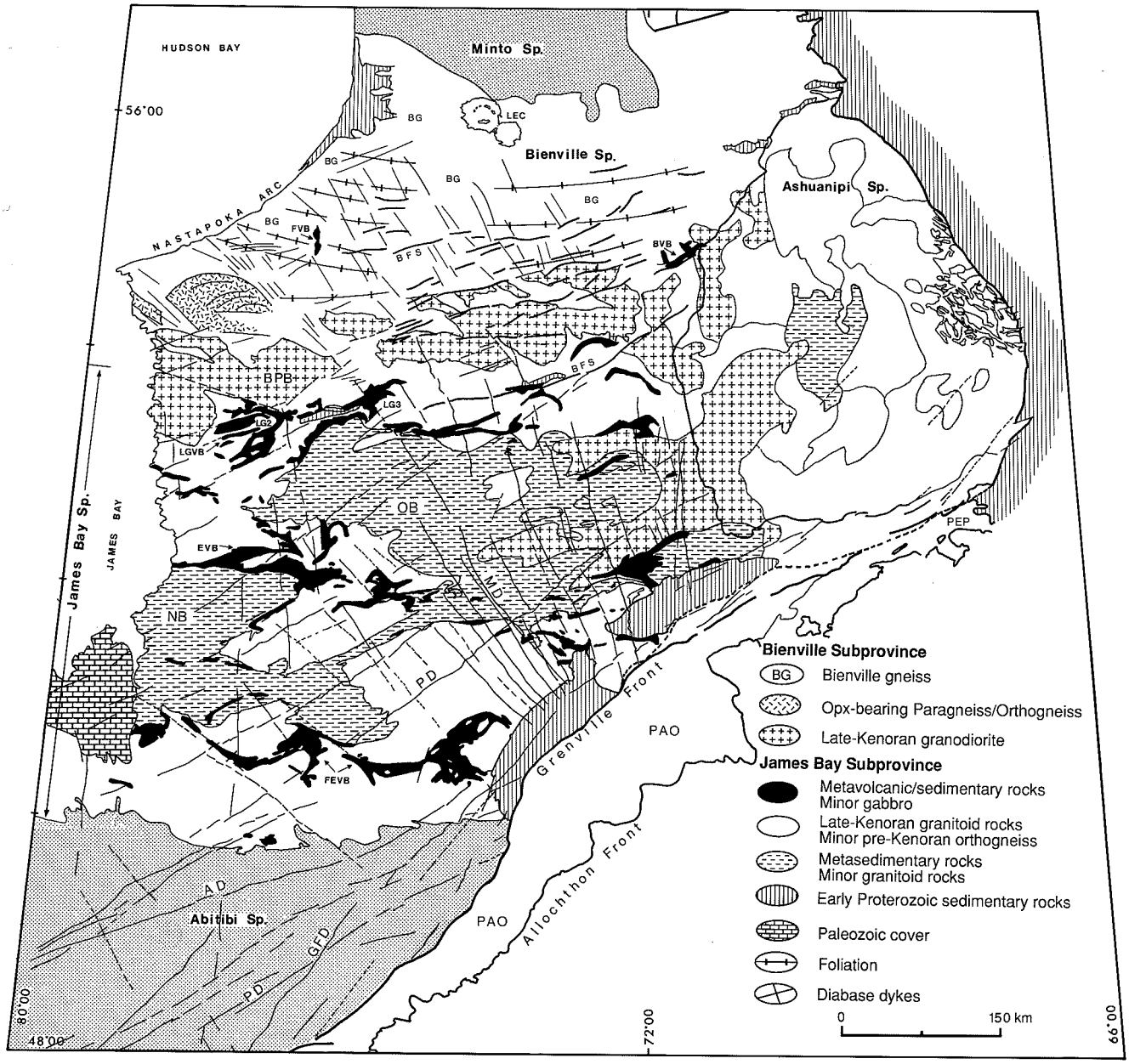

LEC: Lac à l'Eau Claire
FVB: Fagnant Volcanic Belt
BVB: Brézolles Volcanic Belt
BFS: Bienville Fault System
BPB: Bienville Plutonic Suite
EVB: Eastmain Volcanic Belt
LGVB: La Grande Volcanic Belt
FEVB: Frotet-Evans Volcanic Belt

OB: Opinaca Basin
NB: Nemiscau Basin
AD: Abitibi Dyke
PD: Preissac dykes
MD: Mistassini dykes
GFD: Grenville Front dykes
PAO: Parautochthonous Archean orthogneiss
PEP: Parautochthonous Early Proterozoic