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Ontario Geological Survey
Open File Report 6329

Report of Activities, 2016 Resident Geologist Program

Southern Ontario Regional Resident Geologist Report: Southeastern Ontario and Southwestern Ontario Districts and Petroleum Operations

2017

Ontario

ONTARIO GEOLOGICAL SURVEY

Open File Report 6329

Report of Activities, 2016
Resident Geologist Program

Southern Ontario Regional Resident Geologist Report:
Southeastern and Southwestern Ontario Districts and Petroleum Operations

by

A.C. Tessier, P.S. LeBaron, S.J. Charbonneau, D.A. Laidlaw, A.C. Wilson and
L. Fortner

2017

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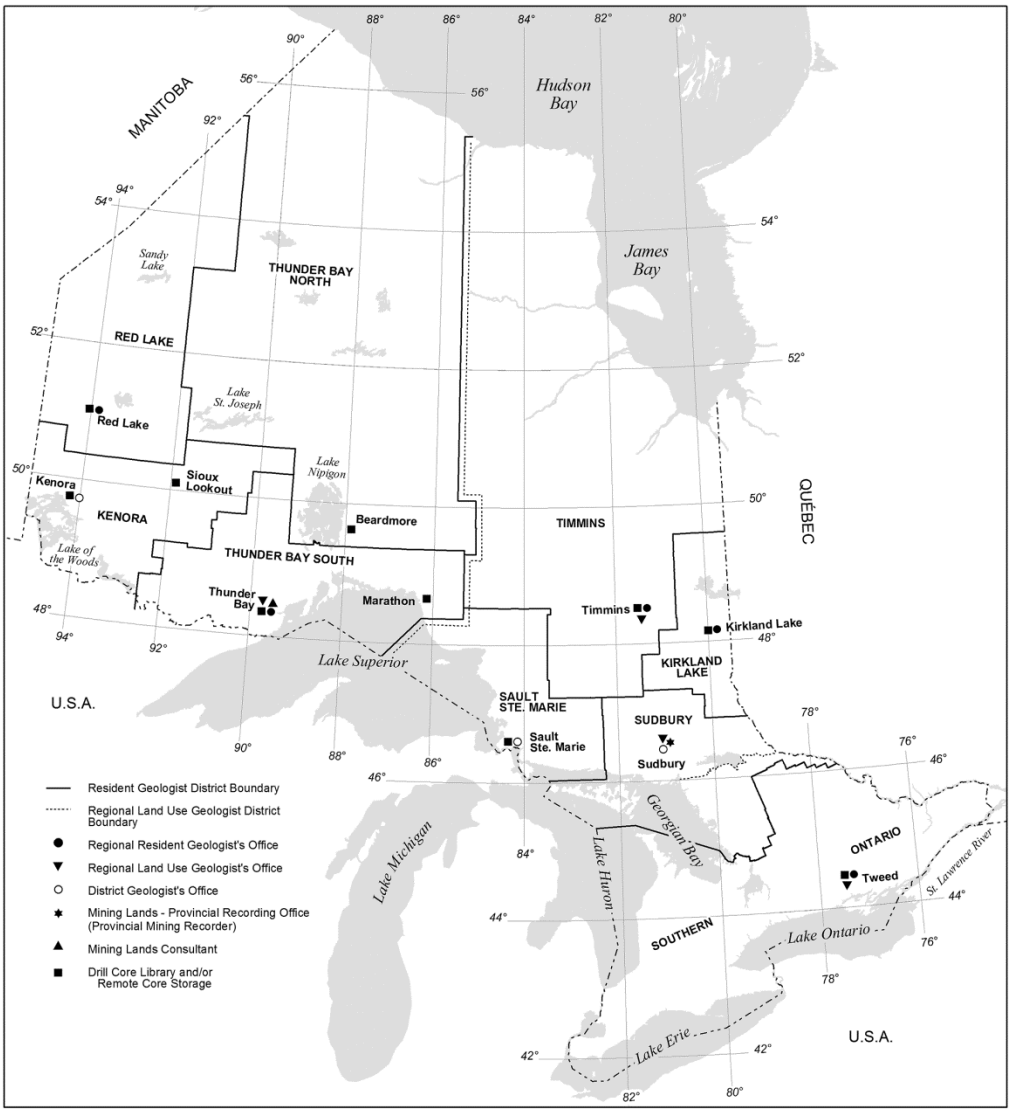

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ONTARIO GEOLOGICAL SURVEY

RESIDENT GEOLOGIST PROGRAM

REPORT OF ACTIVITIES—2016

SOUTHERN ONTARIO
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Southern Ontario Regional Resident Geologist (Southeastern Ontario and Southwestern Ontario Districts)—2016

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INTRODUCTION

The Southern Ontario Region encompasses the most populous part of the province and the country, and includes both the provincial and national capitals. The Region stretches over 800 km and is bordered by the Canada–United States border in the west and the southeast, through the southern Great Lakes (lakes Huron, Erie and Ontario) and along the St. Lawrence River. To the east and northeast, the Region is bordered by the provincial border between Ontario and Quebec. The northern boundary of the Region cuts through Georgian Bay striking eastward north of Lake Simcoe, including Algonquin Park and neighbouring townships.

Geologically, Paleozoic sedimentary rocks cover the southern and parts of the easternmost portions of the Region, whereas the metamorphic Grenvillian rocks of the Central Metasedimentary Belt and Central Gneiss Belt occupy the northern and parts of the eastern portions. Consequently, the Region hosts some of the most diverse and productive geology in the province of Ontario.

Production from mines and quarries continued throughout southern Ontario within both the Grenville Province metamorphic terrane and in the Paleozoic sedimentary rocks of the Region. With the exception of salt mining and brine field operations in Goderich and Windsor, and the Hagersville Gypsum Mine, all mining operations within the Paleozoic sedimentary rocks are for commodities the development of which is designated under the *Aggregate Resources Act* administered by the Ministry of Natural Resources and Forestry. Nevertheless, these operations are covered within this Report of Activities.

In 2016, a total of 155 claims, covering 14263.80 ha, were recorded in Southern Ontario. Compared to the previous year, 30 fewer claims were recorded in 2016, but the area covered by these 155 claims has increased by 13% compared to the claims staked in 2015. Figure 3 shows the claim staking activity for southern Ontario in 2016. Claim staking in subdivided townships, in the Southern Ontario Mining Division follows a map-staking system introduced in 2011. Both map staking and ground staking are scheduled to be replaced by a province-wide, online staking system early in 2018, if legislation regarding Mining Act Modernization is passed early in 2017.

Tables 11 through 19 provide details on currently inactive mineral deposits with identified resources and past-producing mineral occurrences. Please note that, unless otherwise stated, the information about resources presented in these tables and elsewhere in this report refer to historic resources only and are not compliant with National Instrument (NI) 43-101.

The authors note that all Web addresses referenced were accessed in December 2016, unless otherwise noted.

In addition, Universal Transverse Mercator (UTM) co-ordinates are provided in Zone 18, using North American Datum 1983 (NAD83), unless stated otherwise.

MINING ACTIVITY

During 2016, there were 93 mineral extraction operations in southern Ontario, including 9 industrial mineral operations, 4 trap rock producers, 7 cement producer's quarries, 6 brick producer's quarries, 3 gemstone and mineral specimen sites, and 64 dimension-stone quarries. All Ontario production of salt, gypsum (for wallboard), natural gas and petroleum, shale (for brick), lime/dolime, cement, nepheline, high-purity ground calcium carbonate, and the majority of dimension stone, sand and gravel come from the Southern Ontario Region.

For a complete listing of mining activity and locations of operating mines and mills in southern Ontario, please refer to Tables 1 and 2 and Figures 1 and 2. There are also many limestone aggregate quarries in operation that are too numerous to include in the list of mining activity.

An estimated 5000 people were directly employed in mineral extraction and on-site processing plants in southern Ontario in 2016. These numbers do not take into account the indirect jobs created by the mineral industry. In 2016, Ontario's non-metallic mineral production was valued at $3.0 billion—representing 29% of the total value of mineral production in the province. Five of the top 10 commodities produced in 2016 were non-metallic minerals and most of this production came from southern Ontario mines and quarries. Nearly 25% of Ontario's mineral wealth came from southern Ontario.

Wollastonite

CANADIAN WOLLASTONITE – ST. LAWRENCE DEPOSIT

Canadian Wollastonite (www.canadianwollastonite.com) is a privately held company incorporated in Ontario in 2001. The company owns just over 110 ha encompassing a large portion of the St. Lawrence wollastonite deposit north of Kingston near the community of Seeley's Bay. The Closure Plan was accepted in December 2012 by the Ministry of Northern Development and Mines and Canadian Wollastonite began production in 2013. The mine has been in continuous operation since.

Since production began, the company won approval for use of its primary ancillary ore—orthogneiss—as a Superpave™ aggregate in highway road construction. The deposit is the southernmost approved source of Superpave™ aggregates in the Province of Ontario and is well situated to supply the eastern Ontario market. In 2016, the mine's orthogneiss was also approved for use as Class 1 and 2 railway ballast.

So far, the wollastonite ore produced at the St. Lawrence Mine is used in the metallurgical, agricultural and environmental sectors. In 2014, the company introduced wollastonite (calcium silicate) and diopside (calcium magnesium silicate) product into the local Ontario horticultural market, as well as into the northeastern United States as a single source of calcium, magnesium and silica. Wollastonite and diopside have the advantage of producing sources of these 3 elements, which are important elements to plant health and disease resistance, without the introduction of carbon dioxide (CO_2) into the atmosphere.

In 2016, the company also began multiple research projects using wollastonite as a means to sequester phosphorus and heavy metals in tertiary water systems, municipal water treatment, municipal storm water management, and in multiple industrial applications. Based on preliminary results, the company expects all of these to become major new markets for wollastonite.

Canadian Wollastonite plans to construct a beneficiation plant on its property to begin processing high-grade wollastonite and diopside products. Pilot plant testing of the company's revised flow process will be conducted in the second quarter of 2017 (B. Vasily, Canadian Wollastonite, personal communication, January 2017).

Nepheline Syenite

UNIMIN CANADA – NEPHTON AND BLUE MOUNTAIN MINES

Unimin Canada Ltd. (www.unimin.com/; www.canadiannepheline.ca/) is a subsidiary of privately owned, Belgium-based giant Sibelco. Nepheline has been mined in the Havelock area for 80 years, with the Nephton Mine beginning in 1935 and the Blue Mountain operations in 1955. Unimin purchased the site in 1989 and has mined there ever since. The site employs approximately 200 people (R. Marshall, Unimin Canada Ltd., personal communication, December 2015).

Nepheline is used in the production of glass, ceramics, paint, fillers, insulation, abrasives and adhesives. In the glass and ceramics industry, it is used to lower the melting temperature, prompting faster melting, thus saving energy, extending the life of furnaces and reducing emissions. It also increases the quality and toughness of the glass, making it more resistant to breakage.

In paints, nepheline reduces the need for volatile organic compounds (VOCs) and accounts for nearly one third of the weight of the final product.

Unimin is at the permitting stage for the expansion and modernization of the Blue Mountain operations and closure of the Nephton operations. Unimin expects that permitting (including First Nations, public and stakeholder consultation) will be completed in 2017. Unimin conducted pre-consultation meetings with First Nations and regulators to facilitate the permit review process. Construction will take approximately 2 years. The Nephton operations will be decommissioned shortly after a successful startup of the modernization project. Power restrictions prohibit both facilities to operate concurrently.

In 2016, the mine produced approximately 640 000 short tons of nepheline products with a recovery of approximately 75%. Mine reserves are expected to last at least 25 years (R. Marshall, Unimin Canada Plant Manager, personal communication, December 2016).

Salt

Salt production began in Ontario in 1866. There are extensive beds of rock salt found in the Silurian Salina Group (formerly Formation) rocks in parts of southwestern Ontario, west of London. Although there were numerous historic producers in southwestern Ontario, only a few produced more than 100 000 tonnes of salt from brine well operations.

Salt is the only Ontario mineral commodity for which the market and production are directly controlled by weather. Salt for de-icing is extracted from underground as warranted by the market demand.

Provincial and municipal governments are the main market for de-icing salt. The Ministry of Transportation reports that its salt usage varies from 500 000 to 600 000 tons of salt annually, depending on winter weather conditions.

In 2016, Ontario produced an estimated 6.1 million tonnes of salt valued at an estimated $331 million, representing 60% of the total salt production in Canada. Salt remains one of the top 10 minerals produced in Ontario by value of production.

Sifto Canada Corporation and K+S Windsor Salt Ltd. each operate underground mines, brine fields operations and evaporation plants in Goderich and Windsor, respectively. Rock salt from the underground mines is used mostly for road de-icing, feedstock and in industry, where it is used in making a wide variety of products including chemicals, plastics and glass. Food-grade and chemical-grade salt are produced from the brine and evaporation operations.

SIFTO CANADA CORP. – GODERICH MINE AND EVAPORATION PLANT

Sifto Canada Corporation (www.siftocanada.com) is a subsidiary of the United States listed public company Compass Minerals (www.compassminerals.com), which trades on the New York Stock Exchange under the symbol CMP.

Sifto Canada employs 490 people at its Goderich facilities. The Goderich Mine is the largest underground salt mine in the world. It has been in operation for more than 50 years, having produced 150 million tonnes of salt and has defined resources for an additional 120 years of production. The mine produces about 23 000 tons of salt per day. About 80% of production is used as road salt, with the remainder trucked to the plant for refining into water softener or bagging as sidewalk salt. In 2014, the company began a three-year, $150 million project to re-line the mine shaft walls in the 600 m deep mine.

K+S WINDSOR SALT LIMITED – OJIBWAY MINE AND EVAPORATION PLANT

K+S Windsor Salt Limited (www.windsorsalt.com) is a subsidiary of Chicago-based Morton Salt (www.mortonsalt.com), which, in turn, is a subsidiary of K+S AG (www.k-plus-s.com), a global chemical company based in Germany and publicly traded on the Frankfurt Stock Exchange under the symbol SDF.

K+S Windsor Salt is the largest salt producer in Canada and extracts both rock salt from its underground Ojibway Mine and vacuum salt from its nearby brine evaporation plant in Windsor. The Ojibway Mine employs 225 people and the brine evaporation plant employs another 95.

In 2016, the Ojibway Mine produced approximately 2.5 million tons of salt. In July 2016, Windsor announced a $60 million expansion plan to deepen the mine another 400 feet and extend the mine life another 47 years to 2063 (www.windsorsalt.com/news/).

Another 200 000 to 250 000 tons of salt were produced in 2016 at the Windsor evaporation plant where reserves are sufficient for 20 or more years.

Brick and Shale

In 2016, there were 3 companies operating clay brick or tile plants and a total of 6 shale quarries in southwestern Ontario, all of which extract Queenston Formation shale as raw material. The total value of clay products manufactured in Ontario in 2016 was $128 million.

Meridian Brick Ltd. (www.meridianbrick.com) was created in January 2017, through a joint venture between Boral Bricks and Forterra Brick Ltd., which purchased the operations of Hanson Brick Ltd. in 2015. The new company will continue to operate 3 brick plants in Burlington and 1 plant in Aldershot, with shale quarries located at Niagara-on-the-Lake, Burlington and Aldershot. Meridian will become North America's largest brick manufacturer with a total capacity of more than 2.6 billion brick units per year. Of that total, 415 million units or approximately 16% are produced in Ontario. The company employs 130 people at its Ontario facilities.

Brampton Brick Ltd. (www.bramptonbrick.com) operates North America's single largest clay brick plant in Brampton, with production capacity of 300 million units per year. About 300 000 tonnes of Queenston Formation shale are extracted annually from the Cheltenham quarry for the plant, which employs 75 people.

In December 2008, the company applied for re-zoning in order to open a shale quarry at Norval, about 10 km west of Brampton. In 2002, the "Northwest Brampton Shale Resources Review", initiated by the City of Brampton, recommended to reduce the area designated as the Norval Deposit of Queenston Shale from 1377 to 180 ha. Brampton Brick purchased a 35 ha portion of the deposit and proposed to create an excavation area of 9.35 ha. The proposed extraction rate was 200 000 tonnes per year and total yield was projected to be 5.8 million tonnes. In addition to providing security of shale supply for the Brampton plant, the Norval shale contains lower amounts of chlorides and sulphates than the Cheltenham shale. The company proposes to blend the 2 shales to produce a new product line of buff-burning bricks. The municipality of Brampton denied the re-zoning application in 2014 and, in 2016, the company submitted revised plans for the Norval Quarry and held a public information meeting (City of Brampton, "Norval Quarry Re-Zoning Application", www.brampton.ca, accessed January 30, 2017).

The company reported that revenues for the first 9 months of 2016 grew by 12% to $106.3 million, from $94.7 million for the same period in 2015. The increase represents growth in shipments in both the masonry products and landscape products business segments, primarily as a result of weather conditions favourable for construction, and a strong housing market in Canada (Brampton Brick Limited, 2016 Third Quarter Report, www.bramptonbrick.com, accessed January 28, 2017).

Jazbrick, a Canadian company with its head office in Rexdale, operates the Century Brick Ltd. plant in Hamilton and the Rexdale Brick plant in Rexdale. Shale for the brick operations is quarried by Limehouse Clay Products Ltd. at the Halton Hills quarry near Georgetown.

Paisley Brick and Tile Co. Ltd. closed its brick operation in 2016 after 124 years of production. The company previously quarried shale from the Hungry Hollow quarry (owned by Brampton Brick) in Williams Township for its plant in the village of Paisley. The operation employed 14 people.

Cement

There are 7 quarries and 6 modern processing plants in southern Ontario between Kingston in the southeast and St. Marys in the southwest. With the exception of Federal White Cement, which purchases its limestone from nearby quarries, all plants are also operating quarries on site. Production figures for 2016 show a cement production in southern Ontario of 5.4 million tonnes, valued at $645 million.

With the exception of Federal White Cement, each company has port facilities for Great Lakes shipping. The Bath, Picton, Bowmanville and Mississauga plants export significant production to the United States. Combined, the companies have 11 cement kilns with a total clinker production capacity of over 7.5 million tonnes per year.

ST. MARYS CEMENT CANADA INC. – ST. MARYS AND BOWMANVILLE

St. Marys Cement Inc. (www.stmaryscement.com) is a subsidiary of Votorantim Cimentos (www.votorantimcimentos.com), which is part of the Votorantim Group, a privately held and one of the largest industrial conglomerates in Latin America. St. Marys Cement operates limestone quarries and cement plants at Bowmanville and St. Marys. The company employs a total of 245 people at its Ontario facilities. In 2016, the company continued development of a proposal to evaluate the potential of the underground mining of high-quality aggregates from beneath the Bowmanville quarry and the bed of Lake Ontario. The process is at the public consultation and environmental impact study stage.

LAFARGE CANADA INC. – BATH

Lafarge Canada Inc. (www.lafarge-na.com) is a subsidiary of Lafarge North America and is, in turn, a subsidiary of LafargeHolcim (www.lafargeholcim.com), an international manufacturer of building materials based in Switzerland, which trades on the Swiss Exchange under the symbol SIX. Lafarge operates a cement plant in Bath, near Kingston, where they employ approximately 117 people and produce 1.1 million tons of cement per year. Lafarge also operates 3 nearby quarries to supply the Bath cement plant, the most important of which is the Bath limestone quarry (on site with the cement plant). Two small nearby quarries, located just west and northwest of Gananoque, also supply silica to the cement plant as needed.

Lafarge and subsidiaries also operate over 100 quarries, pits and other operations in southern Ontario producing aggregate, concrete, cement and fly-ash cement.

CRH CANADA GROUP INC. – MISSISSAUGA AND COLBORNE

CRH Canada Group Inc. (www.crhcanada.com) is a subsidiary of CRH plc (www.crh.com), an international group of diversified building materials businesses headquartered in Dublin, Ireland, which trades on the Irish Stock Exchange under the symbol CRG, and on the London Stock Exchange and New York Stock Exchange under the symbol CRH. CRH Canada operates a cement plant and adjacent shale quarry in Mississauga. Limestone is supplied to this cement plant from the company's Ogden Point quarry located on Lake Ontario at Colborne. These operations employ a total of 181 people.

CRH also operates 16 aggregate pits and quarries, 27 concrete plants, 4 "Redimix" plants and 7 asphalt plants in southern Ontario.

ESSROC CANADA INC. – PICTON

Essroc Canada Inc. (www.essroc.com) is a subsidiary of Italcementi Group (www.italcementigroup.com), an Italian company that was taken over in October 2016 by HeidelbergCement (www.heidelbergcement.com), which is a German multinational building materials company trading on the Frankfurt Stock Exchange under the symbol HEI.

Essroc operates a quarry and cement plant in Picton with a production capacity of about 1.2 million tonnes of clinker. The company employs 136 workers at the Picton site. At current reserves, the life of the quarry is expected to be about 86 years.

FEDERAL WHITE CEMENT LTD. – WOODSTOCK

Federal White Cement Ltd. (www.federalwhitecement.com) is a privately held Canadian company based in Embro, Ontario. The company operates a specialized white architectural cement plant in Embro, near Woodstock, using limestone purchased from local quarries. The plant employs about 50 people.

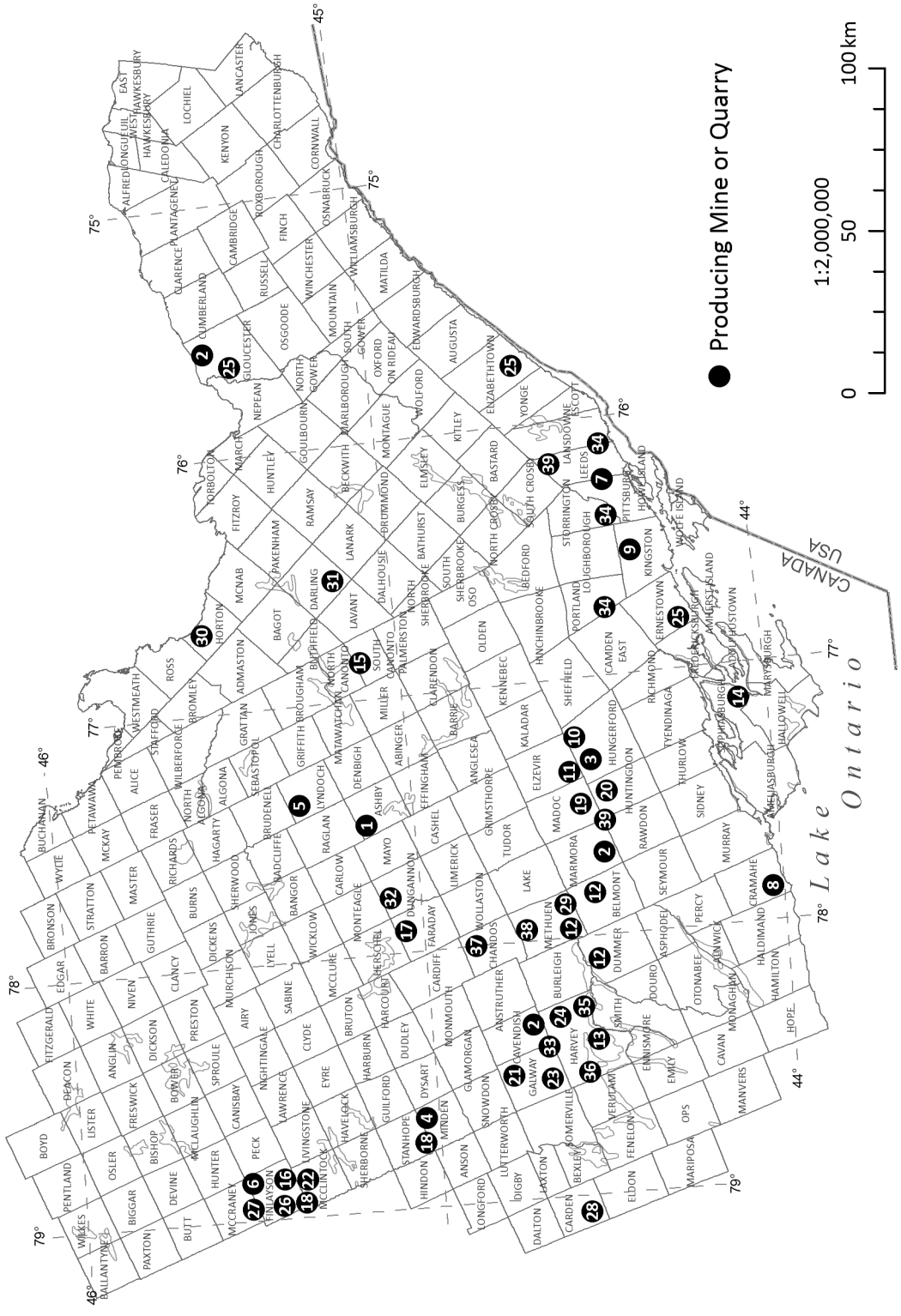

Figure 1. Mining activity in the Southeastern Ontario District in 2016 (keyed to Table 1).

Table 1. Mining activity in the Southeastern Ontario District in 2016 (keyed to Figure 1).

No.	Company/Individual (Mine Name)	Township(s) (Commodity)	Mining Activity
1	2065342 Ontario Ltd. (Simpson Lake Quarry)	Ashby (Marble)	White, dolomitic marble is quarried and shipped to Coloured Aggregates plant in Marmora for the production of specialty aggregate.
2	Aecon Construction and Materials Ltd.	Gloucester, Marmora, Cavendish (Dolomitic sandstone)	Dolomitic sandstone from the Ottawa Quarry in Gloucester Township is produced from the lower member of the March Formation (11 m thick) for use in pavement aggregate. Limestone aggregate is produced from the site of the former Marmoraton iron mine in Marmora Township. Burgundy coloured granite and limestone are quarried in Cavendish Township for use as crushed stone aggregate and decorative stone.
3	A. Marmoro and Terrazzo Olympic, LLC (Tweed Marble Quarry)	Hungerford (Marble)	Quarry was purchased in 2013.
4	Attia Quarries	Minden (Granite)	Stone is quarried for use as landscaping, dimension, flag and masonry stone.
5	Aqua Rose Gems and Minerals (Beryl Pit / Rose Quartz Pit)	Lyndoch (Gemstones, mineral specimens)	Quarrying operations for rose quartz, beryl, feldspar, lyndochite, amazonite, cleavelandite, peristerite, columbite, fluorite and bertrandite. Two quarries are in operation: the Beryl Pit and the Rose Quartz Pit, which charge a fee for mineral collecting.
6	Boothby Quarry	Finlayson (Granite)	Granite gneiss is quarried for flagstone and landscape stone.
7	Canadian Wollastonite (St. Lawrence Mine)	Pittsburgh, Leeds and Lansdowne (Wollastonite)	Wollastonite skarn rock is produced and marketed as an agricultural soil additive. Orthogneiss is also being quarried and used in Superpave™ aggregate.
8	CRH Canada Group Inc. (Ogden Point Quarry)	Cramahe (Limestone, cement)	The quarry has been in production since 1959. It produces between 1.9 and 2.1 Mt of limestone per year. Crushed stone from the quarry is shipped by lake to the company's cement plant in Mississauga. The quarry employs 20 people.
9	Cruickshank Construction Limited	Kingston (Limestone)	The Elginburg Quarry near Kingston produces 500 000 tonnes of limestone annually. This company has 12 operating quarries throughout eastern Ontario including Green Valley, Kemptville, Brockville, Iroquois, Napanee and Verona. They produce a range of products from fine aggregate to armour stone. Their stone has been used in shoreline protection projects along the St. Lawrence Seaway, including a $3.5 million breakwater and a marina project in Prescott.
10	Danford Construction Ltd. (Tweed Quarry)	Elzevir, Hungerford (Granite-gneiss)	Granite-gneiss is extracted, crushed and approved for use in Superpave™ aggregates.
11	Danford Granite Ltd. (Bridgewater Trap Rock Mine)	Elzevir (Trap Rock)	In 2016, 60 000 tonnes of crushed basalt/gabbro were shipped and approved for rock wool manufacturing by Roxul Inc., Milton. Danford plans to expand quarry production in 2017. Metabasalt is also quarried for use as railway ballast.
12	Drain Bros. Excavating Inc. (Havelock Quarry)	Belmont, Dummer, Methuen (Basalt, limestone, granite)	Basalt is extracted for use as trap rock from the Havelock Quarry in Belmont township. Limestone and granite are quarried for aggregate in Dummer and Methuen townships, respectively.
13	Dufferin Aggregates	Harvey (Limestone)	Grey limestone is extracted for use as armour stone, landscaping stone and crushed stone.
14	Essroc Canada Inc. (Picton Quarry)	Sophiasburg (Cement)	A cement plant and on-site limestone quarry with an annual production of slightly less than 1 000 000 tons. This is one of the largest cement plants in North America and employs 160 people.
15	Ferromin Inc. (Tomclid Iron Mine)	South Canonto (Magnetite)	Magnetite is mined and crushed as high-density aggregate for use in heavy concrete applications including radiation shielding.
16	Fraser Quarry	Finlayson (Gneiss)	Predominantly pink gneiss is extracted for landscaping and other decorative applications.
17	Graf Quarry	Faraday (Marble)	A variety of landscape and dimension stone is extracted from a quarry of calcitic marble breccia formerly held by Senator Stone and marketed as "Temagami Pink".
18	Haliburton Stone Works	McClintock, Minden (Granite, dolomite and limestone)	A variety of granite and limestone dimensional and landscape stones produced from 2 quarries.

No.	Company/Individual (Mine Name)	Township(s) (Commodity)	Mining Activity
19	I.K.O. Industries Ltd. (I.K.O. Quarry)	Madoc (Trap Rock)	Since 1991, I.K.O. Industries Ltd. has operated a trap rock quarry east of Madoc on the south side of Hwy 7. The quarry is located within a ridge of grey to black, fine-grained, agglomeratic metavolcanic rock. An on-site mill and colouring plant produce roofing granules, which are trucked to the company's asphalt shingle manufacturing plant in Brampton. In addition to roofing granules, stone from the quarry is crushed to produce HL-1 aggregate (asphalt road surfacing mix). The quarry is licenced under the *Aggregate Resources Act* to produce up to 1 Mt per year.
20	JC Rock (Crookston Quarry)	Huntingdon (Limestone)	Historic producer; in 2010, saw dimension stone removed for restoration project, Belleville.
21	Jeff Parnell Contracting Limited	Galway (Limestone)	Natural and dimension-cut armour stone, rockery stone, garden stone, natural surface steps and natural and dimensional flagstone.
22	John Bacher Construction Limited	McClintock (Granite, gneiss)	Building stone, flagging stone, and landscaping stone.
23	Johnston Quarry	Galway (Limestone)	Gull River Formation limestone is removed for use as landscaping stone, flagstone and building stone.
24	Kawartha Rock Quarry Inc.	Harvey (Limestone)	Limestone is quarried to produce armour stone and flagstone.
25	Lafarge Canada Inc. (Bath, Brockville, Bearbrook and Hawthorne quarries)	Ernestown, Elizabethtown, Gloucester (Cement, dolomitic sandstone, limestone)	In Ernestown Township, the company operates a cement plant and on-site limestone quarry with a capacity to produce 1 Mt of cement. Silica used in the production of cement is extracted from the company's Potsdam sandstone quarry in Pittsburgh Township, as well as from recycled foundry sands. In Elizabethtown Township, dolomitic sandstone from the lower member of the March Formation (at least 19 m thick) is used for road aggregate. Markets are served in the Brockville, Prescott and Cardinal areas. Limestone of the lower member of the Gull River Formation, the upper member of the Bobcaygeon Formation and the lower member of the March Formation (11 m thick) is quarried for use as high-quality aggregate in Gloucester Township.
26	McDonald Quarry	Finlayson (Gneiss)	Flagstone, building stone, armour stone
27	McFadyen's Stone Quarry	Finlayson (Gneiss)	Flagstone, building stone, armour stone, guillotine cut ashlar, sawn thinstone veneer and custom guillotine, hearths and pier caps.
28	Miller Paving Ltd.	Carden (Limestone)	This quarry east of Brechin produces grey limestone for use as aggregate, architectural stone, landscaping/armour stone, asphalt limestone, crushed limestone and manufactured sand.
29	MRT Aggregates Inc. (MRT Traprock)	Methuen (Trap Rock)	Metagabbro is quarried and crushed on site for use as premium aggregate for HL-1 purposes. Portable crusher is moved on site as required. Production began in December 2002 and, in 2003, production totalled 100 000 t. The product is used by Miller Paving and also sold outside the company.
30	Nesbitt Aggregates	Horton (Granite)	Granite riverstone is quarried, sorted and split for use as flagstone, fieldstone, landscaping and masonry stone. The majority of production is exported to the United States.
31	OMYA (Canada) Inc. (Tatlock Quarry)	Darling (Calcite)	Calcitic marble is mined to produce high-purity, fine-grind calcite for fillers with terrazzo chips and landscaping stone as secondary products. Annual production is 250 000 tons and quarry reserves currently stand at over 5 000 000 tons.
32	Princess Sodalite Mine	Dungannon (Sodalite)	Decorative stone, landscaping stone, mineral specimens including fee for collecting.
33	Redstone Quarries	Galway, Harvey, Cavendish (Limestone, sandstone)	Beige limestone and red sandstone are quarried for weathered landscaping stone and armour stone blocks.
34	Rideauview Contracts Ltd. (Ellisville, McCallum, Petworth, Rideauview, Sloan and Battersea quarries)	Rear of Leeds & Lansdowne, Storrington, Portland (Sandstone, limestone, granite)	Sandstone is produced for flagstone, granite blocks and masonry stone from the Ellisville Quarry in Rear of Leeds & Lansdowne Township. Limestone from the McCallum and Petworth quarries (in Storrington and Portland townships, respectively) is quarried for building restoration and new construction. In Storrington Township, red and cream sandstone are quarried at the Rideauview and Sloan quarries for the production of ashlar, flagstone and landscaping stone and red granite is quarried at the Battersea Quarry.
35	Rigbe's Quarry	Harvey (Limestone)	Buff limestone is removed for use as weathered armoury and rockery, crushed aggregates and landscape stone.

No.	Company/Individual (Mine Name)	Township(s) (Commodity)	Mining Activity
36	Stonescape Quarry	Harvey (Limestone)	Limestone flagstone and ledgerock are quarried north of Buckhorn.
37	T. Pluard (Elite Blue)	Chandos (Marble)	A blue grey metasedimentary rock is extracted for a variety of uses, including armour stone, landscaping stone and dimension stone
38	Unimin Canada Ltd. (Blue Mountain Quarry)	Methuen (Nepheline syenite)	Nepheline syenite is mined from a quarry and processed in 2 mills at Nephton and Blue Mountain, respectively. Magnetite is produced as a by-product. Production rate is 2500 tons per day. The mine opened in 1955 and employs 152 people.
39	Upper Canada Stone Co. Ltd. (Pink Marble, Royal Green Marble, Madoc White Marble, Medium Buff Marble, Black Marble, Blue-Grey Marble, Light-Buff Marble and Kingston Red Granite quarries)	Madoc, Huntingdon, Marmora, Rear of Leeds and Lansdowne (Marble, granite)	In Madoc, Huntingdon and Marmora townships, several colours of fine-grained marble are quarried for use as landscaping stone, dimension stone, terrazzo and decorative aggregate. In Rear of Leeds and Lansdowne Township, red granite is produced for precast concrete panels, pavers, split block, spun concrete poles and landscaping.

Table 2. Producing mines and quarries in the Southwestern Ontario District* in 2016 (keyed to Figure 2).

No.	Company/Individual (Mine or Quarry Name)	Township(s) (Commodity)	Mining Activity
1	A & A Natural Stone Ltd. (A & A Quarry)	Keppel (Dolostone)	Grey dolostone is produced for use as flagstone, landscape stone and specialty aggregate.
2	Arriscraft International Inc. (Adair Marble Quarries)	Albemarle (Dolostone)	Dolostone is produced for use as architectural stone.
3	Attia Quarries (Rama and Seabright quarries)	Rama (Dolostone)	Stone is quarried for use as landscaping, dimension, flag and masonry stone.
4	Block and Stone Resource Group Inc.	Amabel (Dolostone)	Dolostone is quarried for use as dimension stone.
5	Brampton Brick Ltd. (Cheltenham and Hungry Hollow North quarries)	Chinguacousy, Williams (Shale)	Queenston Formation shale is extracted for use in the company's brick plant.
6	Bruce Peninsula Stone Ltd. (Lindsay, Wiarton and Mar quarries)	Lindsay, Amabel, Albemarle (Dolostone)	Dolostone is produced for landscaping and building stone products.
7	Carmeuse Lime Canada Ltd. (Beachville Quarry)	Zorra (Limestone)	Limestone is extracted, crushed and processed in on-site lime plant.
8	CGC Inc. (Hagersville Mine)	Oneida (Gypsum)	An on-site wallboard plant utilizes gypsum from the mine.
9	Compass Minerals (Goderich Mine and brine fields)	Goderich (Salt, salt in brine)	This is the largest underground salt mine in the world. The company also produces salt from an adjacent brine field operation. Most production is distributed via Great Lakes shipping. 2016 is the second year of a 3-year, $150 million project to re-line shaft walls in the 600 m deep mine.
10	Credit Valley Quarries Co. Ltd.	Caledon, Chinguacousy (Sandstone, limestone)	Sandstone is extracted for construction and landscaping applications. The stone has been used in many notable buildings including Toronto's Old City Hall and the Ontario Legislature (Queen's Park).
11	CRH Canada Group Inc. (Mississauga Quarry)	Toronto (Shale)	CRH Canada Group Inc. operates a cement plant and adjacent shale quarry. Limestone is shipped to the plant from Ogden Point quarry on Lake Ontario at Colborne. Formerly Holcim Canada Inc.
12	Cut Above Natural Stone (Cut Above Natural Stone Quarry)	Rama (Limestone)	Buff brown, white, light to dark grey limestone is quarried for use as armour stone, cubical weathered wallstone, flagstone and random slabs.
13	Dufferin Aggregates (Flamborough Quarry)	West Flamborough (Dolostone)	Dolostone is produced for use as armour, landscaping and crushed stone.
14	E.C. King Contracting Ltd. (Sydenham Quarry)	Sydenham (Dolostone)	High-purity dolostone is crushed for construction aggregate and agricultural lime.
15	Ebel Quarries Inc. (Ebel and Arnold Property quarries)	Amabel (Dolostone)	Light and dark brown and black dolostone is produced for use as flagstone, landscaping stone, slabs, steps and wallstone.

No.	Company/Individual (Mine or Quarry Name)	Township(s) (Commodity)	Mining Activity
16	Fowler Construction Company Limited (Fleming Quarry)	Rama (Gneiss)	Granitic gneiss is quarried for use as flagstone, building, landscaping, masonry and crushed stone.
17	Georgian Bay Marble and Stone (Cook Quarry)	Amabel (Dolostone)	Dolostone is produced for use as landscaping stone, steps and building stone.
18	Hilltop Stone and Supply Inc. (Hilltop Quarry)	Esquesing (Sandstone)	Grey and buff sandstone is quarried for use as flagstone, masonry stone and dimension stone.
19	Hope Bay Quarry Inc.	Albemarle (Dolostone)	Dolostone is produced for use as flagstone, aggregate and armour stone.
20	Jazbrick (Georgetown Quarry)	Esquesing (Shale)	Queenston Formation shale is extracted for use in the company's brick plant. Formerly Century Brick Ltd.
21	Lafarge Canada Inc. (Dundas and Woodstock quarries)	West Flamborough, Zorra (Dolostone, Limestone)	Dolostone is crushed for use as high-quality aggregate and steel making flux. Limestone is extracted and crushed for aggregate from quarry near site of former cement plant.
22	Limberlost Stone Inc. (Limberlost Quarry)	Albemarle (Dolostone)	Light and dark brown and grey dolostone is quarried for use as flagstone, landscaping stone, steps, slabs, coping and coursing.
23	Meridian Brick Ltd. (Aldershot, Burlington and Niagara-on-the-Lake quarries)	East Flamborough, Niagara (Shale)	Queenston Formation shale is extracted for use in the company's brick plant. Formerly Forterra Brick Ltd.
24	Owen Sound Ledgerock Ltd. (Owen Sound, Senesun and Wiarton quarries)	Keppel, Amabel (Dolostone)	Dolostone is produced for use as custom-cut and architectural cut stone, masonry, ledgerock wallstone, marble tiles and slabs and landscape stone.
25	Rice and McHarg Ltd. (Rice and McHarg Quarry)	Esquesing (Sandstone)	Grey and buff sandstone is produced for use as flagstone, masonry and landscaping stone.
26	Rockleith Quarry Ltd. (Rockleith Quarry)	Orillia (Limestone)	Beige, tan and blue-gold limestone and dolomitic limestone is produced for use as dimensional building stone.
27	Speiran Quarries Ltd. (Speiran Quarry)	Rama (Limestone)	The quarry is operated by Gott Natural Stone '99 Inc. White limestone is produced for use as flagstone, landscaping stone, waterfall slabs, retaining wall blocks and steps.
28	St. Marys Cement Inc. (Bowmanville and St. Marys quarries)	Darlington, Blanshard (Limestone)	Limestone is quarried and processed at cement plant complexes in Bowmanville and St. Marys.
29	The Canadian Salt Company Ltd. (Ojibway Mine and brinefields)	Sandwich (Salt, salt in brine)	Underground workings are adjacent to international border. The company also produces salt from an adjacent brine field operation. In 2016, the company continued a multi-year, $300 million investment in the mine and brine fields, expected to add 45 years of mine life beyond the current 10 year projection.
30	Wiarton Stone Quarry Inc. (Wiarton Stone Quarry)	Amabel (Dolostone)	Light brown, grey/beige and black dolostone is quarried for use as flagstone, steps, waterfall stone, curbing stone.

**All oil and gas production in Ontario occurs in the Southwestern Ontario District. For information on oil and gas exploration and development activity in Ontario in 2016, please refer to the report of the Petroleum Operations Section (this volume).*

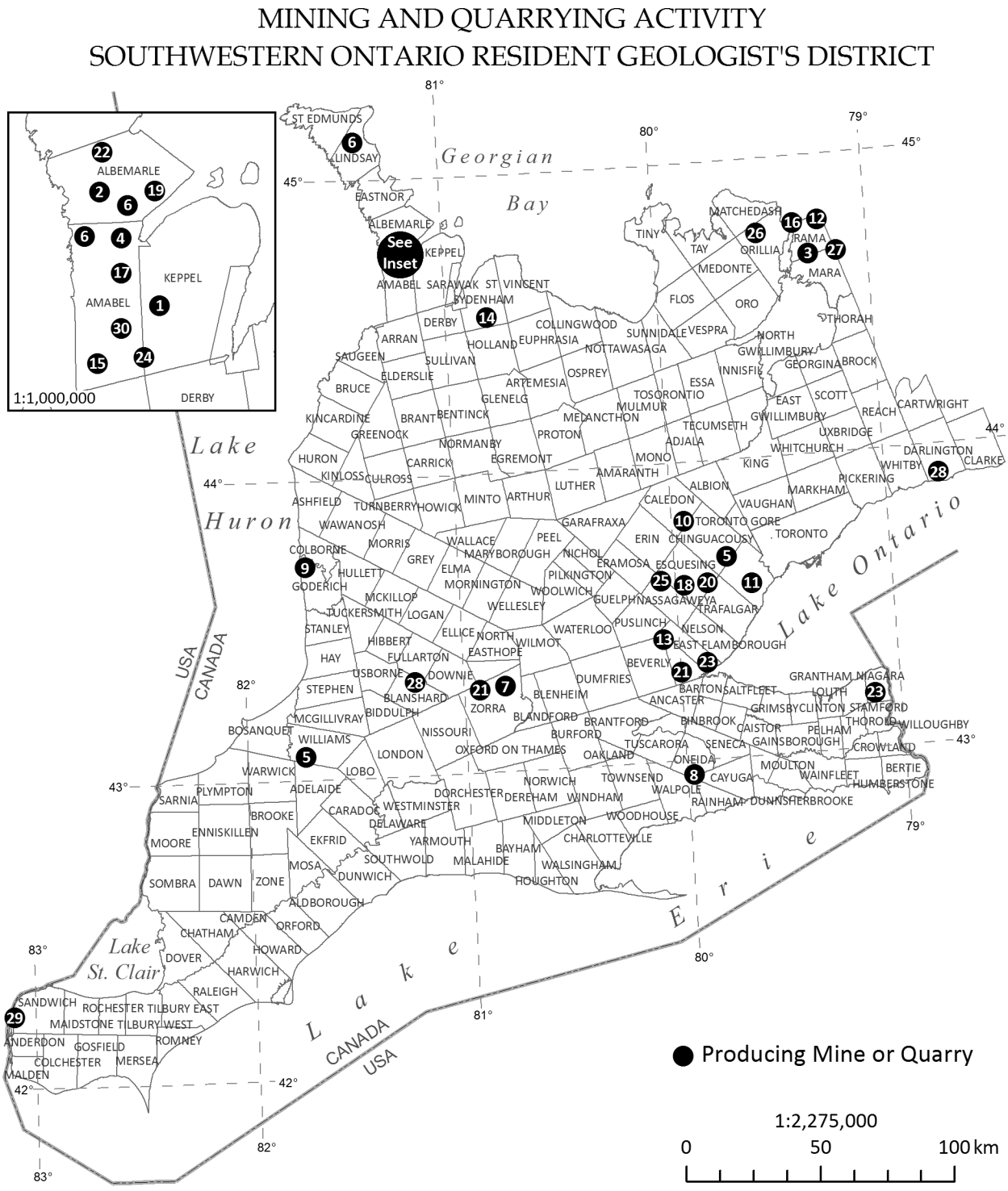

Figure 2. Producing mines and quarries in the Southwestern Ontario District in 2016 (keyed to Table 2).

Dimension and Building Stone

WIARTON AREA QUARRIES

The Wiarton area on the Bruce Peninsula in southwestern Ontario is the centre of the province's dimension-stone industry. As of 2016, 22 quarries were licenced under the *Aggregate Resources Act* to extract dimension stone for building, landscaping and flagstone markets in the County of Bruce. An additional 15 quarries are licenced to extract stone in the neighbouring County of Grey. Rowell (2012) identifies, as provincially significant, bedrock resources in the County of Bruce and also provides details of national and provincial parks, physical, cultural and environmental constraints on development, including the Niagara Escarpment Plan, which limit development of resources within that area for dimension stone, as well as for crushed stone aggregate.

ORILLIA AREA QUARRIES

Five companies operate a total of 7 dimension-stone quarries in Rama Township near Orillia in Paleozoic limestone of the Gull River Formation. Each of the companies has some form of on-site processing to split and/or cut stone to customer specifications. Both white-weathering, micritic limestone and, to a lesser extent, beige-weathering dolostone from the Gull River Formation are extracted from the Orillia area quarries for use as landscape, masonry and armour stone. All of these quarries are situated on lands where both mining and surface rights are privately owned. The quarries at Longford, opened in the 1880s and now inactive, were well known for both limestone (Longford Stone) and dolostone (Rama Stone) used in the construction of many historic buildings in Toronto, Peterborough and Orillia.

PETERBOROUGH AREA QUARRIES

There has been a long history of dimension-stone production in the Peterborough area. In 2016, 6 companies operated 6 dimension-stone quarries in the Peterborough area. Stone from these quarries is produced for export, as well as for local markets.

In 4 of the quarries, Paleozoic limestone of the Gull River Formation is extracted for a variety of applications, including landscape, masonry and armour stone. Each of the companies has some form of on-site processing to split and/or cut stone to customer specifications. The Parnell quarry in Galway Township is located on a contact between the Paleozoic sedimentary rock and Proterozoic metamorphic rock of the Canadian Shield. In addition to Gull River Formation limestone, dolostone and deep red ("wine") granite have been quarried at this site. At the Plourde quarry in Chandos Township, a blue-grey interbedded marble and amphibolite unit is quarried to produce "Elite Blue" dimension stone. Four of these quarries are situated on lands where both mining and surface rights are privately owned. The remaining 2 quarries are located on Crown land.

Drain Bros. Excavating Ltd. – New Dimension Stone Processing Plant

In 2016, Drain Bros. Excavating Ltd. began constructing a new dimension-stone processing plant on the site of their trap rock quarry and plant at Havelock, near Peterborough. The facility will contain a large (48 inch) diameter diamond saw, a smaller saw, hydraulic guillotines and conveyor systems. A small guillotine will be located in a separate outbuilding.

Initially, stone will come from the company's limestone quarry in the Buckhorn area and granite quarry in Belmont Township, north of Havelock. Products will include armour stone, landscaping stone, steps and sills, paving stone, ashlar and veneer stone. The range of product sizes will allow almost all stone to be utilized, and any remaining waste will be crushed for aggregate.

The large saw will operate on a computer-guided, mobile frame that will allow automatic cutting of multiple blocks within an area of 16 by 60 feet. An automated conveyor system will move the blocks between saws and guillotines with minimal handling. The plant will operate year-round, with production scheduled to begin in mid-2017.

The plant will add 16 full-time jobs to the 22 positions currently existing at the Havelock trap rock and ethanol operations.

The products will be marketed directly from the Havelock site and through a second distribution centre in Stouffville.

Possible spin-off jobs and development opportunities may come in the areas of transportation, increases in landscaping business demand, and in local quarry development to provide a wider variety of stone products. The company will consider purchasing other types of southern Ontario stone for processing at the plant, such as marble from the past-producing Tweed and Omega (Perth area) quarries (D. Drain, Drain Bros. Excavating Ltd., personal communication, January 2017).

KINGSTON AREA QUARRIES

Quarrying of limestone as building stone in the Kingston area began in the early 1800s and the industry expanded rapidly during construction of the Rideau Canal from 1826 to 1832. Kingston limestone, white-weathering, micritic limestone of the Gull River Formation, is a prominent feature of many government buildings, churches and the buildings of Queen's University and the Royal Military College.

Rideauview Contracts Ltd. operates the only 2 quarries that currently produce limestone dimension stone: the Petworth Quarry, about 25 km northwest of Kingston, and the McCallum Quarry, about 10 km northeast of Kingston on the Battersea Road. In 2016, the company acquired a permit to expand the Petworth Quarry to the north, doubling the surface area of the quarry (W. Jackson, Rideauview Contracts Ltd., personal communication, August 2016). Stone from the Petworth Quarry has been used in recent years in restoration of buildings at the Royal Military College.

SANDSTONE QUARRIES

Sandstone of the Whirlpool Formation (Lower Devonian) has been quarried in the Brampton area since 1840. Locally known as Credit Valley stone, it was used in the construction of a number of notable projects in Toronto including Old City Hall, the Ontario Legislature (Queen's Park), pillars at Union Station, and the Timothy Eaton Memorial Church.

Three quarries continue to produce sandstone in the Brampton area. There is a perennial demand for Credit Valley sandstone for new projects, as well as a large demand for restoration of many historic sandstone buildings in the Greater Toronto Area.

In southeastern Ontario near Kingston, Nepean Formation (Cambrian) sandstone is quarried and processed as dimension stone in a variety of finishes for stone veneer, lintels, headers, steps, stone blocks and archways. The stone is used for restoration projects in Canada and the United States, including recent and ongoing restoration of the Parliament Buildings in Ottawa, as well as for new building projects. Nepean Formation sandstone is also a popular landscaping stone.

Trap Rock

There are 4 companies operating trap rock quarries in southeastern Ontario, all located within the area of Highway 7 between Peterborough and Tweed. Products include roofing granules, high-performance aggregate, railway ballast, and raw material for mineral wool production.

Drain Bros. **Excavating Ltd.** quarries metabasalt near Havelock for the production of railway ballast, filter stone, high-performance aggregate, roofing granules, and mineral wool raw material. The company has on-site crushing facilities.

MRT Aggregates Inc. operates a quarry in metagabbro about 20 km north of Havelock. The company produces crushed stone on site for use as high-performance aggregate and railway ballast.

IKO Industries Ltd. quarries a fine-grained, massive, intermediate rock, classified as andesite, for the production of roofing granules. The company has an on-site crushing and colourizing plant. The granules are shipped to the company's Brampton plant for manufacturing asphalt shingles.

Danford Granite Ltd. operates the Bridgewater trap rock quarry, about 4 km north of Highway 7, between Madoc and Tweed. The company has opened quarries in both high-iron gabbro and high-magnesium gabbro. The former has been tested and approved as railway ballast and road aggregate; the latter is under development as a source of raw material for mineral wool manufacturing. In 2015, the company conducted a re-sampling program on archived diamond-drill core, stored at the Tweed Drill Core Library, from a past talc exploration program on the property as part of an evaluation of the consistency of the high-magnesium zone. The company shipped 30 000 tonnes of gabbro to Roxul Inc. in Milton for rock wool manufacturing tests in 2015. The results were positive and the company shipped an additional 60 000 tonnes in 2016. Between 60 000 and 70 000 tonnes are expected to be produced for Roxul in 2017 (A. Danford, Danford Granite Ltd., personal communication, January 2017). The company operates several bedrock aggregate quarries in eastern Ontario and employs 25 permanent and 25 seasonal workers.

Calcium Carbonate (Marble)

OMYA CANADA INC. – TATLOCK QUARRY

OMYA Canada Inc. (www.omya.com) is a subsidiary of OMYA, a privately held global producer of industrial minerals headquartered in Switzerland. Worldwide, OMYA produces mainly fillers and pigments derived from calcium carbonate and dolomite. OMYA is also a worldwide distributor of specialty chemicals.

The company extracts white calcitic marble from a high-purity zone at the Tatlock Quarry in Darling Township. The marble is shipped to the company's processing plant in Perth for production of ground calcium carbonate products that are used primarily in the paint, paper and plastic industries. In 2016, the quarry produced about 650 000 tonnes of ore. Together, the Tatlock Quarry and Perth processing plant employ about 92 permanent workers.

EXPLORATION ACTIVITY

Assessment files received for the Southern Ontario Region are listed in Table 3. Exploration activity is listed in Table 4 and the location of exploration projects are shown in Figure 3. It should be noted that the number of assessment files received for southern Ontario does not reflect the amount of exploration work that is carried out in the Region. The reason is that the vast majority of exploration work in southern Ontario is carried out on private land where claim holders are not required to submit assessment work.

In 2016, most of the exploration activity and expenditures in the Southern Ontario Region were focussed on gold. Smaller projects also focussed on graphite, industrial minerals, vermiculite and uranium-thorium-rare earth elements.

Table 3. Assessment files received in the Southeastern Ontario District in 2016.

Abbreviations

AEM ..... Airborne electromagnetic survey
AM ..... Airborne magnetic survey
ARA ..... Airborne radiometric survey
Beep ..... Beep Mat survey
Bulk ..... Bulk sampling
DD ..... Diamond drilling
DDH ..... Diamond-drill hole(s)
Enviro ..... Environmental base line survey
GC ..... Geochemical survey
GEM ..... Ground electromagnetic survey
GL ..... Geological survey
GM ..... Ground magnetic survey
GRA ..... Ground radiometric survey
Grav ..... Gravity survey
HLEM ..... Horizontal loop electromagnetic survey
HM ..... Heavy mineral sampling
IM ..... Industrial mineral testing and marketing
IP ..... Induced polarization survey
Lc ..... Line cutting
Met ..... Metallurgical testing
Micro ..... Microscope (mineral identification)
OD ..... Overburden drilling
ODH ..... Overburden drill hole(s)
OMIP ..... Ontario Mineral Incentive Program
OPAP ..... Ontario Prospectors Assistance Program
PEM ..... Pulse electromagnetic survey
PGM ..... Platinum group metals
Pr ..... Prospecting
RES ..... Resistivity survey
Samp ..... Sampling (other than bulk)
Seismic ..... Seismic survey
SP ..... Self-potential survey
Str ..... Stripping
Tr ..... Trenching
VLEM ..... Vertical loop electromagnetic survey
VLFEM ..... Very low frequency electromagnetic survey

No.	Township or Area (Commodity)	Company Name	Year	Type of Work	AFRO Number	Resident Geologist Office File Designation
1	Ashby (Au, Kimberlite)	R. Lawrence	2015–2016	Pr	2.57024	Ashby #25
2	Cardiff (Mineral Specimens)	The Corporation of the Municipality of Highlands East	2016	GL	2.56874	Cardiff #269
3	Cardiff (U, Th, REE)	Skead Holdings Ltd.	2015–2016	Assay, GC	2.56836	Cardiff #267
4	Cardiff (U, Th, REE)	Skead Holdings Ltd.	2013–2015	Assay, Pr	2.56358	Cardiff #268
5	Cardiff (U, Th, REE)	Skead Holdings Ltd.	2015–2016	Assay, Pr	2.56829	Cardiff #270
6	Cardiff (U, Th, REE)	Skead Holdings Ltd.	2015–2016	Assay, GC	2.56835	Cardiff #271
7	Cardiff (U, Th, REE)	Skead Holdings Ltd.	2015	Assay, GC	2.56301	Cardiff #272
8	Glamorgan (Mineral Specimens)	The Corporation of the Municipality of Highlands East	2014–2016	Pr	2.56886	Glamorgan #35
9	Griffith (Dolomitic Marble)	Dacre Industrial Minerals Inc.	2015	Drill Core	2.56577	Griffith #32
10	Grimsthorpe (Au)	J. Chard, R. Dillman	2015–2016	Assay, Pr	2.56611	Grimsthorpe #95
11	Hindon (Copper)	JD Exploration Inc.	2015	Assay, GL, IP, Lc, Pr	2.56371	Hindon #28
12	Lyndoch (Graphite)	M. Forget	2016	Assay, GL, Pr, Str	2.56569	Lyndoch #57
13	Lyndoch (Graphite)	A. Dubblestein	2015–2016	Assay, Pr, Str	2.56628	Lyndoch #58
14	Methuen (Ilmenite)	Trigan Resources Inc.	2015	Assay, GC	2.56451	Methuen #63
15	Snowdon (Base Metals)	Skead Holdings Ltd.	2015	Assay, GC	2.56329	Snowdon #25

Table 4. Exploration activity in the Southeastern Ontario District in 2016 (keyed to Figure 3).

Abbreviations

AEM ..... Airborne electromagnetic survey
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Micro ..... Microscope (mineral identification)
OD ..... Overburden drilling
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OMIP ..... Ontario Mineral Incentive Program
OPAP ..... Ontario Prospectors Assistance Program
PEM ..... Pulse electromagnetic survey
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Pr ..... Prospecting
RES ..... Resistivity survey
Samp ..... Sampling (other than bulk)
Seismic ..... Seismic survey
SP ..... Self-potential survey
Str ..... Stripping
Tr ..... Trenching
VLEM ..... Vertical loop electromagnetic survey
VLFEM ..... Very low frequency electromagnetic survey

No.	Company/Individual	Township/Area (Commodity)	Exploration Activity
1	Crown William Mining Corp.	Madoc (Au)	Samp, Assay
2	Chard, J.; Dillman, R.	Grimsthorpe (Au)	Pr, Assay
3	Danford Granite Ltd.	Elzevir (Trap Rock)	DD
4	Dubblestein, A.	Lyndoch (Graphite)	Pr, Str, Assay
5	Forget, M.	Lyndoch (Graphite)	GL, Pr, Str, Assay
6	Lawrence, Robert	Ashby (Au, Kimberlite)	Pr
7	Skead Holdings Ltd.	Cardiff (U, Th, REE)	GC, Samp, Assay
8	Skead Holdings Ltd.	Monmouth (U, Th, REE)	Samp, Assay
9	The Corporation of the Municipality of Highlands East	Cardiff (Mineral Specimens)	GL
10	The Corporation of the Municipality of Highlands East	Glamorgan (Mineral Specimens)	GL
11	Union Glory Gold Ltd.	Kaladar (Au)	DD
12	Waring, R.	Anglesea (Au)	Pr, Str

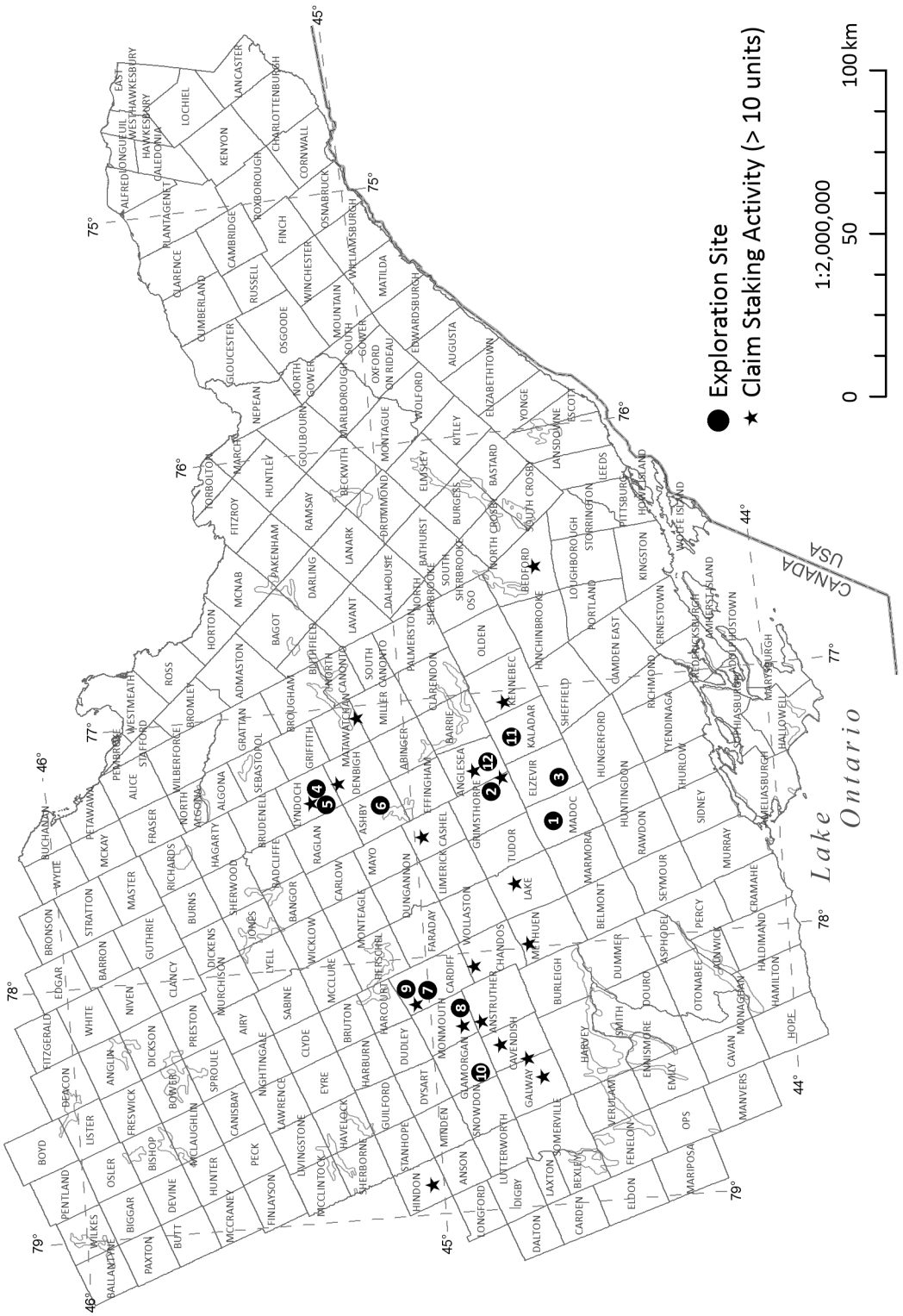

Figure 3. Exploration activity in the Southeastern Ontario District in 2016 (keyed to Table 4).

Gold

UNION GLORY GOLD LIMITED

The largest exploration project in the Southeastern Ontario District in 2016 consists of the Addington gold project. The project is located in Kaladar Township approximately 10 km north of the village of Kaladar.

From May to November 2016, Union Glory completed 48 diamond-drill holes at the Addington gold project for a total of 9553 m. The objective of the drilling program was to confirm the historical model of 5 near-vertical gold zones, plunging northeast and hosting a potentially economic resource. In addition, baseline environmental and preliminary metallurgical studies were also commenced.

In 2013, the company completed a program of sampling of archived diamond-drill core stored at the MNDM Drill Core Library in Tweed. Results of the 2013 work and a thorough description of the geology of the Addington Mine are documented by McBride (2013). In June 2015, Union Glory Gold Limited completed 5 diamond-drill holes, totalling 305 m, on the Addington gold mine property. Diamond drilling completed in 2015 was intended to confirm results of previous drilling. The company did not released the results of the 2015 drilling.

Prior to 1921, the Addington Mine is reported to have produced about 480 ounces of gold from a quartz-tourmaline vein zone in arsenopyrite-bearing tuffaceous rocks between mafic metavolcanic rocks of the Tudor Formation and overlying clastic metasedimentary rocks of the Flinton Group. Five mineralized zones were identified on the property with a combined, NI 43-101–non-compliant resource estimates of 160 000 t grading 5.16 g/t Au (measured); 130 000 t grading 5.63 g/t Au (indicated); and 425 000 t grading 3.79 g/t Au (inferred) (Johnson 1983 cited *in* McBride 2013).

The geology of the property and the work program carried out by Union Glory Gold are described in greater detail in this report (*see* "Property Examinations" "Union Glory Gold Limited, Addington Property, Kaladar Township").

CROWN WILLIAM MINING CORPORATION

From October 2016 to January 2017, Fladgate Exploration Consulting Company completed a program of sampling and relogging diamond-drill core for Crown William Mining Corporation on the Bannockburn gold project in Madoc Township. The drill core is stored at the MNDM Drill Core Library in Tweed. The deposit, formerly known as the Mono Gold Mines Inc. prospect, consists of a complex series of quartz veins at a folded contact between mafic metavolcanic and metasedimentary rocks, which contains a NI 43-101–non-compliant resource of 372 000 tons grading 0.395 ounces of gold per ton (Schorn 1998).

During the summer of 2013, approximately 10% of the historic holes were relogged and sampled. The results of the program revealed numerous quartz vein intersections that were not sampled previously and which were found to carry grades of over 10 g/t Au over narrow widths. A zone of low-grade mineralization, named the Conduit zone, was also outlined. Combined with higher grade mineralization within the quartz veins, the Conduit zone may be amenable to open-pit mining (Fingas 2013).

The purpose of the 2016 core relogging and sampling program was to resample additional holes in the areas where new veins were sampled during the 2013 resampling program and drill holes interpreted to be intersecting the Conduit zone. A total of 3988 samples were collected from 31 historic diamond-drill holes. Assays are pending; however, preliminary results show trends similar to those observed in 2013 of high-grade narrow vein intercepts and disseminated low-grade wall-rock mineralization within the

Conduit zone. The 2016 resampling program should further explain the relationship between the Conduit zone and the high-grade veins with emphasis on the control(s) of the ore shoots on the property (C. Jeffs, Fladgate Exploration Consulting Corporation, personal communication, February 2017).

The geology of the property and the work program carried out by Crown William are described in greater detail in this report (see "Property Examinations" "Crown William Mining Corporation, Bannockburn Gold Project, Madoc Township").

R. WARING

Prospector R. Waring continued exploration of his gold prospect in in the vicinity of Killer Creek in Anglesea Township, concessions XII and XIII, lots 25 and 26.

Gold mineralization occurs in rusty, smoky quartz veins within sheared metavolcanic rocks, possibly associated with east-trending cross structures in the vicinity of the Partridge Creek shear zone. The geology of the property is described in detail by Sangster et al. (2016, p.32-35: *see* "Property Examinations" "Waring Creek Gold Prospect, Anglesea Township").

The 2016 exploration program, funded by an Ontario Exploration Corporation grant, consisted of trenching of the known quartz vein zones with a small backhoe and additional prospecting for new quartz vein occurrences (Photo 1). Additional stripping of the quartz vein zones is planned during the 2017 field season to determine the orientation and extent of the vein structures and to confirm the presence of gold mineralization.

Graphite

Development of the Kearney and Bissett Creek deposits, which are 2 advanced-stage graphite projects in the Grenville Province, were stalled in 2016 because of a lack of financing. The properties, briefly described below, are described in more detail by Sangster et al. (2014, p.15-17).

Photo 1. Shallow-dipping extensional quartz vein at high angle to foliation (gravel-pit vein, Waring property). Dowhaluk (1991) reported a grab sample assaying 22.5 g/t Au and Waring (2016) reported a grab sample assaying 66.6 g/t Au.

ONTARIO GRAPHITE LTD. – KEARNEY MINE

The Kearney Mine in Butt Township, near Huntsville, was first brought into production in 1989 and remained operational through 1994, during which time it achieved a peak production rate of 10 000 tonnes per year of flake graphite product. The mine has been under new ownership and management since 2007. An NI 43-101 report, completed in October 2013 for Ontario Graphite Ltd., confirmed 51.5 million tonnes of Measured and Indicated Resources (2.14% Cg[7] average) and 46.8 million tonnes of Inferred Resources (2.0% Cg average) (www.ontariographite.com, under Kearney Mine | Fact Sheet).

NORTHERN GRAPHITE CORPORATION – BISSETT CREEK DEPOSIT

The Bissett Creek deposit of Northern Graphite Corporation (www.northerngraphite.com) is located in Maria Township, northern Renfrew County, Southern Ontario Mining Division, but is approximately 2 km north of the boundary of the Southern Ontario Resident Geologist Region. In 2014, the company reported that it amended the Preliminary Economic Assessment to reflect a doubling of the annual graphite production upon start-up, rather than after 3 years of production as initially proposed. The new proposal calls for production of 44 200 tonnes of graphite annually for the first 10 years (Northern Graphite Corporation, news release, June 24, 2014). The deposit contains 69.8 million tonnes of Measured and Indicated Resources (1.74% Cg average) and 24.0 million tonnes of Inferred Resources (1.65% Cg average). In 2015, the company announced the successful production of coated spherical graphite for use as anode material in lithium ion batteries (Northern Graphite Corporation, news release, May 19, 2015).

RESIDENT GEOLOGIST STAFF AND ACTIVITIES

The Southern Ontario Regional Resident Geologist's office, located in Tweed, is the only Resident Geologist Program office south of the French River. The office is staffed by A.C. Tessier, *P.Geo*., Regional Resident Geologist; P.S. LeBaron, *P.Eng*., District Geologist; D.A. Laidlaw, *P.Geo.*, Regional Land Use Geologist; and S.J. Charbonneau, District Geological Assistant. A.C. Wilson, *P.Geo.*, Mineral Deposit Compilation Geologist—Northeastern Ontario, contributes to updates and review of the Mineral Deposit Inventory database for southern Ontario. A detailed description of the latter's activities is included in this report (*see* "Mineral Deposit Compilation Geologist—Northeastern Ontario").

The former Regional Resident Geologist for southern Ontario, P.J. Sangster, retired in April 2016, and the position was filled by A.C. Tessier in October 2016. From April to October, P.S. LeBaron was Regional Resident Geologist (Acting) and, from May to August, L.A.F. Hall was District Geologist (Acting) for southeastern Ontario.

Additional support was provided by D. McColeman, Administrative Assistant (Acting), to the Senior Manager, Resident Geologist Program, Sudbury. Summer Experience Program (SEP) student, R. Holt, provided field season support.

The Resident Geologist Program monitors, stimulates and facilitates mineral exploration and the sustainable development of Ontario's mineral resources. Program services and functions are grouped into key areas including

- geological consultation and advisory services
- provision of public access to geoscience databases and other resource materials
- documentation of mineral exploration and development activity
- geoscience for land-use planning
- public education

[7] "Cg" is a calculated value: graphite as carbon = total carbon less the amount of carbon present as CO_2.

The Southern Ontario Regional Resident Geologist's office also provides support to the ministry's Mineral Development and Lands Branch–Mining Lands Section front-counter client services and works with the MNDM Aboriginal Relations Branch to assist in fostering relations between the mineral industry and First Nation communities.

The Southern Ontario Regional Resident Geologist's office in Tweed offers public access to a complete library of Ontario Geological Survey publications for southern Ontario and a technical library of related publications. Diamond-drill core from industry and government projects across southern Ontario is available for examination with prior appointment.

Special Projects

In 2016, the District Geological Assistant participated in the Resident Geologist Program (RGP) Data Standards Working Group. The project aims to standardize the collection and distribution of various unique RGP data holdings in all offices across the province. To date, all university theses, mine plans and drill-core logs have been scanned and a spatial index of the university theses catalogue has been distributed online via OGSEarth application (www.ontario.ca/ogsearth). Additionally, the SEP student assisted with identifying, scanning and indexing approximately 400 unique hard-copy documents from the office's mineral deposit inventory and assessment files. Most of these documents represent donated files and reports that are not part of the assessment file database. Plans are to make this material available online in the future.

There are over 6000 mineral occurrences in southern Ontario documented in the Mineral Deposit Inventory (MDI) database (Ontario Geological Survey 2017). Staff of the Southern Ontario Regional Resident Geologist's office work with A.C. Wilson, Mineral Deposit Compilation Geologist—Northeastern Ontario, on an ongoing basis to ensure the integrity of the database. Site investigations to confirm the presence and accurate location of MDI data points are an essential part of the process. During the 2016 field season, visits were made to 21 MDI locations in southeastern Ontario and 4 sites in southwestern Ontario. In general, MDI records were validated; however, some locations were corrected based on new global positioning system measurements.

First Nations Interactions

During 2016, activities co-ordinated by the Aboriginal Relations Branch included a presentation to members of the Southern Ontario Prospectors Association and staff of the Tweed Resident Geologist Office on Aboriginal and treaty rights and the duty to consult, in addition to MNDM programs and supportive actions regarding First Nations interactions. Staff of the Tweed Resident Geologist Office offered to provide, in the fall of 2016, a Prospecting Course for the Algonquins of Ontario. However, the timing was not convenient and a request was made to reschedule to the spring of 2017.

Presentations

In March, staff assisted in the development and presentation of the Ontario booth at the Prospectors and Developers Association of Canada (PDAC) Annual Convention. The Regional Resident Geologist (Acting) presented talks on "Critical Minerals – Ontario Potential". The Regional Resident Geologist (Acting) also attended the Northeastern Ontario Mines and Mineral Symposium in Sudbury in April.

In May, 2 meetings were organized for a client group, including the Southern Ontario Prospectors Association, the first of which featured updates on Mining Act Modernization, online staking and mining lands administration, presented by R. Denomme of the Mining Lands Branch; and a presentation on

Aboriginal Outreach by B. Hughes, C. Ralph and T. McDonald of the Aboriginal Affairs Branch. The second meeting featured a summary of OGS projects for the 2016 field season by M.C. Smyk and R.M. Easton of the Earth Resources and Geoscience Mapping Section of the OGS; and a presentation on the Limerick Township copper-nickel-cobalt prospect by geological consultant D. McBride.

Other activities included talks by P.S. LeBaron, Regional Resident Geologist (Acting), on "Ontario Geological Survey – Role and Responsibility" and "Geoscience, Minerals and Land Use Planning in Ontario" to a delegation from the China Ministry of Lands and Resources at Queen's University (June); attendance at a one-day symposium on minerals and metals of the battery supply chain (lithium, graphite and cobalt) as part of the Mines and Money conference in Toronto (September); and a presentation on southern Ontario industrial minerals at a meeting of the Mineral Development and Lands Branch in Sudbury (October).

In December, a third meeting for the Southern Ontario Prospectors Association and other RGP clients was held, featuring an update on Mining Act Modernization by R. Denomme of the Mining Lands Branch and a summary of Exploration Plans and Permits by S.E. Halet of the Mineral Exploration and Development Section.

Mineral Shows, Outreach and Field Trips

In May, the Resident Geologist Office hosted an Open House as part of the province-wide celebration of the 125th anniversary of the creation of the Ontario Geological Survey.

Staff presented a poster and mineral display at the Bancroft Gemboree in August, highlighting historic and current mineral deposits of the Bancroft–Barry's Bay area. The District Geologist gave 3 presentations on "The Geological History of Southern Ontario".

In October, as part of the Ancaster Gem and Mineral Show, the District Geologist gave a series of talks on "Minerals in Your Life" to 240 elementary school students and, with the District Geological Assistant, provided a weekend-long poster and sample display.

Field trips to several marble quarries and gold prospects were provided by the District Geologist for the Scarborough Gem and Mineral Club in May; the Kawartha Rock and Fossil Club in July; the Kingston Gem and Mineral Club in September; and the Buffalo Geological Society and the Niagara Peninsula Geological Society in October.

A field trip highlighting gold and copper-nickel deposits of southeastern Ontario was provided for 20 members of the Southern Ontario Prospectors Association in September. The trip featured examinations of the Ore Chimney, Mono and Dingman gold prospects and the Limerick copper-nickel deposit.

Diamond-Drill Core Collection

The Resident Geologist's Office (RGO) maintains an off-site diamond-drill core storage compound on Hunt Road, approximately 2 km south of the Village of Tweed. In addition to core stored on traditional core racks, the site houses over 200 000 m of irreplaceable drill core from southern Ontario stacked on pallets. A smaller collection of core, that is less likely to survive outdoor storage, is housed at the RGO facility in Tweed.

In 2016, clients conducted 2 significant relogging and sampling programs on diamond-drill core stored at the Tweed Drill Core Library. The first sampling program was triggered by the discovery of a previously unsampled zone of graphite mineralization identified during an examination of drill core from the

Bancroft area. The client was looking for rare earth element mineralization associated with a former uranium exploration project. The second program involved sampling of previously unsampled sections of drill core from the Bannockburn gold project, in Madoc Township, of Crown William Mining Corp. at the former Mono gold prospect. From November 2016 to February 2017, approximately 4000 samples were collected. For further information about this project, *see* "Exploration Activity" "Gold". These 2 major projects and other occasional users represent a total of 283 person-days of Drill Core Library use in 2016.

Other work completed at the Drill Core Library in 2016 includes the acquisition of 364 boxes (a total of approximately 1600 m) of drill core from the former Canada Talc Mine site in Madoc, brushing out and clearing debris from the site, and re-boxing of 750 core boxes as part of an ongoing maintenance program.

Table 5 provides a five-year summary of program activity and Table 6 lists new publications added to the Resident Geologist Program office (in Tweed) technical library during 2016.

Table 5. Program activity statistics (five-year summary) for the Southern Ontario Regional Resident Geologist's office.

Activity	2012	2013	2014	2015	2016
Field Investigations / Property Visits	45	45	39	36	27
Field Trips Given / Field Guides Written	2	3	3	6	7
MDI Records Revised	265	173	64	351	456
Presentations to Ministry of Municipal Affairs and Housing, Ministry of Natural Resources and Forestry, Ministry of Aboriginal Affairs	15	14	17	7	6
Clients Visits to RGP–Tweed Office	330	394	232	263	226
Drill Core Library Users	12	114	40	69	283
Client Communications / Interactions (Presentations/Poster Sessions)	>3000	>3000	>3000	>3000	>3000

Table 6. Library acquisitions in 2016 by the Southern Ontario Region (publications of particular interest to the Southern Ontario Region are shown in bold).

Title	Author(s)	Type and Year of Publication
A Library of Standards for Rock Names, Rock Modifiers and Terms Related to Structure, Alteration, Mineralization and Minerals for Precambrian Rocks in Ontario	T.L. Muir, S. Buse, N.F. Trowell and M. Duguet	Ontario Geological Survey, Open File Report 6289, 204p., 2016
Aggregate Resources Inventory of the County of Middlesex and the City of London, Southern Ontario	V.L. Lee	Ontario Geological Survey, Aggregate Resources Inventory Paper 78, 104p., 2016
Aggregate Resources of Ontario—2015	Ontario Geological Survey	Ontario Geological Survey, ARO—2015, 2016
Geographic Index to Published Reports, Maps and Digital Data, 2011–2015	Ontario Geological Survey	Ontario Geological Survey, Miscellaneous Paper 178, 266p., 2016
Index to Maps, Bedrock Geology 1991–2015	Ontario Geological Survey	Ontario Geological Survey, scale 1:1 000 000, 2016
Index to Maps, Surficial Geology 1991–2015	Ontario Geological Survey	Ontario Geological Survey, scale 1:1 000 000, 2016
Index to Published Reports, Maps and Digital Data, 2011–2015	Ontario Geological Survey	Ontario Geological Survey, Miscellaneous Paper 177, 98p., 2016
Precambrian Geology of the Mud Lake Area, Grenville Province	M. Duguet, V. Dubé-Bourgeois and S. Ma	Ontario Geological Survey, Preliminary Map P.3785, scale 1:20 000, 2016
Geological, Geochemical and Geophysical Data Related to the Mud Lake Area, Grenville Province	M. Duguet	Ontario Geological Survey, Miscellaneous Release—Data 327, 2016

Title	Author(s)	Type and Year of Publication
Results of Quaternary Geology Mapping in the Lindsay and Peterborough Areas, Southern Ontario	A.S. Marich	Ontario Geological Survey, Open File Report 6321, 59p., 2016
Quaternary Geology, Lindsay Area, Southern Ontario	A.S. Marich	Ontario Geological Survey, Preliminary Map P.3798, scale 1:20 000, 2016
Quaternary Geology, Peterborough Area, Southern Ontario	A.S. Marich	Ontario Geological Survey, Preliminary Map P.3799, scale 1:20 000, 2016
Results of Till Sample Analyses of the Lindsay and Peterborough Areas, Southern Ontario	A.S. Marich	Ontario Geological Survey, Miscellaneous Release—Data 333, 2016
Groundwater Hydrochemistry Data for Multi-Depth Well Sampling in the Early Silurian Carbonates of the Niagara Escarpment Cuesta	E.H. Priebe and V.L. Lee	Ontario Geological Survey, Miscellaneous Release—Data 337, 2016
Stream Sediment and Water Geochemical Data, Lake Erie Tributaries, Ontario	H.E. Burke	Ontario Geological Survey, Miscellaneous Release—Data 340, 2016
Three-Dimensional Modelling of Surficial Deposits in the Orangeville–Fergus Area of Southern Ontario	A.K. Burt and J.E.P. Dodge	Ontario Geological Survey, Groundwater Resources Study 15, 2016
Report of Activities 2015, Resident Geologist Program, Kirkland Lake Regional Resident Geologist Report: Kirkland Lake and Sudbury Districts	D.L. Guindon, D.G. Farrow, L.A.F. Hall, C.M. Daniels, R.L. Debicki, A.C. Wilson, L.A. Bardeggia and N. Sabiri	Ontario Geological Survey, Open File Report 6318, 106p., 2016
Report of Activities 2015, Resident Geologist Program, Red Lake Regional Resident Geologist Report: Red Lake and Kenora Districts	A.F. Lichtblau, C. Ravnaas, C.C. Storey, R.D. Tuomi, A. Tims, R.L. Debicki, T.K. Pettigrew, G.F. Paju and J. Wetendorf	Ontario Geological Survey, Open File Report 6314, 130p., 2016
Report of Activities 2015, Resident Geologist Program, Southern Ontario Regional Resident Geologist Report: Southeastern Ontario and Southwestern Ontario Districts and Petroleum Operations	P.J. Sangster, P.S. LeBaron, S.J. Charbonneau, D.A. Laidlaw, R.L. Debicki, A.C. Wilson and L. Fortner	Ontario Geological Survey, Open File Report 6319, 65p., 2016
Report of Activities 2015, Resident Geologist Program, Thunder Bay North Regional Resident Geologist Report: Thunder Bay North District	G.D. White, R.M. Cundari, M.R. Brunelle, T.K. Pettigrew, R.D. Tuomi, A. Tims and R.L. Debicki	Ontario Geological Survey, Open File Report 6315, 68p., 2016
Report of Activities 2015, Resident Geologist Program, Thunder Bay South Regional Resident Geologist Report: Thunder Bay South District	M.A. Puumala, D.A. Campbell, R.D. Tuomi, A. Tims, R.L. Debicki, T.K. Pettigrew and M.R. Brunelle	Ontario Geological Survey, Open File Report 6316, 85p., 2016
Report of Activities 2015, Resident Geologist Program, Timmins Regional Resident Geologist Report: Timmins and Sault Ste. Marie Districts	E. van Hees, P. Bousquet, A. Pace, C.M. Daniels, R.L. Debicki, A.C. Wilson, S.A. Beauchamp and J. Walmsley	Ontario Geological Survey, Open File Report 6317, 91p., 2016
Summary of Field Work and Other Activities, 2016	Ontario Geological Survey	Ontario Geological Survey, Open File Report 6323, 394p., 2016
A Dictionary of Mining, Mineral, and Related Terms	P.W. Thrush	U.S. Bureau of Mines, 1275p., 1968
Bedrock Geology and the Precambrian–Paleozoic Unconformity in Southeastern Ontario	R.M. Easton, T.R. Carter and G. DiPrisco	American Association of Petroleum Geologists, 1990 Eastern Section Meeting, Field Trip Guidebook #1, 63p., 1990
Classic Outcrops in the Central Gneiss Belt, Ontario – A Retrospective	A. Davidson, L. Nadeau and N.G. Culshaw	Friends of the Grenville, Field Trip Guidebook, 2012
Discover Prospecting: An Introductory Prospecting Manual	J.R. Parker	Ontario Geological Survey, 2004
Field Course Exercises	S.A. Ferguson	Ontario Department of Mines and Northern Affairs, 1972
Frontenac–Sharbot Lake Relationships: Evaluation of a Provocative Hypothesis Concerning the Tectonics of the Central Metasedimentary Belt, Ontario	R.M. Easton and A. Davidson	Friends of the Grenville, Field Trip Guidebook, 1997
Geological Characteristics of Gold Deposits in the Superior Province of the Canadian Shield	C.J. Hodgson and P.J. MacGeehan	reprint of article *in* Geology of Canadian Gold Deposits, Canadian Institute of Mining and Metallurgy, Special Volume 24, 19p., 1982

Title	Author(s)	Type and Year of Publication
Geology of Titanium-Mineral Deposits	E.R. Force	Geological Society of America, Special Paper 259, 112p., 1991
Glacial Geology of the Toronto–Orangeville Area Ontario	A.K. Watt, L.J. Chapman, D.F. Putnam and W.M. Tovell	Geological Society of America–Geological Association of Canada, joint meeting, Guidebook to Field Trip No.3, 19p., 1953
Guide to the Evaluation of Gold Deposits	M. Vallée	Canadian Institute of Mining, Metallurgy and Petroleum, Special Volume 45, 299p., 1992
Meteorites and "Meteorwrongs", Glassy Materials Including a "Pseudofulgurite", Grenville-Province Minerals, a Suite from Brazil, and Ores and Ore Minerals	G.C. Wilson	Turnstone Geological Services Ltd., Report 2001-100, 54p., 2001
Minerals Handbook 1992–93: Statistics and Analyses of the World's Minerals Industry	P. Crowson	Stockton Press, 319p., 1992
Natural Stone in Canada: A History of Quality	Roc Maquina	Roc Maquina and Natural Resources Canada, 68p., 1999
North of 50 Degrees: An Atlas of Far Northern Ontario	J.E.J. Fahlgren and G. Matthews	The Royal Commission on the Northern Environment and University of Toronto Press, 119p., 1985
Proceedings of the 33rd Forum on the Geology of Industrial Minerals	M. Bélanger, T. Clark and H-L. Jacob (eds.)	Canadian Institute of Mining, Metallurgy and Petroleum, Special Volume 50, 288p., 1998
Report on the Building and Ornamental Stones of Canada, v.I	W.A. Parks	Department of Mines, Canada, 382p., 1912
Summary Report on Regional and Petrographic Studies of the Pleistocene of the London Area	A. Dreimanis and G.H. Reavely	Research Council of Ontario, 1952
The Metallogeny of Lode Gold Deposits: A Syngenetic Perspective	U. Kretschmar and D. McBride	Elsevier, 339p., 2016
Toronto Rocks: The Geological Legacy of the Toronto Region	N. Eyles and L. Clinton	University of Toronto, 41p., 1998 *[note: preliminary version of book later published under the same title by Fitzhenry and Whiteside, 2004]*
William E. Logan's 1845 Survey of the Upper Ottawa Valley	C.H. Smith and I. Dyck (eds.)	Canadian Museum of Civilization, Mercury Series, History Paper 54, 238p., 2007

PROPERTY EXAMINATIONS

In 2016, a total of 27 properties in the Southern Ontario Region were visited by Resident Geologist Program staff; these visits are listed in Table 7.

Table 7. Property visits conducted by the Southern Ontario Regional Resident Geologist and staff in 2016 (keyed to Figures 4 and 5).

Number	Property / Operation	Commodity
	Southeastern Ontario District	
1	Addington Mine, Union Glory Gold Ltd., Kaladar Township	Gold
2	Bobcaygeon graphite property, Earth Resources Ltd., Galway Township	Graphite
3	Bridgewater Quarry, Danford Granite, Elzevir Township	Trap rock
4	Dingman prospect, California Gold Mining Inc., Marmora Township	Gold
5	Edison graphite, Marmora Township	Graphite, gold
6	Frontenac lead mine, Loughborough Township	Mineral specimens (galena, calcite)
7	Gilmour gold mine, Grimsthorpe Township	Gold
8	Griffith marble prospect, Bertus Industrial Ltd., Griffith Township	Dimension stone
9	Lakefield pit, CBM Aggregates, Smith Township	Aggregate
10	Limerick (Macassa) prospect, Hastings Highlands Resources Ltd., Limerick Township	Nickel, copper, cobalt
11	Madoc project, Crown William Mining Corp., Madoc Township	Gold
12	Omega Quarry, OMYA Canada Inc., Darling Township	Marble dimension stone
13	Ore Chimney prospect, Barrie Township	Gold
14	Petworth Quarry, Rideauview Contracts Ltd., Portland Township	Dimension stone
15	R. Waring claims, Anglesea Township	Gold
16	Star East claims, Barrie Township	Gold
17	Star gold mine, Barrie Township	Gold
18	Stonescape Quarry, Harvey Township	Dimension stone
19	Tatlock Quarry, OMYA Canada Ltd., Darling Township	Calcium carbonate
20	Temagami Pink Quarry, W. Graf, Faraday Township	Dimension stone
21	Tweed Marble Quarry, Hungerford Township	Dimension stone
22	Upper Canada Stone, Green Marble Quarry, Huntingdon Township	Stone, scientific interest
23	Upper Canada Stone plant, Madoc Township	Decorative aggregate, landscaping stone
	Southwestern Ontario District	
24	Bowmanville Quarry, St. Marys Cement, Darlington Township	Cement
25	East Duffins headwaters properties (rehabilitated pit), Uxbridge Township	Scientific interest
26	Heber Down Conservation Area (rehabilitated pit), Whitby Township	Scientific interest
27	Mosport pit, CRH Canada Group Inc., Clarke Township	Aggregate
	Outside Southeastern Ontario and Southwestern Ontario Districts	
28	Kirkland Lake area geology field trip	Scientific interest

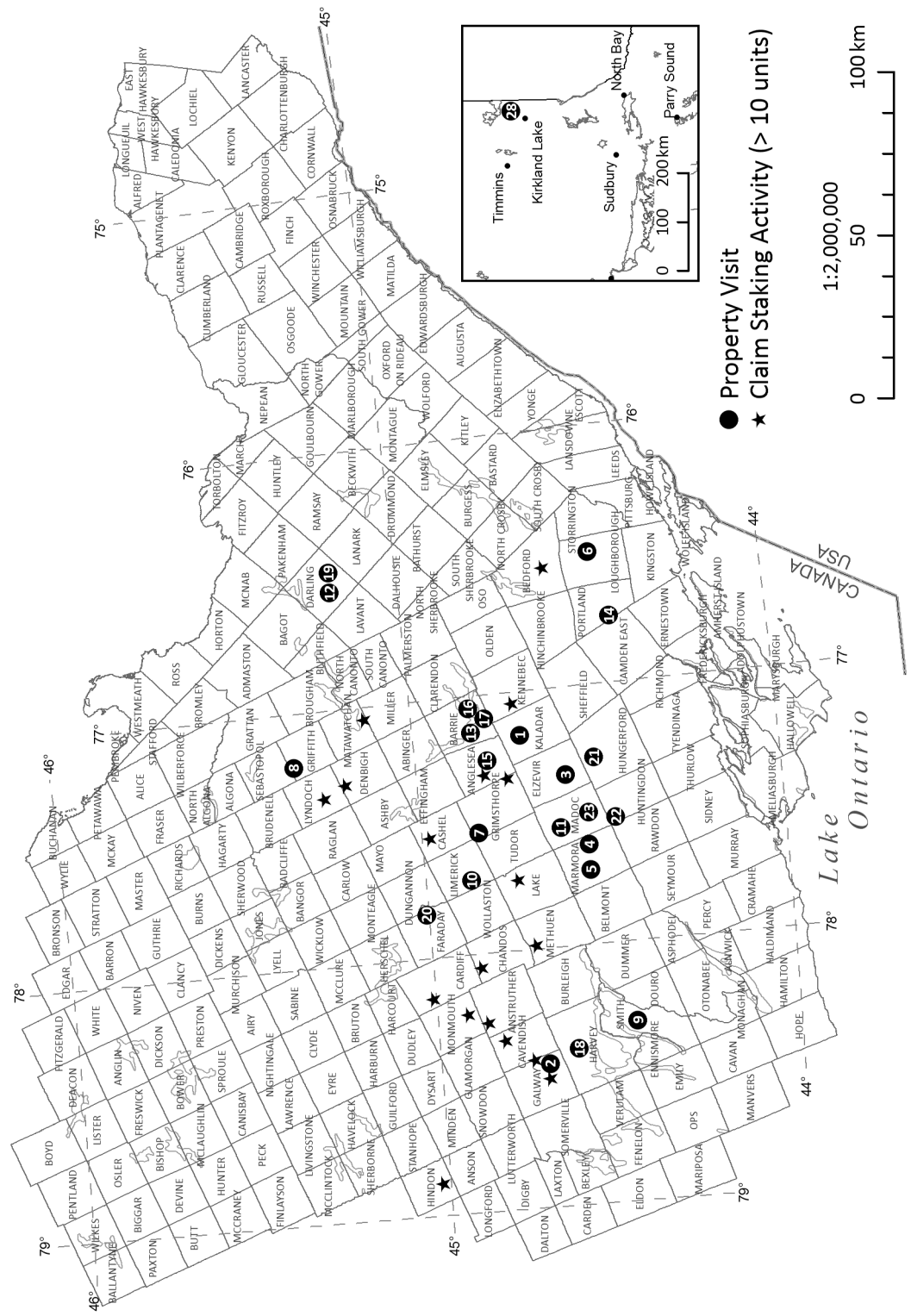

Figure 4. Property visits (keyed to Table 7) and claim staking activity in the Southeastern Ontario District in 2016.

Figure 5. Property visits (keyed to Table 7) in the Southwestern Ontario District in 2016.

Union Glory Gold Limited, Addington Property, Kaladar Township

On November 8, 2016, both the Regional Resident Geologist and the District Geologist visited the Addington gold project while Union Glory Gold Ltd. was in its final stages of drilling at the property. Union Glory Gold has optioned the property from Imperial Metals Corporation and has been actively exploring it since 2013.

LOCATION AND ACCESS

The Addington property covers a total of 162 ha in Kaladar Township on concessions V and VI, lots 23, 24 and 25. The property is situated 10 km north of the village of Kaladar and approximately 75 km north and northeast from the city of Belleville. From Belleville, the property is accessed by driving north on Highway 37 for 46 km, then turning east on Highway 7 until Kaladar. From Kaladar, driving north on Highway 41 for approximately 8 km and turning west on the Flinton Road (County Road 29) for approximately 1.5 km. The old mine infrastructure is located north of the Flinton Road approximately another 1.5 km.

EXPLORATION HISTORY

Highlights of the exploration history of the Addington property are summarized *from* Miller and Knight (1913), Harding (1942), Wolff (1982) and McBride (2013).

1881: The Addington gold prospect was discovered by Golden Fleece Mining Company and was originally known as the Golden Fleece deposit. Little work was carried out on the property until 1887.

1887: Two shallow shafts were sunk and a 10-ton stamp mill was erected by Adelaide Mining Company of Baltimore, Maryland.

1907: A vertical shaft was sunk to a depth of 85 feet and about 50 feet of crosscut was driven (Miller and Knight 1913, p.112).

1907–1915: The mine was operated from by A.B.P. Mining Company under option from Adelaide Mining.

1915–1922: The Cobalt Frontenac Mining Company Limited deepened the shafts to depths of 60 and 100 feet, and a total of 350 feet of drifting and 402 feet of crosscutting were completed. Up to the end of 1919, the total production of the mine was about $10 000 from the 10-ton stamp mill (Harding 1942). In 1922, a cyanide mill plant was added to the mill equipment and the total production for that year was 50 ounces of gold and 26 ounces of silver worth $1056. The mine was not profitable to operate.

1927–1928: Development work was carried out by The Cobalt Frontenac Mining Company Limited at the 100 foot level, discovering 3 veins, having an average width of 20 feet, 30 feet and 12–15 feet, respectively. In 1928, the property was purchased by Rich Rock Gold Mines, a company controlled by Cobalt Frontenac.

1932: The property was sampled by C.N. Thompson and the mine was pumped out to the 100 foot level. Some mining was carried out and part of the mill reopened.

1935–1940: In 1935, the property was under option by Consolidated Mining and Smelting Company of Canada Limited (later to become Cominco Limited), which commenced work on the property. In 1936, the project was assigned to Addington Mines Limited (a subsidiary of Consolidated Mining and Smelting Company of Canada Limited), which took over the exploration and development of the property. Over a two-year period, Addington Mines carried out the most extensive development work to-date at the Addington project (Photo 2). The work included deepening the inclined shaft to a depth of 535 feet, sinking a winze 273 feet below the 500 foot level to the 625 foot and 700 foot levels. A total of 3033 feet of crosscutting and 7096 feet of drifting were completed at the 300-foot, 400-foot, 500-foot and 700-foot levels. Eight surface and 68 underground diamond-drill holes were

completed totaling 8856 feet and a "reserve" estimation was completed. In June 1939, mineral "reserves" were stated at the time as 233 000 tonnes averaging to 0.17 ounces per ton gold with another 103 000 tons of "probable ore" grading 0.09 ounces per ton gold (Table 8 provides historical resources calculations at the Addington Mine: historical resource only, not compliant with NI 43-101).

In the spring of 1939, all work was suspended, with the exception of surface drilling, and the mine was allowed to flood. In 1940, the mill was removed from the mine site and the mine has been inactive since.

1949: The Consolidated Mining and Smelting Company of Canada Limited completed another resource estimate at the property, reporting "reserves" of 160 000 tons grading 0.17 ounces per ton gold and "probable ore" of 166 000 tonnes at a grade of 0.13 ounces per ton gold (tonnage converted from short tons to metric tonnes and grades converted from $ per short ton to ounces per metric tonne (Bell 1949)) (*see* Table 8 for historical resources calculations at the Addington Mine: historical resource only, not compliant with NI 43-101).

Table 8. Historical resources calculated at the Addington project, Union Glory Gold Limited (*from* McBride 2013). All data have been converted to metric tonnes, ounces per tonne (oz/t), grams per tonne (g/t) and equivalent class of resource; however, these are not compliant with NI 43-101.

Addington Mine Property – Historical Resource Estimates (NI 43-101 non-compliant)					
Year	**Author**	**Amount (t)**	**Grade (oz/t)**	**Grade (g/t)**	**Class**
1939	Cominco	233 000	0.18	5.51	Indicated
		94 000	0.09	2.75	Inferred
1949	Bell	160 000	0.17	5.37	Indicated
		166 000	0.13	4.13	Inferred
1981	Johnson	66 000	0.19	5.85	Indicated
		697 000	0.10	3.01	Inferred
1983	Johnson	160 000	0.17	5.16	Measured
		130 000	0.16	5.63	Indicated
		425 000	0.12	3.79	Inferred
1988	Michele Mines (D-zone only)	130 000	0.17	5.16	Indicated

Photo 2. Addington Mine site near Flinton in Kaladar Township, *circa* 1939 (*from* Harding 1942).

1980–1983: The property laid dormant until E&B Exploration optioned the property from Cominco Limited (formerly Consolidated Mining and Smelting Company of Canada Limited) in 1980. Later that year, E&B completed 3 due diligence diamond-drill holes that confirmed the presence of mineralization as stated by Cominco. E&B also calculated a resource (not NI 43-101 compliant) of 66 000 tonnes at a grade of 0.19 ounces per ton gold "indicated" with an additional 697 000 tonnes at a grade of 0.10 ounces per ton gold "inferred".

E&B continued drilling in 1981 with 14 drill holes, for a total of 3092 m. Drilling results from E&B suggested that mineralization extended at depth with improving grades (such as 7.82 g/t Au over 3.08 m and 11.94 g/t Au over 8.89 m). In 1982, 5 additional drill holes were completed (1356 m) testing the D-zone of the deposit. Results varied in grade from 1.44 to 7.47 g/t Au over core lengths of 0.61 to 2.68 m.

In 1983, Senlac Resources Inc. earned an interest in the property by financing a drill program of 9 drill holes, for a total of 1878 m, extending the mineralization with, albeit, disappointing results. In 1983, E&B estimated a resource (NI 43-101 non-compliant) of 160 000 tonnes grading at 0.17 ounces per ton gold in the "measured" category, 130 000 tonnes at a grade of 0.16 ounces per ton gold in the "indicated" category and 425 000 tonnes at a grade of 0.12 ounces per ton gold in the "inferred" category (Johnson 1983) (*see* Table 8 for historical resources calculations at the Addington Mine: historical resource only, not compliant with NI 43-101).

1988: The property remained inactive until 1988 when Michele Mines Limited optioned the property. Michele Mines carried out a drilling program of 15 drill holes, for a total of 3708 m, aimed at the D-zone of the deposit alone. A resource estimate of 130 000 tonnes grading 0.17 ounces per ton gold in the "indicated" category was completed on the D-zone (*see* Table 8 for historical resources calculations at the Addington Mine: historical resource only, not compliant with NI 43-101).

1999–present: The property was acquired by Imperial Metals Corp. in 1999 through a merger. In 2012, Imperial Metals optioned the property to Union Glory Gold, a private company, and Union Glory commenced a review of the mine data in April of that year.

2013: Historical drill core from the MNDM Drill Core Library in Tweed was examined and resampled to upgrade the existing data to be compliant with NI 43-101.

2015: Union Glory Gold Limited completed 5 diamond-drill holes, totalling 305 m, on the Addington gold mine property in Kaladar Township. Diamond drilling completed in June 2015 was intended to confirm results of previous drilling. The company has not released the results of the 2015 drilling.

2016: Union Glory completed 48 diamond-drill holes at the Addington gold project, for a total of 9553 m. The objective of the drilling program, carried out from May to November, was to confirm the historical model of 5 near-vertical gold zones, plunging northeast and hosting a potentially economic resource. In addition, baseline environmental and preliminary metallurgical studies were also commenced.

REGIONAL GEOLOGY

The property is located in the Grimsthorpe domain of the Central Metasedimentary Belt within the Grenville Province. In the Kaladar Township area, rocks of the Grenville Supergroup are characterized dominantly by mafic metavolcanic and clastic metasedimentary rocks with ages between 1300 and 1250 Ma, followed by plutonism at 1250 to 1230 Ma (Easton 1992). The Grenville Supergroup is overlain unconformably by the Flinton Group rocks (*circa* 1155 Ma), which consist dominantly of quartz arenites, conglomerates and pelitic schists (Easton 1992). Metamorphism is generally of greenschist and lower-amphibolite facies and occurred from 1130 to 1070 Ma (Easton 1992, 2000).

The geology of the Kaladar area is described in detail by Wolff (1982). The base of the stratigraphic sequence in the area consists of tholeiitic mafic to intermediate metavolcanic rocks of the Tudor Formation overlain by aluminous, garnetiferous hornblende-biotite schists, which are, in turn, overlain by a metavolcanic and metasedimentary sequence of clastic siliceous gneisses, carbonate metasedimentary rocks, and amphibole-rich gneisses and schists.

The Tudor Formation rocks are overlain unconformably by Flinton Group metasedimentary rocks, which consist of quartz-pebble conglomerates, quartzofeldspathic sandstones and quartzites overlain by carbonate-biotite schists, polymictic pebble conglomerates and calc-silicate gneisses.

The base of the sequence was intruded by the Killer Creek gabbro suite, which was, in turn, intruded by the Elzevir and Northbrook tonalitic batholiths (1270 Ma).

The whole stratigraphic sequence was intruded by late tectonic felsic intrusive rocks, such as leucocratic granitic and pegmatitic dikes.

In the Addington project area, lithological contacts and the dominant foliation are generally parallel, trending north-northeast and dipping steeply to the east. Isoclinal folds are observed locally, with fold axial planes parallel to the dominant foliation and axes plunging gently to the southwest (Wolff 1982).

Similar to the Addington property, other gold occurrences within the belt, such as the Ore Chimney and Harlowe, are all located within metavolcanic rocks near the contact with the Temiskaming-type clastic Flinton Group metasedimentary rocks (Figures 6 and 7). These gold occurrences typically consist of concordant to discordant, quartz and quartz-carbonate (ankerite) veins containing various assemblages of pyrite, pyrrhotite, arsenopyrite and traces of native gold. Locally, such as at the Ore Chimney deposit, veins contain abundant galena, sphalerite and chalcopyrite. Veins are structurally controlled, occurring

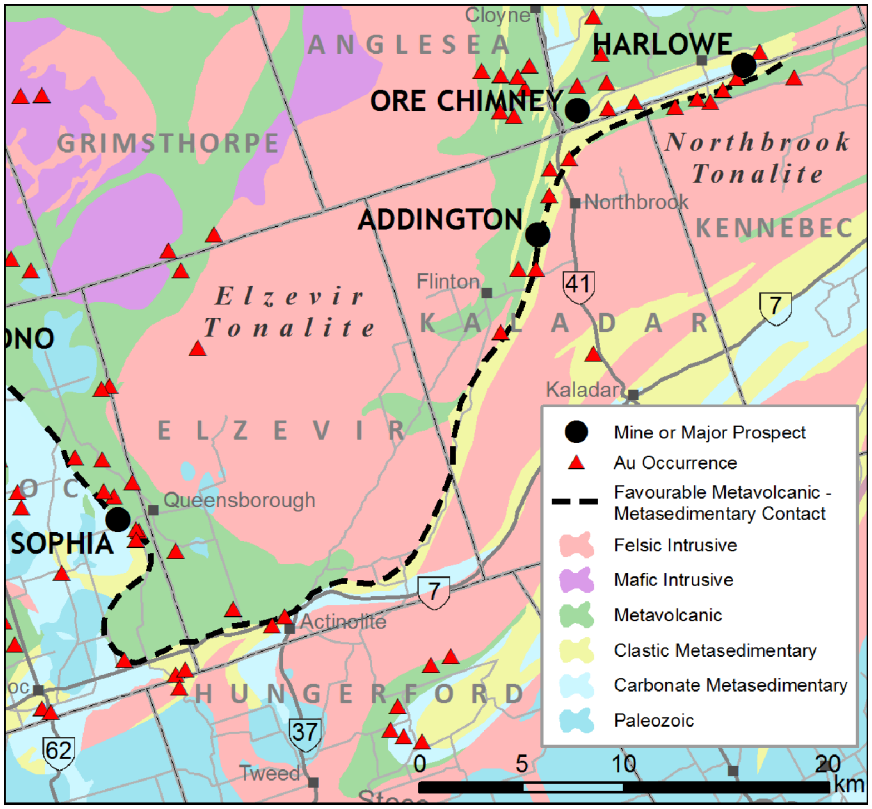

Figure 6. Geology and gold occurrences near the Addington project area (geology *from* Ontario Geological Survey 2011).

within or adjacent to zones of hydrothermal alteration that exhibit iron carbonate and/or biotite-sericite alteration and/or pyrite mineralization.

PROPERTY GEOLOGY

The property geology was mapped by E&B Exploration in the early 1980s. All rock units and the dominant foliation strike 010/65-75E. The western part of the property is underlain by massive to pillowed mafic metavolcanic flows and volcaniclastic rocks of the Tudor Formation. To the east, and unconformably overlying the Tudor Formation rocks, are Flinton Group metaquartzites and metaconglomerates. Near the upper contact of the Tudor Formation volcanic rocks, is a garnetiferous horizon, which is named the Ore Chimney Formation for its typical occurrence at the former Ore Chimney Mine approximately 7 km to the north.

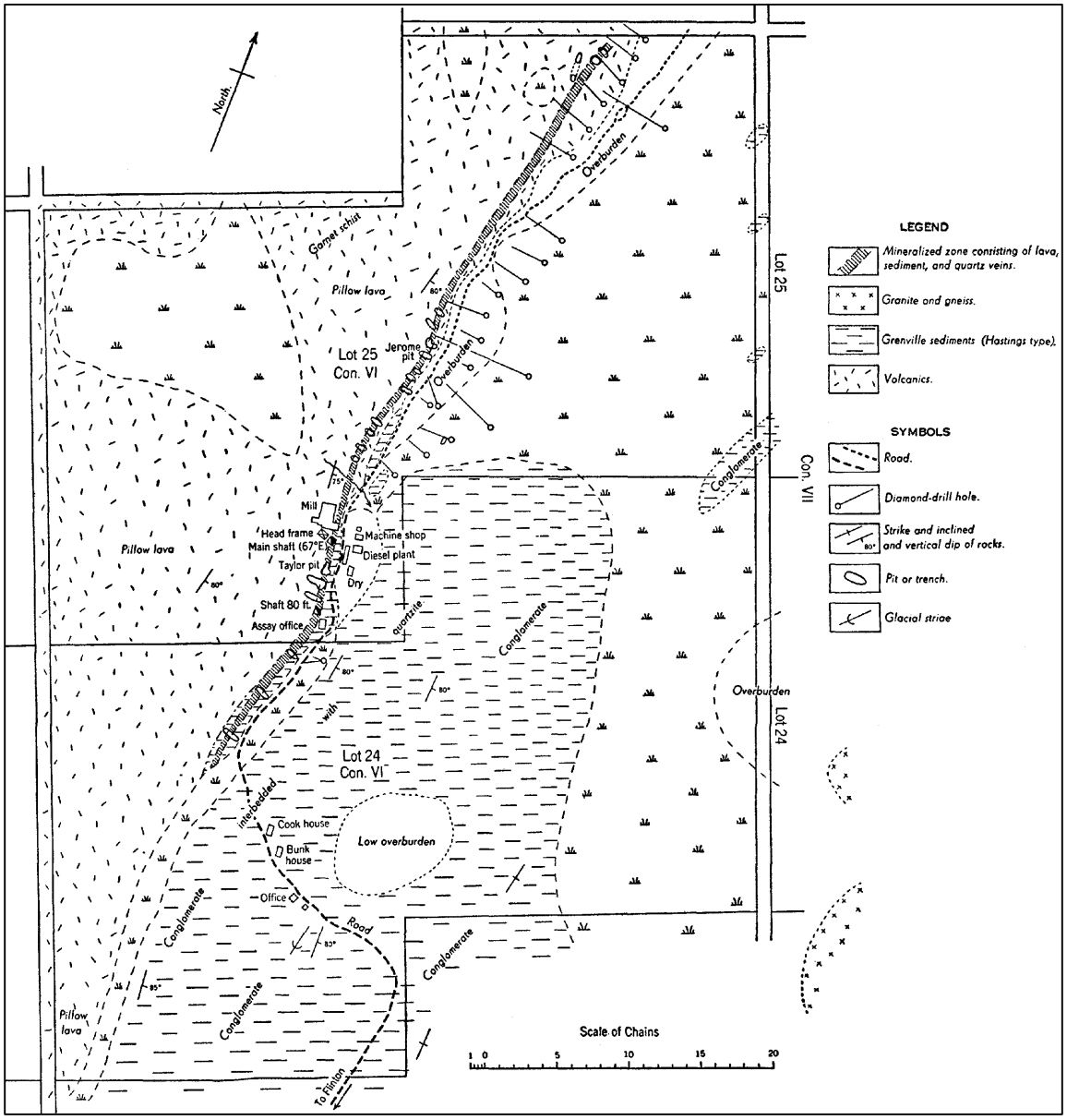

Figure 7. Geological sketch map of the surface area at the Addington Mine (*from* Harding 1942). "Grenville sediments" refer to Flinton Group metasedimentary rocks; "Volcanics" refer to Tudor Formation metavolcanic rocks.

EXPLORATION PROGRAM 2016

The 2016 exploration program consisted of drilling 48 NQ diamond-drill holes, totalling 9553 m. Core was cut on-site with a diamond saw (Photo 3) and stored in a local secure long-term storage facility. A surveyor established the accurate location of the holes being drilled to support the generation of a three-dimensional georeferenced database of both new and historical information. Over 3000 m of historic underground development, on 6 different levels, was georeferenced to facilitate the drilling of the 5 different gold zones (A through E).

A metallurgical test sample was prepared from quartered core composites of the 5 zones and delivered to SGS in Lakefield, Ontario. A baseline environmental program was also commissioned and an independent third-party consulting firm has commenced their studies.

SUMMARY OF RESULTS AND POTENTIAL FUTURE WORK

Mr. Jimmy Sun of Union Glory Gold offered the following quote when asked about the Company's future plans "Union Glory Gold is excited by the unexpected and very promising drilling results, and is formulating plans for substantial additional drilling in the near future to confirm and consolidate these findings".

Union Glory reported the "mineralized zone" was encountered in every drill hole with surprisingly predictable accuracy. At least one of the target zones hosted multiple mineralized zones, with reversals of lithology indicating the existence of possible post-mineralization folding.

Of particular note, the Ore Chimney Formation horizon at the Addington property is reported to be a coarse tuffaceous mafic unit, often uniquely garnetiferous, overlying mafic flows, and grading upwards into a possible silicate facies . Overlying the Ore Chimney Formation horizon, and often intercalated with it, is a greywacke sequence that grades upward through arkosic wackes and finally into arkose. The 5 targeted gold zones drilled to date typically span the contact between the Ore Chimney Formation garnetiferous tuffs and the overlying greywackes.

Photo 3. Union Glory Gold Limited drill camp at the Addington property in November 2016.

The company has indicated that it will complete the detailed survey of all drill collars located to date, continue to build an accurate three-dimensional georeferenced database, continue metallurgical studies, continue environmental baseline studies, complete in-house resource estimate studies, and commence definition-scale drilling, if warranted.

Crown William Mining Corporation, Bannockburn Gold Project, Madoc Township

On August 8, 2016, the District Geologist, SEP student R. Holt, and D. Spires, Inspection and Compliance Officer, MNDM Sudbury, examined the geology and surface exploration workings on the Bannockburn project area (formerly the Mono gold prospect) and the Emmenbe project area (formerly the Bannockburn gold mine) of Crown William Mining Corporation. To conform to historic records, the Bannockburn project will be referred to as the "Mono zone" and the Emmenbe project as the "Bannockburn mine".

LOCATION AND ACCESS

The Bannockburn project area is located in north-central Madoc Township, about 16 km north of Madoc and less than 1 km from the village of Bannockburn. The main zone of interest, formerly known as the "northeast area" of Mono Gold Mines Inc., is covered by 2 leased mining claims in Concession VI, Lot 29 (western half). Access is by a gravel road leading east from Highway 62, approximately 400 m north of Bannockburn.

The area of the old Bannockburn gold mine in Concession V, Lot 29, west of Highway 62 and west of the Moira River, was also examined and is briefly described below. The river can be crossed on a log-and-plank foot bridge at the north end of Bannockburn, from which an all-terrain vehicle trail leads southwestward approximately 400 m to trenches and shafts in the old mine area.

EXPLORATION HISTORY

Unless otherwise noted, the following exploration history is summarized *from* Schorn (1998).

Gold was first discovered in Ontario at the Richardson Mine in Eldorado, about 5 km south of Bannockburn. The Bannockburn Mine was developed prior to 1894 and operated until 1898. The only record of production is 3.5 ounces of gold from 100 tons of ore between 1894 and 1896. Numerous trenches and 4 shallow shafts (maximum depth about 22 m) were sunk on the main vein over a strike length of about 220 m (Malczak, Carter and Springer 1985).

In 1981, Mono Gold Mines Inc. acquired the old Bannockburn Mine and staked adjoining claims and, in 1984, gold mineralization was discovered in the "northeast area" during an exploration program that included a ground very low frequency electromagnetic (VLF–EM) and magnetometer survey, geological mapping and sampling. By the end of 1986, Mono Gold Mines had completed over 100 diamond-drill holes, totalling over 30 000 feet, outlining a deposit of about 250 000 tons of ore grading 0.45 ounces of gold per ton. Additional drilling in 1987 led to a revised tonnage and grade estimate of 372 000 tons averaging 0.39 ounces of gold per ton (Sawyer Consultants Inc. 1987). Resource estimations are not compliant with NI 43-101.

In 1988, Mono entered an agreement with Micham Exploration Inc. to conduct underground exploration work. A ramp was driven to the 25 m level, at which depth a drift was continued along the quartz vein zone for about 100 m. With a declining price of gold in 1989, the project was stopped.

In 1993, with the price of gold rising above $400 per ounce for the first time in 30 months, Mono contracted a mining company to dewater the workings and continue underground exploration. The results of this work were not sufficiently encouraging to warrant additional investment, and Mono abandoned the property.

In 1996, Madoc Mining Company Limited applied for a permit to extract a bulk sample of up to 10 000 tons from the underground workings. Work continued sporadically over the following year, as funds to pay the mining contractor were difficult to raise. However, the contractor agreed to continue working in exchange for a 50% interest in any gold that was recovered from the bulk sample. By the end of September 1997, 1300 tons of ore were shipped to a custom mill operated by St. Andrew Goldfields near Timmins. By this time, the price of gold had dropped below $300 per ounce and the project was abandoned in October 1997. Results of the bulk sample test are unknown.

The portal to the underground workings was sealed once again, and the property remained dormant until 2011, when Crown William Mining Corporation acquired the mineral rights to the property and began a re-evaluation of the "northeast area". Beginning with a review of past exploration work, the company followed up in 2013 with re-examination and sampling of diamond-drill core from the property, stored at the MNDM Drill Core Library in Tweed. In 2015, the company completed a program of surface mapping, stripping and channel sampling, followed by a second phase of diamond-drill core sampling in late 2016.

REGIONAL GEOLOGY

The property is located in the Grimsthorpe domain of the Central Metasedimentary Belt, Grenville Province, dominated by mafic metavolcanic and clastic metasedimentary rocks older than 1270 Ma (Easton 2008). In the Madoc and Tudor townships area, mafic metavolcanic and volcaniclastic rocks of the Tudor Formation form a relatively narrow (3–5 km wide), northerly trending belt between carbonate-dominated metasedimentary rocks of the Belmont domain to the west and tonalite-granodiorite of the Elzevir pluton (1270 Ma) to the east. Metamorphic grade is lower to middle greenschist.

Several gold occurrences, including the Tudor, Sophia and Mono deposits, are located within the belt, spatially associated with metavolcanic rocks near the contact with clastic metasedimentary rocks (*see* Figure 7). All consist of quartz and quartz-carbonate (ankerite) veins containing various assemblages of pyrite, pyrrhotite, arsenopyrite and traces of native gold. All are structurally controlled, occurring within or adjacent to zones of hydrothermal alteration that exhibit pervasive iron carbonate and/or biotite-sericite alteration and/or pyrite mineralization.

The association of gold mineralization with the end of Tudor Formation volcanism may extend to other areas, such as the Cordova, Deloro, Dingman and Bannockburn deposits, in which plutonic rocks have intruded the volcanic–sedimentary contact area; and the Addington, Ore Chimney and Harlowe area deposits where the volcanic rocks are unconformably overlain by conglomerates and quartzites of the Flinton Group (Figure 8).

PROPERTY GEOLOGY

Mono Zone

The gold-bearing Mono zone is situated at the contact between mafic metavolcanic and overlying metasedimentary rocks on the southeastern limb of a southwesterly plunging anticline (Figure 9). Both units show pervasive axial planar foliation and locally intense development of small-scale S and Z folds.

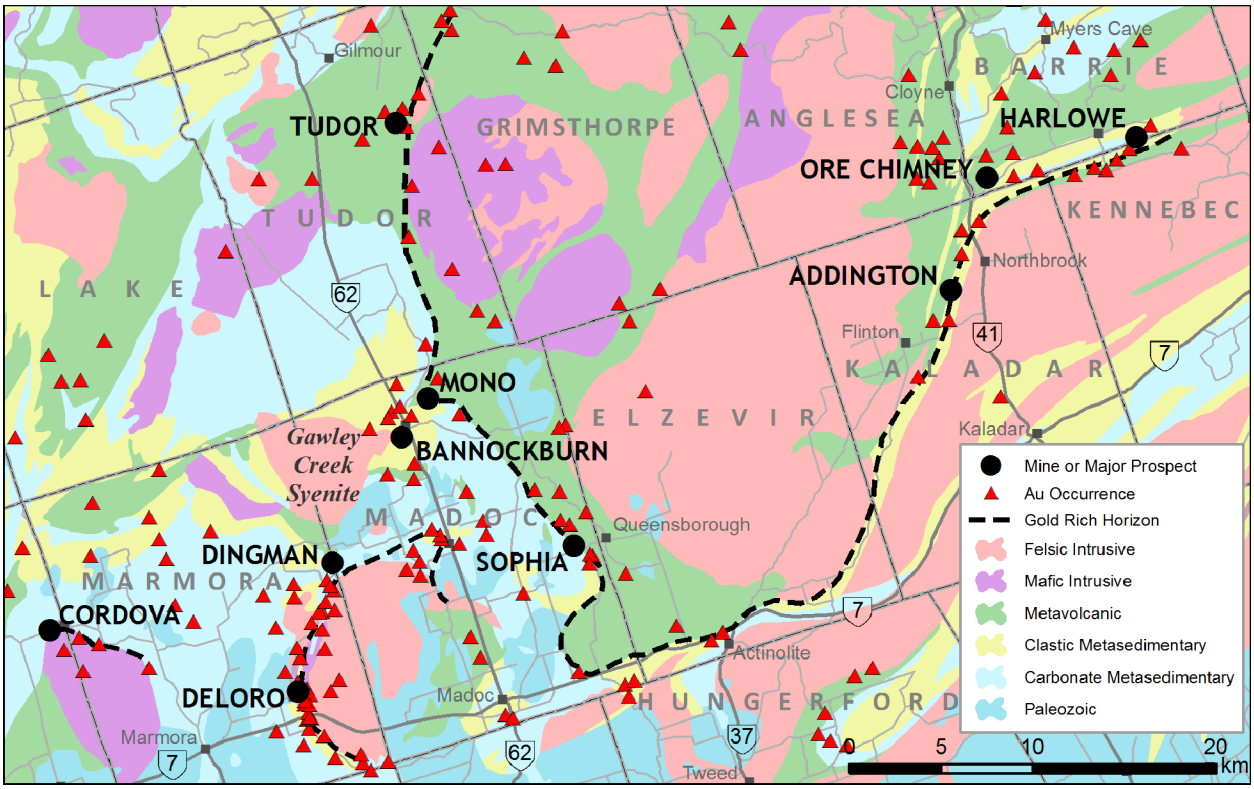

Figure 8. Geology and gold occurrences of the Marmora–Madoc–Harlowe area, southeastern Ontario (geology *from* Ontario Geological Survey 2011).

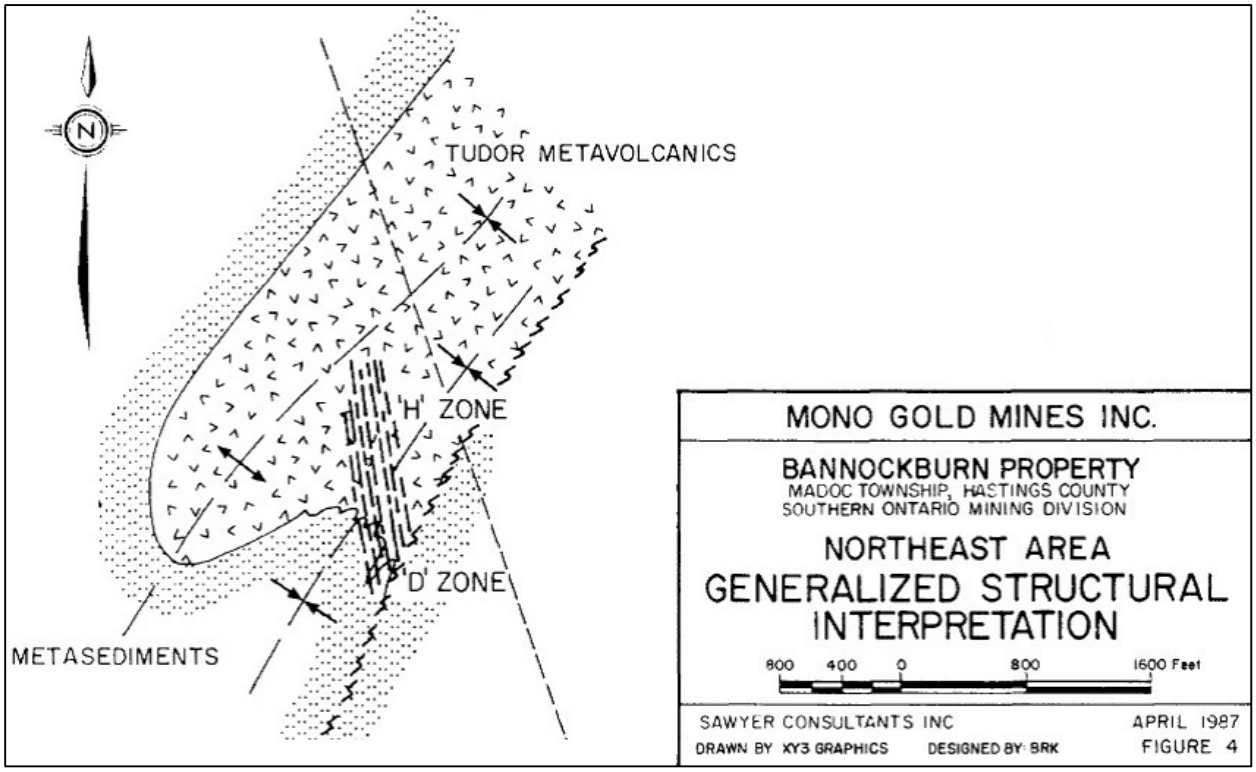

Figure 9. Generalized structural geology of the "northeast area" of the Mono gold prospect (*from* Sawyer Consultants Inc. 1987).

The predominant type of metasedimentary rock is rusty, banded, quartz-sericite schist commonly containing up to 10% disseminated pyrite, pyrrhotite, and traces of chalcopyrite and sphalerite. The unit exhibits strong deformation and is silicified and carbonatized near the main quartz vein zone. Less sulphide-rich units of metagreywacke are also highly deformed, along with conformable to low-angle, crosscutting quartz veins along the axis of the anticline to the southwest of the metavolcanic–metasedimentary rocks contact (Photo 4).

Chloritic, garnetiferous schist also occurs as a discontinuous band up to 21 m wide in the metavolcanic–metasedimentary rocks contact zone. The schist contains biotite, minor sericite, up to 40% garnet, and local concentrations of pyrite and pyrrhotite (King and House 1987).

The metavolcanic rocks are mafic, dark green and chloritic, locally exhibiting highly stretched pillow structures. More strongly foliated, chloritic schist zones may represent tuffaceous units.

Fingas (2015) has identified 4 generations of quartz veins:

1. conformable, sugary, narrow veins containing very little carbonate; strongly deformed and boudinaged, locally abundant pyrite and pyrrhotite, but negligible gold content; interpreted as thin, interflow chert beds.
2. conformable to subparallel to foliation, sugary to coarsely granular texture, highly deformed, but with little boudinage; ferroan carbonate along vein margins; occur in both metasedimentary and metavolcanic rocks, interpreted as being related to development of primary axial-planar foliation; weakly to moderately anomalous in gold content.

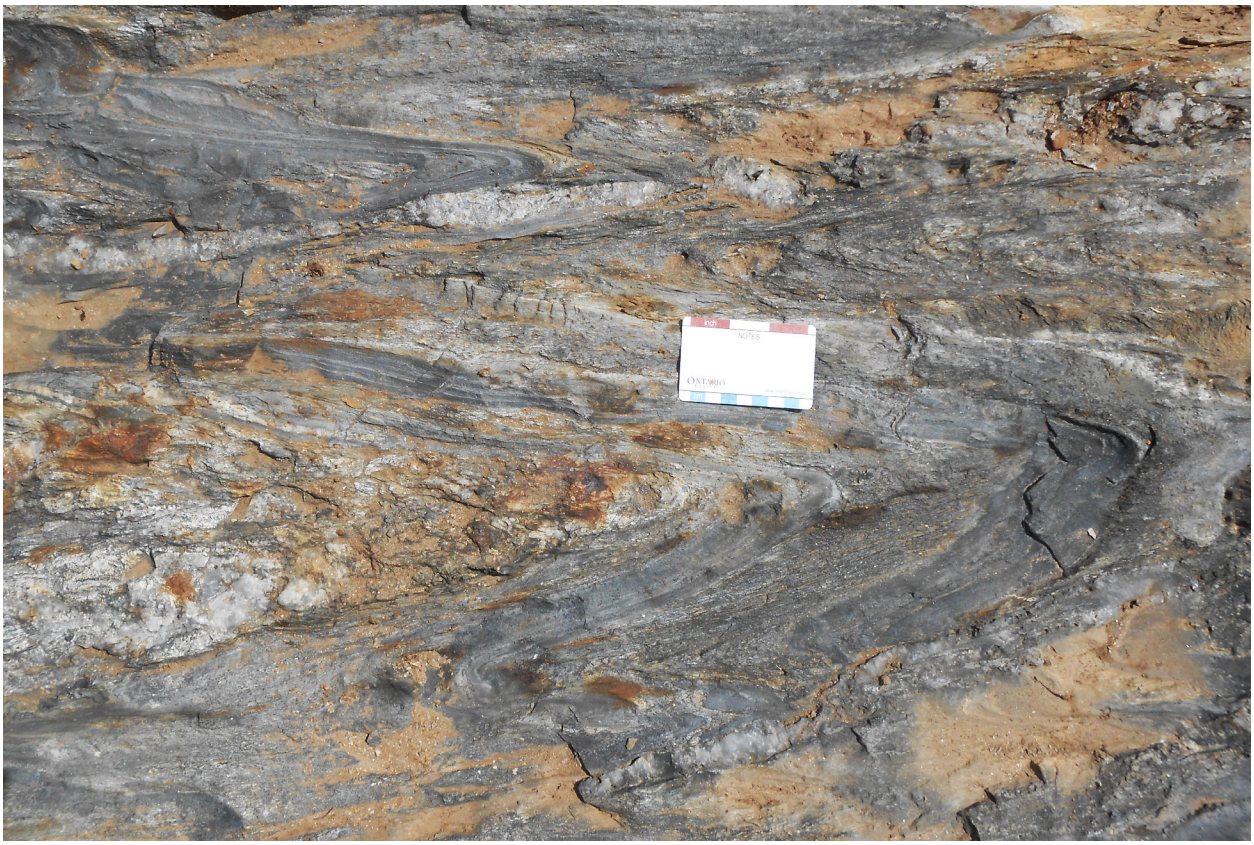

Photo 4. Strongly deformed metagreywacke, silicified and sericitic, with conformable quartz veins, Mono zone of the Bannockburn property, Crown William Mining Corporation.

3. crosscutting, high-grade, gold-bearing quartz-carbonate veins; north to northwesterly striking, moderately northerly dipping, folded about northeasterly plunging fold axes; locally banded with milky to clear quartz laminations; accessory minerals include ferroan carbonate, chlorite, pyrite, pyrrhotite and tourmaline; native gold may be locally associated with tetradymite and telluro-bismuthinite.

   Photo 5 shows a second generation vein, 50 to 60 cm thick, crosscutting the foliation in metavolcanic rocks, exhibiting a Z-fold structure plunging moderately northeastward along the plane of the quartz vein portion of the outcrop.

4. narrow, foliation-parallel, quartz veins that show little deformation and crosscut the earlier vein sets; possibly related to the deformation event that folded the second generation vein set; not known to be mineralized.

Although the second generation quartz veins extend across the metavolcanic–metasedimentary rocks contact, gold mineralization is restricted to a zone about 140 m long and 50 m wide, roughly centred along the contact zone. Within this area, a zone of low-grade mineralization, termed the “Conduit zone”, has been identified in which the combination of low-grade mineralization in wall rock and higher grade mineralization in quartz veins may be of sufficient average grade to be amenable to open pit mining (Fingas 2013).

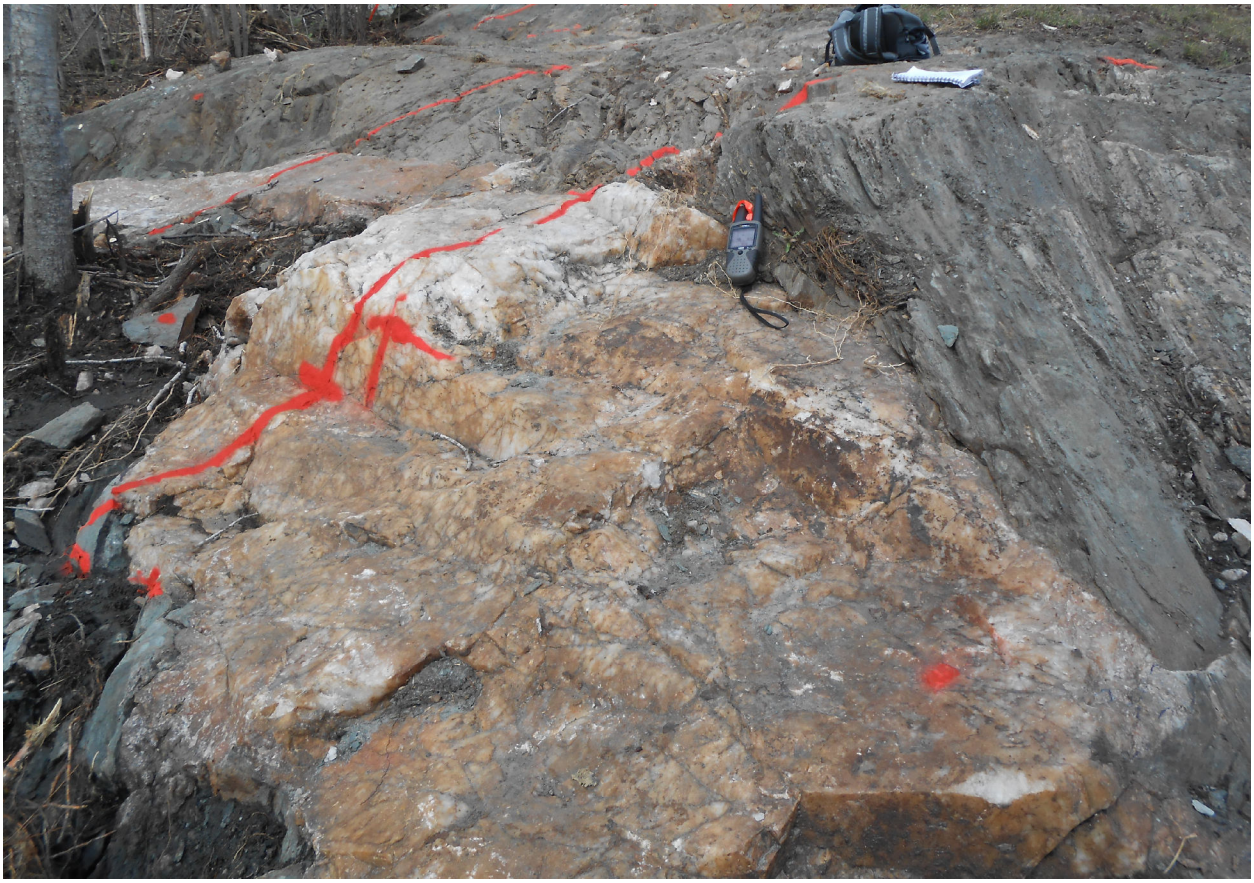

Photo 5. Second generation quartz vein, crosscutting the foliation in mafic metavolcanic rock, Mono zone of the Bannockburn property, Crown William Mining Corporation.

Bannockburn Mine Area

The area of the historic Bannockburn gold mine was briefly examined during the property visit. Several trenches and 2 shafts (6 m and 8 m deep) were located. The trenches expose grey, iron-stained quartz veins in siliceous metagreywacke containing up to 5% disseminated pyrite, similar in appearance to the metasedimentary rocks at the Mono zone.

The shafts expose quartz veins in red, altered syenite containing sericite and minor disseminated pyrite. This zone probably represents the eastern margin of the Gawley Creek syenite (*see* Figure 8). Because of the presence of known gold mineralization at the Bannockburn Mine, the presence of sulphide-bearing metasedimentary rocks and quartz veins similar to those of the Mono zone, and the presence of a felsic intrusion associated with the gold mineralization, further examination of the area by the Regional Resident Geologist and District Geologist is proposed for the 2017 field season.

EXPLORATION PROGRAM 2016

The drill core relogging and sampling program completed for Crown William Mining Corporation by Fladgate Exploration Consulting Corporation from October 2016 to January 2017, was intended to follow up on the 2013 core-sampling program, in which approximately 10% of the historic holes were relogged and sampled. The results of the 2013 program revealed numerous quartz vein intersections that were not sampled previously and which were found to carry grades of more than 10 g/t Au over narrow widths and identified low-grade mineralization within the Conduit zone. A total of 3988 samples were collected from the cores of 31 holes.

SUMMARY OF RESULTS AND POTENTIAL FUTURE WORK

Assays from the 2016 drill-core sampling program are pending; however, preliminary results show trends similar to those observed in 2013 of high-grade narrow vein intercepts and disseminated low-grade wall-rock mineralization within the Conduit zone. The 2016 resampling program should further explain the relationship between the Conduit zone and the high-grade veins, with emphasis on the control(s) of the ore shoots on the property (C. Jeffs, Fladgate Exploration Consulting Corporation, personal communication, February 2017).

The 2017 field program may include stripping and channel sampling on the Conduit zone and a satellite remote sensing test survey over a 200 m square area in the vicinity of the old Bannockburn Mine workings to determine whether the method can detect structures favourable for gold mineralization (A. Schweitzer, Crown William Mining Corporation, personal communication, January 2017).

RECOMMENDATIONS FOR EXPLORATION

Flake Graphite in the Grenville Province of Southern Ontario

Note: The following recommendation is from *LeBaron (2017).*

BACKGROUND

The global demand for graphite has increased steadily since 2012. Projections for increased demand to 2020 range from 3 to 5% per year for traditional applications, such as refractories, lubricants, foundries and recarburizing, to 10 to 15% per year for batteries (Shaw 2015). The projected increase in demand for high-purity flake graphite is based upon increasing use of lithium-ion and other graphite-component batteries in electric vehicles, cell phones and energy storage systems.

Total consumption of natural graphite in the United States in 2015 was 55 500 tonnes. Tesla Motors' proposed lithium-ion battery "gigafactory", expected to begin production in 2017, is estimated to require up to 95 000 tonnes of flake graphite per year at full production. There are currently no producing graphite mines in the U.S. and only 2 in Canada (British Columbia and Quebec), producing a total of 30 000 tonnes of graphite per year (United States Geological Survey 2016).

HISTORICAL GRAPHITE PRODUCTION AND EXPLORATION IN SOUTHERN ONTARIO

Graphite mining in southern Ontario began in 1870 at the Globe graphite mine and continued until the closure of Canada's largest graphite producer, the Black Donald Mine, in 1954. The Black Donald Mine produced a total of about 87 000 tonnes of graphite, making it one of the most important producers of flake and amorphous graphite in North America. Graphite production, totalling less than 1000 tonnes, was also obtained from 3 other mines, the Tonkin–Dupont, National Graphite and Timmins mines, during this period. Locations of the mines are shown on Figure 10.

More recent production of graphite in southern Ontario has come from the Kearney Mine, which operated from 1989 to 1994, during which time it produced 17 000 tonnes of flake graphite concentrate from almost 1 million tonnes of ore.

An increase in the price of flake graphite in the 1980s generated new exploration activity, primarily on previously known occurrences, which resulted in the definition of 2 significant deposits in the Central Gneiss Belt (Kearney and Bissett Creek: *see* Figure 10). More recent exploration in the Central Metasedimentary Belt resulted in the discovery of new graphite occurrences in the Bobcaygeon area and at the Malcolm prospect, an extension of the previously known Little–Bryan occurrence (*see* Figure 10). Table 9 shows a list of graphite prospects with resource estimates in southern Ontario.

Table 9. Graphite prospects with resources, southern Ontario.

Property	Township	Resource*	Reference
Northern Graphite (Bissett Creek)	Maria	69.8 Mt @ 1.74% Cg (Measured+Indicated) 24.0 Mt @ 1.65% Cg (Inferred)	Northern Graphite Corp. (www.northerngraphite.com)
Ontario Graphite (Kearney)	Butt	51.5 Mt @ 2.14% Cg (Measured+Indicated) 46.8 Mt @ 2.0% Cg (Inferred)	Ontario Graphite Ltd. (www.ontariographite.com)
Victoria Graphite (Portland)	Bastard	295 000 t @ 6% Cg	MacKinnon and LeBaron (1992)
Kirkham Graphite (Stewart Lake)	Bedford	1.6 Mt @ 9.5% Cg	MacKinnon and LeBaron (1992)
Globe Graphite	North Elmsley	50 000 t @ 7% Cg	MacKinnon and LeBaron (1992)
Timmins Graphite	North Burgess	1.0 Mt @ 8% Cg	MacKinnon and LeBaron (1992)
National Graphite	Cardiff	1.4 Mt @ 4.1% Cg	Hewitt (1965)

**NI-43-101–compliant resource: Measured and Indicated, Inferred; all others are NI-43-101–non-compliant.*

GEOLOGY OF THE GRAPHITE OCCURRENCES

Graphite occurs in both the Central Gneiss Belt (CGB) and the Central Metasedimentary Belt (CMB) of southern Ontario (*see* Figure 10).

The CGB is dominated by quartzofeldspathic gneisses, intruded by a variety of mafic to felsic plutonic rocks. Metamorphic grade is generally upper amphibolite to granulite. The CMB hosts rocks of the Grenville Supergroup, a sequence of metavolcanic rocks, marbles, quartzites, calc-silicates, paragneisses, and amphibolites, all intruded by mafic to felsic plutonic rocks. Metamorphic grade ranges from greenschist in the south-central area to upper amphibolite in the north and west (Bancroft terrane) and upper amphibolite to granulite in the southeast (Frontenac terrane).

Graphite in the Central Gneiss Belt

The 2 major graphite deposits of the CGB, Bissett Creek and Kearney, consist of disseminated, large-flake graphite in rusty-weathering, banded, biotite-rich quartzofeldspathic paragneiss with minor pyrite and pyrrhotite. Non-graphitic gneiss includes pale grey, quartz-rich, pale to dark green-grey, diopside-rich and brownish biotite-amphibole-garnet-bearing varieties (Photo 6).

Although the original character of the host rock, in most cases, has been obliterated by the high degree of metamorphism involved, the overall composition, mineralogy and geological setting indicate a sedimentary rock, usually quartz rich, as the host. The presence of calc-silicate minerals in some of the gneissic units suggests that there may have been a carbonate component, either as a cement or as interbedded layers in the siliceous sediments.

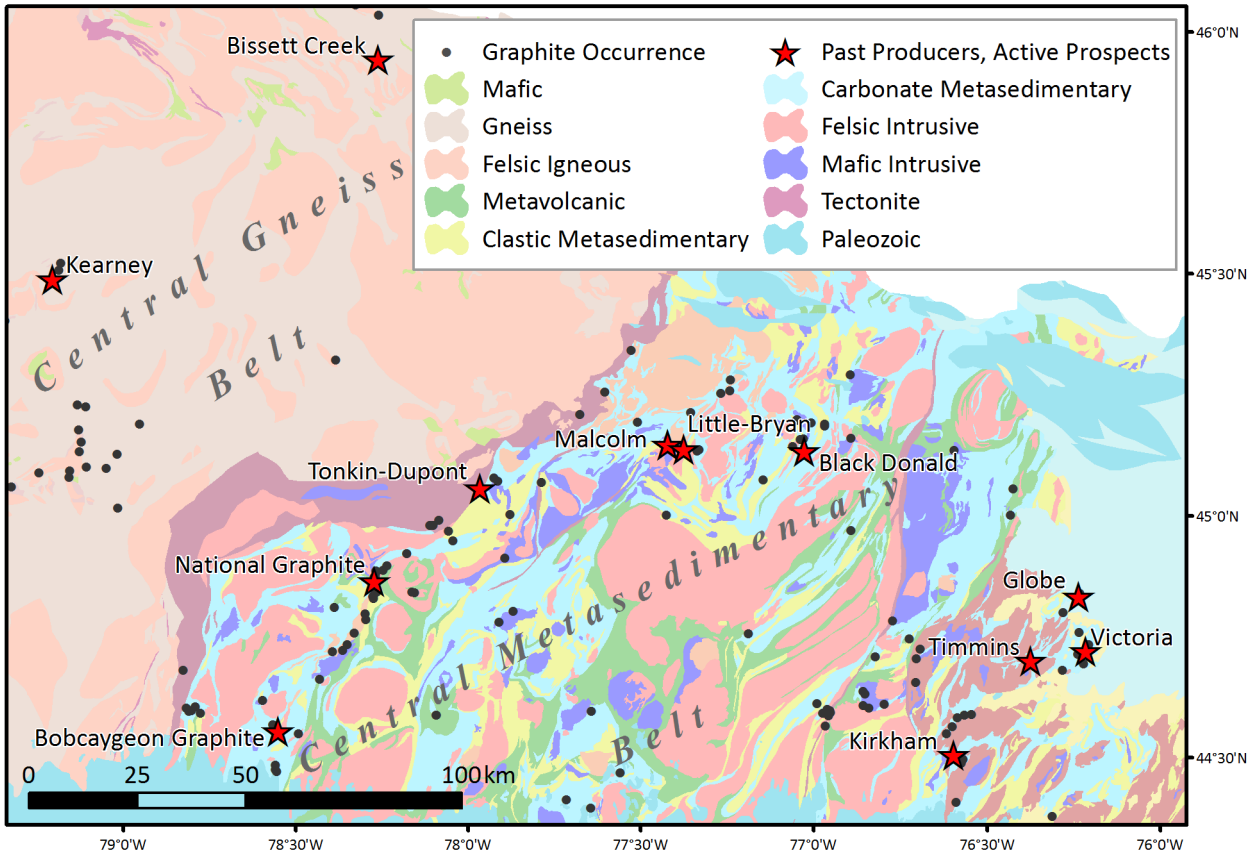

Figure 10. Locations of southern Ontario graphite occurrences, past-producing mines, and active prospects (geology *from* Ontario Geological Survey 2011).

Graphite in the Central Metasedimentary Belt

Graphite occurrences within the CMB are concentrated in areas dominated by highly metamorphosed sedimentary rocks of the Bancroft terrane in the northwest and the Frontenac terrane in the southeast (*see* Figure 10). All occur either within crystalline marble or siliceous metasedimentary rocks within or close to transition zones between carbonate-dominated units and siliceous paragneisses, indicating a shallow, nearshore marine depositional environment favourable for the accumulation of organic material—the most probable source of carbon in these deposits. For example, the Black Donald Mine stratigraphy consists of a graphitic marble unit containing minor calc-silicates and chlorite, overlain by siliceous marble containing quartz, phlogopite, diopside, scapolite and tremolite; and underlain by quartzite and limy quartzite, followed by beds of white to grey marble. The quartzites are rich in pyrite and pyrrhotite and weather rusty brown (Hewitt 1965).

Another example of graphite occurring with siliceous, pyrrhotite-rich metasedimentary rocks is seen at the Little–Bryan and Malcolm properties in Lyndoch Township. Two conductive (graphite-pyrrhotite) zones (Figure 11) occur within a southerly dipping sequence of metasedimentary rocks, including calcitic and dolomitic marble and hornblende-quartz-feldspar-biotite paragneiss. The southern graphite-pyrrhotite unit occurs within a transition zone between carbonate-rich units to the north and siliceous paragneiss to the south. A significant difference between the graphite mineralization observed on the Malcolm and the Little–Bryan properties is that the Malcolm zone includes marble-hosted graphite with little to no pyrrhotite in addition to the quartz-rich, rusty, graphite-pyrrhotite-bearing gneiss of the Little–Bryan zone.

In 2015, the Ontario Geological Survey discovered 5 new graphite occurrences associated with sulphide-rich schists and gneisses in the Centennial Lake area, about 13 km southwest of the Black Donald Mine and within the same general stratigraphy. The occurrences are located along the edges of regional magnetic anomalies shown on the Renfrew area aeromagnetic survey (Ontario Geological Survey 2014a) and are described by Duguet, Duparc and Mayer (2015).

Photo 6. Bissett Creek deposit, showing the pit in the high-grade graphite zone; the rock face is 3 m high. The inset photo, in the bottom right corner, shows the hanging wall of barren, quartz-feldspar-biotite gneiss with granitic leucosomes.

RECOMMENDATIONS FOR EXPLORATION

Exploration for graphite deposits is recommended in both the Central Gneiss Belt and the Central Metasedimentary Belt of the Grenville Province in southern Ontario.

Most of Ontario's past graphite production has come from mines within the CMB, where favourable stratigraphy consisting of transition zones between marble and siliceous metasedimentary rocks hosts flake graphite deposits in areas of upper amphibolite- to granulite-facies metamorphism. Linear magnetic anomalies may indicate zones of pyrrhotite mineralization that have been observed to occur with, or in close spatial association with, graphite mineralization. Airborne electromagnetic surveys have also been successful in locating zones of pyrrhotite and graphite mineralization.

Graphite mineralization in the CGB is associated with sulphide-bearing quartzofeldspathic gneiss sequences where calc-silicates may indicate former carbonate units that may have been a source of organic material. The CGB deposits discovered to date are very large tonnage, relatively low-grade deposits that produce a high-purity, large-flake, high-value concentrate. A regional bedrock map by the Ontario Geological Survey (1991) identifies areas of the CGB that are underlain predominantly by paragneiss and migmatite. Airborne magnetic surveys in these areas may be useful in locating zones of pyrite-pyrrhotite mineralization that are associated with graphite in the known deposits. Narrow zones of higher grade graphite and/or sulphide mineralization may respond to electromagnetic survey methods.

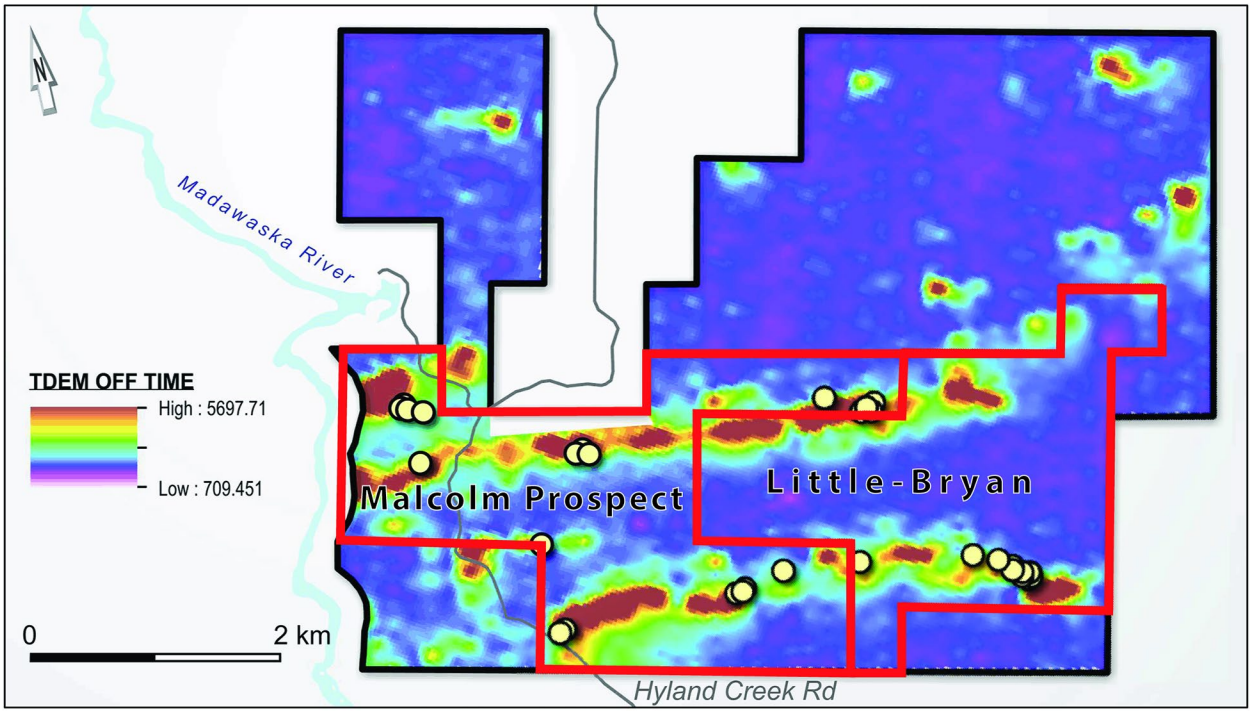

Figure 11. Results of an airborne time-domain electromagnetic (TDEM) survey, conducted by Standard Graphite Corp., showing linear conductive zones, graphite-bearing sample locations (yellow circles outlined in black) and the location of the Malcolm and Little–Bryan claim blocks (outlined in red) (*modified from* Standard Graphite Corp., news release, February 21, 2012, www.standardgraphite.com, under News | 2012). The claim blocks are located approximately 8 km west-northwest of the community of Griffith.

Nickel-Copper-(Cobalt-Platinum Group Metals) Mineralization in Southeastern Ontario

Note: The following recommendation is from *LeBaron and Tessier (2017).*

BACKGROUND

Nickel and cobalt, along with lithium and graphite, are important components of the rapidly growing battery market. It has been estimated that the electric vehicle battery market will increase by 5 times the current level, while the market for stationary electric storage will increase 8-fold between 2015 and 2020 (Benchmark Mineral Intelligence Magazine, December 2015 (Q4); www.benchmarkminerals.com).

About 75% of the global cobalt output is the result of by-product from copper and nickel processing. Low base-metals prices have resulted in cuts to production of copper and nickel, which may leave cobalt in short supply as demand increases.

SOUTHERN ONTARIO NICKEL-COPPER OCCURRENCES AND PREVIOUS EXPLORATION

Several nickel-copper prospects discovered in southeastern Ontario prior to 1965 have seen little additional exploration work since that time, with the exception of some activity in the 1990s by various companies and from 2008 to 2012 by First Nickel Inc.

Table 10 lists nickel-copper occurrences in southeastern Ontario that are associated with mafic intrusions. The locations of these occurrences are shown in Figure 12. More complete details are available in the Mineral Deposit Inventory online database (Ontario Geological Survey 2017).

Table 10. Magmatic nickel-copper occurrences in southeastern Ontario. Numbers correspond to locations shown in Figure 12.

Occurrence Number and Name	Township	Concession(s), Lot(s)	Significant Mineralization (Company and Year)	Additional Reference
1. Crowe River	Lake	III, 14-17	Zone 53 m long, averaging 2.3% Cu over 2.1 m (DH, Alsof Mines, 1958)	Sopha (1958)
2. Macassa	Limerick	VI-VII, 28-29	3.5 Mt @ 0.8% Ni, 0.25% Cu, 0.05% Co (DH, Lac Minerals, 1971)	Carter (1984)
3. Simon	Lyndoch	B, 1	S. zone amphibole gneiss, 230 000 t @ 1.09% Cu; N. zone gabbro, chalcopyrite, pyrrhotite, magnetite (DH, Young-Davidson Mines, 1965)	Carter (1984)
4. Bonter	Marmora	V, 27	0.45% Ni, 0.26% Cu over 54.0 m (DH, Consolidated Mining and Smelting Company, 1943)	Thomson (1950)
5. Ellerington	McClintock	IX, 18	1.36% Ni, 0.2% Cu, 0.098% Co over 4.5 m (DH, Slocan Van Roi Mines, 1959); 1.12 g/t Pt (Orogrande Resources, 1997)	Perry (1959); Hanych (1997)
6. Sharbot Lake	Olden	VI, 10	Sulphide zone 228 m long, 46 m wide; 0.3% Ni, 0.3% Cu, 0.14% Co over 5.5 m (DH, Sharbot Lake Mines, 1957)	Malczak, Carter and Springer (1985)
7. Ameranium	Raglan	VI, 10	Surface sampling 0.5% Ni, 1956	A.S. Bayne & Co. (1956)
8. Genricks Lake	Raglan	VI, 17	Surface sampling 0.5% Ni, 1956	A.S. Bayne & Co. (1956)
9. Landolac	Raglan	IV, 20	Surface sampling 1.9% Cu, 0.85% Ni, 0.07% Co, 2 to 12 ppb Pd	Wilson (1994)
10. Raglan	Raglan	IV, 20	0.25% Cu, 0.04% Ni over 1.37 m (DH, Raglan Nickel Mines, 1956); 81 ppb Pt, 133 ppb Pd (McArthur Mills Exploration, 1987)	Raglan Nickel Mines Ltd. (1956) Mayer and Pearson (1987)
11. Lingham Lake	Tudor	III, 2	0.9% Ni, 0.35% Cu (DH, Louada Exploration, 1967)	Shields (1967)

Abbreviations: DH – drill hole.

First Nickel Inc. completed 2 airborne electromagnetic and magnetometer surveys in 2008, covering several of the known nickel-copper occurrences listed in Table 10, as well as prospective mafic intrusions in the Bancroft to Marmora area. The northern survey area, the Raglan Hills project, was centred on the Raglan Hills gabbro, which hosts the Raglan Township occurrences (*see* Figure 12: numbers 7 to 10). The southern survey area, the Belmont project, covered numerous smaller mafic intrusions, including those hosting the Lake, Limerick, and Marmora township occurrences (*see* Figure 12: numbers 1, 2 and 4).

From 2009 to 2012, First Nickel Inc. completed prospecting and ground verification of airborne electromagnetic anomalies, followed by diamond drilling on several of the prospects. On the Belmont project, 19 diamond-drill holes, totalling 4230 m, were completed and on the Raglan project, 47 holes were drilled, for a total of 7520 m. First Nickel Inc. reported assays from diamond-drill core of up to 0.47% Ni and 0.64% Cu across 5.8 m from the Raglan prospect (Easton, Duguet and Magnus 2011). The bulk of the drilling on the Raglan prospect was done on only 2 properties. Despite a proposal for additional work in both areas and the presence of numerous untested geophysical targets, no diamond drilling was done on claim blocks in Marmora Lake area or Belmont Township in the southern project area, and no further work was done in the Raglan area. In 2013, the company, going through financial hardship, halted its exploration efforts in southern Ontario (First Nickel Inc., news release, April 2, 2013).

The First Nickel Inc. airborne geophysical survey data were purchased by the Ontario Geological Survey and released as a data set and a series of maps (Ontario Geological Survey 2010a-e). Outlines of the survey areas are shown on Figure 12.

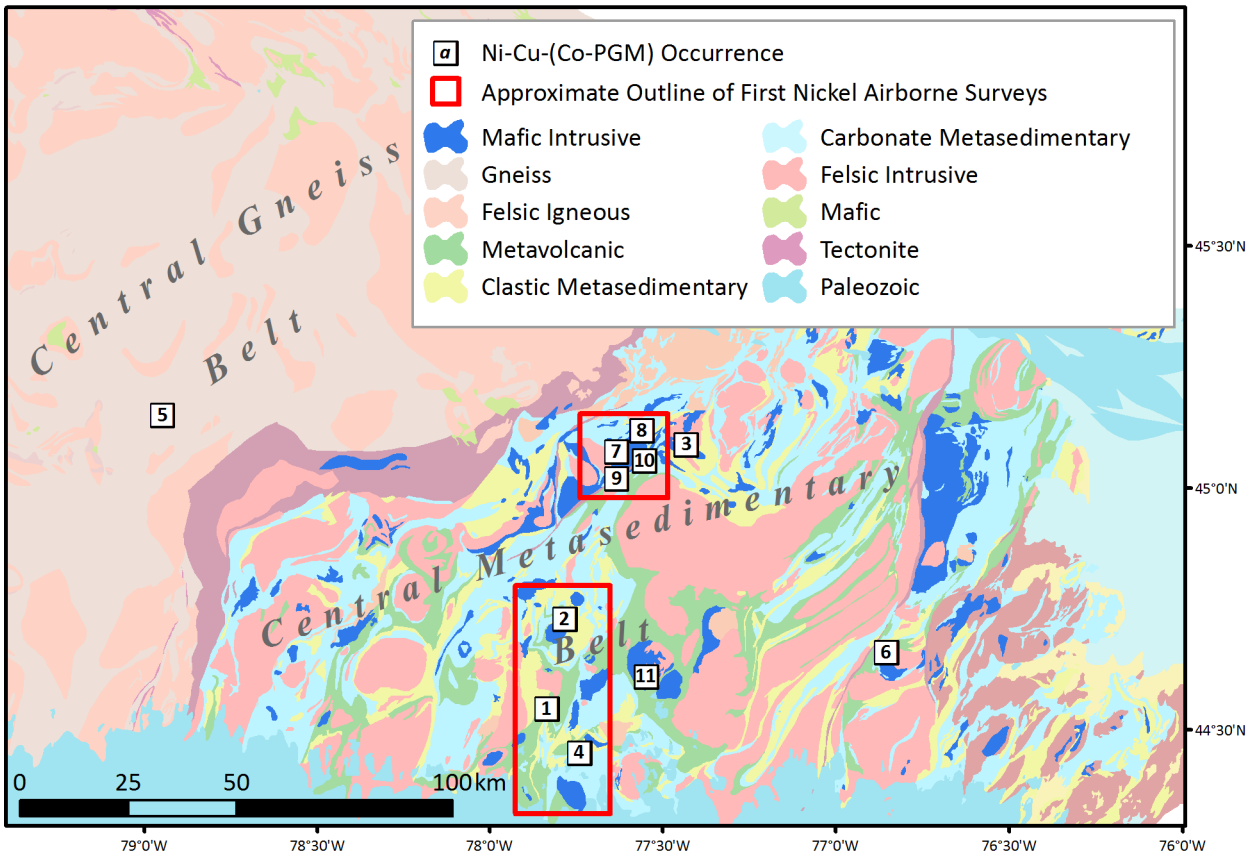

Figure 12. Geology of southeastern Ontario, showing locations of magmatic nickel-copper occurrences associated with mafic intrusions (keyed to Table 10). Geology *from* Ontario Geological Survey (2011).

GEOLOGY OF THE NICKEL-COPPER OCCURRENCES

Easton (1992) identified 2 suites of gabbroic intrusions within the Central Metasedimentary Belt in Ontario: an older Killer Creek suite (>1270 Ma) and a younger Lavant suite (1250–1230 Ma). Nickel-copper mineralization occurs in both suites and, in the absence of geochronological data, the suites may be difficult to distinguish. Examples of occurrences in the CMB and of 1 occurrence in the Central Gneiss Belt are described below.

Central Metasedimentary Belt

Mineralization at the Macassa nickel-copper deposit consists of disseminated pyrrhotite, pentlandite, chalcopyrite and pyrite in a band of metapyroxenite within the Thanet gabbro of the Lavant suite. The main zone, containing a drill-indicated resource 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 @ 0.3% Ni (Carter 1984). Limerick Mines Ltd. drilled 4 diamond-drill holes to confirm results of previous drilling and did ground magnetic surveys on other parts of the property in 2004.

The Raglan Hills gabbro, which is lithologically similar to the Killer Creek suite (Easton 1992), is predominantly a gabbro-anorthosite intrusion with hornblendite at the margins and pyroxenite to olivine pyroxenite in the central part. The Raglan occurrence consists of a 155 m long, 90 m wide, 6 to 15 m thick lens of disseminated pyrrhotite, chalcopyrite and pyrite hosted by anorthositic metagabbro (Carter 1984). Work to date has focussed on 4 sulphide occurrences discovered in 1956, where First Nickel Inc. reported a diamond-drill core intersection of 0.47% Ni and 0.64% Cu across 5.8 m (Easton, Duguet and Magnus 2011). The presence of nickel-copper mineralization with anomalous values for platinum group metals (*see* Table 10) indicates that additional work is warranted in this large intrusive complex.

Central Gneiss Belt

Metagabbroic anorthosite bodies, tens of metres wide and tens of kilometres long, occur in the Fishog and McClintock domains of the Algonquin terrane of the CGB. Easton (1992) considers these to be layered anorthositic intrusions with a likely emplacement age of 1400 to 1300 Ma. Wilson (1994) describes a layered mafic intrusion in Sri Lanka that has been flattened to one-twentieth its original thickness and stretched to 20 times its original length during granulite-facies metamorphism, and suggests that the thin, extensive mafic bodies in the CGB have potential for nickel-copper mineralization.

In McClintock Township, drilling by Randsburg International Gold Corporation has intersected several nickel-copper-cobalt-bearing sulphide zones with anomalous values of platinum group metals (*see* Table 10: Ellerington occurrence) within a 4 to 5 km wide band of anorthosite, gabbro, diorite and ultramafic rocks flanked by paragneiss (Tweed Resident Geologist Office, MDI file MDI31E07SW00033). Although the occurrence was discovered in 1941, there has been very little exploration work in the surrounding area, and the geology has not been mapped in detail. This occurrence lies within an area mapped by Lumbers and Vertolli (2003) as monzogranite, suggesting that the distribution of mafic rocks in the area may be more extensive than is indicated.

Possible “Indicator Mineral” Occurrences

Most of the southeastern Ontario nickel-copper occurrences are located at, or near, the margins of intrusions, indicating that wall-rock assimilation may have induced sulphide saturation in the magma (Easton and Fyon 1992). Eckstrand (1995) suggests that high zinc content in chromite associated with mafic to ultramafic intrusions may indicate assimilation of zinc-bearing sulphidic metasedimentary rocks.

Similarly, green spinel, which may be iron-rich (hercynite) or zinc-rich (gahnite), may also be the product of sulphidic wall-rock assimilation. Green spinel has been reported in marginal phases of the Chenaux gabbro (Wilson 1994), the Lavant–Oso gabbro (Wolff 1985) and in pyroxenites in several locations in the McClintock Township area (Adams and Barlow 1910). A stream sediment anomaly consisting of 23 grains of gahnite from a sample taken within 500 m of the Killer Creek gabbro, and a second anomaly of 17 gahnite grains located about 24 km to the south (Felix, Reid and Easton 2006) may be derived from the Killer Creek intrusion.

RECOMMENDATIONS FOR EXPLORATION

Southeastern Ontario nickel-copper occurrences, in some cases with significant copper and anomalous platinum group metals values, are hosted by a variety of mafic to ultramafic intrusive rocks within the CMB and less so within the CGB, the locations of which are well defined on geological maps. In both areas, the intrusions should be examined in more detail for features, such as evidence of magma mixing and wall-rock assimilation. Many are located near the contact zones between metasedimentary and metavolcanic rocks: these are favourable sites for the presence of pyritic, rusty schists, which are common in the CMB.

Based upon the relatively low level of previous exploration for magmatic nickel-copper deposits in southeastern Ontario, additional exploration is recommended. Limited airborne electromagnetic and magnetometer surveys by First Nickel Inc. were successful in locating targets for magmatic sulphide exploration and are recommended for areas of mafic intrusions not covered by the surveys shown in Figure 11, particularly in the area of the Lavant gabbro complex, the large mafic intrusion located north of the Sharbot Lake nickel-copper-cobalt occurrence (*see* Figure 12: number 6).

MINERAL DEPOSITS NOT BEING MINED

Tables 11 through 19 list currently inactive mineral deposits with identified resources and past-producing mineral occurrences.

Table 11. Historic production of gold – Southeastern Ontario District.

Mine	Township	Operating Years	Tons Milled	Ounces Produced	Grade (ounces/ton)
Big Dipper	Barrie	1907–1909	52	17	0.33
Cook	Marmora	1901–1904	1483	289	0.26
Cordova	Belmont	1892	120 670	22 774	0.19
Craig	Tudor	1905–1906	1850	248	0.13
Deloro	Marmora	1897–1902	39 143	10 360	0.26
Gatling 5 Acre	Marmora	1900–1903	6114	2353	0.38
Gilmour	Grimsthorpe	1909–1910	550	172	0.31
Golden Fleece	Kaladar	1919–1922	unknown	480	unknown
Ledyard	Belmont	1893–1994	55	13	0.24
Pearce	Marmora	1893–1908	239	302	1.26
Richardson	Madoc	1866–1868	unknown	75 – 100	0.408
Sophia	Madoc	1896–1901	1800	110	0.06
Sovereign	Marmora	1878 1892–1900	unknown 1962	970 370	unknown 0.19
Star of the East	Barrie	1905–1907	976	134	0.14
		Total	**174 894**	**38 592**	

Table 12. Historic production of copper, lead, zinc – Southeastern Ontario District.

Mine	Township	Operating	Tons Milled	Production
Kingdon	Fitzroy	1884–1885, 1914–1931	905 000	76 821409 pounds Pb concentrate; 857 312 pounds Zn concentrate; 60 074 072 pounds Pb recovered
Long Lake	Olden	1897–1925, 1973–1974	3442, not available	$41 550 ore value, 9467 tons Zn valued at $1 227 000
Eldorado Copper	Madoc	1906	not available	234 000 pounds Cu matte containing 230 ounces Au, 182 ounces Ag, 109 000 pounds Cu
Hollandia Lead	Madoc	1903–1906	not available	2 653 365 pounds Pb

Table 13. Historic production of fluorite – Southeastern Ontario District.

Mine	MDI Number	Township	Operating Years	Total Production (Tons)
Bailey	31C06NW00003	Madoc	1907, 1916, 1917, 1944–1950	25 000
Blakely	31C06NW00019	Huntingdon	1918–1920, 1928, 1941–1947	5026
Coe	31C06NW00008	Huntingdon	1941–1942	114
Dwyer	31E01SE00091	Cardiff	1918–1920, 1943, 1944	97
Herrington South	31C05NE00009	Huntingdon	1917	13
Howard, Fred Hill	31C06NW00014	Huntingdon	1918, 1920, 1929, 1940–1942, 1944	2500
Johnston	31C06NW00013	Huntingdon	1943, 1944–1947, 1949	187
Keene	31C06NW00004	Huntingdon	1918–1919, 1943, 1944, 1950	5000
Kilpatrick	31C06NW00005	Huntingdon	1944, 1953–1959	11 566
Lee Junior	31C05NE00008	Madoc	1917, 1940, 1943–1945	2000
Lee Senior	31C05NE00006	Madoc	1916–1918, 1942, 1943	1600
McIlroy	31C05NE00003	Madoc	1917–1918, 1923, 1944	540
Miller	31C05NE00005	Madoc	1917–1919	460
Noyes	31C06NW00011	Huntingdon	1917–1920, 1941–1943	25 000
Palmateer	31C06NW00016	Huntingdon	1942	44
Perry	31C06NW00009	Huntingdon	1915–1920, 1941–1943	8000
Perry Lake	31C06NW00007	Huntingdon	1910, 1913, 1915, 1917, 1952, 1960	4000
Ponton	31C05NE00004	Madoc	1929–1942	1500
Rogers	31C06NW00018	Huntingdon	1909–1914, 1943–1951	45 000
Rooks	31C12SE00003	Madoc	1916–1918	100
South Reynolds	31C06NW00010	Huntingdon	1917–1918, 1943	100
Wallbridge and Herrington	31C05NE00007	Madoc	1920–1922, 1941–1943	6600
William Reynolds	31C12SE00002	Madoc	1941–1942	88

Fluorspar, a commercial fluorite product, is used as a flux in the making of steel and ceramics, as a constituent in the electrolytic process of making aluminum and in the production of hydrofluoric acid (HF). During World War II, a Canadian Government assistance program in the form of loans and drill hole explorations stimulated development of the Madoc deposits (Guillet 1964, p.1).

Table 14. Historic production of iron – Southeastern Ontario District.

Mine	Township	Operating Years	Tons Milled	Grade (% Fe)
Calabogie	Bagot	1883–1901	10 000	26
Martel	Bagot	pre-1890	2000	58.71
Williams (Black Bay)	Bagot	1880–1890	25 000	51.89
Black Lake	Bedford	1882–1884	4000	40
Glendower	Bedford	1873–1895	50 000	50 – 60
Belmont (Ledyard)	Belmont	1899–1900, 1911–1913	8433	51.2
Blairton	Belmont	1820–1875	300 000	51.8
Playfair (Dalhousie)	Dalhousie	1866–1871	11 100	57.6
Radnor	Grattan	1901–1907	18 824	47.5
Eagle Lake (Blessington)	Hinchinbrooke	1887–1891	700	65.55
Tomahawk (Mag-Iron)	Lake	1947, 1950–1957	2096	50.9
Wilbur	Lavant	pre-1900, 1907–1908	146 892	56.69
Magnetawan	Lount	1910–1912	6000	59.55
Paxton	Lutterworth	pre-1910	1000	not available
Miller	Madoc	1899	6823	not available
Wallbridge	Madoc	1900–1901, 1919, 1921	3421	not available
Marmoraton	Marmora	1952–1978	28 000 000	40
Bessemer	Mayo	1902–1913	99 613	42.18
Childs	Mayo	1913	9649	38.7
McNab	McNab	1873–1874	15 000	68
Robertsville and Mary	Palmerston	1895, 1900–1901, 1918–1909	13 477	70.5
Fournier	South Sherbrooke	1873	600	60
Howland	Snowdon	1880–1882	1500	58
Victoria	Snowdon	1882	unknown	58.35
Dog Lake	Storrington	1899	600	51.12
St. Charles	Tudor	1900–1902	5186	57 – 60
Coe Hill	Wollaston	1884–1914	100 000	51.4
		Total	**28 841 914**	

Table 15. Past-producing magnetite mines – Southeastern Ontario District.

Deposit / Township	Mineral Deposit Inventory Number / Status	Description	Reference*
Belmont (Ledyard) Belmont Tp.	MDI31C12SW00004 (Past Prod. w Reserves)	Drilling from 1906 indicated 200 000 tons of concentrating ore	MRC 11, p.287
Bessemer Mayo Tp.	MDI31F04SE00012 (Past Prod. w Reserves)	Reserves estimated at 2 480 819 tons averaging 28.62% recoverable Fe from 4 deposits	MRC 11, p.167
Black Lake Bedford Tp.	MDI31C10SE00026 (Past Prod. w/o Reserves)	Disseminations and massive magnetite in exposed widths from 10 to 50 feet	MRC 11, p.134
Blairton Belmont Tp.	MDI31C05NW00026 (Past Prod. w Reserves)	1914 reserves calculated at 1 800 000 tons of 51.8% Fe and 0.5 million tons of 54.9% Fe	MRC 11, p.288
Bluff Point Bagot Tp.	MDI31F07SE00011 (Past Prod. w/o Reserves)	Two main magnetite-bearing zones, each about 500 feet long and 40 feet wide	MRC 11, p.313
Calabogie Bagot Tp.	MDI31F07SE00009 (Past Prod. w Reserves)	The deposit contains 27 200 000 tons of ore grading 22.28% Fe proven by diamond drilling, recoverable by open pit	MDC 20, p.67
Chaffey South Crosby Tp.	MDI31C09NW00011 (Past Prod. w Reserves)	Reserves estimated to a depth of 500 feet are 11 110 000 gross tons averaging 29.76% Fe	MRC 11, p.258
Childs Mayo Tp.	MDI31F04SE00013 (Past Prod. w Reserves)	Reserves estimated at 6 193 330 tons averaging 19.25% recoverable Fe	MRC 11, p.169

Deposit / Township	Mineral Deposit Inventory Number / Status	Description	Reference*
Coe Hill Wollaston Tp.	MDI31C13SW00010 (Past Prod. w Reserves)	Reserves estimated in 1914 at 600 000 tons averaging 51.4% Fe	MRC 11, p.177-178
Glendower Bedford Tp.	MDI31C10SE00022 (Past Prod. w/o Reserves)	Early drilling indicated massive and disseminated ore at a depth of 500 feet	MRC 11, p.135
Grattan (Radnor) Grattan Tp.	MDI31F06NE00017 (Past Prod. w Reserves)	Proven reserves of 3 639 600 tons to a vein depth of 363 feet and indicated reserves of 9 099 000 tons to a vertical depth of 600 feet, averaging 27.74% Fe	MDC 20, p.98
Howland Snowdon Tp.	MDI31D15SE00096 (Past Prod. w/o Reserves)	Magnetite in a zone 25 feet in diameter at surface and larger with depth	MRC 11, p.149
Marmoraton Marmora Tp.	MDI31C05NE-00014 (Past Prod. w Reserves)	27 966 762 tons of ore averaging 42.8% Fe produced	OFR 5515, p.322
Martel Bagot Tp.	MDI31F07SE00013 (Past Prod. w/o Reserves)	Magnetite body 20 feet thick, dipping 60° southeast	MRC 11, p.317
Matthews North Crosby Tp.	MDI31C09NW00009 (Past Prod. w Reserves)	Estimated reserves to depth of 400 to 500 feet are 33 727 000 gross tons averaging 25.08% Fe, which includes 11 861 000 gross tons averaging 31.36% Fe	MRC 11, p.257
Radenhurst and Caldwell Lavant Tp.	MDI31F02NE00012 (Past Prod. w Reserves)	Main zone with indicated tonnage of 6500 tons of ore per slope foot averaging 32.77% Fe. Three additional zones totalling 1600 feet in length, averaging 17.08%, 16.71% and 25.50% Fe	MRC 11, p.251
Rankin Mayo Tp.	MDI31F04SE00016 (Past Prod. w Reserves)	Reserves estimated at 15 691 599 tons containing 15.3% recoverable Fe	MRC 11, p.170
Robertsville Palmerston Tp.	MDI31C15NE00005 (Past Prod. w/o Reserves)	Two zones, Robertsville Mine is 700 feet long and 50 feet wide and the Mary Mine 900 feet to northwest	MRC 11, p.141
St. Charles Tudor Tp.	MDI31C13SE00014 (Past Prod. w/o Reserves)	Three main deposits within an area of approximately 13 500 square feet	MRC 11, p.176
Summit Lake (Tomclid) South Canonto Tp.	MDI31F02SW00032 (Past Prod. w Reserves)	Published reserves in 1993 estimated at 3 Mt averaging 40% Fe; reserve estimate has not been adjusted to reflect production from the deposit in late 1990s	MP 161, p.377
Tomahawk Lake Tp.	MDI31C12NW00002 (Past Prod. w Reserves)	Lenses and patches of magnetite occur over a strike length of approximately 1000 feet	MRC 11, p.155
Victoria Snowdon Tp.	MDI31D15SE00098 (Past Prod. w/o Reserves)	Deposit was worked from a trench 240 feet long and 16 feet wide	MRC 11, p.150
Wilbur Lavant Tp.	MDI31F02SE00009 (Past Prod. w/o Reserves)	Nine workings reported	MRC 11, p.252
Williams Bagot Tp.	MDI31F07SW00027 (Past Prod. w/o Reserves)	Two zones of magnetite, approximately 800 and 240 feet long, 20 feet wide	MRC 11, p.318
Yuill Darling Tp.	MDI31F02NE00009 (Past Prod. w/o Reserves)	Lens of high-grade magnetite, 30 m long and 9 m wide, mined to a depth of 21 m	MDC 20, p.92

***Source:** *Mineral Resources Circular (MRC) [No.1-14], then renamed to Mineral Deposit Circular (MDC) [No.15–].*
***Note:** *The resource estimates listed in this table are historic figures and do not follow the required disclosure for reserves and resources as outlined in National Instrument 43-101.*

Table 16. Titanium, tantalum and REE occurrences (compiled from MDI database: Ontario Geological Survey 2014b) – Southeastern Ontario District.

Name	Township	MDI File #	Commodity	Deposit Status
Harrington, Marsh Ore Bed	Marmora	MDI31C05NE00135	Au, Fe, Ti	Occurrence
Green Island Rutile	Huntingdon	MDI31C06NW00088	Ti	Occurrence
Matthews, Newboro Lake	North Crosby	MDI31C09NW00009	Fe, Ti	Past Producer with Reserves
Chaffey	South Crosby	MDI31C09NW00011	Fe, Ti	Past Producer with Reserves
Tommy Lake	North Crosby	MDI31C09NW00131	Ti	Occurrence
Ricketts	Lake	MDI31C12NE00109	Fe, Ti	Occurrence
Orton	Tudor	MDI31C12NE00122	Fe, Ti	Past Producer w/o Reserves
Hastings Road Magnetite	Tudor	MDI31C12NE00185	Fe, Ti	Occurrence
Harold White, Twin Lake	Methuen	MDI31C12NW00114	Fe, Ti	Occurrence
Horse Lake, Tripp	Methuen	MDI31C12NW00127	Fe, Ti	Occurrence
Maloney	Marmora	MDI31C12SW00002	Cr, Cu, Fe, Ni, Ti	Past Producer w/o Reserves

Name	Township	MDI File #	Commodity	Deposit Status
Canadian Nickel	Methuen	MDI31C12SW00121	Ti	Occurrence
Ridgway	Marmora	MDI31C12SW00122	Cu, Fe, Ti	Occurrence
Jocko Lake	Limerick	MDI31C13NE00107	Fe, Ti	Occurrence
Umfraville	Wollaston	MDI31C13NW00057	Co, Fe, phosphate, Ti	Occurrence
Canning Lake	Minden	MDI31D15NE00052	Fe, Ti	Occurrence
Pine Lake	Glamorgan	MDI31D16NW00215	Fe, Ni, Ti, V	Occurrence
Basin, Silver Crater (Basin)	Faraday	MDI31E01SE00054	Mica, Mo, Nb, Th, U, Ti	Past Producer w/o Reserves
Allen Lake	Harcourt	MDI31E01SE00306	Fe, Ti	Occurrence
Gal–Wood	Sabine	MDI31E08NE00010	Gd, Nb, Ta, Ti, U	Occurrence
Woodcox	Monteagle	MDI31F04NW00020	Ce, feldspar, Nb, U, Ta, Th, Ti, zircon	Past Producer w/o Reserves
Macdonald Mine	Monteagle	MDI31F04NW00023	Cu, feldspar, Mo, Nb, REE, Th, Ti, U, zircon	Past Producer w/o Reserves
Opeongo	Sebastopol	MDI31F06NE00093	Ag, Ce, Nb, Ta, Th, Ti, U, Y, zircon	Occurrence
East Rockingham	Brudenell	MDI31F06NW00085	Au, Ti	Occurrence
South Lamberts	Griffith	MDI31F06SE00161	Ti	Occurrence
Horton Tp., Ottawa River	Horton	MDI31F10SE00019	Fe, Ti	Occurrence
Mahoney and Morin	Sabine	MDI31E08SE00002	Feldspar, Nb, REE, Ta, U	Past Producer w/o Reserves
Genesee No.2 South	Monteagle	MDI31F04NW00018	Feldspar, Nb, Si, Ta, Th, U	Past Producer with Reserves
Plunkett, Plunkett South	Monteagle	MDI31F04NW00019	Ce, feldspar, amethyst, Mo, Nb, Th, Ta, U	Past Producer w/o Reserves
Dubblestein	Bangor	MDI31F05SW00010	Nb, Ta, Th, U	Occurrence
Tooeys Lake, Tooley Lake	Brougham	MDI31F06SE00090	Nb, Ta, Th, U	Occurrence
Renfrew Minerals, Wal–Gem West Quarry	Lyndoch	MDI31F06SW00013	Be, feldspar, fluorite, Mo, Nb, REE, Si, Ta, Th, U, zircon	Producing Mine
Barr Feldspar Quarry, Woermke	Fraser	MDI31F14SW00003	Ce, feldspar, Nb, Ta, Th, U	Past Producer w/o Reserves
Quinn	Olden	MDI31C10NW00366	Cu, Ni, REE	Occurrence
Orser–Kraft	South Sherbrooke	MDI31C15SE00027	Feldspar, Nb, REE, Th, U	Past Producer w/o Reserves
Nobles Bay, Rogers, J.	North Burgess	MDI31C16SE00004	Mica, REE	Past Producer w/o Reserves
Maclaren, W.L.	North Burgess	MDI31C16SW00017	Mica, phosphate, REE	Past Producer w/o Reserves
Christie Lake	South Sherbrooke	MDI31C16SW00142	Magnetite, Nb, REE	Occurrence
Drude South	Cavendish	MDI31D09NW00079	REE, Th, U	Occurrence
Copper Anomaly	Lutterworth	MDI31D15SE00151	Cu, REE, Sr, zircon	Occurrence
Rare Earth Anomaly	Lutterworth	MDI31D15SE00152	Cu, REE, Sr, zircon	Occurrence
North Rare Earth Anomaly	Lutterworth	MDI31D15SE00153	Cu, REE, Sr, zircon	Occurrence
Laurencin, M.	Cardiff	MDI31D16NE00160	Mo, REE, Th, U	Occurrence
McLennan, J.G.	Peck	MDI31E07NE00006	Nb, REE	Occurrence
Malcovitch, P.	Clyde	MDI31E08NW00003	Ce, REE, U	Occurrence
Gole, J.G.	Murchison	MDI31E09SE00004	Feldspar, Nb, REE, Si, U, zircon	Past Producer w/o Reserves
Cameron and Aleck	Murchison	MDI31E09SE00005	Feldspar, Nb, REE	Past Producer w/o Reserves
D'Eldona, Yankee Dam	Butt	MDI31E11NE00070	Nb, REE, U	Occurrence
Plunkett North	Monteagle	MDI31F04NW00185	Feldspar, REE, U	Occurrence
Lake Clear	Sebastopol	MDI31F06NE00092	REE, Th, U	Occurrence
Price, E.C., Quadeville	Lyndoch	MDI31F06SW00014	Be, feldspar, fluorite, Nb, phosphate, REE, Si, Th, U, zircon	Producing Mine
Universal Light Metals	Lyndoch	MDI31F06SW00065	Be, Ce, Nb, REE, Th, U	Occurrence
Lake Property, Lake Mine	Dickens	MDI31F12SW00006	Feldspar, REE	Past Producer w/o Reserves

Note: *MDI database was queried for Ti, Ta and REE occurrences. This listing indicates the presence of the commodities, not necessarily their order of abundance. This list should be used as a preliminary guide only. Hard copies of these complete MDI files are located at RGP office in Tweed.*

Table 17. Uranium deposits not currently being mined in the Southeastern Ontario District in 2016.

Deposit Township	MDI Number	Commodity	Reserve	Reserve Reference
Zenmac Burleigh, Anstruther Tps.	MDI31D09NE-00033 (Developed Prospect w Reserves)	U, Th	Indicated and inferred reserves are estimated at 406 000 tons grading 1.77 pounds U_3O_8 per ton	OFR 5311, p.461
Pole Star Burleigh, Anstruther Tps.	MDI31D09NE-00042 (Prospect)	U	Estimated size and grade from diamond drilling is 370 000 tonnes averaging 0.8 kg U_3O_8 or double using a lower grade of 0.6 kg/tonne	OFR 5635, p.199-200
Canadian Dyno Cardiff Tp.	MDI31D16NE-00032 (Past Prod. w Reserves)	U, Th	Reserves of possible ore were estimated at 500 000 tons grading 0.065% U_3O_8	OFR 5311, p.71-72
Bicroft (Centre Lake) Cardiff Tp.	MDI31D16NE-00043 (Past Prod. w Reserves)	U, Th	Estimated reserves above 1200 foot level: 559 000 tons grading 2.0 pounds U_3O_8 per ton before dilution (1960)	OFR 5311, p.66-67
Blue Rock Occurrence Monmouth Tp.	MDI31D16NE-00143 (Developed Prospect w Reserves)	U, REE	Reserves estimated at 292 444 tons at 0.095% U_3O_8 within 500 feet of shaft & to a depth of 600 feet; 56 720 tons at 0.120% U_3O_8 to a depth of 200 feet in the Lake zone	OFR 5311, p.132, 133
Empire B Zone Monmouth Tp.	MDI31D16NE-00146 (Developed Prospect w Reserves)	U, Th, F	Drilling has indicated reserves of 2 179 166 tons grading 0.726 pounds U_3O_8 per ton	OFR 5311, p.135
Kenmac Chibougamau Cardiff Tp.	MDI31D16NE-00165 (Prospect)	U, Th	Estimated reserves: 200 000 tons averaging 0.20% U_3O_8 (1955)	OFR 5311, p.101
Rare Earth #1 Monmouth Tp.	MDI31D16NW-00195 (Developed Prospect w Reserves)	REE, U, Th	Official estimated reserves 541 821 tons indicated averaging 0.116% U_3O_8 (1957)	MRC 4, p.26
Farcroft Anstruther Tp.	MDI31D16SE-00059 (Developed Prospect w/o Reserves)	U	not known	
Garland Anstruther Tp.	MDI31D16SW-00093 (Prospect)	U, Th	not known	
Cavendish Cavendish Tp.	MDI31D16SW-00099 (Prospect)	U, Th	Estimated reserves: 435 624 tons grading 0.096% U_3O_8 (chemical)	OFR 5311, p.476
Bicroft (Croft) Cardiff Tp.	MDI31E01SE-00224 (Prospect)	U	Estimated reserves in 3 zones: 979 810 tons grading 1.20 pounds U_3O_8 per ton	OFR 5311, p.84-85
Fission Cardiff Tp.	MDI31E01SE-00235 (Prospect)	U, Th, F	not known	
Baumhour–Campbell Faraday Tp.	MDI31E01SE0-0248 (Prospect)	U, Th	not known	
Mell–Quirke Monteagle Tp.	MDI31F04NE-00067 (Prospect)	U, Th	not known	
Greyhawk Mine Faraday Tp.	MDI31F04SW-00036 (Past Prod. w Reserves)	U, Th	Estimated reserves of 0.2 million tons grading 0.065% U_3O_8	MDC 23, p.62
Faraday/Madawaska Mine Faraday Tp.	MDI31F04SW-00037 (Past Prod. w Reserves)	U, Th	Proven and probable reserves of 1 023 086 tons at 0.145% U_3O_8 (1976)	MDC 23, p.60

Note: *The resource estimates listed in this table are historic figures and do not follow the required disclosure for reserves and resources as outlined in National Instrument 43-101.*

Table 18. Mineral deposits not currently being mined in the Southeastern Ontario District in 2016. (Note: table does not include nepheline syenite, trap rock, REE and dimension-stone deposits.)

Abbreviations

AF ..... Assessment Files
AR ..... Annual Report
CAMH ..... *Canadian and American Mines Handbook*
CMH ..... *Canadian Mines Handbook*
GR ..... Geological Report
MDC.....Mineral Deposit Circular [No.15–]
[*formerly* Mineral Resources Circular, No.1-14]
MDI ..... Mineral Deposit Inventory
MLS ..... Mining Lands, Sudbury
MP ..... Miscellaneous Paper
NM ..... *The Northern Miner*
OFR ..... Open File Report
PC ..... Personal Communication
Status: A; E; I; M ..... Active; Exploration; Inactive, Mining

Deposit Township	MDI File Number	Status	Commodity	Reserves	Reserve Reference
Ore Chimney prospect Barrie Township	MDI31C14SE-00142 (SO 1130)	AE	Ag, Au, Zn, Pb	11 000 tons above the 500-foot level Averages: 0.2 oz per ton Au, 5.64 oz per ton Ag, 2.0% Zn, 1.0% Pb	MDC 12, p.132; MDC 18, p.33
Macassa Nickel Limerick Township	MDI31C13SE-00099 (SO 0595)	AE	Ni, Cu	2 000 000 tons @ 1.0% Ni, 0.25% Cu	MDC 12, p.138
Renfrew Zinc (Renprior) Admaston Township	MDI31F07NE-00063 (SO 0286)	AE	Zn	16 000 tons @ 10.5% Zn to a depth of 30 m; Breakwater Resources optioned the property to Noranda Mining and Exploration in 1996	MDC 12, p.226; MDC 20, p.17
Harvey Simon prospect Lyndoch Township	MDI31F03NW-00044 (SO 0259)	AE	Cu, Fe, Zn	250 000 tons @ 1.1% Cu to 350 feet	MDC 12, p.226; MDC 20, p.45
Clyde Forks deposit Lavant Township	MDI31F02SE-00064 (SO 0351)	I	Cu, Sb, Ag, Hg	60 000 tons @ 0.67% Cu, 0.37% Sb, 0.03% Hg, 1.32 oz per ton Ag	MDC 20, p.36
Twin Lakes Diorite Methuen Township	MDI31C12NW-00114 (SO 3840)	AE	Ti	13.2 Mt of 21.7% TiO_2, recoverable from open pit to a depth of 165 m, with rock:ore ratio = 0:54. Diorite wall rock is currently being mined by MRT Aggregates for trap rock	Kingston, MacKinnon and Caley (1990, p.99)
Grattan deposit Grattan Township	MDI31F06NE-00017 (SO 0270)	AE	Fe	Proven: 3 639 600 tons to a vein depth of 363 feet. Indicated: 9 099 000 tons to a vertical depth of 600 feet @ average grade of 27.74% Fe	MDC 20, p.98
Radenhurst–Caldwell deposit Lavant Township	MDI31F02NE-00012 (SO 0349)	I	Fe	Main lens 2000 feet long by 31.3 feet wide; contains 6500 tons per slope foot at a grade of 32.77% Fe; 3 additional zones totalling 1600 feet in length average 17%, 16.7% and 25.5% Fe	MDC 20, p104
Bessemer deposit Mayo Township	MDI31F04SE-00012 (SO 0235)	AE	Fe	No.4 deposit 2 480 819 tons @ 28.62% recoverable Fe. In 2007–2008, deposit was evaluated as source of iron	MDC 20, p.110
Childs deposit Mayo Township	MDI31F04SE-00013 (SO 0236)	AE	Fe	6 193 330 tons @ 19.25% recoverable Fe. In 2007–2008, deposit was evaluated as source of iron	MDC 20, p.114
Calabogie Magnetite property / Algoma Ore Prop. Ltd. Bagot Township	MDI31F07SE-00009 (SO 0353)	AE	Fe	Reserves of 45 million tons @ 25% Fe to 500 feet and 28% Fe to 1000 feet	MDC 11, p.314
Buckhorn deposit Bagot Township	MDI31F07NE-00069 (SO0362)	I	Mo	Largest of numerous small lenses contains 1500 tons @ 1% MoS_2	MDC 20, p.132
Bannockburn (Madoc Mining Company Ltd.) Madoc Township	MDI31C12NE-00195 (SO 7274)	A	Au	225 000 tons grading 0.267 ounce per ton Au	MP 161, p.377
Cooper Spruce Ridge Resources Ltd. Elzevir Township	MDI31C11SW-00044 (SO 2679)	I	Au, talc	3 Mt @ 30–33% recoverable talc and 40 000 t @ 8.0 g/t Au	OFR 5945, p.92; OFR 5808, p.79
Dingman deposit Marmora Township	MDI31C12SE-00040 (SO 3590)	AE	Au	11.6 Mt @ 0.97 g/t Au	OFR 6296, p.50-51
Hawley Ram Petroleum Limited Olden Township	MDI31C10NW-00117 (SO 4057)	I	Wollastonite	2.5 Mt @ 32% wollastonite to a vertical depth of 75 m	OFR 5943, p.337

Deposit Township	MDI File Number	Status	Commodity	Reserves	Reserve Reference
Marmora Gitennes Exploration Inc. Marmora Township	MDI31C12SE-00096 (SO 3729)	I	Wollastonite	450 000 t (open pit) @ 47% wollastonite, plus 680 000 t @ 39% wollastonite in a separate zone	OFR 5715, p.50
Trudeau C. Roger Young Hungerford Township	MDI31C11SW-00049 (SO 1192)	A	Calcite, dolomite	4 Mt high-purity dolomite; no reserve estimate available for the calcite zone	OFR 5958, p.11-11
Verona–Kirkham Stewart Lake Resources Inc. Bedford Township	MDI31C10SE-00023 (SO 1244)	A	Graphite	1.6 Mt grading 9.5% graphite in 2 separate zones	MDC 33, p.16
Cal Graphite Corp. Butt Township	MDI31E11NE-00004 (N0129)	AE	Graphite	Reserves of 60 Mt grading 3% graphitic carbon – Ontario Graphite Ltd. development project 2011	MDC 33, p.10
Globe Graphite Mine North Elmsley Township	MDI31C16SE-00016 (SO 1604)	I	Graphite	500 000 t of approximately 7% graphite below mined out portion to the 300-foot level	MDC 33, p.25
Cordova Mine Belmont Township	MDI31C12SW-00005 (SO 1670)	AE	Gold	115 982 tons grading 0.21 ounces per ton Au	OFR 5808, p.43
Newboro prospect North and South Crosby townships	MDI31C09NW-00009 (SO1466) MDI31C09NW-00011 (SO1469)	I	Iron, titanium	45 Mt proven and probable averaging 26.24% Fe, 6.60% TiO_2	OFR 5515, p.316
Madawaska Mine Faraday Township	MDI31F04SW-00037 (SO0223)	I	Uranium	Measured reserve of 385 193 short tons grading 0.143% U_3O_8, 1 098 283 pounds U_3O_8; indicated reserve of 450 988 short tons grading 0.158% U_3O_8, 1 427 195 pounds U_3O_8, total reserves of 836 181 short tons grading 0.151% U_3O_8, 2 525 478 pounds U_3O_8	OFR 5515, p.393
Addington Mine Kaladar Township	MDI31C11NE-00010 (SO0882)	I	Gold	Total geological reserve of 758 000 tons grading 0.14 ounces per ton Au	OFR 5808, p.71

Note: *The resource estimates listed in this table are historic figures and do not follow the required disclosure for reserves and resources as outlined in National Instrument 43-101.*

Table 19. Mineral deposits not currently being mined in the Southwestern Ontario District in 2016.

Abbreviations

AF ..... Assessment Files
AR ..... Annual Report
CAMH ..... *Canadian and American Mines Handbook*
CMH ..... *Canadian Mines Handbook*
GR ..... Geological Report
IMR ..... Industrial Mineral Report
MDC ..... Mineral Deposit Circular [No.15–]
[*formerly* Mineral Resources Circular, No.1-14]
MDI ..... Mineral Deposit Inventory
MLS ..... Mining Lands, Sudbury
MR ..... Mining Recorder
NM ..... *The Northern Miner*
OFR ..... Open File Report
PC ..... Personal Communication
PRW ..... Petroleum Resources Well No.

Deposit Name / NTS	Commodity	Tonnage-Grade Estimates and/or Dimensions	Ownership References	Reserve References*	Status
Amherstburg Quarry silica prospect (40J/03SE)	Silica	20 m thick over 66 ha (20–26 $\times 10^6$ t @ 94% SiO_2)	Amherst Quarries (1969) Ltd.	OFR 5861, p.32 IMR 9, p.29, 31	Inactive
Big Creek 1 (40J/03SE)	Silica	19.5 m thick @ 25 m (10×10^6 t of sandstone)	N/A	IMR 9, p.29	Inactive
Big Creek 1 (40J/03SE)	Silica	14.6 m thick @ 34.4 m (10×10^6 t of sandstone)	N/A	IMR 9, p.29	Inactive
Dow–Moore 2-20-12 (40J/16NW)	Salt	21 m thick @ 698 m 73 m thick @ 582 m 114 m thick @ 410 m	N/A	PRW Dow–Moore 2-20-XII	Inactive
Eastnor–Lindsay prospect (41H/03SW)	Dolomite	60 $\times 10^6$ t dolomite @ <0.10% impurities (SiO_2+Fe_2O_3+Al_2O_3)	N/A	PRW OGS Lindsay 7-III W	Inactive
Imperial Oil No.560, Sombra 2-12-H, Gormlay No. 1 (40J/090NW)	Salt	32.2 m thick @ 612.6 m 84.1 m thick @ 490.7 m 46.9 m thick @ 388.6 m	N/A	PRW Sombra 2-12-H	Inactive
Imperial Oil No.597, Logierait No.1-Y-R, R.C. Fleck No. 2B (40J/16NW)	Salt	29.6 m thick @ 680 m 87.8 m thick @ 544 m	N/A	PRW Imperial Oil No. 597B	Inactive
Lindsay prospect (41H/03SW)	Dolomite	>35 $\times 10^6$ t dolomite @ <0.10% impurities (SiO_2+Fe_2O_3+Al_2O_3)	N/A	PRW OGS Lindsay 31-VIII W	Inactive
Patton Farm (40J/03SE)	Silica	5.4 m thick @ 10.1 m	N/A	IMR 9, p.29	Inactive
Sunburst GB #7 McGillivray 41-NB (40P/04NE)	Salt	88.7 m thick @ 363.6 m 5.8 m thick @ 339.5 m	N/A	PRW Sunburst GB #7	Inactive
Tobermory prospect (41H/04NE)	Dolomite	60 $\times 10^6$ t dolomite @ <0.10% impurities (SiO_2+Fe_2O_3+Al_2O_3)	N/A	PRW OGS St. Edmunds 47-III W	Inactive
Union Gas–Enniskillen No. 29, D.V.L.A. No. 1 (40J/16SW)	Salt	25.6 m thick @ 610.8 m 78.6 m thick @ 485.5 m	N/A	PRW Union Gas–Enniskillen No. 29	Inactive
Union Gas–Moore No. 12 P&I Williams No. 1 (40J/16SW)	Salt	26.2 m thick @ 577.3 m 70.7 m thick @ 456.6 m	N/A	PRW Union Gas-Moore No. 12 P&I Williams No. 1	Inactive
Union–Moore No. 22 (40J/16SW)	Salt	36 m thick @ 580 m 32 m thick @ 437 m	N/A	PRW Union Moore No. 22	Inactive

***Note:** The resource estimates listed in this table are historic figures and do not follow the required disclosure for reserves and resources as outlined in National Instrument 43-101.*

OGS ACTIVITIES AND RESEARCH BY OTHERS

Multi-year mapping and related projects in southern Ontario by staff of the Earth Resources and Geoscience Mapping Section, Ontario Geological Survey, continued during the 2016 field season.

In the eastern part of the Central Metasedimentary Belt, Grenville Province, the second phase of a two-year bedrock mapping project in the Perth area was completed. A second project presents a deposit model for rare earth element and related metallic mineralization associated with syenite magmatism, based upon new geochemical and geochronological data obtained during recent mapping projects in the Cobden, Brudenell and Perth areas. Details of both projects are presented in the following articles, published in *Summary of Field Work and Other Activities 2016* (Ontario Geological Survey 2016):

- Precambrian and Paleozoic Geology of the Perth Area, Grenville Province; by R.M. Easton
- Metasomatism, Syenite Magmatism and Rare Earth Element and Related Metallic Mineralization in Bancroft and Frontenac Terranes: A Preliminary Deposit Model; by R.M. Easton

Other OGS studies related to Paleozoic geology and energy studies, Quaternary geology, aggregate resources and groundwater resources in southern Ontario were in progress in 2016. Detailed descriptions of the following projects are included in *Summary of Field Work and Other Activities 2016* (Ontario Geological Survey 2016):

Aggregate Resources and Industrial Minerals

- Aggregate Resources Inventory for the County of Peterborough, Southern Ontario; by L.A. Handley

Surficial Geochemistry

- Update on Lake Erie Tributary Sediment and Water Phosphorus Study; by H.E. Burke and R.D. Dyer

Paleozoic Geology and Energy Studies

- The Silurian–Devonian Unconformity in Subsurface and Outcrop of Southwestern Ontario; by S. Sun, F.R. Brunton and J. Jin

Groundwater Studies

- Regional-Scale Groundwater Mapping in the Early Silurian Carbonates of the Niagara Escarpment: Final Update; by E.H. Priebe and F.R. Brunton
- The Niagara Peninsula in Three Dimensions: A Drilling Update; by A.K. Burt
- Subsurface Data Collection for Three-Dimensional Sediment Mapping in the Central Part of the County of Simcoe, Southern Ontario; by R.P.M. Mulligan
- The Provenance of, and Possible Relationship Between, Methane and Halogens in Groundwater in Southeastern Ontario; by A.J. Lemieux, I.D. Clark, S.M. Hamilton, C.M. Rogerson and D.F. Kelton
- The Investigation of Groundwater as a Source of High Iodine Levels in Milk from Dairy Herds in Eastern Ontario; by C.M. Rogerson, D.F. Kelton, S.M. Hamilton, A.J. Lemieux and I.D. Clark
- Ontario Geological Survey–Geological Survey of Canada Groundwater Geoscience Collaboration: Southern Ontario 2015-2019; by H.A.J. Russell and R.D. Dyer

Geophysical surveys that were completed or in progress in southern Ontario in 2016 are described in *Summary of Field Work and Other Activities 2016* (Ontario Geological Survey 2016).

- Summary of Geophysical Projects and Activities; by D.R.B. Rainsford and S. Biswas

Several other OGS publications related to geoscience projects in southern Ontario were released in 2016 and are listed in Table 6.

University Research and Collaborations

The following information was provided to the Southern Ontario Regional Resident Geologist's office concerning research projects by faculty and graduate students of various accredited universities, which were in progress or were published in 2016 and in early 2017. This section is not a comprehensive summary of university research in the Southeastern Ontario and Southwestern Ontario districts, as it is based solely on information provided directly by university researchers.

- Dr. H.C. Halls (University of Toronto) continued his work on the paleomagnetic properties of Grenville Province gneisses to characterize the remanence signature of the Grenville Province south of the Allocthon Boundary Thrust.
- Dr. W.M. Schwerdtner (University of Toronto), Dr. T. Rivers (Memorial University of Newfoundland), J. Tsolas, D.H. Waddington, S. Page and J. Yang competed a paper entitled, "Transtensional Origin of Multi-Order Cross Folds in a High-Grade Gneiss Complex, Southwestern Grenville Province: Formation During Post-Peak Gravitational Collapse" (Schwerdtner et al. 2016).
- Jieying Wang completed an MSc thesis, with Dr. B. Kendall (University of Waterloo), entitled "Uranium and Molybdenum Isotope Constraints on Ocean Redox Conditions During Deposition of the Upper Devonian Kettle Point Formation, Ontario". The thesis examines the role of the local versus global ocean redox conditions on the Frasnian–Famennian mass extinction event in the Late Devonian.
- C. Drever, with Dr. C. Yakymchuk (University of Waterloo), is working on an MSc thesis with the support of Northern Graphite Corporation. The thesis, entitled "Petrogenesis of the Bissett Creek Flake Graphite Deposit: Implications for Regional Graphite Mineralization Models in the Grenville Province, Ontario", examines the lithogeochemistry and carbon isotope signatures of graphite-bearing paragneisses within the deposit.
- Dr. G.R. Dix (Carleton University) is supervising 2 thesis studies:
  - an MSc thesis by He Kang:
    "Geology of Paleozoic Outliers (Manitoulin Island, Callendar, and Algonquin Park Regions)"
  - a PhD thesis by Nkechi Oruche:
    "Middle to Upper Ordovician Foreland Sequence Stratigraphy, Ottawa Embayment"

REGIONAL LAND USE GEOLOGIST ACTIVITIES—SOUTHERN REGION

Land Use Planning Activities

The southern Regional Land Use Geologist, based in Tweed, co-ordinates input into land use planning activities in the Southern Ontario Resident Geologist District (southeastern Ontario and southwestern Ontario districts) and the part of the Sudbury District south of the French River, including Manitoulin Island and St. Joseph Island. The southern Regional Land Use Geologist position was staffed throughout 2016 by Deborah A. Laidlaw, *P.Geo.*

The boundaries of the Regional Land Use Geologists' regions are indicated on Figure 13.

Figure 13. Extent of Regional Land Use Geologists' areas of responsibility (red lines indicate the regional boundaries; grey lines indicate the municipal boundaries).

The objective of the position is to ensure that geoscience information is considered in policy and land use planning decisions. The geoscience information relates to

- mineral-related values and economic opportunities;
- natural geological and mining-related hazards;
- renewable and non-renewable energy sources; and
- groundwater resources.

Program activities that support this objective include helping develop, deliver and administer provincial policies, practices and procedures; and providing advice and guidance to municipalities, agencies and others involved in or affected by land use planning regarding geoscience-related matters.

In 2016, the southern Regional Land Use Geologist dealt with a variety of land use planning issues throughout the southern region. The following sections summarize the work that was done.

CROWN LANDS

The Ministry of Northern Development and Mines (MNDM) engages with the Ministry of Natural Resources and Forestry (MNRF) when Crown land use planning activities have the potential to impact provincial mineral interests, or to expose those using Crown lands to natural geological or mining-related hazards. These activities relate to forest management planning; energy and other major infrastructure projects; Far North land use planning; proposals to modify existing parks or create new ones; and various other initiatives related to Crown land use.

Forest Management Planning

The forest management planning process involves consideration of a wide range of values, including mineral values, in the context of forestry activities, and the relevance of legislation other than the *Crown Forest Sustainability Act*, such as the *Mining Act*. The southern Regional Land Use Geologist provided input into the development of the French–Severn Forest Management Plan 2019–2029.

Approved forest management plans, with detailed information about annual operations, including plans for creating new access routes or decommissioning existing routes, and maps showing forest access roads are posted on the MNRF Web site (www.efmp.lrc.gov.on.ca/eFMP/home.do).

Provincial Parks and Conservation Reserves

In 2016, the southern Regional Land Use Geologist responded to requests for comments on reviews of Provincial Park management plans, including Algonquin, Charleston Lake, Killbear and Stoco Fen provincial parks. The reviews address topics such as zoning, park uses, management of cultural and natural resources, and access. The MNRF posted updates of these park management plans on the Environmental Registry (www.ebr.gov.on.ca/ERS-WEB-External/) in 2016 for public comment and final decisions were made to proceed with the proposals for Stoco Fen and Charleston Lake. No decision notices on the final outcome for Killbear and Algonquin provincial parks have yet been released.

MUNICIPAL AND PRIVATE LANDS

The Ministry of Northern Development and Mines supports municipal and private land use planning through the One Window Planning Service led by the Ministry of Municipal Affairs (MMA). When requested, the southern Regional Land Use Geologist provides input into, and reviews, draft Official Plans, Official Plan Amendments, draft plans of subdivision and consent (severance) applications to ensure that provincial mineral interests, natural geological hazards and mining-related hazards are appropriately considered in the planning process.

Municipal Planning

The Provincial Policy Statement (PPS), which guides municipal planning in Ontario, is issued under the provisions of the *Planning Act*. The PPS was last modified in 2014. The revision includes enhanced provisions to help ensure that municipal Official Plans recognize mining operations and areas with significant mineral potential, so that they can be protected from incompatible land uses.

As a participant in MMA's One Window Planning Service for Official Plans and their amendments, the southern Regional Land Use Geologist provided comments, mineral values mapping and other input as required for Official Plans and Official Plan Amendments, including

- 28 consent (severance) applications in 16 lower-tier municipalities;
- 19 Official Plans and related planning initiatives (such as zoning by-laws and subdivision approvals) in 17 communities;
- and 7 new draft Official Plans or Official Plan updates.

The municipalities involved in these planning initiatives are listed in Table 20; their locations are shown in Figures 14 and 15.

The southern Regional Land Use Geologist attended the Ontario East Municipal Conference and the Northeastern Ontario Planning Authorities Workshop to network with clients and service providers engaged in municipal planning. Both events dealt with planning issues that cover parts of the southern Regional Land Use Geologist's region.

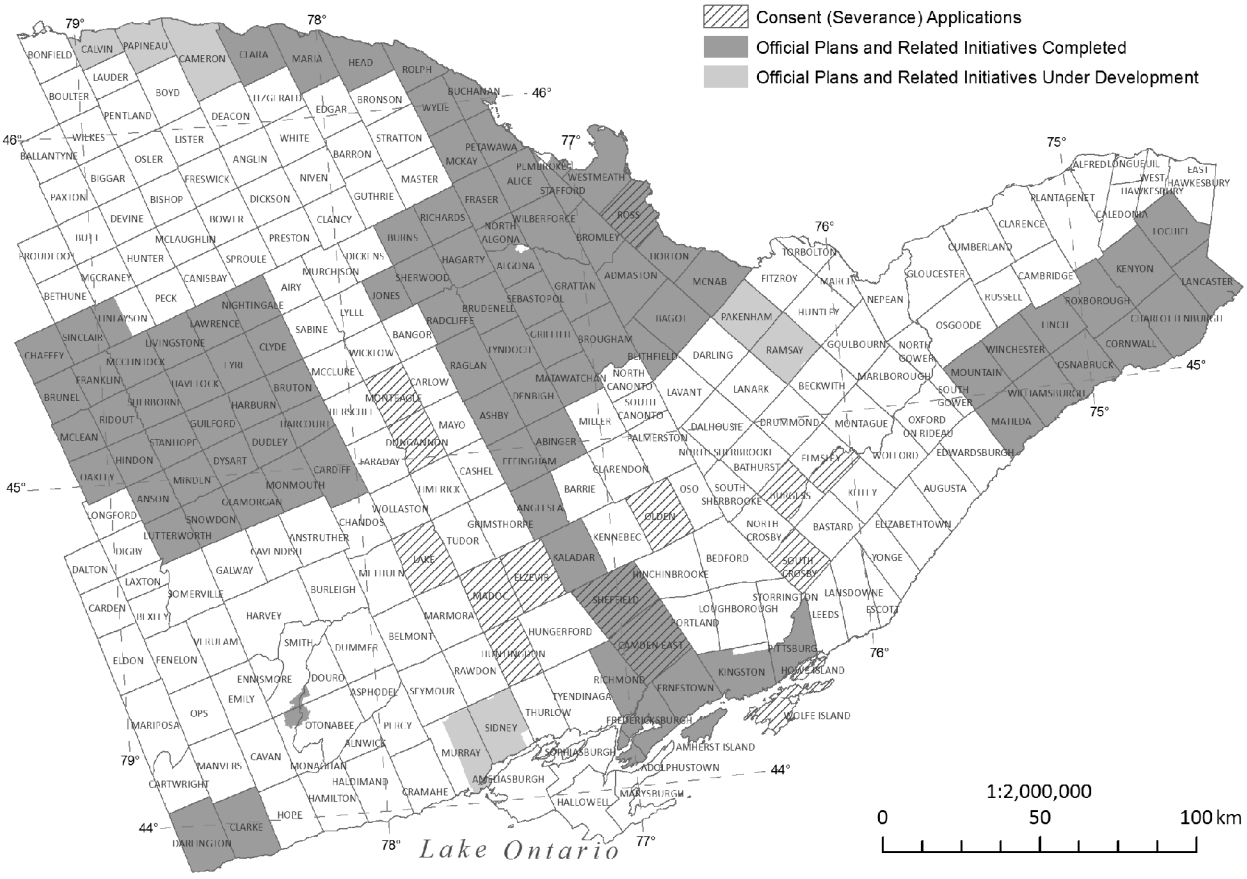

Figure 14. Planning initiatives with MNDM input, southeastern Ontario.

Table 20. Municipal planning initiatives with MNDM input, southern Ontario, 2016.

Consent (Severance) and Subdivision Applications
Consent, Dungannon, Township of
Consent, Elzevir, Township of
Consent, Foley, Township
Consent, Frontenac Islands, Township of
Consent, Goderich, Town of (8)
Consent, Huntingdon, Township of (2)
Consent, Lake, Township of
Consent, Madoc, Township of (2)
Consent, Monteagle, Township of (4)
Consent, North Burgess, Township of
Consent, Olden, Township of
Consent, Ross, Township of
Consent, Seneca, Township of
Consent, South Crosby, Township of
Consent, South Elmsley, Township of
Consent, Stone Mills, Township of

Completed Official Plans and Related Initiatives
Brantford, City of
Clarington, Municipality of
Cornwall, City of
Goderich, Town of
Haliburton, County of
Kingston, City of
Lambton, County of
Lennox and Addington, County of
London, City of
Muskoka, District Municipality of
Niagara-on-the-Lake, Town of
Peterborough, City of
Renfrew, County of
Shelburne, Town of (2)
Stormont, Dundas and Glengarry, United Counties of
The Archipelago, Township of
Windsor, City of (2)

Official Plans and Related Initiatives Under Development
Armour, Township of
Arnprior, Town of
East Nipissing Planning Area
Grey, County of
Mississippi Mills, Municipality of
Parry Sound, Town of
Quinte West, City of

Other Activities

The southern Regional Land Use Geologist also undertook other related work in 2016, as outlined below.

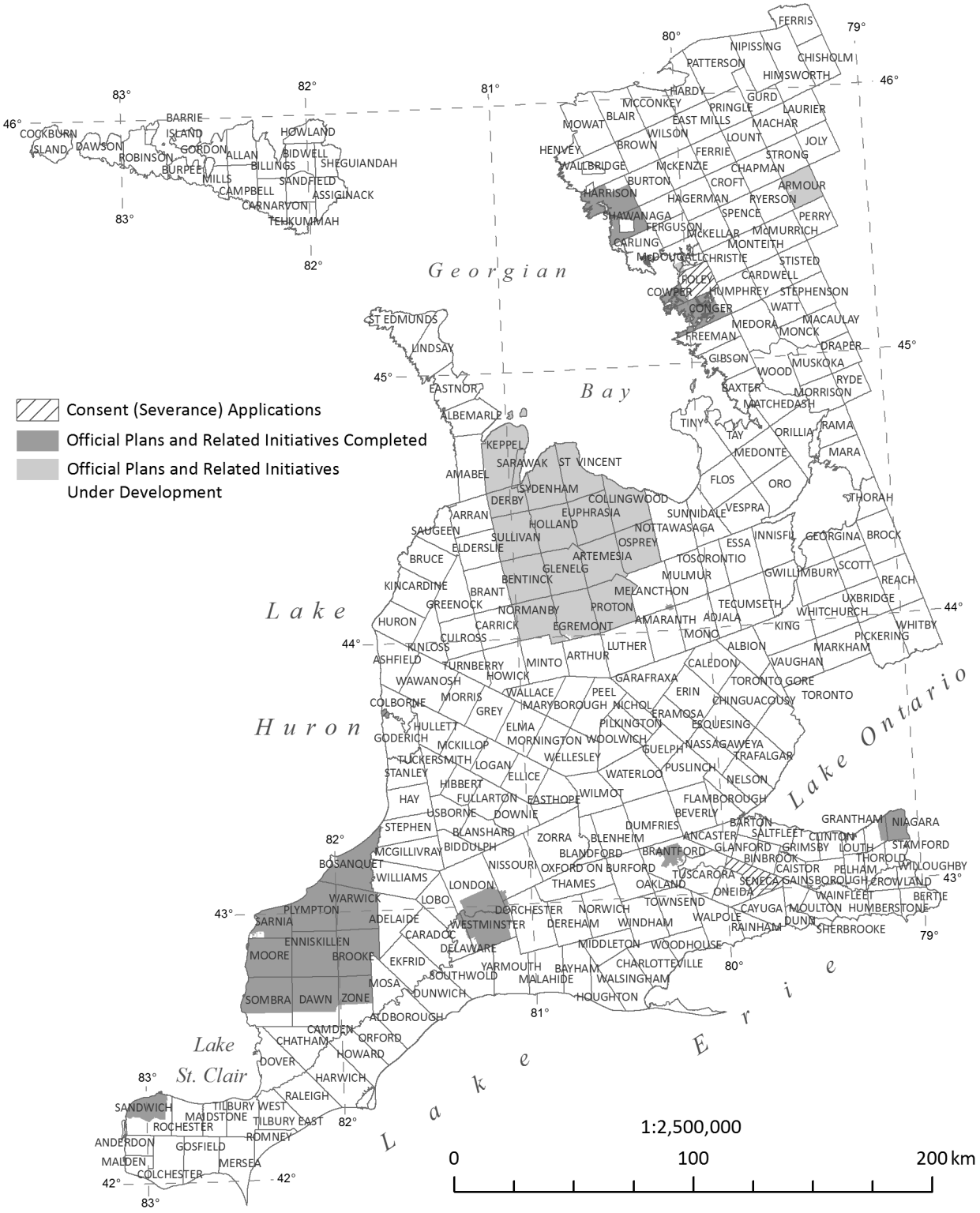

Figure 15. Planning initiatives with MNDM input, southwestern Ontario.

GEOSCIENCE POLICY OPTIONS

A goal of Ontario's Mineral Development Strategy (www.mndm.gov.on.ca/en/mines-and-minerals/mineral-development-strategy) is to develop geoscience policy options that would integrate geoscience information into government decision making and inform provincial land use planning decisions related to the environment, ecology, climate change and public health and safety. A committee consisting of a core team with members from MNDM and an inter-ministerial group with representatives from various provincial ministries was set up to help develop options, to consult with other Ontario Public Service (OPS) geoscientists and scientists for their input and perspective and to promote awareness that geoscience policy options are being prepared. The southern Regional Land Use Geologist participated on the committee by attending teleconferences and providing input to geoscience policy-related initiatives.

CLASS ENVIRONMENTAL ASSESSMENTS

Class Environmental Assessments ("Class EAs") are documents that set out a standard environmental assessment process to evaluate the potential environmental effects of a project. There are currently 11 Class EAs in effect in Ontario, relating to the development of new infrastructure, such as dams, transmission lines, pipelines, highway corridors, commuter rail stations and bus terminals, and sewer and water facilities; the establishment of new parks and conservation reserves; forest management plans; and Crown land dispositions.

The southern Regional Land Use Geologist worked with staff from MNRF and other ministries to ensure that relevant geoscience information and provincial mineral interests were identified and accommodated early in the planning process of projects subject to Class EAs. In 2016, feedback was provided for reviews of the following 2 Class EA projects within southern Ontario:

- a proposal to upgrade Highway 404 in York Region by the Ministry of Tranportation; and,
- a project to construct a natural gas pipeline in the Fenelon Falls and Lindsay areas.

GUIDANCE MATERIALS

In 2016, the southern Regional Land Use Geologist was called upon by partner ministries to review and provide input on proposed new or updated policies, and/or supporting guidance materials. Comments were prepared and submitted for the following

- Ontario Municipal Board (OMB) Review Consultation;
- One Window Screening Criteria: A Checklist of Provincial Interests - Specific Ministry Policy Areas for MNDM; and,
- Lake Simcoe Shoreline Management Guidelines and Management Strategy.

CONFERENCES

The southern Regional Land Use Geologist engaged with clients at the Bancroft Gemboree. With approximately 5000 attendees each year, the Bancroft Gemboree is the largest gem and mineral show in Canada. It provides staff from the Resident Geologist Program with an opportunity to share information regarding the mineral sector with mineral collectors and the general public.

The southern Regional Land Use Geologist also attended the following symposia, workshop and field tour:

- 2016 Northeastern Ontario Mines and Minerals Symposium in Sudbury;
- Ontario Stone Sand and Gravel Association Rehabilitation Workshop and Tour in Ajax; and
- Toronto Geological Discussion Group Mini-Symposium on Innovation and Change in Mineral Exploration.

MINERAL DEPOSIT COMPILATION GEOLOGIST—NORTHEASTERN ONTARIO

The Mineral Deposit Compilation geologists (MDCG) investigate and document mineral deposits and occurrences across the province. Through field visits, comprehensive literature research and personal research, they work with regional and district Resident Geologist Program staff to ensure that the Mineral Deposit Inventory (MDI) database is regularly updated. Regular updates are required to ensure that the Ministry of Northern Development and Mines is using the most up-to-date information in making land-use planning and policy decisions. A.C. Wilson is the northeastern Ontario MDCG.

The MDI database is a dynamic compilation of over 19 200 records describing most of the known mineral occurrences in Ontario. It is an important reference tool for explorationists interested in exploring and acquiring mining properties in Ontario. When used in conjunction with other spatial databases generated by the Ontario Geological Survey, it provides an additional tool for making mineral discoveries in Ontario.

A focus was made on updating MDI records for the Black River–Matheson land-use planning update. Data for each of the 12 townships have been compiled and entered into the database.

Township updates were compiled and entered for the following:

Mining Division	Townships	Status
Larder Lake	Hislop, Playfair, Walker, Cook, Benoit, Melba	complete
Sudbury	Cameron, Denison, Drury, Hallam, Baldwin, Porter, Foster, Mongowin, Merrit, Papineau	complete
Porcupine	Yeo, Potier, Arbutus, Huffman	complete
Sault Ste. Marie	Riggs	complete
Southern Ontario	Bathurst, Cavendish, Elmsley, Glamorgan, Kitley, Monmouth, Niagara, Snowdon	complete

The northeastern Ontario MDCG also worked on changes and updates to MDI records for a variety of land-use planning decisions in the Larder Lake Mining Division and the Sault Ste. Marie Mining Division.

Total changes to the provincial MDI database, completed by the northeastern Ontario MDCG, in 2016 included 589 updated records, 174 records deleted and 3 new records. Deletion of an MDI record occurs when there is a duplication of data or similar occurrences are closer than 400 m of each other.
A breakdown, by office, of the provincial records revised by the northeastern Ontario Mineral Deposit Compilation Geologist is provided in Table 21.

Table 21. Mineral Deposit Inventory records revisions in 2016.

Resident or District Office	Updates	Deletions	New
Kirkland Lake	134	7	2
Sault Ste. Marie	23	0	0
Southeastern Ontario	303	152	1
Sudbury	70	15	0
Timmins	59	0	0
Total	589	174	3

The publicly available version of the MDI database was updated in February 2016 and is available from the OGS online data warehouse, GeologyOntario (www.ontario.ca/geology). The Mineral Deposit Inventory can also be viewed geographically using the OGSEarth application (www.ontario.ca/ogsearth), which helps users discover data through the Google Earth™ mapping service.

ACKNOWLEDGMENTS

The authors would like to thank all producers, exploration companies, prospectors and developers who provided access to their operations or supplied information throughout 2016. Strong communication links between stakeholder groups and government ministries are essential for effective program delivery and, ultimately, to improve the delivery of government services.

Staff and clients of the Southern Ontario Resident Geologist Office would like to acknowledge and thank Pam Sangster for her leadership, guidance and friendship during her time in Tweed. Pam began her career with MNDM as District Geologist in Timmins, from 1980 to 1997, and was the Southern Ontario Regional Resident Geologist from 1997 to 2016. In addition to her responsibilities as the Regional Resident Geologist, Pam was the Industrial Minerals and Dimension Stone specialist for the program.

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Ontario

Ontario Geological Survey
Regional Resident Geologist Program

Petroleum Operations Section—2016

by

L. Fortner

2017

CONTENTS

Petroleum Operations Section—2016

Petroleum Operations Section—2016

L. Fortner[1]

[1]Geologist, Petroleum Operations Section, Ministry of Natural Resources and Forestry, London, Ontario

INTRODUCTION

Through 2016, drilling frequency in Ontario licenced by the Petroleum Operations Section has maintained the historic low realized in 2014. Exploration and development activity has been nearly non-existent in 2015 and 2016.

The average price of oil sold in Ontario during the year was $56 per barrel: significantly less than the $61 per barrel in 2015. The price of natural gas in Ontario averaged $3.08 per MMBtu in 2016, slightly higher than the average of $2.95 per MMBtu in 2015.

Produced oil volumes fell to a new low again in 2016. Preliminary data compiled from unaudited annual production reports submitted to the Petroleum Operations Section indicate that annual oil production dropped approximately 8% to an estimated 57 000 m^3 in 2016, compared with 61 919 m^3 (revised) in the previous year. The combined impact of decreased production and drop in price per unit volume of oil resulted in an estimated total sales value of $20.2 million, a 15.4% drop from the estimated value of $23.9 million in 2015, which was, in turn, a 43.3% drop from the estimated value of $42.1 million in 2014.

The continuing decline in oil production is directly related to reduced levels of drilling activity since 2004, such that there is insufficient new production to replace that from older existing wells. Suppression of the price of oil, which began in 2014, combined with the longer term pressure on the price of natural gas, has almost entirely eliminated new petroleum drilling in the province.

Natural gas production continued its downward trend in 2016, falling 4.3% from a revised production of 161 662 $\times 10^3$ m^3 in 2015 to a preliminary unaudited figure of 154 721 $\times 10^3$ m^3 in 2016. Estimated total value of gas production in 2016 fell to $16.0 million, as compared with a revised total value of $17.3 million in 2015.

ACTIVITY

A total of 4 licences to drill and operate new wells were issued by the Ministry of Natural Resources and Forestry in 2016: a significant drop compared with 11 in 2015. An additional 44 licences were issued in 2016 to plug or operate existing wells, consistent with the 43 licences issued in 2015.

Drilling of new wells has somewhat stabilized at its historic low, with 5 reported in 2016, compared to 6 in 2015 and 7 in 2014. The new drills in 2016 consisted of 1 development well, 1 exploration well, 1 natural gas storage well, and 2 stratigraphic tests. This result is similar to that reported for 2015 of 1 development well, 2 natural gas storage wells, and 3 stratigraphic tests, with the notable exception of a nominal return to exploration in 2016.

Commercial exploration and development experienced no success in 2016, with the single development effort being a private gas well and the single exploration attempt being plugged and abandoned. There had been 1 commercial success in 2015, with a single development well reported as an active gas producer. No exploration drilling had occurred in Ontario in 2015.

Cambrian Play

In 2016, 1 exploration well was intended to test the Cambrian interval for oil and gas in Kent County; however, it was plugged and abandoned. There had been no exploratory wells drilled to test the Cambrian in 2015 or 2014.

As in 2015, no development wells were drilled to the Cambrian in 2016. There had been 1 development well drilled to this target in 2014, which had been the first since 2010.

Ordovician Play

There were no exploration or development wells drilled to an Ordovician target in 2016 or 2015.

Silurian Sandstone Play

No exploration wells have been drilled to test Silurian sandstone since 2011.

The only development well drilled in 2016 in any play was a Silurian sandstone private gas producer.

Silurian Carbonate Play

There have been no exploratory or development wells drilled for Silurian Guelph Formation reef and/or Salina Group targets since 2013.

Devonian Play

No exploration wells have been intended for the Devonian play since 2013.

No development wells were drilled to test the Devonian in 2016. Only 1 development well, drilled in 2014, has targeted this interval since 2009.

EXPLORATION TRENDS

Unchanged from the last report, North American natural gas prices have, for several years, maintained their weakness because of the oversupply from the United States. Low natural gas prices have a dramatic impact on exploration and development activity in Ontario, which has been essentially halted. With North American oil prices also suppressed since late 2014, incentive for oil exploration has also disappeared. Consensus amongst industry analysts regarding the near future of oil and gas prices is not generally optimistic.

Metric Conversion Table

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 023	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.307 951	cubic yards	1 cubic yard	0.764 554 86	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 962	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 747	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 622 6	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton(short)	**907.184 74**	kg
1 t	1.102 311 3	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 9**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy) / ton (short)	1 ounce (troy) / ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights / ton (short)	1 pennyweight / ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	Multiplied by	
1 ounce (troy) per ton (short)	31.103 477	grams per ton (short)
1 gram per ton (short)	0.032 151	ounces (troy) per ton (short)
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

*Note: Conversion factors in **bold** type are exact. The conversion factors have been taken from or have been derived from factors given in the* Metric Practice Guide for the Canadian Mining and Metallurgical Industries, *published by the Mining Association of Canada in co-operation with the Coal Association of Canada.*

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