

# Temporal and spatial distribution of magmatic Ni-Cu-PGE, Cr, and Fe-Ti-V deposits in the Bird River–Uchi–Oxford-Stull–La Grande–Eastmain superdomain: a new metallotect within the Superior Province

**M.G. Houlé**

*Geological Survey of Canada, GSC-Québec, 490 Couronne Street, Québec, Québec, Canada G1K 9A9*

**C.M. Lesher**

*Mineral Exploration Research Centre, Department of Earth Sciences, Laurentian University, 935 Ramsey Lake Road, Sudbury, Ontario, Canada P3E 2C6*

**R.T. Metsaranta**

*Ontario Geological Survey, 933 Ramsey Lake Road, Sudbury, Ontario, Canada P3E6B5*

**J. Goutier**

*Géologie Québec, Ministère des Ressources naturelles, 70 avenue Québec, Rouyn-Noranda, Québec, Canada J9X 6R1*

**H.P. Gilbert**

*Manitoba Geological Survey, 360-1395 Ellice Avenue, Winnipeg, Manitoba, Canada R3G 3P2*

**V. McNicoll**

*Geological Survey of Canada, GSC-Ottawa, 601 Booth Street, Ottawa, Ontario, Canada K1A 0E8*

**Abstract.** Cr and Fe-Ti-V mineralization in ultramafic intrusions is known from several areas of the Superior province, but was considered to be of marginal significance until the discovery of world-class Cr deposits and potentially significant Fe-Ti-V mineralization in the McFaulds Lake greenstone belt ("Ring of Fire" area) of northern Ontario. Ni-Cu-(PGE), Cr-PGE, and Fe-Ti-V deposits/occurrences in the northern part of the Superior Province occur predominantly within Neo-archean supracrustal successions along the margins and within the interiors of the Bird River–Uchi–Oxford-Stull–LaGrande–Eastmain domains (BUOGE "superdomain"). This superdomain defines a major Cr-Ni-Cu-PGE-V metallotect that appears to be fundamentally different from other parts of the Superior Province, such as the Abitibi greenstone belt or the apparently relatively unmineralized North Caribou core, Island Lake, and Goudalie domains. Detailed studies of the tectonic, volcanic, and petrogenetic settings of key areas of the BUOGE superdomain are in progress and should provide light on why this metallotect is so different from those in the southern part of the Superior Province.

**Keywords:** chromite, nickel, Superior Province, Oxford-Stull, LaGrande–Eastmain, Bird River

## 1 Introduction

The discoveries of world-class Cr deposits, significant Ni-Cu-PGE deposits, and numerous Fe-Ti-V occurrences in the McFaulds Lake (a.k.a. "Ring of Fire") area of northern Ontario have greatly renewed interest in orthomagmatic mineralization associated with mafic-ultramafic intrusions in the Superior Province. Mafic-ultramafic intrusions and ultramafic volcanic rocks are widespread throughout the Superior Province, but their association with significant Ni-Cu-PGE-Cr-V mineralization is not evenly distributed across the craton.

The purpose of this contribution is to identify a new

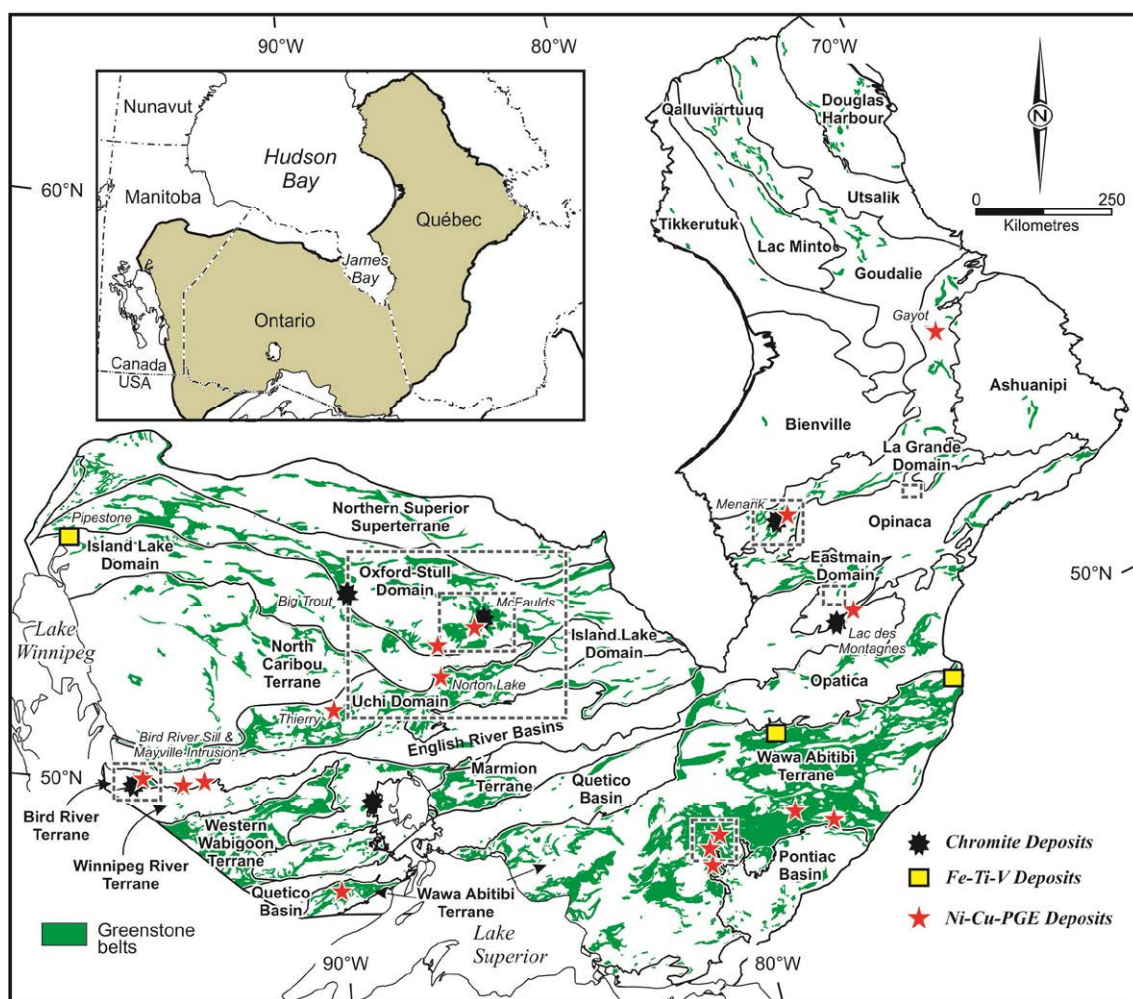
Cr-Ni-Cu-PGE-V metallotect within the Superior Province based on currently available information and interpretations of the various terrane and domain boundaries within the province.

## 2 The Superior Province

The Superior Province is one of the largest coherent Archean cratons in the world, with exceptional mineral endowments reflected in the presence of numerous world-class Au, Cu-Zn-(Au) VMS deposits, and significant Ni-Cu-PGE deposits (Poulsen et al. 1992).

Early investigations of the Superior Province recognized a limited number of subprovinces based on general lithological characteristics (e.g., Card and Ciesielski 1986). Subsequently, more detailed lithological and stratigraphic data were used to define the subprovinces as terranes and domains (e.g., Thurston et al. 1991). Since then, however, considerable effort has been devoted by the Manitoba and Ontario Geological Surveys, Géologie-Québec, and the Geological Survey of Canada using high-resolution geochronological, structural, stratigraphic, geochemical, and tectonic data (e.g., Stott et al. 2010) to identify stratigraphically and tectonically-distinct terranes and domains.

The Uchi, Oxford-Stull, La Grande, and Eastmain domains have been correlated across the entire Superior Province (Stott et al. 2010), and the Bird River domain, located across the English River basin from the Uchi, appears to share some geological similarities (Gilbert et al. 2008). Taken together, the geochronological, stratigraphic, structural, tectonic, and metallogenic data suggest that the Bird River–Uchi–Oxford-Stull–La Grande–Eastmain domains form a ~E-W "BUOGE" superdomain across the Superior Province (Fig. 1).



**Figure 1.** Schematic geological map showing the main Ni-Cu-PGE sulphide and chromite deposits of the Oxford-Stull, LaGrande, and Eastmain domains, and the Bird River and the Abitibi greenstone belts within the Superior Province. Outline boxes indicate the main locations under investigation within the TGI4 high-magnesium ultramafic to mafic systems subproject. Terranes, domains and boundaries are modified from Stott et al. (2010).

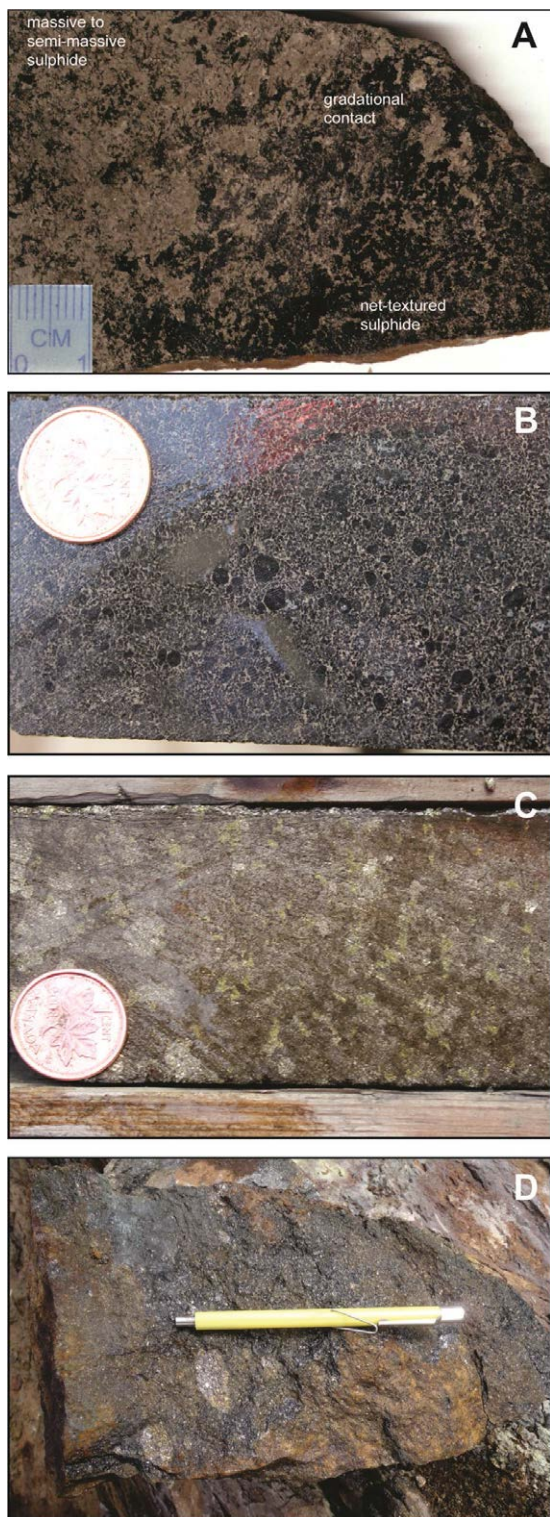
### 3 Komatiites and mafic and ultramafic intrusions in the BUOGE

Komatiites and mafic to ultramafic intrusions occur throughout the entire BUOGE superdomain and range from Meso- to Neoproterozoic. Cr, Ni-Cu-PGE, and Fe-Ti-V mineralization occur preferentially within supracrustal successions along the margins, but also within the interiors of the BUOGE superdomain.

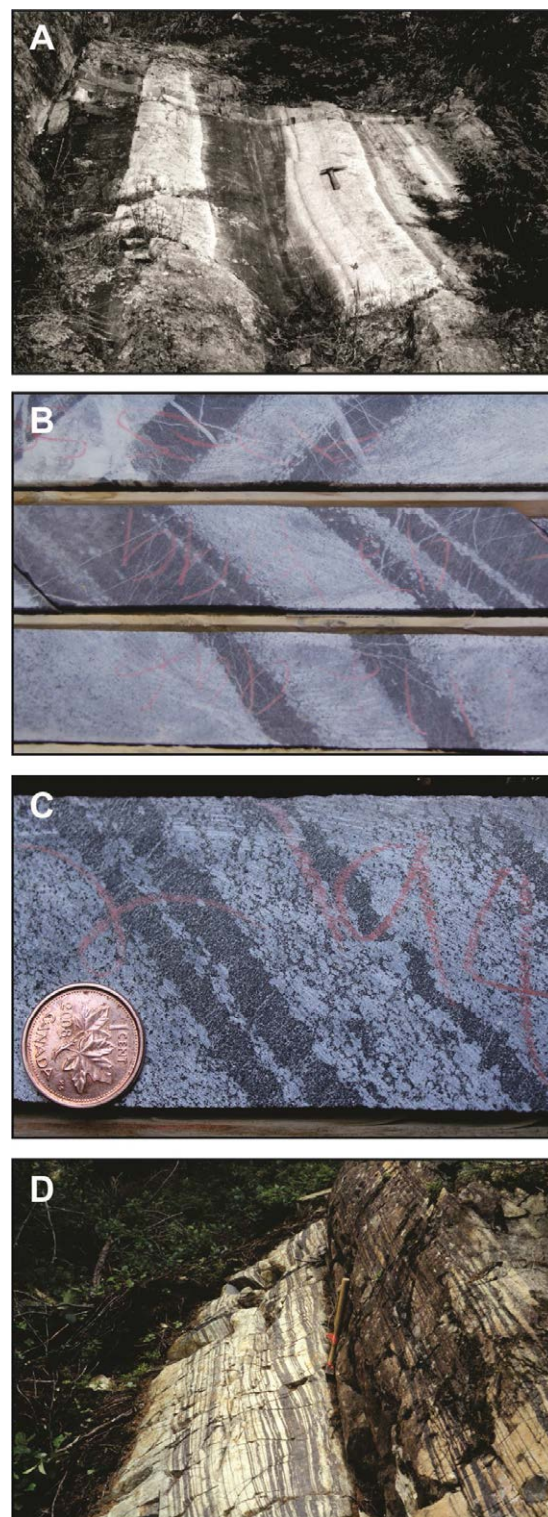
Metallogenic associations within this superdomain provide additional geological constraints for the metallogenic evolution of the Superior Province, for example in the case of Ni-Cu-PGE deposits, which are abundant in the Wawa-Abitibi terrane (Houlé and Lesher 2011) and Bird River domain, but minor in the Uchi, La Grande, and Eastmain domains, and absent in the Island Lake, Wabigoon, and Goudalie domains. Ni-Cu-PGE deposits occur across the BUOGE superdomain and appear to range in age from Neoproterozoic to Mesoproterozoic, with the best examples occurring within the Bird River (e.g., Maskwa – Bird River Sill; Fig. 2A), Uchi (e.g., Norton Lake), Oxford-Stull (e.g., Eagle’s Nest - Ring of Fire Intrusive Complex; Fig. 2B and 2C), Eastmain (e.g., Nisk), and La Grande (e.g., Gayot; Fig. 2D) domains

(Table 1). Cr mineralization is virtually absent in most of the Superior terranes or domains except for domains that potentially belong to the BUOGE superdomain. Similarly to Ni-Cu-PGE deposits, Cr-PGE deposits also occur across the BUOGE superdomain and appear to be mainly Neoproterozoic in age, with the best examples occurring in the Bird River (e.g., Chrome - Bird River Sill; Fig. 3A), Oxford-Stull (e.g., Black thor and Blackbird - Ring of Fire Intrusive Complex; Fig. 3B and 3C respectively), and La Grande (e.g., Menarik; Fig. 3D) domains (Table 1). In comparison Fe-Ti-V deposits appear to be more spatially restricted and less abundant, and so far have been recognized only within the westernmost parts of the Oxford-Stull domain (e.g., Pipestone). However, other important Fe-Ti-V deposits also occur near the northern margin of the Abitibi terrane in Québec (Bell River and Lac Doré Complexes).

Thus far, only the McFaulds Lake Cr deposits (Black Thor and Black Label deposit, Big Daddy deposit, Blackbird deposit) and McFaulds Lake Ni-Cu-PGE deposits (Noront Eagle’s Nest) appear to be economic, but they demonstrate the potential for much greater amounts of mineralization in the BUOGE (Table 1).



**Figure 2.** Typical Ni-Cu-PGE mineralization associated with mafic and ultramafic intrusions in the BUOGE superdomain. A) Gradational contact between semi-massive sulphide and net-textured sulphide at the Maskwa deposit, Bird River Sill, Manitoba (after Stansell 2006). B) Net-textured sulphide at Eagle's Nest in the Ring of Fire Intrusive Complex, Ontario. C) Massive sulphide at Eagle's Nest in the Ring of Fire Intrusive Complex, Ontario. D) Peridotite with disseminated sulfides containing cm-scale blebs of massive sulfides from the L occurrence in the Gayot area (courtesy of Mines Virginia).



**Figure 3.** Typical Cr mineralization associated with mafic and ultramafic intrusions in the BUOGE superdomain. A) Layered chromitites in the Bird River Sill, southeast Manitoba (after Williamson 1990). B) Layered chromitites at the Black Thor deposit in the Ring of Fire Intrusive Complex, northern Ontario. C) Layered chromitites at the Blackbird deposit in the Ring of Fire Intrusive Complex, northern Ontario. D) Layered chromitites in the Menarik Igneous Complex, James Bay area, Québec.

## 4 Concluding Remarks

The BUOGE superdomain defines a major Cr-Ni-Cu-PGE-V metallogenic province that appears to be fundamentally different from the adjacent terrains in terms of magma composition (low-Mg komatiite/high-Mg tholeiite vs. high-Mg komatiite/tholeiite), volcanic-subvolcanic setting (ultramafic intrusions > lava flows vs. ultramafic intrusions < lava flows), and sedimentary environments (oxide-facies iron formation > sulphide-facies iron formation vs. oxide-facies iron formation < sulfide-facies iron formation) from the Ni-Cu-PGE dominated systems in the Abitibi greenstone belt or the apparently relatively unmineralized North Caribou core, Island Lake domain and Goudalie domain.

Detailed studies of the tectonic, volcanic, and petrogenetic settings of key areas of the BUOGE superdomain are in progress and should provide light on why this metallogenic province is so different from those in the southern part of the Superior Province.

**Table 1.** Ni-Cu-PGE, Cr-PGE, and Fe-Ti-V mineralization in the BUOGE superdomain.

	Ni-Cu-PGE	Cr	Fe-Ti-V
<b>Bird River</b>	<i>Maskwa</i> <i>M2 Mayville</i> <i>Dumbarton</i> Page & Ore Faults	<i>Chrome</i> <i>Page</i> <i>Bird Lake</i> <i>Euclid</i>	
<b>Uchi</b>	<i>Thierry</i> Norton Lake		
<b>Oxford-Stull</b>	<i>Eagle's Nest</i> AT-12	<b>Blackbird</b> <b>Black Thor</b> <b>Big Daddy</b> <b>Black Creek</b> Big Trout	<b>Pipestone</b> Butler Thunderbird <i>Highbank</i>
<b>La Grande</b>	Gayot Menarik	<i>Menarik</i> <i>Nadine</i>	<i>Baie Chapus</i>
<b>Eastmain</b>	Nisk	Lac des Montagnes Lac Fed	

**Bold:** major, **Bold-Italic:** significant, Plain: minor, *Italic:* Marginal

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