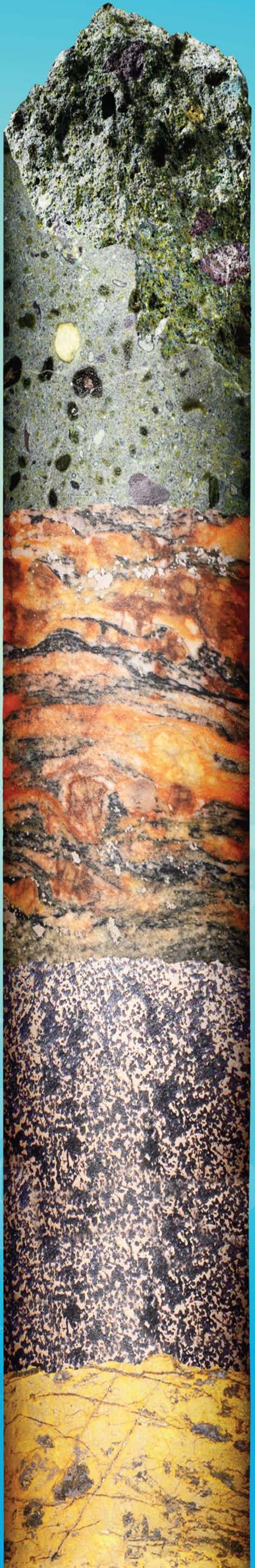
RECOMMENDATIONS for Exploration

2013 - 2014



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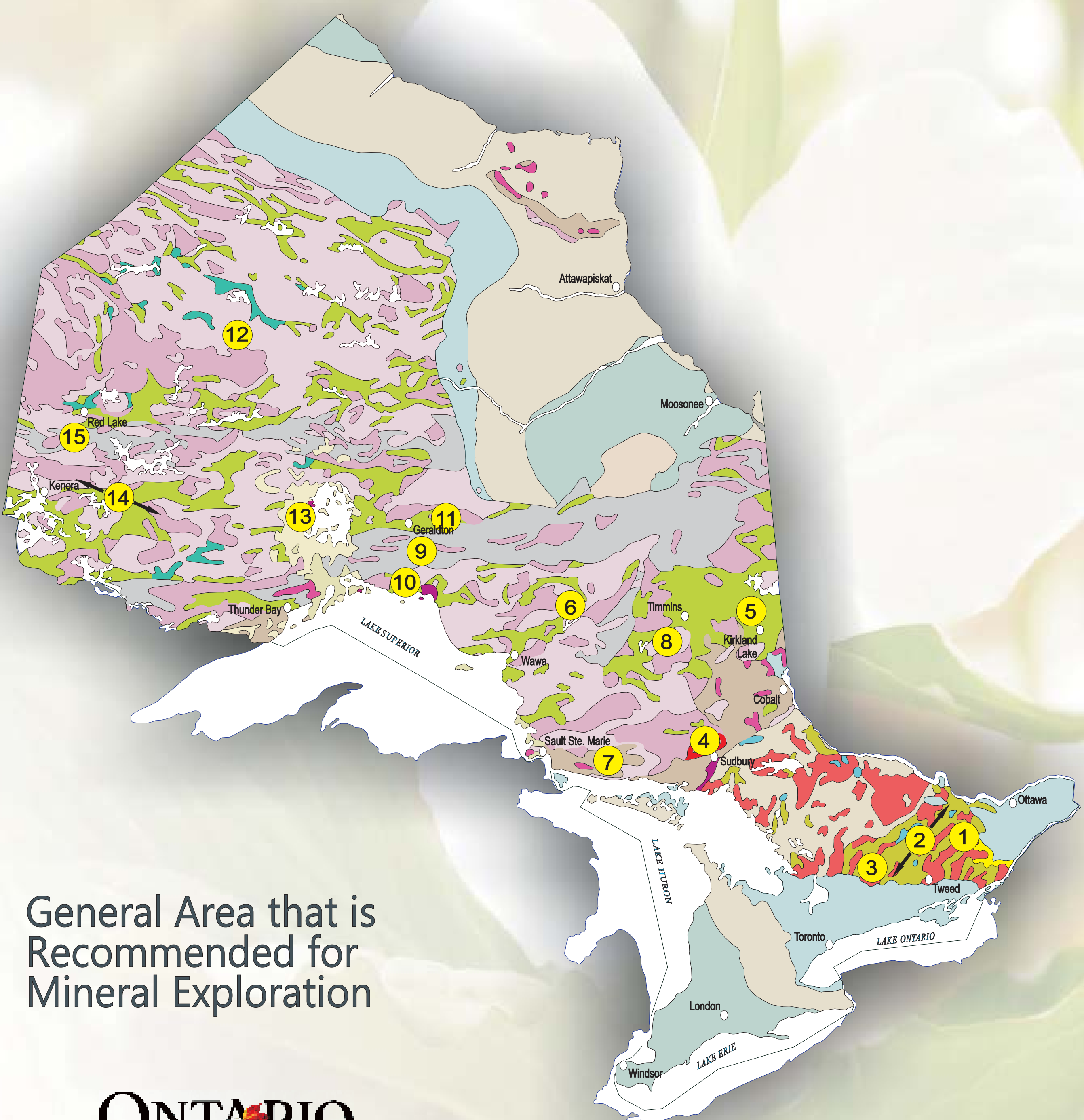
Ministry of Northern Development and Mines

Ontario

Recommendations for Exploration

2013-2014



General Area that is Recommended for Mineral Exploration

ONTARIO
CANADA

Photo courtesy of Karen Labonte

Ontario Geological Survey
Resident Geologist Recommendations for Exploration

The Ontario Geological Survey is pleased to issue its 2013 Recommendations for Exploration. These recommendations are the product of the Ministry's dedicated and knowledgeable staff located across the province.

Each year recommendations are developed based on the wealth of geological and exploration data available to our staff (and you) and any new information or concepts derivative from the current year's activities.

Please review our current recommendations and feel free to discuss these in detail with any of our geoscientists.

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About the Resident Geologist Program

Resident Geologists are the stewards of public geological and mineral exploration information for their districts. They provide a broad range of advisory services on geological topics of interest to the public, municipal governments, and the mineral industry.

They are the local experts on why geoscience information is important, what information is available and what's been happening in exploration.

The program provides primary client services through a network of 8 field offices strategically located across the province. Services include:

- collecting and maintaining geological data
- monitoring exploration activity
- conducting property examinations
- providing geological and exploration advice

We provide geoscience information to support:

- public safety
- environmental planning
- land use planning
- mineral sector investment and economic development

We provide information and training to First Nation Communities regarding prospecting, mineral exploration and mining.

Contents

HIGHLIGHTS

- **Large areas of the Lavant Lake Gabbro Complex remain unexplored**
- **Geological Survey of Canada report Ni and Co values**
- **Unexplained magnetic anomalies**

The Lavant Lake Gabbro Complex

The Lavant Lake Gabbro complex has been little studied and may be a worthwhile target for exploration. The northeast trending intrusion occupies large portions of the Townships of Darling, Dalhousie, Lavant, North Sherbrooke and Oso. It has a total length of approximately 45 km and a width of 14.5 km at its widest part and is generally without structure except near its margins (Pauk 1989). Easton (1993) describes it as a differentiated igneous intrusion, locally layered and showing a considerable compositional range from ultramafic phases to gabbroic anorthosite and tonalite. Published airborne magnetic map anomalies seem to indicate more variation in the Complex than is shown by current mapping.

Several small, magmatic massive magnetite deposits occur near the margins of the Lavant Lake Gabbro, including the Yuill iron mine, the Darling and Lavant deposits.

Mineral Deposit Inventory data and assessment work on file with the Tweed office indicates that exploration of the Lavant Lake Gabbro complex has been generally limited to the search for 1) iron, 2) vein-hosted gold deposits in proximity to the Robertson Lake Shear Zone, and more recently 3) high purity muscovite prospects.

Although not documented in any published reports by the Ontario Geological Survey, several early reports by the Geological Survey of Canada make reference to 2 nickel occurrences "with a dark-gray, fine-grained diorite" in northeastern Dalhousie Township. Analysis of samples from the occurrences returned values of 0.165% Ni, trace Co with the "metalliferous portion of the ore" containing 0.23% Ni from first site and 0.09% Ni, trace Co from the second site.

Road access to the area is good, as is outcrop exposure. As of October 2013, the MNDM CLAIMS application indicates areas of open Crown Land.

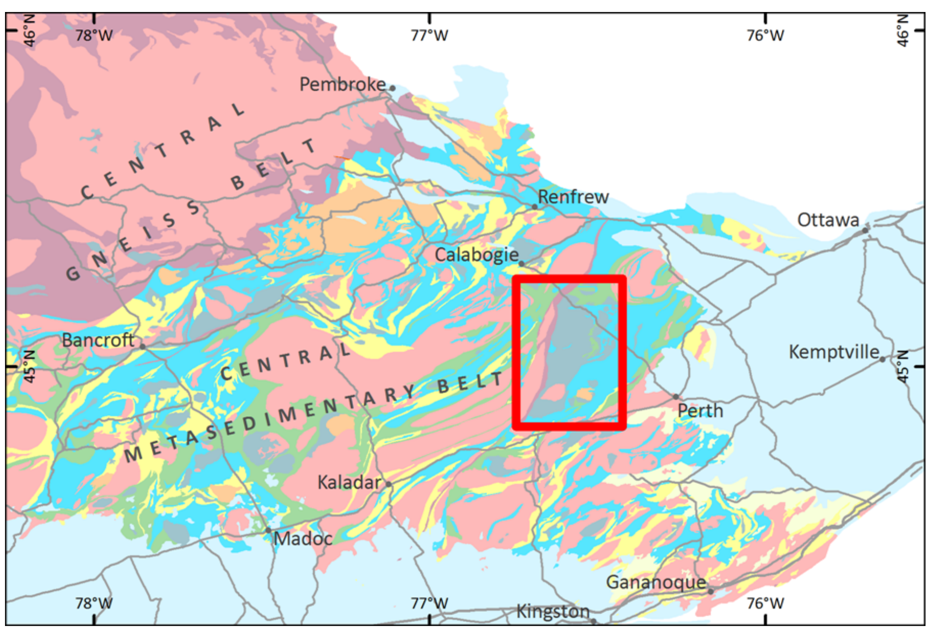

Figure 1. Location of the Lavant Lake Gabbro Complex.

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The Lavant Lake Gabbro Complex …cont'd

- 1898: Geological Survey of Canada, Annual Report Volume 11, Part R, p. 27
- 1897: Geological Survey of Canada, Annual Report Volume 10, Part A, p. 60
- 1896: Geological Survey of Canada, Annual Report Volume 09, Part R, p. 38
- 1892: Geological Survey of Canada, Annual Report Volume 06, Part R, p. 38

Easton, R.M. 1992. The Grenville Province and the Proterozoic history of central and southern Ontario; in Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part2, p.714-904.

Pauk, L. 1989. Geology of the Lavant Area, Lanark and Frontenac Counties; Ontario Geological Survey Report 252, 61p. Accompanied by Map 2515, Scale 1:31 680.

Pauk, L. 1989. Geology of the Dalhousie Lake Area, Lanark and Frontenac Counties; Ontario Geological Survey Report 245, 57 p. Accompanied by Map 2512, Scale 1:31 680.

HIGHLIGHTS

- **Copper mineralization is widespread and occurs in a variety of lithologic associations**
- **Significant anomalies of Cu in till**
- **Very little past exploration for copper since early– to mid–1900s**

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Copper Potential in the Grenville Province, Southeastern Ontario

Copper prices in the 3rd quarter of 2013 were up more than 8 percent from the previous 3 months, based primarily upon new economic data from the U.S. and China, which are indicating that the base metal market is slightly more optimistic than the rest of the financial markets (http://www.reuters.com/article/2013/09/30/markets-metals-idUSL6N0HQ10M20130930).

There are numerous examples of copper mineralization associated with a variety of deposit types in the Central Metasedimentary Belt (CMB) and the Central Gneiss Belt (CGB).

Cu (Ni, PGE) associated with mafic-ultramafic intrusions

The Macassa Ni-Cu Deposit in Limerick Township consists of disseminated pyrrhotite, pentlandite, chalcopyrite, and pyrite in a band of metapyroxenite within the Thanet Gabbro. The deposit, containing drill-indicated reserves (non-NI43-101 compliant) of 3.5 Mt grading 0.8% Ni, 0.25%Cu, and 0.05% Co, is about 320 m long, averages 17 m in width, and has been drilled to a depth of 365 m. A second zone, about 1200 m to the south, contains 1.2 Mt averaging 0.3% Ni (Carter 1984).

Within the CGB, Cu-Ni mineralization is associated with mafic intrusive rocks at the Ellerington Occurrence in McClintock Township and the Dupel Occurrence in Hindon Township. Best drill hole intersections at the former were 1.36% Ni and 0.2% Cu over 4.5 m (with a report of 1.12 g/t Pt in a grab sample) and, at the latter, 1.2% Cu over 5 m.

Stratiform, sedimentary-hosted (VMS?) Cu-Zn-(Ag)

The Simon Copper Prospect in Lyndoch Township and the Deer Lake Cu-Zn-Ag Occurrence in Belmont Township are hosted by metasedimentary rocks in contact with metavolcanic rocks and may represent volcanogenic sulphide accumulations.

The Simon Prospect consists of disseminated sulphides in a conformable lens containing 250 000 tonnes grading 1.09% Cu (Carter et al. 1980), between amphibolitic metavolcanics and tuffaceous quartz-feldspar paragneiss.

The Deer Lake Occurrence is a sulphide-rich schist lying between mafic metavolcanics and cherty wackes and tuffs. Mineralization has been intersected in widths of over 80 m, with total sulphide content of 25% over 8 m intervals. Grades are low, averaging about 0.05% Cu, 0.5% Zn and 0.2 opt Ag, but grab samples have assayed up to 0.67% Cu and 2.47 opt Ag (Malczak et al. 1985).

Cu-Fe-(Au, Mo) skarn (Iron Oxide-Copper-Gold association?)

The Eldorado Copper Mine in Madoc Township consisted of a small sulphide lens along the contact between a granitic intrusion and dolomitic marble located close to the Deloro granite. The upper 25 m were oxidized to hematite, however the lower sulphide ore produced 109 000 pounds (about 50 t) of copper, 182 ounces Ag and 23 ounces Au at average grades of about 7% Cu, 0.25 opt Ag (7.5 g/t) and 0.03 opt Au (1.0 g/t).

Copper Potential in the Grenville Province, Southeastern Ontario …cont'd

Several other deposits of gold, iron, and copper are associated with the Deloro granite. When viewed as a whole, the mineralizing system has characteristics similar to that of iron oxide-copper-gold (IOCG) deposits. The Miskwaa monzonitic pluton in Harvey Township is also known to host magnetite, copper, molybdenite and uranium mineralization (Morton 1983) which may be indicative of an IOCG system. Both the Deloro and Miskwaa plutons belong to the the Methuen granitic intrusive suite, suggesting that other granites of the Methuen suite should be considered as targets for IOCG mineralization.

Porphyry Cu-Au Mineralization

Several Cu-Au occurrences in the Marble Lake-Mazinaw Lake area of the Mazinaw Terrane consist of chalcopyrite-tetrahedrite-bearing quartz veins in dolomitic marble, associated with porphyritic, trondhjemitic stocks and dikes. In some cases, sulphide mineralization is disseminated within the marble and trondhjemite. Easton (1992) has suggested that these occurrences may represent the outer shell of a porphyry copper system and that significant mineralization may lie at depth.

Regional Geochemical Anomalies: Cu in till

Geological Survey of Canada Open File Report 3175 (Kettles and Shilts 1996) shows Cu anomalies in till within the CMB and adjacent rocks of the CGB (Figure 1). The points shown represent the 95 to 100 percentile groups of the GSC analyses, corresponding to values of 223 to 1115 ppm Cu. The concentration of copper occurrences in bedrock in the southern part of the map area may be a reflection of the focus of past exploration in the south rather than the absence of bedrock mineralization in the more northern part. The presence of several Cu anomalies in till with no apparent bedrock source up-ice, particularly in the area of the boundary between the CMB and the CGB, suggests that additional exploration in those areas is warranted.

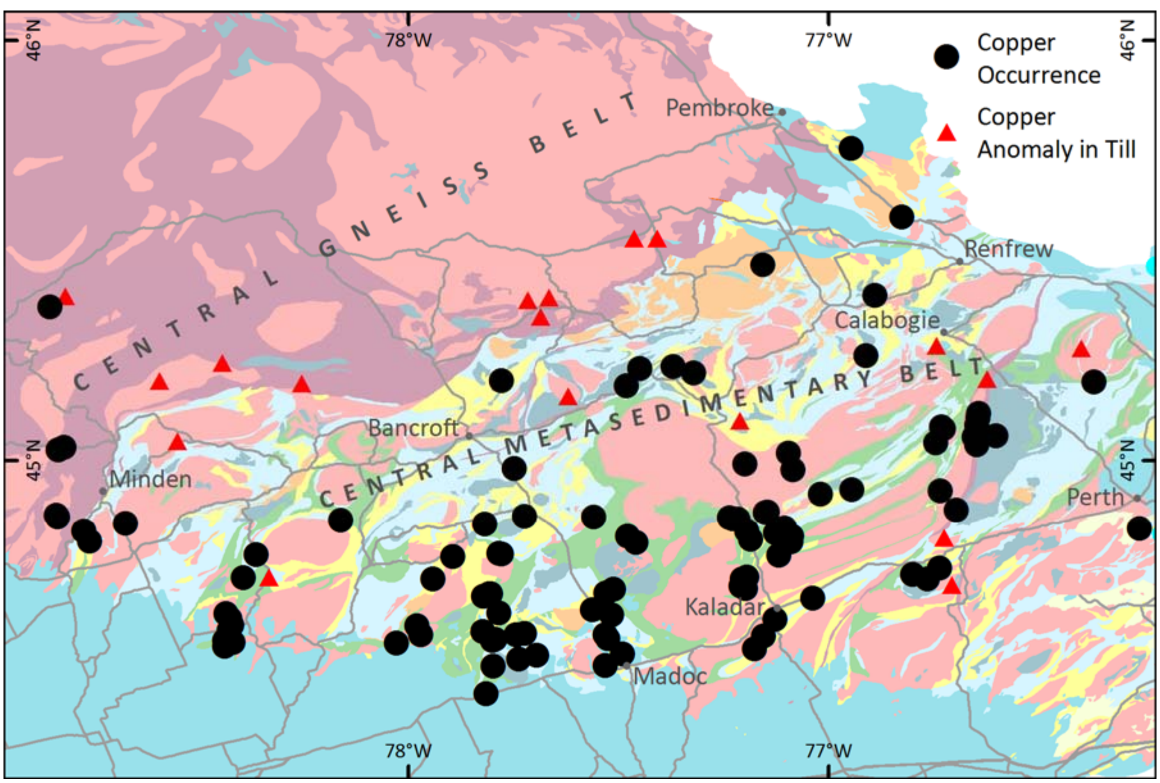

Figure 1. Copper in southeastern Ontario – locations of occurrences in bedrock (Ontario Geological Survey, Mineral Deposit Inventory Database 2013) and anomalies in till (Kettles and Shilts 1996)

Copper Potential in the Grenville Province, Southeastern Ontario …cont'd

Carter, T.R. 1984. Metallogeny of the Grenville Province, southeastern Ontario; Ontario Geological Survey, Open File Report 5515, 422 p.

Carter, T.R., Colvine, A.C. and Meyn, H.D. 1980. Geology of base metal, iron, and molybdenum deposits in the Pembroke -Renfrew area; Ontario Geological Survey, Mineral Deposits Circular 20, 186p.

Easton, R.M. 1992. Potential porphyry copper mineralization within the Mazinaw Terrane, Grenville Province; Ontario Geological Survey, Open File Report 5828, 24p.

Kettles, I.M. and Shilts, W.W. 1996. Geochemical and lithological composition of surficial sediments, southeastern Ontario; Geological Survey of Canada, Open File 3175, 33p

Malczak, J., Carter, T.R. and Springer, J.S. 1985. Base metal, molybdenum and precious metal deposits of the Madoc-Sharbot Lake area, southeastern Ontario; Ontario Geological Survey, Open File Report 5548, 374p.

Morton, R.L. 1983. Geology of Harvey Township, Peterborough County; Ontario Geological Survey, Report 230, 50p. Accompanied by Map 2475, scale 1:31 680.

HIGHLIGHTS

- **Ontario has had no Mg metal production since 2007; demand is growing**
- **Brucite has higher Mg content than traditional dolomite and magnesite ores**
- **SE Ontario hosts high-purity dolomitic marbles and conditions favourable for brucite alteration**

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Brucite in Southeastern Ontario—Industrial Mineral and Magnesium Ore

Global consumption of magnesium metal reached a new high in 2012 at 1.2 million tonnes, with demand growing 5.5 percent a year over the past decade. Increases in auto sales, particularly in China, and the trend toward producing light weight vehicles has led Roskill Information Services to predict an annual 5% growth in magnesium metal consumption through 2017 (Topf 2013). Since the closure of the Timminco Metals dolomite-based magnesium plant (Haley Station, southeastern Ontario) in 2007, there has been no production of Mg metal in Canada.

Most current producers of Mg metal use the energy-intensive Pidgeon process, combining calcined dolomite ore and ferrosilicon and using about 11 tonnes of raw materials for every tonne of magnesium produced. In electrochemical extraction processes, dolomite or magnesite ore is crushed, roasted and mixed with seawater, producing magnesium hydroxide. The $Mg(OH)_2$ is heated and reacted with chlorine to produce molten magnesium chloride, which is electrolyzed to release Mg.

Brucite, $Mg(OH)_2$, has a much higher content of MgO (69.1wt%) or Mg (41.6 wt%) than any other naturally-occurring magnesium compound, except the high-temperature metamorphic mineral periclase (MgO), which is rare in nature as it retrogrades to brucite in the presence of water. In comparison, the main currently exploited Mg-bearing minerals, magnesite and dolomite, contain 28.8 and 12.6 wt % Mg, respectively. Brucite has the additional advantage, in both energy consumption and environmental considerations, of producing no CO_2 during the calcining process and is therefore a mineral of considerable interest as an alternative raw material for production of MgO and elemental Mg.

As an industrial mineral, brucite can be used for magnesia production, in flame retardants, electric wire insulation, carpet backing, agricultural feed, specialty cements, and as a functional filler in plastic compounds (Simandl 2007).

Most brucite deposits of economic interest are associated with shallow-level, low-quartz, igneous intrusions into high-purity dolomite or magnesite-bearing sedimentary rocks. Addition of silica from the intrusion or from impurities within the carbonate rocks will produce a calc-silicate assemblage. In most cases, the brucite-bearing zone is located closest to the intrusion and is best developed where fracturing and or faulting has increased permeability and allowed CO_2 to escape during the reactions: dolomite = periclase + calcite + CO_2; magnesite = periclase + CO_2.

In the 1940s, Alcan quarried brucite in the Grenville Province for the production of MgO from dolomitic marble-hosted deposits near Wakefield, Quebec. In southeastern Ontario, brucite occurrences have been documented within high-purity dolomitic marble adjacent to syenitic intrusive rocks in Hinchinbrooke and Marmora townships (Figure 1).

The Hinchinbrooke occurrences are hosted by a series of narrow dolomitic marble units that may be roof pendants within syenitic rock of the Chippewa Pluton (Easton 2001).

Brucite in Southeastern Ontario—Industrial Mineral and Magnesium Ore …cont'd

The Marmora occurrence consists of brucitic marble that is currently being quarried for decorative aggregate. The quarry exposes a zone 150m wide and 250m long in white dolomitic marble containing pervasive brucite mineralization which, on the weathered surface, has been altered to white chalky hydromagnesite. Brucite content appears to be between 20-30% and the brucitic zone may extend along strike to the north and south of the quarry. The marble is adjacent to both a marginal, syenitic phase of the Deloro granite and the Moira River fault zone – ideal conditions for the development of brucite in the thermal metamorphic aureole of the intrusion.

Brucite has not been the focus of any significant exploration in southeastern Ontario and may have been overlooked during government mapping and sampling of the marble belts. Dolomitic marble near the margins of syenitic, dioritic and gabbroic intrusive rocks may host additional deposits of brucite. The geology and geochemistry of Grenville marble belts and specific prospects are documented in the following Ontario Geological Survey reports:

- Geochemistry of Grenville Marble in Southeastern Ontario, Mineral Deposits Circular 28, 1989.
- Precambrian Dolomite Resources in Southeastern Ontario, Open File Report 5712, 1990.
- High-Purity Calcite and Dolomite Resources of Ontario, Open File Report 5954, 1996.

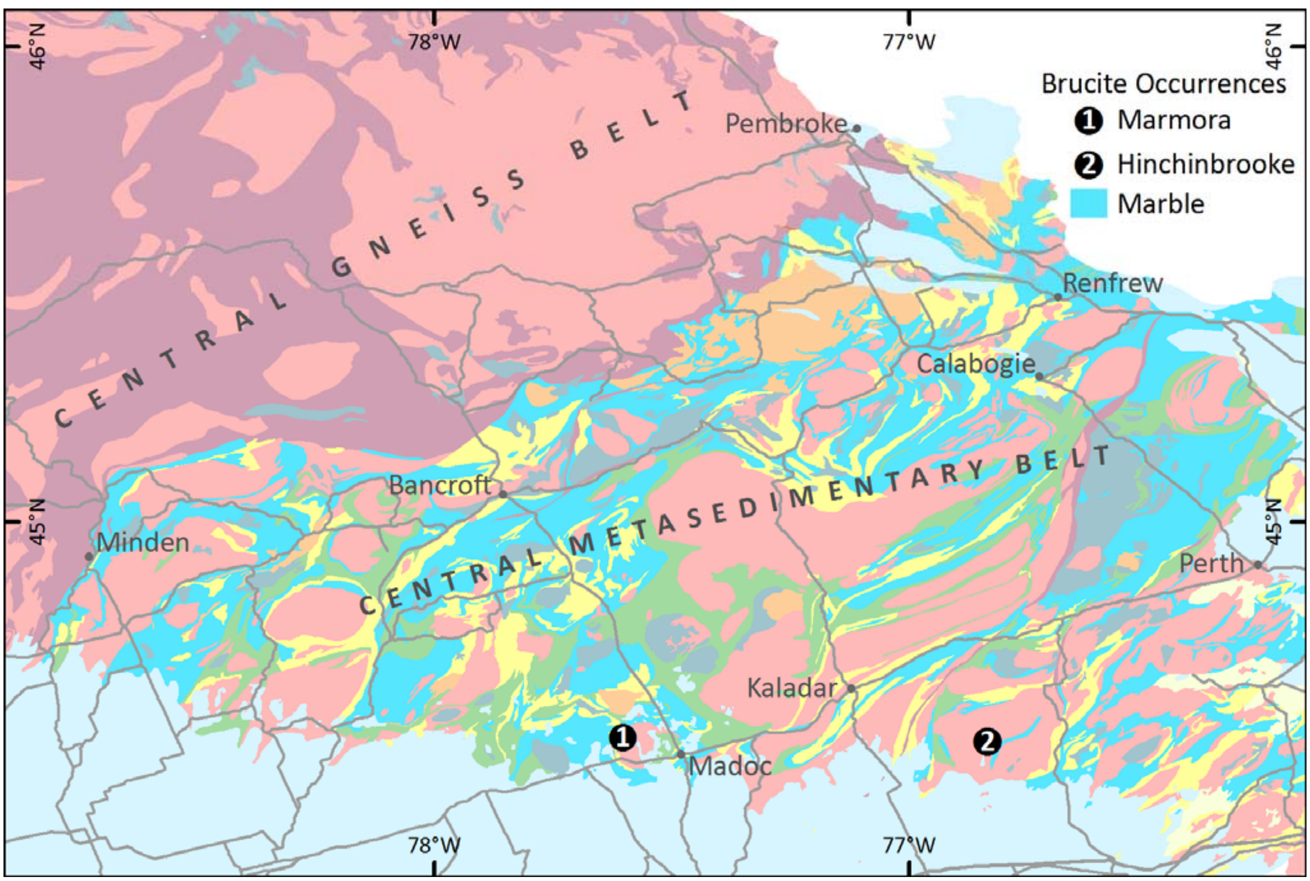

Figure 1. Brucite occurrences and marble belts, southeastern Ontario.

Brucite in Southeastern Ontario—Industrial Mineral and Magnesium Ore …cont'd

Easton, R.M. 2001. Precambrian geology, Tichborne area; Ontario Geological Survey, Preliminary Map P.3442, scale 1:50 000.

Grant, W.T., Papertzian, V.C., and Kingston, P.W. 1989. Geochemistry of Grenville marble in southeastern Ontario; Ontario Geological Survey, Mineral Deposits Circular 28, 266p.

Kelly, R.I. 1996. High-purity calcite and dolomite resources of Ontario; Ontario Geological Survey, Open File Report 5954, 39p.

LeBaron, P.S. and MacKinnon, A. 1990. Precambrian dolomite resources in southeastern Ontario; Ontario Geological Survey, Open File Report, 5712, 134p.

Simandl, G.J., Paradis, S. and Irvine, M. 2007. Brucite - industrial mineral with a future; Geoscience Canada v.34, no.2, p57-64.

Topf, A. 2013. Lighter vehicles, Chinese auto sales driving magnesium demand; www.magnesiuminvestingnews.com, July 25, 2013

HIGHLIGHTS

- **PGE targets to consider are previously documented Ni-Cu occurrences whose concentrations are considered uneconomic, yet may hold high potential for PGE**
- **Previously mapped mafic dikes in the West and North ranges of the Sudbury Structure, may prove beneficial to the discovery of new Ni-Cu-PGE offset dike orebodies**
- **More emphasis should be put on Muskoka flagstone, which is in high demand and close to large markets**

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Platinum Group Elements in the "Nipissing—Huronian Magmatic Belt"

Exploration for platinum group elements has been the dominant activity in the Sudbury District for the past few years. The majority of work has been conducted on differentiated mafic intrusive rocks of the East Bull Lake suite that include the River Valley, Agnew, and East Bull Lake complexes (ca. 2.45 Ga). Some work was also carried out on Nipissing gabbro rocks (2.22 Ga), mainly east of Wanapitei Lake. Much of this ground is held in good standing under the Mining Act as unpatented claims, leases, and patents.

Opportunities for land acquisition on ground underlain by these mafic intrusive rocks are limited. However, marginal areas of these mafic intrusive rocks may also be prospective for platinum group elements. These include, but are not necessarily restricted to, the following:

- mafic intrusive rocks north of the East Bull Lake complex in Lockeyer and Mandamin townships;
- mafic intrusive rocks, particularly those currently considered as Nipissing gabbro west of Sudbury to Elliot Lake and hosted in Huronian Supergroup metasedimentary rocks of the Penokean Fold Belt;
- Archean mafic intrusive rocks hosted within the Benny greenstone belt;
- mafic intrusive complexes hosted within the Central Gneiss Belt (i.e., the Whitestone, Arnstein and Eau Claire anorthosites, as well as Mattawan and McConkey townships);
- areas within the Grenville Front Tectonic Zone east of the River Valley Complex (Flett, Angus, and Parkman townships).

Other targets to consider are previously documented Ni-Cu occurrences whose concentrations are considered uneconomic, yet may hold high potential for PGE. There are two distinct styles of mineralization that are enriched in PGE, Ni, Cu, Au, and Ag:

1) disseminated magmatic sulphides, particularly within inclusion leucogabbronorite; and
2) disseminated to massive structurally-controlled sulphides.

Both types are enriched in platinum, palladium, copper, nickel, gold and silver. However, recent work in the area suggests the magmatic sulphides are more strongly enriched in the platinum group elements.

Sudbury Igneous Complex–Offset Dike Structures (Ni-Cu-PGE)

The nickel, copper, and platinum group metal ores of the Sudbury Igneous Complex (ca. 1.85 Ga) are found in four distinct environments:

1) Contact (e.g., Levack, Garson, Falconbridge mines);
2) Embayment (e.g., Creighton, Frood? mines);
3) Footwall (e.g., McCreedy West, Strathcona mines);
4) Offset Dike (Copper Cliff North & South, Totten and Victoria mines).

Platinum Group Elements in the "Nipissing—Huronian Magmatic Belt" …cont'd

Exploration activity for undiscovered offset dikes of the Sudbury Igneous Complex has been strong as of late. Discoveries by Vale Canada Limited of the Kelly Lake deposit on the Copper Cliff Offset and the Totten Mine on the Worthington Offset suggests that prospective ground includes areas underlain by Archean granitic and migmatitic rocks, particularly north and west of the Sudbury Igneous Complex. Targets are offset dikes and footwall zones that are typically enriched in Ni, Cu, Pt, Pd, and Ag. A mineralized extension of the Worthington Offset was discovered west of the Totten Mine in an area previously mapped as diabase.

- Wallbridge Mining Company Limited is actively exploring for Ni, Cu, PGE, Au, and Ag at the former Jonsmith Mines Limited Milnet Mine in Parkin Township. The property is hosted by the Parkin Offset (Whistle Offset), which shows no surface expression at its origin near the former Whistle Mine.
- Further north from the North Range of the Sudbury Igneous Complex, several offset dikes lacking surface expression have been defined by airborne and ground geophysical surveys, as well as diamond drilling.

Offset dikes are composed of fine- to medium-grained norite with inclusions of mafic to ultramafic composition. The inclusions vary in size from several millimetres to greater than one metre. These dikes may either be mineralized or unmineralized; those that are mineralized display a characteristic pockmarked weathered surface that distinguishes them from other types of dikes. The commonly weathered minerals are usually pyrrhotite and chalcopyrite.

Geophysical surveys (magnetic, Magneto-Telluric), as well as prospecting and geological surveys of previously mapped mafic dikes in the West and North ranges of the Sudbury Structure, may prove beneficial to the discovery of new offset dike orebodies in a century-old mining district.

Flagstone

Exploration for high-quality flagstone should be emphasized as production from one of Ontario's oldest and largest flagstone operations, the Mill Lake Stone Quarry, has all but ceased in recent years. This type of gneissic rock can be found along the Parry Sound shear zone from Parry Sound east to Huntsville. The Muskoka flagstone is in high demand and close to large markets.

Building Stone

Studies in the 1980's found that granites and gneisses south of the Grenville Front are generally less fractured than the more variable rock types of the Superior and Southern provinces north of the front. From a tectonic point of view, these observations make much sense. The rocks to the north are older, and have experienced several more periods of tectonic deformation.

- North of the Grenville Front, several promising building stone prospects have been found in the Espanola Formation north and east of Sudbury. The Espanola Formation can be traced from near Sault Ste. Marie to north and east of the Sudbury Igneous Complex, a distance of about 300 km. It is mostly drab grey, well-bedded limestone, siltstone or dolostone.

Around the Sudbury Igneous Complex, areas may be found where the Espanola Formation is highly altered. These appear to be coincident with Sudbury brecciation. Examples of this are

- soda metasomatic alteration with associated metallic minerals
- skarn development as evidenced by a large scheelite deposit east of Espanola
- replacement by magnetite as at Cartier, or
- simple brecciation and recrystallization, as now found in Parkin, Grigg and Scadding townships.

These latter areas of brecciation and recrystallization have yielded some attractive and very solid appearing sample tiles which should be of interest to the building trade. More investigation of the Espanola Formation around the Sudbury Igneous Complex is warranted in areas of alteration for a) their metallic minerals, and b) for their building stone potential.

HIGHLIGHTS

- **More than 50 Recommendations for Exploration since 1978: 50% of them gold-related but also including the potential of diamondiferous kimberlite pipes**
- **Gold deposition models have shifted focus from lithological to alteration and structural constraints**
- **Apart from Au, production in the Kirkland Lake District has also come from base metals, PGEs, As, industrial minerals (asbestos and barite) and stone**

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"There is Nothing New Under the Sun"

The Kirkland Lake Resident Geologist District is one of the smallest, but is economically well endowed. Over the past 110 years, the bulk of the economic value of production has been from gold, silver and iron. There has been minor production of base metals (Cu, Ni, Co), PGE's, arsenic, industrial minerals (asbestos and barite) and stone. Diamondiferous kimberlite pipes have also been found. Over the past 35 years, geological models for the district have drastically changed, however mineral deposit models have done less so. Emphasis on gold deposit models has shifted from lithology to alteration and structure, with a resulting shift in emphasis of recommendations for exploration over the years.

As the title suggests, recommendations tend not to be new but are a re-evaluation and update of one from the past. With tighter financial markets, many companies have been compiling data and re-examining their holdings. The Kirkland Lake Resident Geologist and District Geologist staff has more than 65 years of combined experience in the district. They have contributed to more than 50 Recommendations for Exploration with about 50% of them gold related. Titles and references to previous recommendations are listed below.

Table 1. Recommendation for Exploration Compilation 1978 to 2012 (published annually in the Resident Geologist Report of Activities)

Topic	TITLE	MP / OFR
Au Structures	Gold exploration targets in the northern Burntbush area	OFR 6236
Au Structures	Gold structures in the Kirkland Lake District	OFR 6248
Au Structures	Larder Lake - Cadillac Break under Huronian cover	MP 138
Au Structures	Larder Lake - Cadillac Break west of Matachewan	OFR 6131
Au Structures	North-trending auriferous and non-auriferous quartz veins and structures in the Kirkland Lake area	OFR 6150
Au Structures	Potential "new gold camp" in Lake Abitibi area	OFR 6051
Au Structures	Untested gold potential of the North Branch of the Destor - Porcupine Fault Zone	OFR 5991
Barite	Additional barite potential in Yarrow Township	OFR 6114
Diamonds	Diamond exploration – west of Kirkland Lake	OFR 6184
Diamonds	Diamond potential and lamprophyre in the Lake Timiskaming Structural Zone	OFR 6051
Diamonds	Diamond potential and lamprophyre in the Lake Timiskaming Structural Zone – 2002 update	OFR 6114
Diamonds	Diamond-bearing lamprophyre in the Kirkland Lake–Cobalt Area	OFR 6184
Diamonds	Exploration for diamonds	OFR 6083
Diamonds	Exploration for diamonds - revisited	OFR 6150
Diamonds	Kimberlite targets northeast of Kirkland Lake	OFR 6131
Diamonds	Using Operation Treasure Hunt data to search for kimberlite pipes	OFR 6051
Geochemistry	Basal till sampling	MP 122
Geochemistry	Lake Sediment Survey - Au, Ag, Ni anomaly Bayly Township	MP 142
Geochemistry	Till sampling, esker sampling, gold in Archean sediments	MP 134
Gold	"Blind" epigenetic gold deposit exploration	MP 161
Gold	Allsopp-- Huston gold property	OFR 6007

"There is Nothing New Under the Sun" …cont'd

Topic	TITLE	MP / OFR
Gold	Carbonate alteration zones in drill core stored at Kirkland Lake Remote Drill Core Storage Site	OFR 6150
Gold	Enhanced aeromagnetic data in Lebel and Gauthier townships – a potential tool for gold exploration	OFR 5991
Gold	Gold along the contacts between volcanic and sedimentary rocks	MP 128
Gold	Gold deposits in the Blake River Assemblage	OFR 6248
Gold	Gold in Matheson area & Gauthier volcanics	OFR 5892
Gold	Gold potential in the Shining Tree Area	OFR 6131
Gold	Gold-rich volcanic massive sulphide (vms) deposits in Ontario	OFR 6250
Gold	Highway 101 corridor gold	OFR 5958
Gold	Kerr Mine – Gauthier Assemblage – Nettie Lake gold trend	OFR 6184
Gold	Low grade open pit potential - Fenn-Gibb, Y-D type	OFR 5943
Gold	Milligan auriferous quartz boulders - comments and recommendations	OFR 6150
Gold	Potential "new gold camp" in Lake Abitibi area	OFR 6007
Gold	Potential for further gold discoveries in the Gauthier Group of volcanic rocks	OFR 6131
Gold	Re-evaluation of past gold producers	MP 152
Gold	Shining Tree – give me a break	OFR 6265
Gold	There are prospective gold areas other than along the big faults	OFR 6287
Gold	Victoria Creek gold zone	OFR 5921
IOCG	Iron-Oxide-Copper-Gold Potential (in the Huronian Supergroup)	OFR 6114
Iron	Iron ore – renewed interest	OFR 6204
PGE	Copper--Nickel--PGE mineralization Temagami area	OFR 6007
PGE	PGE - Cr potential in Nordica, McEvay and Sheba townships	OFR 5991
Placer Au	Paleoplacer gold in the Cobalt Embayment	MP 95
Placer Au	Paleoplacer gold potential in the Lorrain Formation of the Huronian Supergroup	OFR 6184
Placer Au	Placer gold deposits in the Kirkland Lake area	MP 107
Porphyry Cu	Porphyry copper potential in the Kirkland Lake District	MP 91
VMS	Assessment of volcanic/sedimentary rocks for Cu-Zn-Pb potential in Shining Tree area	OFR 6114
VMS	Base metals in Ben Nevis Area	MP 147
VMS	Canagau Property – Ben Nevis Township	OFR 6131
VMS	Clifford, Ben Nevis, Pontiac, Townships copper-zinc-gold area	MP 101
VMS	Epidote alteration with possible VMS association in Maisonville Township	OFR 6007
VMS	Massive sulfide mineralization Matheson area	OFR 5973
VMS	VMS potential & Archean lode-gold deposits	MP 158
VMS	VMS potential in the basement rocks in Cobalt	MP 84

"There is Nothing New Under the Sun" …cont'd

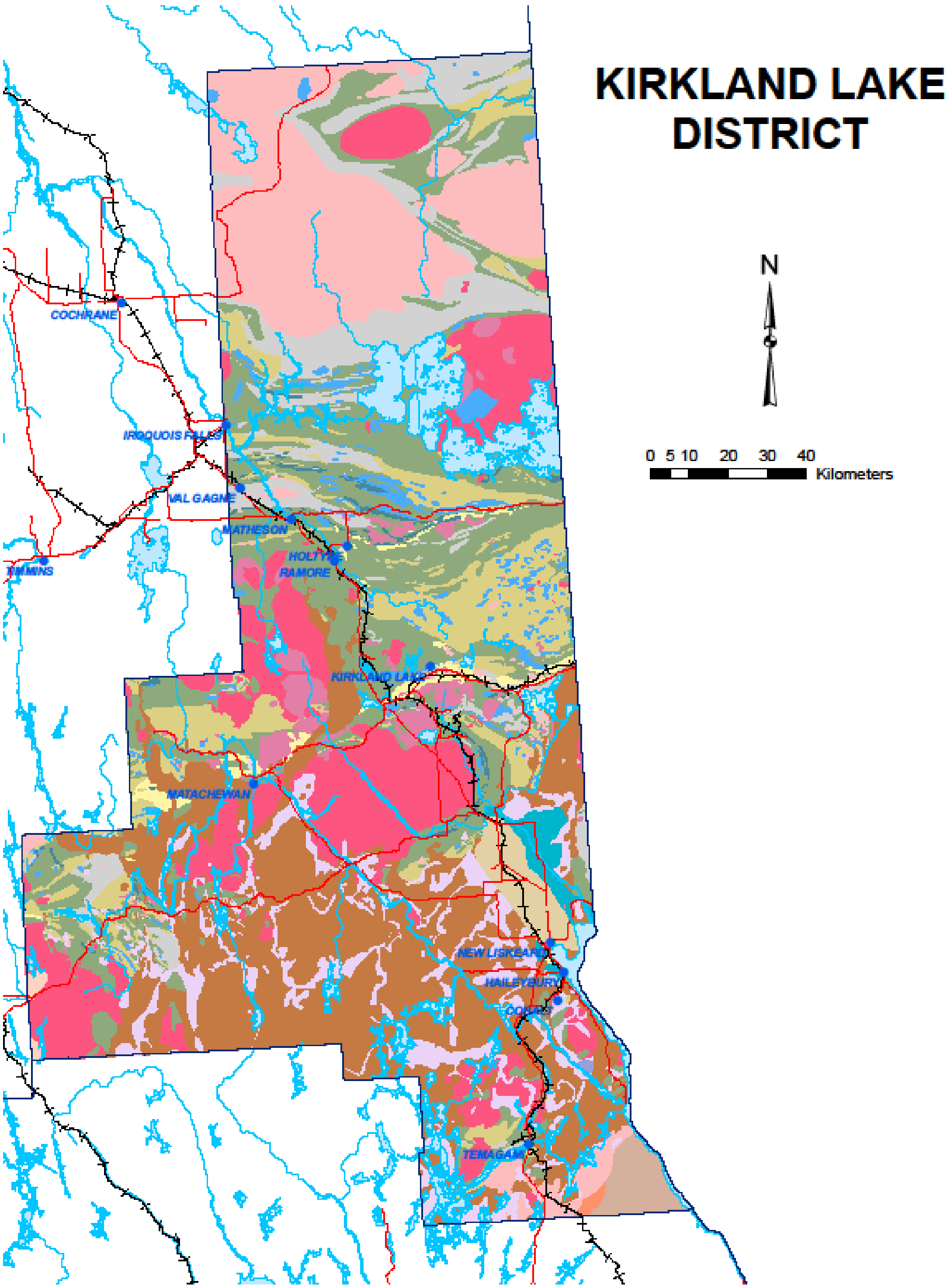

Figure 1. General geology of the Kirkland Lake District.

HIGHLIGHTS

- **The TTG phases of the MLB in Leeson and Brachin townships have been known to host economically significant brittle—ductile shear—hosted gold quartz vein deposits.**
- **The past producing Renabie gold mine operated in Leeson Township for over 40 years producing over 1 million ounces of gold**
- **There are 37 known gold occurances hosted in the TTC phases of the MLB; all are associated with west to northwest trending quartz veins hosted in brittle—ductile shear zones.**

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Gold Hosted in the Trondhjemitic, Tonalitic and Granodioritic Phases of the Missanabie Lake Batholith

Recent gold discoveries involving brittle–ductile shear-hosted gold quartz vein deposits in trondhjemitic–tonalitic phases in 1) the Marmion Lake batholith at the Hammond Reef project of Osisko Mining Corporation, and 2) the Côté Lake deposit within the Chester Granitoid Complex, owned by IAMGOLD Corporation, have given prospectors a new model when searching for gold deposits in Ontario. The Missanabie Lake Batholith (MLB) should be considered a target, based on the new model.

The Missanabie Lake Batholith (MLB) is part of the Wawa Domal Gneiss Terrane (WDGT) which represents an easterly transition from predominantly greenschist facies metavolcanics rocks of the Michipicoten Greenstone Belt to tonalitic, trondhjemitic and granodioritic (TTG) gneisses of the WDGT. Gold mineralization lies outside the Michipicoten Greenstone Belt, and is concentrated within the WDGT.

The rocks of the TTG are coarse-grained, foliated, and weathered pale-grey, and exhibit well-developed layering consisting of varying proportions of mafic minerals, generally biotite. The trondhjemitic–tonalitic phases host a series of west- to northwest-trending quartz veins that cross-cut the regional metamorphic foliation as a result of brittle–ductile shearing. The vein structures provide a means of structural control for the gold mineralization in the area.

Alteration within the TTG consists of hematite, giving the rock a distinctive reddish colour, as well as sericite, quartz and pyrite. Disseminated to massive pyrite, with accessory galena, molybdenite and chalcopyrite in the shear-hosted quartz veins are characteristically associated with the gold mineralization (Sage and Heather 1991).

The TTG phases of the MLB in Leeson and Brackin townships have been known to host economically significant brittle–ductile shear-hosted gold quartz vein deposits. The past-producing Renabie gold mine operated in Leeson Township for over 40 years, producing over 1 million ounces of gold.

There are 37 known gold occurrences hosted in the TTG phases of the MLB; all are associated with west- to northwest-trending quartz veins hosted in brittle–ductile shear zones. The Renabie Main Zone, Nudulama, C Zone and the Braminco zones are some examples of the larger gold mineralized zones identified in the TTG (see Table 1 and Figure 1).

Table 1. Tonnage and grade estimates for some of the larger mineralized zones in the TTG (Pace, A. and McMillan R., 2012).

Name of Mineralized Zones	Township	Tonnage Estimate (tonnes)	Gold (oz/ton)
Renabie Main Zone	Leeson	1 000 000	0.2
Nudulama	Leeson	579 325	0.194
Braminco Zone (comprised of #21 Vein, #7 Vein and B Vein)	Brackin	100 000 (#21 Vein) 23 000 (#7 Vein) 5 000 (B Vein)	0.15 0.31 0.26

(Tonnage and grade is referenced from Table 21: "Mineral Deposits not being mined in the Wawa Area 2012", Pace and McMillan 2012)

Gold Hosted in the Trondhjemitic, Tonalitic and Granodioritic Phases of the Missanabie Lake Batholith …cont'd

The ability to recognize areas of shear-hosted quartz veins within the deformed TTG phases of the MLB can be paramount in identifying further exploration opportunities. The discoveries of the Hammond Reef and Côté Lake properties should bring new attention to the exploration potential for gold mineralization in the area.

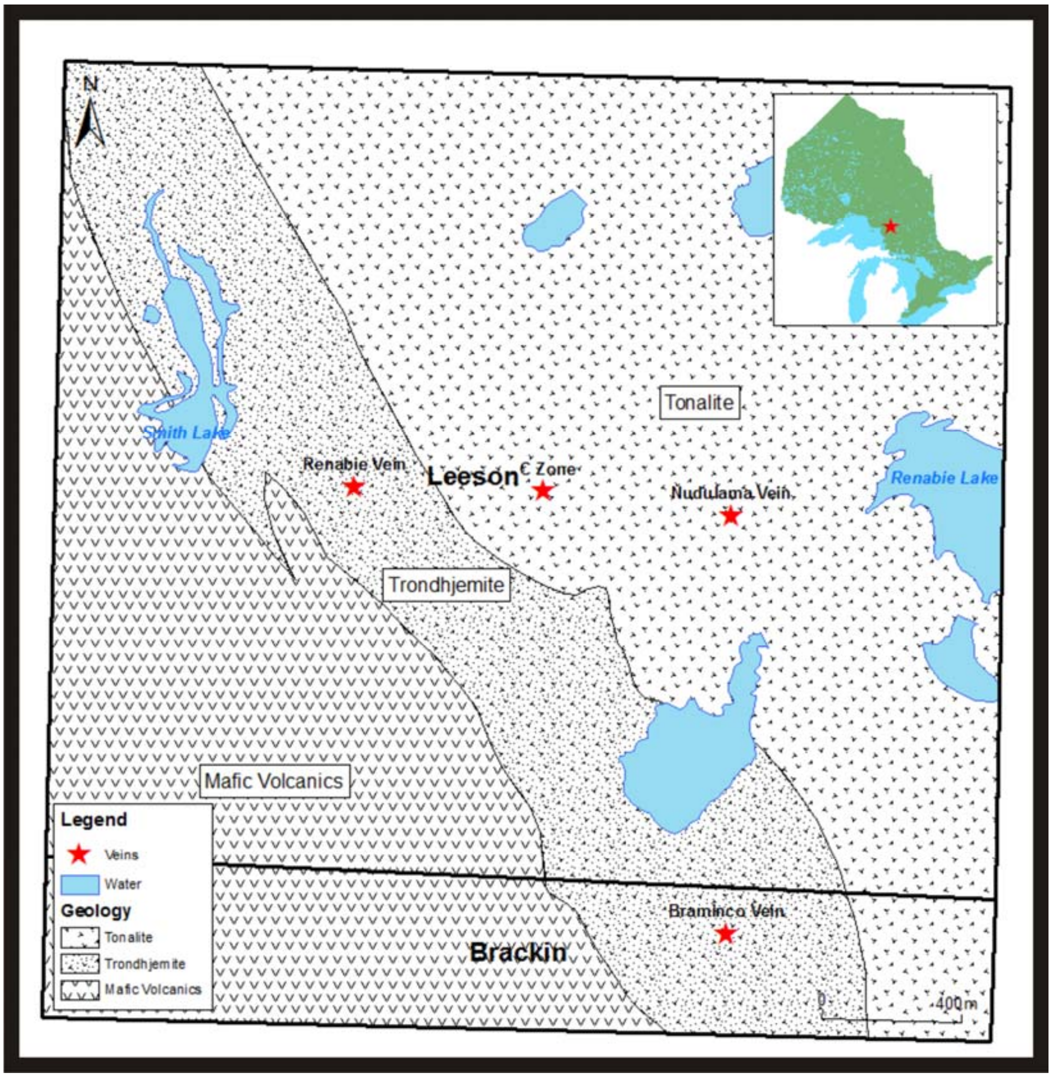

Figure 1. Geology map illustrating the locations of some of the larger mineralized zones hosted within the trondhjemite–tonalite phases of the Missanabie Lake Batholith (Callan N.J, 1991, modified by McMillan, R. 2013).

Callan J.N., 1991, Syn-deformational shear zone-hosted Au-quartz vein mineralization in TTG host rocks, Renabie Mine area, North Ontario: structural analysis, microstructural characteristics and vein paragenesis, Ontario Geological Survey, Open File Report 5759.

Pace, A., and McMillan, R., 2012. Sault Ste. Marie Resident Geologist's District 2012; *in* Report of Activities 2012, Resident Geologist Program, Timmins Regional Resident Geologist Report: Timmins and Sault Ste. Marie Districts, Ontario Geological Survey, Open File Report 6286. p. 40-41.

Sage, P.R., and Heather, B.K., 1991, The Structural, Stratigraphy and Mineral Deposits of the Wawa Area: Field Trip A6, Geological Association of Canada, p. 81-97.

HIGHLIGHTS

- **Recent mapping by Lewis (2012) reclassified a basal sandstone unit as the Matinenda Formation on the basis of its textural characteristics and its elevated uranium content**
- **The sandstone is anomalously high in uranium with typical portable gamma-ray spectrometer values of 300 cpm**
- **In addition to the uranium potential of the Matinenda Formation, recent exploration activities have discovered that rare earth elements are also associated with the quartz-pebble conglomerate**

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Rare Earth Element and Uranium Potential in the Newly Reclassified Matinenda Formation

In 2012, the Earth Resources and Geoscience Mapping Section of the Ontario Geological Survey initiated a 2 year project to map the geology of Albanel and Varley townships, located northwest of Elliot Lake, Ontario. The townships are situated at the contact between the Ramsey–Algoma granitoid complex of the Archean Superior Province to the north and the unconformably overlying Paleoproterozoic Huronian Supergroup of the Southern Province to the south. The Archean rocks in Albanel Township consist dominantly of felsic intrusive rocks and lesser mafic volcanic rocks, both of which are cut by mafic dikes of the Paleoproterozoic Matachewan dike swarm.

Previous mapping by Siemiatkowska (1977) identified a basal sandstone unit at the eastern end of Albanel Township as being part of the Mississagi Formation. Recent mapping by Lewis (2012) reclassified this unit as the Matinenda Formation on the basis of its textural characteristics and its elevated uranium content.

The basal sandstone unit identified during the mapping project is a yellow to light green arkose containing plagioclase and quartz. Intercalated within the sandstone unit are quartz pebble conglomerates that range up to 2 cm in diameter; clasts are subrounded and moderately well sorted. The sandstone is anomalously high in uranium with typical portable gamma-ray spectrometer values of 300 counts per minute (cpm). On fracture surfaces and especially in the quartz-pebble conglomerate layers, maximum gamma-ray spectrometer readings of up to 5000 cpm total (200 ppm U) were measured (Lewis 2012).

The quartz-pebble conglomerate of the Matinenda Formation is host to the low-grade placer uranium deposits that were mined at Elliot Lake. In addition to the uranium potential of the Matinenda Formation, recent exploration activities have discovered that rare earth elements are also associated with the quartz-pebble conglomerate. The reclassification of the basal quartz-pebble conglomerate as Matinenda Formation is important because it extends those productive rocks at Elliot Lake into Albanel Township (Table 1). Besides uranium, further investigations are warranted to test the basal quartz-pebble conglomerate for its rare earth element potential.

Preliminary geology map P.3773, Precambrian Geology, Albanel Township Southern and Superior Provinces by D. Lewis, 2013, is available for download illustrating this change in lithology.

Table 1: Assay-mode gamma-ray spectrometric readings from quartz-pebble conglomerate within the Matinenda Formation.

Sample	Easting (m)	Northing (m)	K (wt%)	U (ppm)	Th (ppm)
1.	348555	5160635	7.6	199.6	355.9
2.	348555	5160635	9.1	192.1	511.3
3.	350064	5160688	4.5	122.6	463.5

Abbreviation: ppm = parts per million, wt% = weight percent

Rare Earth Element and Uranium Potential in the Newly Reclassified Matinenda Formation …cont'd

Notes:

1. *UTM coordinates are in Zone 17, NAD83*
2. *To obtain U_3O_8 multiply U by 1.1793. All K, U and Th data for samples 1 and 2 were recorded using an Exploranium GR-135G MiniSpec gamma-ray spectrometer and sample 3 was recorded using a RS-125 Spectrometer. The instrument was stabilized daily and data were recorded using the assay mode with a dead-time adjusted 5 minute count time.*
3. *Samples 1 and 2 were assayed by Lewis (2012) and sample 3 was assayed by Pace (2012).*

Lewis, D. 2012. Lithological and structural mapping of Albanal Township, Southern and Superior Provinces; in Summary of Field Work and other Activities 2012, Ontario Geological Survey, Open File Report 6280, p.16-1 to 16-11.

Siemiatkowska, K.M. 1977. Geology of the Wakomata Lake area, District of Algoma; Ontario Geological Survey, Report 151, p.48-49.

HIGHLIGHTS

- **Cadillac—Larder Lake Fault, one of the most prolific gold bearing faults in Ontario**
- **Does it transect the Kenogamissi Batholith and continue through the Swayze Greenstone Belt**

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The Westward Continuation of the Cadillac—Larder Lake Fault Through the Kenogamissi Batholith, Abitibi Subprovince

The Cadillac – Larder Lake Fault (CLLF) is one of the most important crustal structures controlling gold mineralization in the Abitibi subprovince. In Ontario, over 40 million ounces of gold have been mined along the fault from Matachewan to the Quebec border and a similar amount of production plus reserves occur on the Quebec segment. Many attempts have been made to trace the fault westward beyond Matachewan in recognition of the proliferation of gold deposits along its length. Historically the west-trending CLLF has been considered to swing southward beneath Paleoproterozoic cover rocks and merge with the Ridout Fault. The Ridout Fault delineates the southern boundary of the Kenogamissi Batholith and transects the southern part of the Swayze greenstone belt. Alternative scenarios for the location of the CLLF west of Matachewan include: i) it being overridden or reoriented along a north trending detachment fault coinciding with the Deloro-Tisdale assemblage boundary as a result of a detachment fault; ii) ingestion along the east margin of the Kenogamissi batholith; and iii) its continuation through the Halliday Dome and across the Kenogamissi Batholith to re-emerge on the west side of the batholith in the Swayze greenstone belt.

Evidence that the CLLF might pass through the Halliday Dome area include strongly deformed Timiskaming sediments in Midlothian and Halliday townships and the presence of talc+chlorite+carbonate schists identified in diamond drilling at the Edleston gold deposit in Sothman Township.

The possible reappearance of the CLLF on the west side of the Kenogamissi Batholith in the Swayze Greenstone Belt is suggested by a west-trending deformation zone in southern Newton and Dale townships (Atkinson et al. 2011), syenite-hosted gold mineralization at the Claude Rundle Mine and the west-trending Denyes Lake high strain zone identified by Heather and Shore (1999).

The identification of gold mineralization within supracrustal rocks on either side of the Kenogamissi Batholith associated with major west-trending deformation suggests a physical link may exist and this presents intriguing exploration targets. If the CLLF does indeed transect the Kenogamissi Batholith, it opens up new possibilities for gold exploration within the batholith and enhances the prospectivity of the area to the west in the Swayze Greenstone Belt.

The Westward Continuation of the Cadillac—Larder Lake Fault Through the Kenogamissi Batholith, Abitibi Subprovince …cont'd

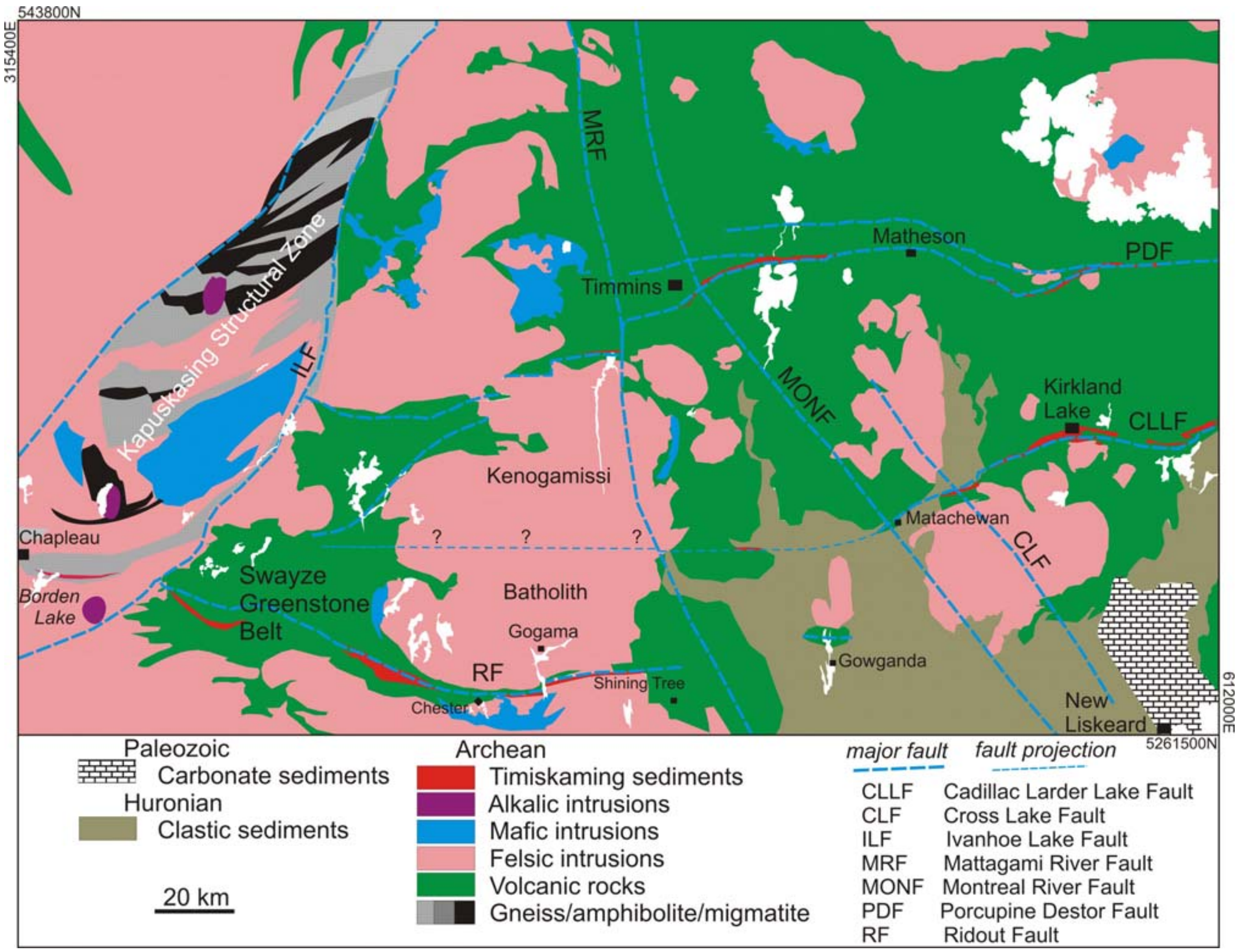

Figure 1. General geology of the western extension of the Cadillac Larder Lake Fault.

Atkinson, B.T., Bousquet, P., Pace, A., Butorac, S., Draper, D.M., Metsaranta, D.-A. and Wilson, A.C. 2011. Report of Activities 2010, Resident Geologist Program, Timmins Regional Resident Geologist Report: Timmins and Sault Ste. Marie Districts; Ontario Geological Survey, Open File Report 6264, 127p.

Heather, K.B. and Shore, G.T. 1999. Geology of the Swayze greenstone belt, Ontario; Geological Survey of Canada, Open File 3384a, scale 1:50 000.

HIGHLIGHTS

- **Regional geology, geophysical and lake sediment geochemistry data suggest that the area northeast of Killala Lake has potential for the occurrence of mineralized alkalic and/ or mafic to ultramafic intrusions**

- **This is an area that has seen limited historic exploration activity and is largely open for staking.**

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Exploration Potential in the Area Northeast of Killala Lake

The area to the northeast of Killala Lake lies within the Quetico metasedimentary basin. The geology of this area is dominated by metasedimentary rocks and derived migmatites which have seen limited historic exploration activity; however, regional geology, geophysical and geochemical data suggest that this area may have potential for the discovery of mineralized alkalic (e.g., diamond, rare earth elements, niobium, graphite) and/or mafic to ultramafic (e.g., copper, nickel, PGE) intrusions.

Mineralized Mesoproterozoic alkalic intrusions in the area north of Lake Superior typically occur in close spatial association with deep crustal fracture systems (Sage 1991). Although no such structure has previously been mapped in this area, the following observations suggest the possibility that such a structure exists in the area northeast of Killala Lake:

Regional distribution of intrusions and mineralization

- Southwest of Killalla Lake, the Mesoproterozoic Prairie Lake Carbonatite Complex and Killalla Lake alkalic complex occur along an approximately linear northeast trend that parallels the Killala Lake Deformation Zone (KLDZ). Following this trend further northeast toward the northern margin of the Quetico basin, a series of mafic intrusions (possibly also of Mesoproterozoic age) resume this same trend toward the Nagagami River and Martison Lake alkalic complexes (Figure 1).

- Documented mineralization along the trend of the KLDZ based on Mineral Deposit Inventory records (Ontario Geological Survey 2013) includes: i) Prairie Lake complex: Nb, U, REE and phosphate, ii) Killala Lake complex: Cu-Ni, Nb, iii) Nagagami River complex: Nb, and iv) Martison Lake complex: phosphate, Nb, REE. Other notable occurrences: diamond-bearing dike south of Killala Lake; Albany graphite diatreme adjacent to Nagagami River complex.

Geophysical and lake sediment geochemistry data

- A broad gravity high (Ontario Geological Survey 1999) extends northeast from Killala Lake, suggesting the presence of higher density rocks (and a possible deep-crustal structure) below the metasedimentary cover rocks. A number of lake sediment anomalies were noted in this area during a 1999 survey that was carried out as part of Operation Treasure Hunt (Ontario Geological Survey 2000). The most common anomalies were for Cu, Ni, Cr, Co and/or PGE (Figure 1). Similar anomalies can also be seen in data from an earlier Geological Survey of Canada lake sediment survey (Friske et al. 1991).

General Recommendations

An exploration program in this area should utilize all available geological, geophysical, geochemical and topographic information to identify targets. For example, co-incident magnetic and electromagnetic anomalies that have close spatial association with intersecting bedrock lineaments and lake sediment geochemical anomalies would warrant follow-up prospecting to determine if they are related to alkalic or mafic/ultramafic intrusions.

Exploration Potential in the Area Northeast of Killala Lake …cont'd

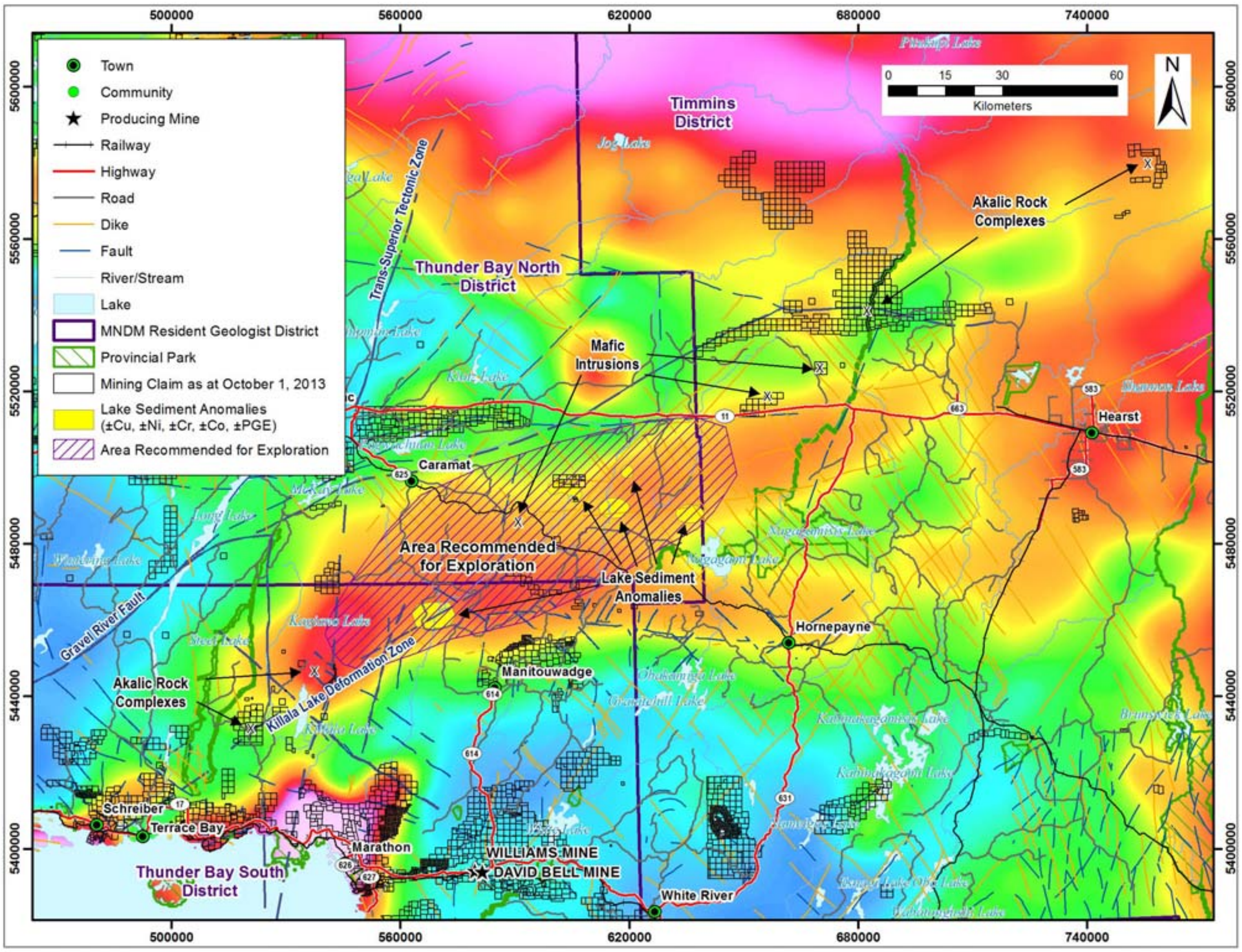

Figure 1. Regional gravity map illustrating locations of intrusions, structures and geochemical anomalies.

Friske, P.W.B., Hornbrook, E.H.W., Lynch, J.J., McCurdy, M.W., Gross, H., Galletta, A.C., Durham, C.C. 1991. National geochemical reconnaissance lake sediment and water data, Northwestern Ontario (NTS 42D, 42E South), Geological Survey of Canada, Open File 2360.

Ontario Geological Survey 1999. Single master gravity and aeromagnetic data for Ontario; Ontario Geological Survey, Geophysical Data Set 1036.

——— 2000. Nakina-Longlac area lake sediment survey: Operation Treasure Hunt – Area B; Ontario Geological Survey, Open File Report 6035, 144p.

——— 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release—Data 126 – Revision 1.

——— 2013. Mineral Deposit Inventory—2013; Ontario Geological Survey.

Sage, R.P. 1991. Alkalic rock, carbonatite and kimberlite complexes of Ontario, Superior province; in Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 1, p.683-709.

HIGHLIGHTS

- **Renewed interest in gold exploration underway on the western and northern margins of the Terrace Bay Batholith**
- **Recent discoveries of high-grade gold showings by local prospectors open up potential for gold mineralization on the eastern margin of the Terrace Bay Batholith**

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Gold Potential in the Jackfish Lake Area

The Schreiber-Terrace Bay area has been the subject of sporadic gold exploration and development activity for more than 100 years, with some small-scale production having occurred prior to 1942 from the Empress, Gold Range, Harkness-Hays and North Shore deposits (Marmont 1984). Recently, renewed exploration interest has been shown in the area, with notable projects being carried out on the following historic properties:

- Northshore property, GTA Resources and Mining Inc. http://www.gtaresources.com/and joint venture partner Balmoral Resources Inc., http://www.balmoralresources.com/s/Home.asp
- Harkness-Hays property, Strike Minerals Inc., http://strikeresources.com.au/
- Empress property, Alto Ventures Ltd. http://www.altoventures.com/s/Home.asp\
- South Priske and Syine properties, Oren Kravchik (Prospector)

Gold occurrences on all of these properties have a close spatial association with the Terrace Bay batholith, which has been interpreted to have played an important role in the localization of gold mineralization (Marmont 1984). All of these occurrences are located near the western or northern margins of the batholith, which have seen the majority of historic exploration activity. By contrast, the eastern margin of the intrusion has seen much less prospecting and exploration activity. Recent prospecting programs by local prospectors; W. Richards (and partners) and R. Wahl in the area east of Jackfish Lake have uncovered new high-grade surface gold showings associated with quartz veins and breccias (pyrite, +/-chalcopyrite,+/-malachite, +/- silver, +/- galena, +/-molybdenite) hosted within both the intrusive rocks of the Terrace Bay batholith and the adjacent supracrustal rocks. Gold values of up to 1.28 opt Au were obtained on Richards's property and up to 39 g /t Au on Wahl's ground (http://users.renegadeisp.com/~rwahl/Jackfish%20Lake%20Property.htm). These new discoveries indicate that the Jackfish Lake area has gold potential that would benefit from sustained, systematic exploration programs.

In addition to being near the contact of the Terrace Bay batholith, the area immediately to the east of Jackfish Lake has a number of other geological characteristics that are suggestive of the potential for the discovery of a gold deposit. Examples illustrated on the geological map of Walker (1967) include the presence of a diversity of lithologies, a number of fault/shear structures, a major fold hinge, and areas of silicified and carbonatized rock. A number of west to west-northwest trending, linear magnetic anomalies also pass through the Jackfish Lake area (Ontario Geological Survey 2003). These magnetic lows may be related to the presence of reverse-polarized late-Proterozoic diabase dikes. Nevertheless, such intrusions often exploit previously-existing Archean structures that could be important for the localization of gold mineralization.

Gold Potential in the Jackfish Lake Area …cont'd

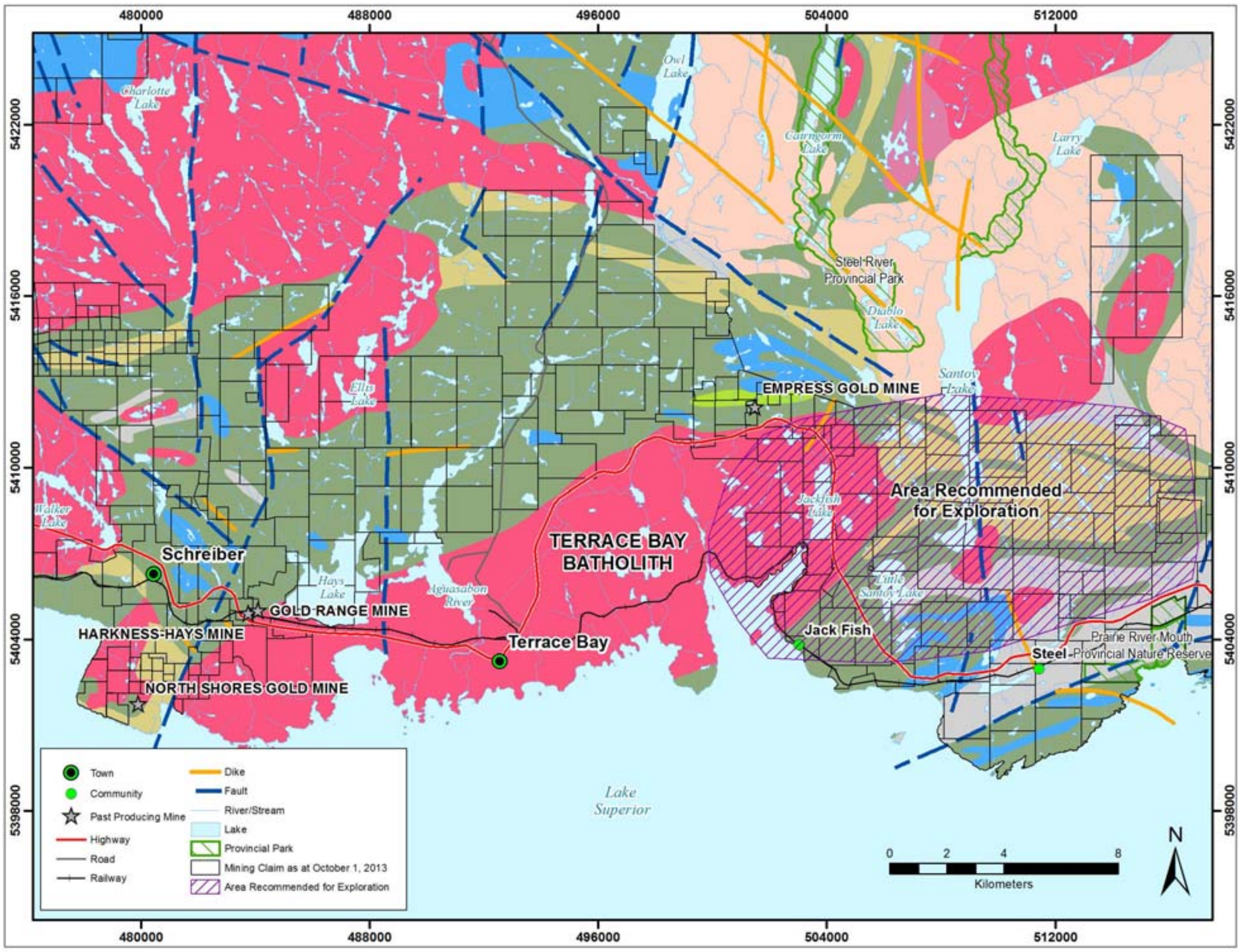

Figure 1. Geology map illustrating Terrace Bay batholith and area recommended for exploration

Finally, it should be noted that the geological characteristics of the Jackfish Lake area, including the geochemistry of the Terrace Bay batholith, correlate well with the structurally controlled magmatic hydrothermal model for Archean lode gold deposits of Beakhouse (2007).

Beakhouse, G.P. 2007. Structurally controlled, magmatic hydrothermal model for Archean lode gold deposits: a working hypothesis; Ontario Geological Survey, Open File Report 6193, 133p.

Marmont, S. 1984. The Terrace Bay batholith and associated mineralization; Ontario Geological Survey, Open File report 5514, 95p.

Ontario Geological Survey 2003. Ontario airborne geophysical surveys, magnetic and electromagnetic data, Schreiber area; Ontario Geological Survey, Geophysical Data Set 1104 - Revised.

Walker, J.W.R. 1967. Geology of the Jackfish-Middleton Area; Ontario Department of Mines, Geological report 50, 41p.

HIGHLIGHTS

- **High priority, multi-element Cu-Ni-PGE anomalies are open for staking**

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Cu-Ni-PGE Mineralization in the Quetico-Eastern Wabigoon Domain Boundary

The Quetico-Eastern Wabigoon Domain boundary east of Longlac has experienced minimal exploration activity related to Cu-Ni-PGE mineralization. The lack of any detailed geological mapping, in particular where rocks of the far eastern Wabigoon domain are overlain by Paleozoic cover of the James Bay Lowlands northeast of Caramat, has deterred exploration in this area. Discovery of PGE-bearing mafic intrusive bodies along the northern boundary of the Quetico basin both in the Atikokan-Shebandowan area to the west and in the Hearst area to the east, enhances the mineral potential of the entire domain boundary zone east of Lake Nipigon. Work by East West Resource Corporation and Canadian Golden Dragon Resources Ltd. in 1999 to 2000 on their McCoig-Fintry-Shuel township properties, 80 km west of Hearst, has identified several pyroxenite-gabbro bodies containing anomalous Cu-Ni-PGE mineralization.

There are several sources of information, both past and recent, that can be used to locate magnetic anomalies, which may be related to mafic intrusive bodies in this area. The 1962 joint federal-provincial government regional airborne magnetometer survey maps (scale 1:63 360) and the 1:1 000 000 scale Geology of Ontario (1991) maps should be studied. In particular the total magnetic field (Map 2586, OGS 1991) and vertical magnetic gradient (Map 2590, OGS 1991) series are highly useful in delineating anomalous magnetic features. The Operation Treasure Hunt Nakina-Longlac Area Lake Sediment Survey (OGS 2000b) contains information that should be utilized in conjunction with the geophysical data (1991 and 1962) for the eastern Longlac region. Several anomalous areas related to Cu-Ni-PGE mineralization have been identified by the survey and should be explored. These are listed in order of importance as follows:

1. East Chipman Lake-Fernow Lake area (O'Meara-Fernow townships).
2. Sadie-Meg-McKay lakes area (south-southeast of Longlac).
3. Caramat-Mustela Creek area (Caramat area).
4. East Lukinto-Sandlink lakes area (east of Longlac).

It is significant to note that all four of these areas display multi-site, multi-element anomalies i.e., PGE with accompanying base metal signatures. The drainage systems within each of these areas should be studied carefully with special attention to in-flow points, basin influence and any known local bedrock geology.

Gupta, V.K. 1991. Vertical magnetic gradient of Ontario, east-central sheet; Ontario Geological Survey, Map 2590, scale 1:1 000 000.

Gupta, V.K. 1991. Shaded image of total magnetic field of Ontario, east-central sheet; Ontario Geological Survey, Map 2586, scale 1:1 000 000.

Innes, D.G. and Ayres, L.R. 1969. Caramat-Pagwa sheet, Thunder Bay and Cochrane districts; Ontario Department of Mines, Geological Compilation Series Map 2202, scale 1:253 440.

CU-NI-PGE Mineralization in the Quetico-Eastern Wabigoon Domain Boundary …cont'd

Ontario Department of Mines-Geological Survey of Canada. 1962. Lake Sheet, Thunder Bay District, Ontario; Ontario Department of Mines-Geological Survey of Canada, Map 7101G, Airborne magnetic Survey, scale 1 inch to 4 mile.

Ontario Geological Survey. 2000b. Nakina-Longlac area lake sediment survey: Operation Treasure Hunt - Area B; Ontario Geological Survey, Open File Report 6035, 144p.

HIGHLIGHTS

- **The Horseshoe Lake greenstone belt represents an under explored belt with potential for significant iron formation-hosted gold mineralization**

- **Field work in the belt confirms the presence of heavily sulphidized iron formation located 1.5 km along strike from a historical occurrence of similar character**

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Targeting Iron Formation-Hosted Gold in the Horseshoe Lake Greenstone Belt

The Horseshoe Lake greenstone belt is located approximately 90 km northwest of Pickle Lake, Ontario and 55 km southwest of Goldcorp Inc.'s Musselwhite Mine. The belt can be accessed by boat through the Pipestone River from Highway 808, by float plane or by helicopter. Highway 808 intersects the eastern portion of the Horseshoe Lake greenstone belt.

The Horseshoe Lake greenstone belt is a 30 km long by 8 km wide, east-trending volcanic-sedimentary sequence and is subdivided into 5 tectonostratigraphic assemblages (Figure 1): 1) Northern Horseshoe assemblage (quartz-rich sedimentary rocks interlayered with oxide and sulphide facies iron formation and mafic metavolcanic rocks), 2) Southern Horseshoe assemblage (small wedge of metasedimentary rocks), 3) Wapamisk assemblage (calc-alkaline basalt, andesite, dacite and rhyolite flows and tuffs with intercalated iron formation), 4) Horseshoe assemblage (limestone, chert, wacke and quartz arenite) and, 5) Central Horseshoe assemblage (mafic metavolcanic rocks with interlayered clastic metasedimentary rocks, oxide and sulphide iron formation and limestone). Late-stage deformation in the belt resulted in the development of 4 significant east-trending shear zones (North Boundary, Northern Horseshoe Lake, Southern Horseshoe Lake and Kecheokagan Lake fault zones) which define tectonostratigraphic assemblage boundaries (Jensen 1988).

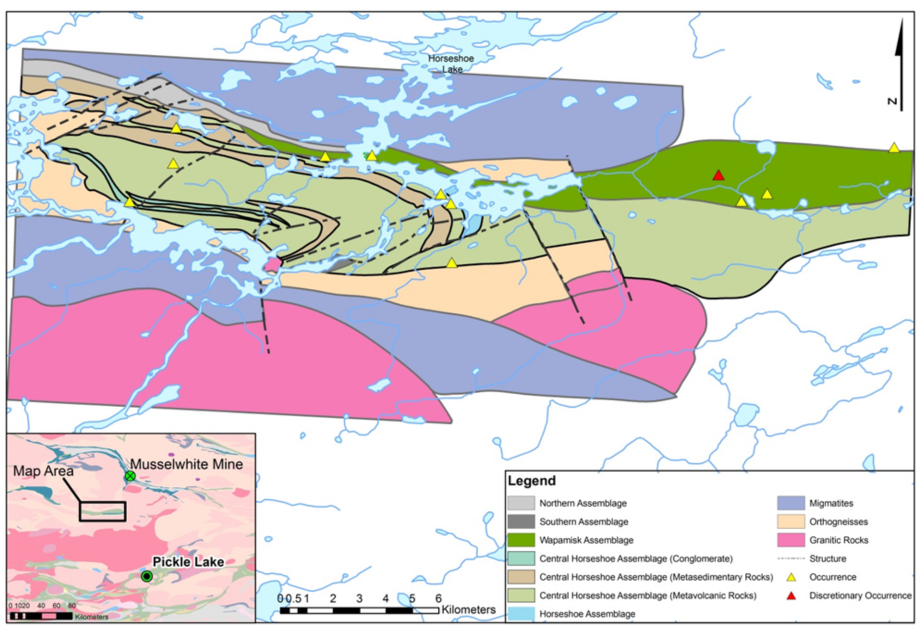

Figure 1: Geological map of the Horseshoe Lake greenstone belt (*modified from* Thurston, Osmani and Stone 1991 and Jensen 1988).

Targeting Iron Formation-Hosted Gold in the Horseshoe Lake Greenstone Belt …cont'd

In June of 2013, staff of the Resident Geologist's Program visited the Horseshoe Lake greenstone belt focussing on the Rust Seep occurrence located along the eastern shore of Horseshoe Lake within the Wapamisk assemblage. A traverse conducted across the stratigraphy of the Wapamisk assemblage revealed a mafic volcanic package interlayered with coarse, clastic sedimentary rocks and iron formation. Mafic volcanic units displayed variable degrees of deformation with deformed outcrops showing evidence of moderate to strong shearing. The majority of mafic metavolcanic rocks displayed moderate to heavy quartz carbonate alteration present as flooding and in fractures. The Rust Seep occurrence (Zone15 U, 649902E, 5787446N) consists of thinly bedded, heavily sulphidized, oxide facies iron formation in contact with highly sheared mafic metavolcanic rocks (cf. Talbot 1996). Localized massive sulphide lenses were present along with disseminated and blebby sulphide patches comprised of pyrite, pyrrhotite and arsenopyrite. Assay results from field efforts in the Horseshoe Lake belt are pending.

The Horseshoe Lake greenstone belt represents an under explored belt that displays favourable conditions for gold mineralization, most notably gold within iron formation. Several historic gold occurrences have been documented in the belt and are summarized in Table 1. Iron formation located at the Rust Seep occurrence hosts known gold mineralization (historical assay of 0.62 g/t Au; Talbot 1996). Additionally, the Rust Seep occurrence lies 1.5 km along strike to the east of the Sulphide Zone occurrence which suggests a significant unit of iron formation with high potential for gold mineralization. Attention should also be paid to large scale folds, faults and shear zones within the belt (cf. Osmani and Stott 1988) which will also assist targeting favourable areas for gold mineralization. At the time this article was drafted (September 2013), there were no claim holdings in the Horseshoe Lake greenstone belt.

Table 1: Additional Mineral Deposit Inventory (MDI) points for gold occurrences in the Horseshoe Lake greenstone belt.

Occurrence / Area (UTM Zone 15; NAD83)	Assemblage / Targets for Exploration
Last Lake Shear Zone (A Anomaly) / Kecheokagan Lake Area (642600E, 5786650N)	Central Horseshoe assemblage / Gold mineralization occurs in a pyrite-mineralized zone of silicified "gabbroic-textured" metavolcanic flows and metasedimentary rocks in close proximity to a northeast-striking structure (Talbot, 1996).
Pipestone River (Dome South Group) / Kecheokagan Lake Area (653418E, 5783778N)	Central Horseshoe assemblage / Gold mineralization occurs within northwest-striking quartz veins located along contacts between "gabbroic-textured" mafic metavolcanics and later intermediate and felsic dykes. The most notable assay result obtained from this assemblage returned 24.26 g/t Au. (Morris, 1975).
Reg Lake Shear Zone / Kecheokagan Lake Area (642600E, 5788000N)	Central Horseshoe assemblage / Sheared mafic metavolcanic rocks containing 2-5% disseminated pyrrhotite and pyrite with numerous felsic dykes or sills. Grab samples results include 760 ppb Au from a sheared mafic metavolcanic rock (Talbot, 1996).
Shear Zone No. 1 (Dome North Group) / Kecheokagan Lake Area (653197E, 5785998N)	Central Horseshoe assemblage / Described as a 3 m wide, rusty, pyritic shear zone striking 055° and hosted within tholeiitic basalts. Mineralization is contained in shear-parallel quartz veins (containing < 5% disseminated pyrite) which parallels a 1.5 m wide quartz feldspar porphyry dyke. The highest grab sample assay result returned 2.49 g/t Au (Sage and Breaks, 1982).
Shear Zone No. 2 (Northwest Gabbro Zone) / Kecheokagan Lake Area (652788E, 5786326N)	Central Horseshoe assemblage / Described as a 1.2 m wide zone of disseminated pyrite (5-10%) comprising a series of 020° -striking en echelon shears within massive, medium-grained "gabbroic-textured" mafic metavolcanics. A grab sample assay returned 3.1 g/t Au (Sage and Breaks, 1982).
Sulphide Zone / Kecheokagan Lake Area (648311E, 5787395N)	Wapamisk assemblage / Described as a massive sulphide horizon up to 7.6 m thick hosted within schistose, chloritic mafic metavolcanic rocks with intercalated dacitic lapilli tuff. The most significant assay includes 1.6 g/t Au over 0.94 m from a diamond drill hole completed by Rio Tinto (Sage and Breaks, 1982).

Targeting Iron Formation-Hosted Gold in the Horseshoe Lake Greenstone Belt …cont'd

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HIGHLIGHTS

- **The discovery of the TBN-complex, in addition to a number of mafic-ultramafic targets confirms the Nipigon Embayment to be a prolific region for Cu-Ni -PGE mineralization**
- **Potential feeder systems which may host Cu-Ni-PGE mineralization may be targeted based on the presence of highly contaminated sills, in conjunction with the intersection of major structures.**

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Targeting Contamination Centres and Structure in Search of Midcontinent Rift-Related Conduit-Hosted Ni-Cu-PGE Deposits

The Midcontinent Rift (MCR) is a 1.1 billion year old Large Igneous Province which produced voluminous magma in the form of dykes, sills and volcanic flows around the Lake Superior and Lake Nipigon areas. The Nipigon Embayment comprises the area around Lake Nipigon underlain by Mesoproterozoic rocks. It has been the focus of considerable exploration activity for nickel-copper-PGE mineralization over the past several years. Positive results include the recent discovery of the Thunder Bay North (TBN) igneous complex (Heggie et al., 2012), located southwest of Lake Nipigon, 50 km northeast of Thunder Bay. The TBN complex comprises a series of layered intrusions, dykes, sills and chonoliths emplaced early in MCR history with mineralization characterized by massive, semi-massive and disseminated sulphides (Miller et al. 2010; Heggie et al. 2012). In addition to the TBN complex, several mafic-ultramafic intrusions (Seagull, Disraeli, Hele, Eva-Kitto) have been the target of much exploration activity. These mafic-ultramafic intrusions are interpreted to have been intruded along lithospheric-scale fault intersections allowing for the tapping of deeply-sourced, primitive magma (Hart and MacDonald 2007). Pre-existing Archean structures have been shown to have had considerable influence on the development of early MCR structures and subsequently, the emplacement of mafic-ultramafic intrusions, including the TBN complex (Hollings et al. 2010; Heggie et al. 2012). Major structures within the Nipigon Embayment including the surrounding and underlying Archean, Wabigoon and Quetico subprovinces as outlined in Hart and MacDonald (2007), are shown in Figure 1.

Chonolith systems are widely interpreted to be the plumbing or feeder systems for overlying volcanic flows or intrusive sills (e.g. Noril'sk,Russia) and are desirable targets for nickel-copper-PGE deposits. Recent evaluation of a large geochemical data set for intrusive rocks associated with the MCR has revealed subtle variations within the Nipigon sills that may serve as an exploration targeting tool in search of the feeder systems to the sill complex (Cundari 2012). This investigation revealed three distinct Nipigon sill types based on Th/Ybpm ratios and εNd(t=1100Ma) values:

- Nipigon type I sill (Th/Ybpm = 1.97 to 3.4; εNd(t=1100Ma) = -0.5 to -1.5);
- Nipigon type II sill (Th/Ybpm = 3.4 to 5.0; εNd(t=1100Ma) = -1.5 to -3.0); and
- Nipigon type III sill (Th/Ybpm = 5.0 to 6.5; εNd(t=1100Ma) = -5.0 to -7.0).

Nipigon sill type I represents the least-contaminated suite; type II represents sills that display moderate contamination and type III represents the most-contaminated sills. The more-contaminated nature of Nipigon sill types II and III are interpreted to be due to magma having undergone more interaction with the country rocks. More-contaminated sills are distributed in clusters which can be termed contamination foci/centres. The two lines of evidence outlined above may serve as exploration tools in the search for desirable target rocks which may host nickel-copper-PGE mineralization. The most significant contamination and subsequent sulphide-saturation of a magma suitable for generation of a nickel-copper-PGE deposit is likely to take place in staging chamber below the near-surface conduit or feeder.

Targeting Contamination Centres and Structure in Search of Midcontinent Rift-Related Conduit-Hosted Ni-Cu-PGE Deposits …cont'd

Sulphide droplets then scavenge metals from the chamber and concentrate in conduits or feeders during emplacement (i.e. Voisey's Bay, Noril'sk) (*further reading* http://pubs.usgs.gov/info/mwni_cu/). Contamination centres within the Nipigon Embayment may serve as targets for the discovery of feeder systems to the sills, as more-contaminated sills are likely to be located proximal to feeder zones. Potential feeder systems may be targeted based on the presence of highly contaminated sills, in conjunction with the intersection of major structures. Figure X outlines areas that remain unstaked in the Lake Nipigon region which satisfy one or both of the criteria described here. Caution should be taken with these criteria as the data gathered and presented here were based on the re-evaluation of an existing data set. Locating feeder systems can be difficult as overlying Nipigon sills and Quaternary sediments may inhibit remote sensing techniques and conceal desirable mafic-ultramafic host rocks.

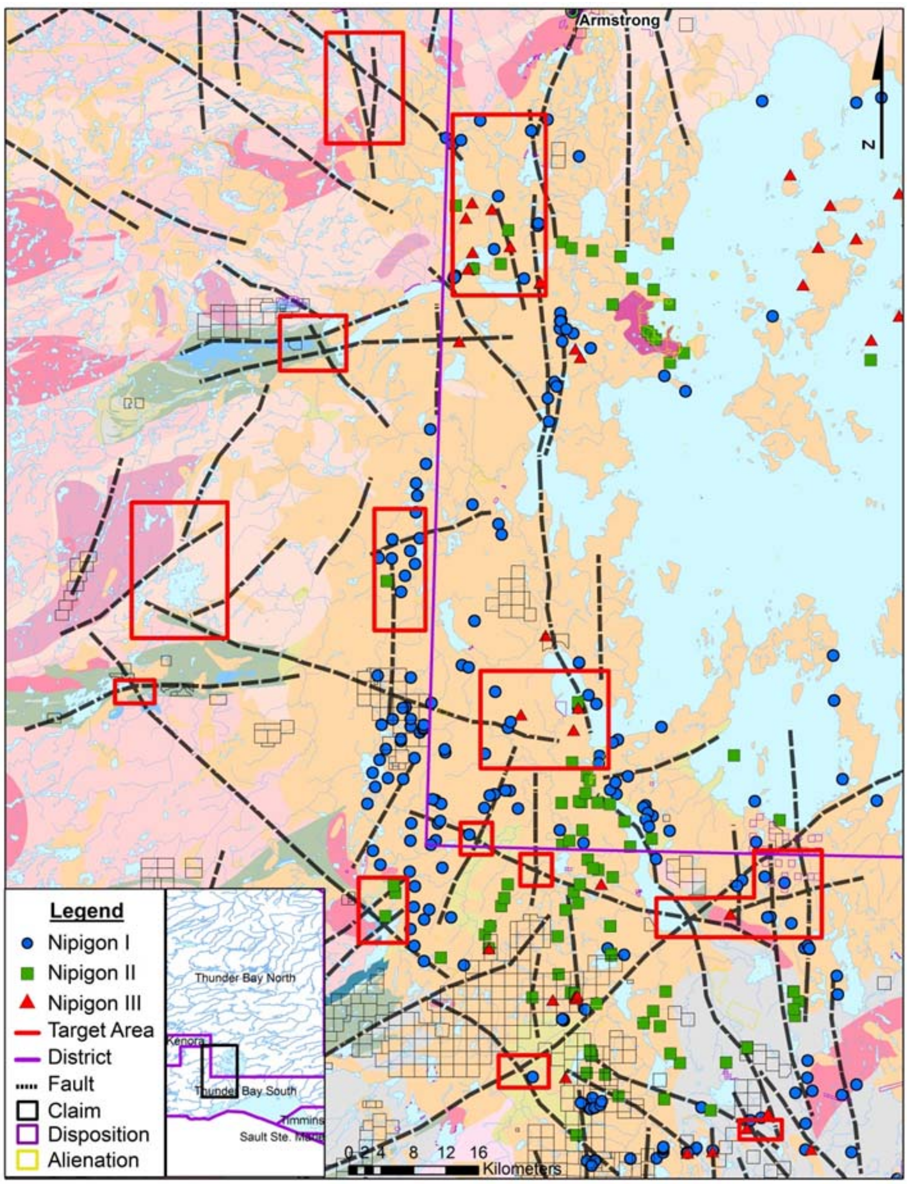

Figure 1. Map of the Nipigon Embayment showing Nipigon sill types I, II and III defined by Th/Yb--$_{pm}$ values. Bedrock Geology *from* Ontario Geological Survey (2006). Major faults after Hart and MacDonald (2007). Active mining claims as of September 3, 2013.

Targeting Contamination Centres and Structure in Search of Midcontinent Rift-Related Conduit-Hosted Ni-Cu-PGE Deposits …cont'd

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HIGHLIGHTS

- **World-wide, pegmatites are known to host a number of economic commodities such as Li, Ta, Sn, Ru, Ce and ceramic grade feldspar and quartz**
- **NW Ontario, particularly the Kenora District, contains numerous rare-metal-bearing granite pegmatites**

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Rare-Metal Potential in the Kenora District

Background

Granite-pegmatite systems can contain a varied range of rare-element enrichments. Pegmatite can be assigned to families based on patterns of these enrichments. The family of pegmatite named NYF is characterized by high concentrations of Nb, Y, and F, and can be enriched with rare-earth elements including Th and U. The rare-earths are a group of metallic elements consisting of the lanthanide series and commonly include yttrium. LCT pegmatites, which are enriched in Li, Cs, Ta can host economic concentrations of rare-elements commonly referred to as rare-metals. The rare-metals are also metallic elements and commonly include lithium (Li), cesium (Ce), rubidium (Rb), tantalum (Ta), beryllium (Be), gallium (Ga), germanium (Ga), hafnium (Hf), indium (In), niobium (Nb), tin (Sn) and zirconium (Zr) (Linnen and Cuney 2005). This recommendation focuses on granite-pegmatite systems which are associated with rare-metal mineralization.

Regional Geological Setting

Granite-pegmatite systems related to economic concentrations of rare-metals are typically found along large-scale regional faults which are often associated with subprovince boundaries and are commonly situated adjacent to metasedimentary rocks (Selway and Breaks 2005). Figure 1 illustrates location of subprovinces and different types of rare-metal granite pegmatites in Northern Ontario. Pegmatites which host concentrations of rare-metals are typically located in rocks adjacent to a fertile felsic intrusive body. Breaks, Selway, and Tindle (2005) state "the Superior Province of Ontario contains 210 rare-element mineral occurrences that are hosted by the following: mafic metavolcanics rocks (52%), clastic metasedimentary rocks (23%), peraluminous granite plutons (20%) and tonalite-granodiorite rocks (5%).

Figure 1. Locations of rare-metal occurrences in northern Ontario (Breaks, Selway, and Tindle 2005).

Rare-Metal Potential in the Kenora District …cont'd

Geological setting

Galeschuk and Vanstone (2005) state Figure 2 "… illustrates a model of pegmatite emplacement in concentric zones or shells about a source pegmatite granite. The poorly evolved, simple beryl bearing pegmatites occur closest to the source, whereas the complex lithium-tantalum bearing pegmatite furthest from the source … The shape of this zonation will be dependant upon the structural conduits and traps available to the migrating pegmatite melt … and may be modified by post -emplacement structural deformation."

Fertile Granite

Fertile granites are late to post tectonic, usually isolated, felsic intrusive units. Breaks, Selway and Tindle (2003) provide a summary of the emplacement, characteristics, rock types, and geochemical evolution of fertile granites. A fertile granite, enriched in rare-metals, is a peraluminous, quartz-rich granite created by the partial melting of pre-existing sedimentary rocks. Based on their bulk whole rock chemistry, igneous rocks are classed as peraluminous (literally "excess alumina") when Al_2O_3>(CaO+Na_2O+K_2O) (Richardson and Birkett 1996). Selway and Breaks (2005) provide a summary of suggested exploration techniques to identify a fertile felsic intrusion. A felsic intrusive body is considered enriched if the rare-metal contents are at least three times that of average continental crust (Selway and Breaks 2005). Table 1 presents the average upper continental crust rare-metal values and also compares these elements corresponding to the average values from the Separation Rapids Pegmatite Group fertile granite.

Table 1. Average rare-metal values (ppm) for upper continental crust and Separation Rapids fertile granite (*modified* from Selway and Breaks 2005).

Element	Continental Crust	Separation Rapids Pluton
Be	3.0	6
Cs	3.7	48
Li	20.0	235
Nb	25.0	66
Rb	112.0	890
Sn	5.5	62
Ta	2.2	19

Rare-metal Pegmatite

Pegmatites which host economic concentrations of rare-metals are derived from a fertile parent granite. Rare-elements (Li, Cs, Rb, Ta, Nb, Sn, F, B, Be, Tl and Ge) typically associated with rare-metal enriched pegmatite are distributed over an area of 10 to 20 km^2 within a 10 km radius of the fertile granite (Figure 7). The pegmatite with the greatest economic potential is often situated distal to the parent granite (Selway and Breaks 2005). There are numerous rare-metal-bearing minerals associated with pegmatite, Table 2 provides a list of the common rare-metal ore minerals.

Rare-Metal Potential in the Kenora District …cont'd

Table 2. Common rare-metal ore minerals hosted in pegmatite (modified from Selway and Breaks 2005).

Symbol	Element	Ore Minerals
Be	Berylium	Beryl
Cs	Cesium	Pollucite
Li	Lithium	Petalite, spodumene, lepidolite, amblygonite
Nb	Niobium	Columbite-tantalite, pyrochlore
Rb	Rubidium	Potassium-feldspar, muscovite (Li-mica)
Sn	Tin	Cassiterite
Ta	Tantalum	Columbite-tantalite, rutile, wodginite

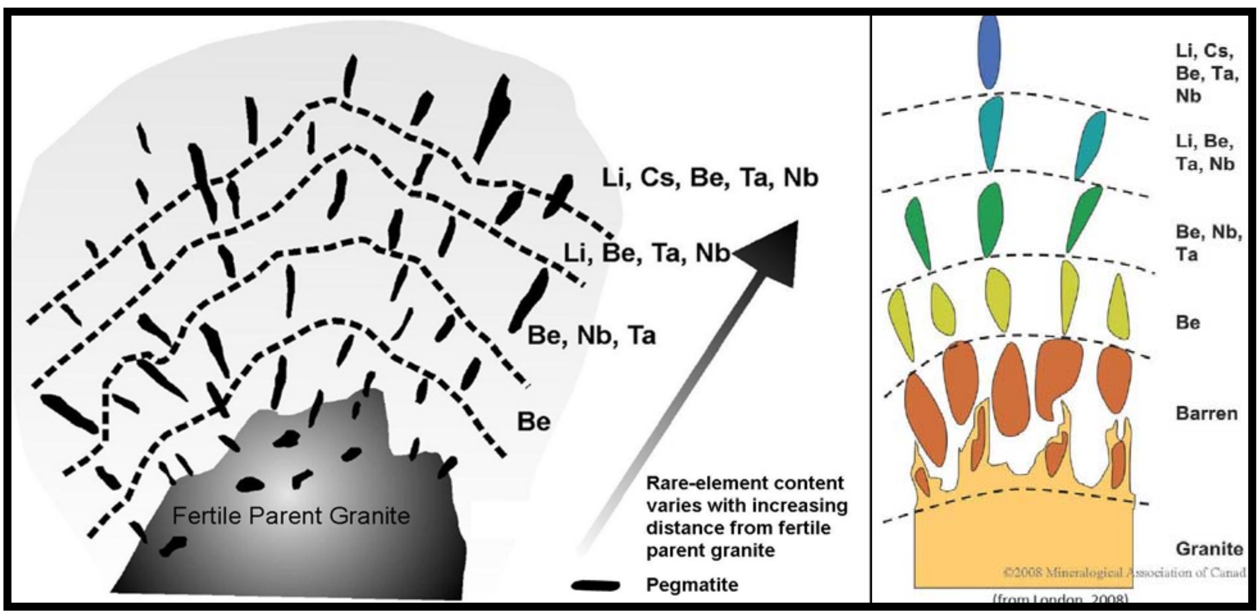

Figure 2. Rare-metal mineralization and pegmatite related to fertile parent granite (modified from Selway and Breaks 2005).

Exploration Techniques

Often the fertile granite is buried; the only surface expression associated with these intrusive rocks is the rare-metal bearing pegmatites themselves. Rare-metal pegmatites are non-magnetic and contain insufficient metallic minerals to be conductive; they typically don't contain radiometric minerals and may not have a sufficient density to mass ratio to allow for differentiation from the host rocks utilizing gravity surveys (Galeschuck and Vanstone 2005). Survey techniques often used in metallic mineral exploration will typically not be useful in the search for fertile granites and pegmatites.

The emplacement of pegmatite is accompanied by the alteration and development of a rare-metal enriched aureole within the adjacent host rocks. Galeschuk and Vanstone (2005) state: "… the best elements with respect to aureole thickness and intensity are Li, Cs, B, Sn, Be and Rb with the latter element forming smaller, less intense aureoles". This mobility of elements associated with pegmatite emplacement can be a valuable asset when developing an exploration program. Selway and Breaks (2005) and Galeschuk and Vanstone (2005) provide summaries of the use of lithogeochemistry as a detection method to define buried pegmatite.

Rare-Metal Potential in the Kenora District …cont'd

Geological mapping, structural studies, lithogeochemical sampling, testing B-horizon soil samples utilizing the Enzyme Leach[SM] analytical technique, and biogeochemistry are some exploration techniques that have been applied to evaluate the rare-metal potential of an area. Galeschuk and Vanstone (2005) provide summaries and comparisons of several of these exploration techniques, which were applied during exploration programs that targeted the potential of buried rare-metal pegmatite bodies near the Tanco Li-Cs-Rb-Ta Deposit. Galeschuk and Vanstone (2005) concluded that the "… use of lithogeochemical surveys as a primary exploration tool in the search for buried rare-element pegmatite has resulted in the documentation of number of lithogeochemical anomalies that remain unexplained after drill testing". Based on this study Galeschuk and Vanstone (2005) concluded:

> Tanco has moved away from lithogeochemistry and is placing increasing emphasis on soil geochemistry and the Enzyme Leach[SM] method as its primary exploration tool. The geochemistry is used in conjunction with geological and structural mapping in an integrated exploration approach.

Recommendation

Granite-pegmatite systems associated with known rare-metal occurrences in the Kenora District are located near the Winnipeg River subprovince boundary, adjacent to metasedimentary rocks, and commonly hosted by supracrustal rocks (Figure 3). A regional approach to identify additional peraluminous felsic intrusions, fertile granites and mineralized pegmatites would examine the geological settings associated with typical emplacement of rare-metal granite-pegmatite systems. Unexplored areas situated adjacent to known rare-metal occurrences illustrated in Figure 3 are prime locations to identify additional pegmatite. Breaks, Selway and Tindle (2003, 2005) provide useful summaries of the geological settings, petrology, rock types and rare-metal mineralization related to these pegmatite cluster areas. These occurrences are commonly identified from the analytical results of lithogeochemical samples collected from exposed pegmatite during government geoscience studies and mineral exploration activities. The exploration techniques discussed previously should be applied in these areas to target additional mineralized pegmatites.

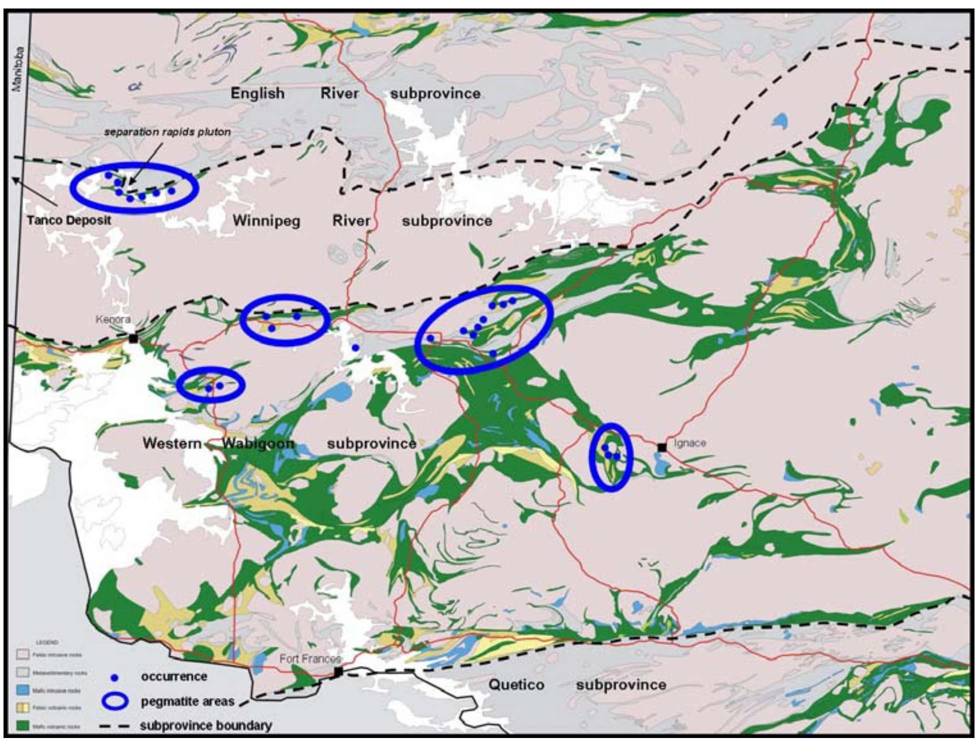

Figure 3. Subprovince boundaries, metasedimentary rocks and location of rare-metal occurrences in the Kenora District (modified from OGS 2003).

Rare-Metal Potential in the Kenora District …cont'd

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HIGHLIGHTS

- **Graphite is a commodity that is undergoing an exploration resurgence (e.g., Zenyatta Ventures Ltd. Albany Project)**
- **Historically graphite has been reported from the English River Metasedimentary rocks**

Graphite in the English River Metasedimentary Rocks

The southern part of the Red Lake Resident Geologist District and the northern part of the Kenora Resident Geologist District are underlain by rocks of the English River subprovince. Reconnaissance scale mapping by Breaks et al. (1975) indicates these comprise highly metamorphosed migmatitic clastic metasedimentary rocks and extensive granitoid intrusive rocks. Some of the metasedimentary rocks contain disseminated graphite flakes. In the past there has been limited exploration directed at flake graphite in the Treelined Lake Area just south of the Red Lake Resident Geologist District boundary (Blackburn et al. 1989).

The Treelined Lake Graphite occurrence (MDI52L08SW00004) also known as the Harrison South occurrence, has been described by Kennedy and Sherlock (1989), Storey (1990), Redden (1993), Hinz and Landry (1994) and Blackburn and Young (2000). The graphitic units are part of an extensive area of migmatitic metasedimentary rocks that extend east-northeast from Treelined Lake into the southern part of the Red Lake district towards Ear Falls. Their mineralogy is biotite-quartz-feldspar with accessory garnet, graphite, pyrite, pyrrhotite and possibly other sulphide minerals. Graphite mineralization has been traced over 2500 metres to the east of the main showing. Assay results by Bellwether Resources Ltd. (quoted in Hinz and Landry 1994) indicate graphite content up to 6.94%. Flake size was not specified, but Storey (1990) made an estimate of flake size from 0.1 to 2 mm with most in the 1mm size range. Blackburn and Young (2000) mapped the immediate area of the Treelined Lake graphite occurence as feldspar-quartz-biotite garnet schist migmatite with up to 45% mobilizate content. Additional graphitic outcrops are noted to the east of the described showing but the map area ends just east of Helder Lake. Figure 1 shows the location of the Treelined Lake graphite occurrence and the metasedimentary rock units that strike into the Red Lake District. Lack of detailed mapping further to the northeast of Helder Lake prevents defining a definite extended graphite rich horizon. The east-northeast striking metasedimentary rocks represent an exploration target for flake graphite that may extend well into the Red Lake Resident Geologist District.

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Graphite in the English River Metasedimentary Rocks …cont'd

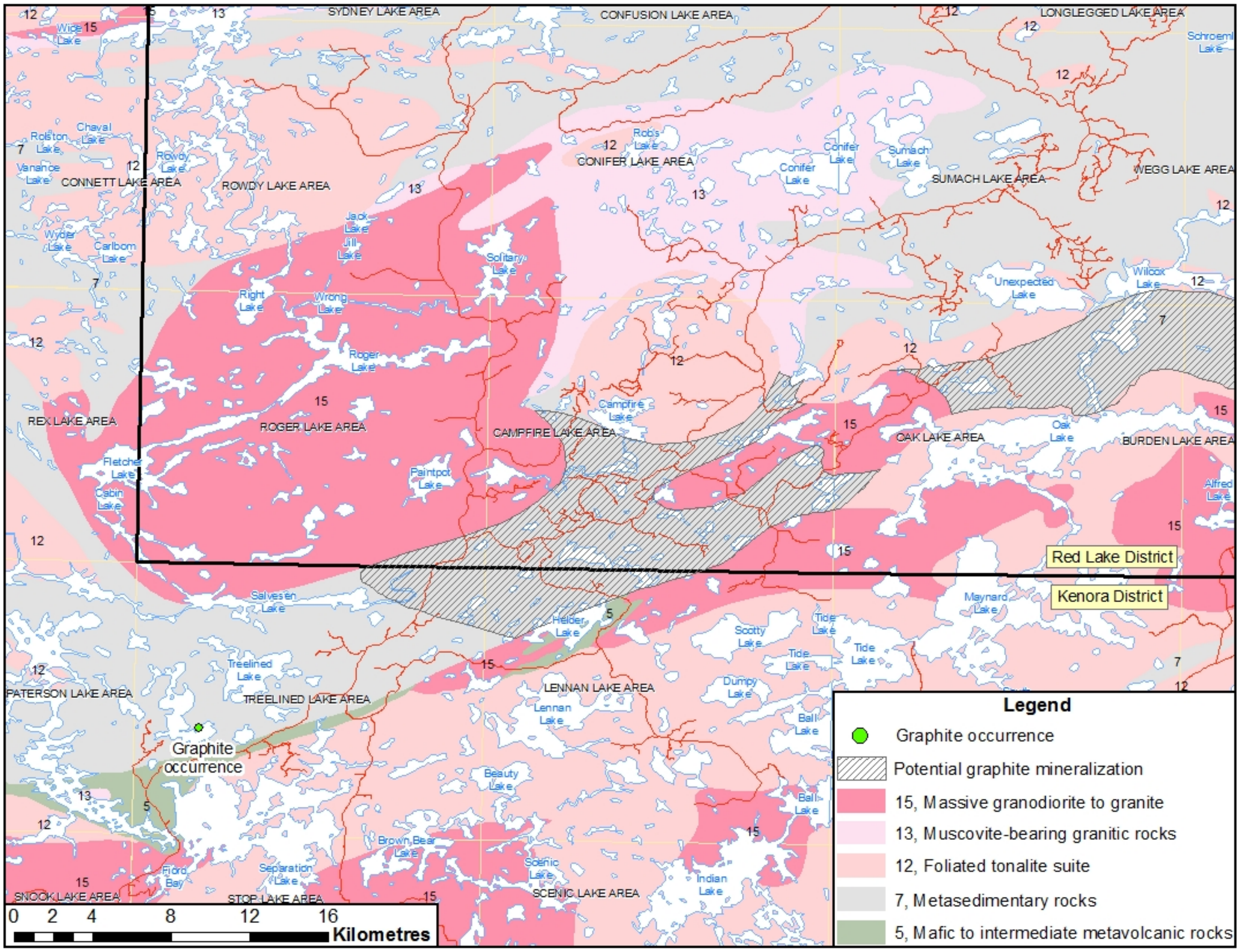

Figure 1. Graphite in the English River metasedimentary rocks. The map shows extensive high metamorphic grade metasedimentary rocks (coloured grey) striking east-northeast into the Red Lake district. Geology from MRD 126-Revision 1.

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