ISSN 1916-6168 (Online)
ISBN 978-1-4868-4246-9 (PDF)

ISSN 1484-9402 (Print)
ISBN 978-1-4868-4245-2 (Print)

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Ontario

Ontario Geological Survey
Open File Report 6368

Report of Activities, 2019 Resident Geologist Program

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

2020

Ontario

ONTARIO GEOLOGICAL SURVEY

Open File Report 6368

Report of Activities, 2019
Resident Geologist Program

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

by

P.S. LeBaron, N. Sabiri, D.A. Laidlaw, S.L.K. Hinz and L. Fortner

2020

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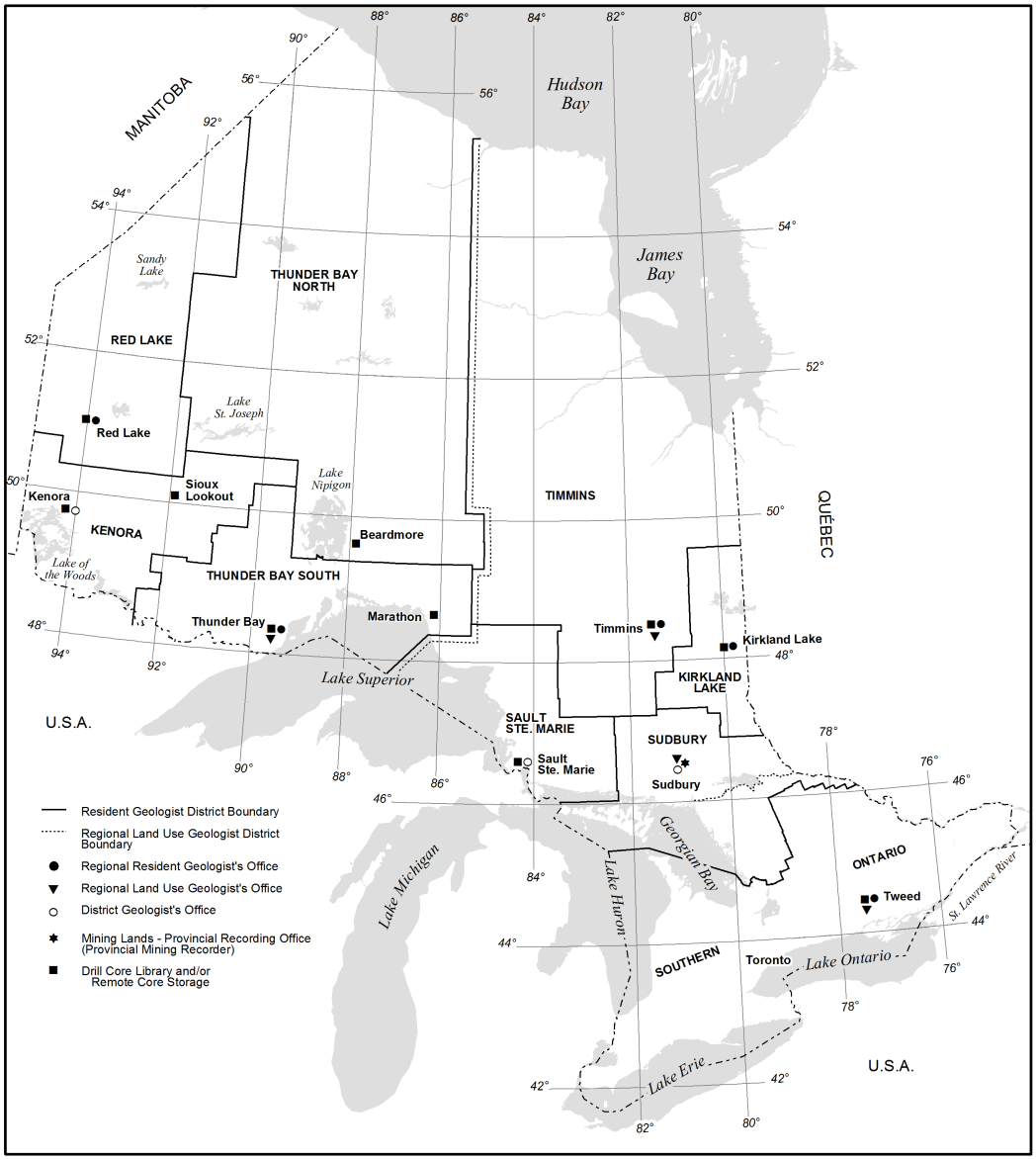

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ONTARIO GEOLOGICAL SURVEY

RESIDENT GEOLOGIST PROGRAM

REPORT OF ACTIVITIES—2019

SOUTHERN ONTARIO
REGIONAL RESIDENT GEOLOGIST REPORT

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INTRODUCTION

The Southern Ontario Region comprises the Southeastern Ontario and Southwestern Ontario districts and encompasses the most populous part of the province and the country. The Region also 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, the south 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 Quebec and Ontario. The northern boundary of the region cuts through Georgian Bay, and then 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 district, whereas Proterozoic metamorphic rocks of the Central Metasedimentary Belt and Central Gneiss Belt of the Grenville Province 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.

Mining claim registration in Ontario is done through the Mining Lands Administration System (MLAS) (www.mndm.gov.on.ca/en/mines-and-minerals/mining-act/mining-lands-administration-ontario), launched by the Ministry of Energy, Northern Development and Mines (ENDM) in April, 2018. This online self-service system provides access to mining claim registration and lands management and replaced traditional ground-staking methods. It marked the completion of the *Mining Act* modernization in support of the ministry's Mineral Development Strategy.

In 2019, there were 237 claims totalling 276 cells recorded electronically in southern Ontario, up from 2018, when 163 claims were recorded following the 3-month hiatus in staking (from January 8 to April 10, 2018) that preceded the introduction of electronic claim registration under MLAS. Figure 3 shows the claim staking activity for southern Ontario in 2019.

Tables 13 through 21 provide details on currently inactive mineral deposits with identified resources and past-producing mineral occurrences. Please note that unless otherwise stated, the resource figures presented in these tables and elsewhere in this report refer to historical resources that are not compliant with National Instrument (NI) 43-101.

The authors note that all Web addresses referenced were accessed in December 2019 and January 2020, 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 2019, there were 104 mineral extraction operations in southern Ontario, including 60 dimension stone quarries, 14 specialty aggregate producers (for pavement, decorative and/or coloured, metallurgical flux, lime and high-density concrete), 8 industrial mineral operations, 9 cement producer's quarries, 7 brick producer's quarries, 4 trap rock producers (one of which also produces the raw material for mineral wool and another produces wollastonite), and 2 gemstone and mineral specimen sites. All of Ontario's production of salt, gypsum, natural gas and petroleum, shale (for brick), lime/dolime, cement, nepheline syenite, high-purity calcium carbonate, and the majority of dimension stone, sand and gravel comes 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.

New estimates for 2019 suggest that approximately 9000 people were directly employed in mineral extraction and on-site processing plants in southern Ontario. These figures do not take into account the indirect jobs created by the mineral industry. In 2019, Ontario's non-metallic mineral production was valued at $2.5 billion—representing 23% of the total value of mineral production in the province. Five of the top 10 commodities produced in Ontario in 2019 were non-metallic minerals and most of this production came from southern Ontario mines and quarries. In 2019, approximately 21% of Ontario's total mineral wealth came from southern Ontario. This number is down from 25% in 2018 because cement is now categorized as a manufactured product♦ (S. Jessome, Mineral Sector Analysis and Promotion Unit, ENDM, written communication, February 2020).

♦*This is based on the Natural Resources Canada categorization for the collection and analysis of data for the "Annual Statistics: Mineral Production of Canada, by Province and Territory". This re-categorization has resulted in the value of the mineral products used to create cement now being recorded only as mineral production. Mineral production values are the values of the minerals without value-added manufacturing (i.e., "cement" being the value-added product).*

Wollastonite

CANADIAN WOLLASTONITE – ST. LAWRENCE DEPOSIT

Canadian Wollastonite (www.canadianwollastonite.com) is a privately held mining company incorporated in the province of Ontario. The company owns just over 220 ha of patent title property, encompassing a large portion of the St. Lawrence wollastonite deposit north of Kingston near the community of Seeley's Bay. The property straddles the boundary between the Township of Leeds and the Thousand Islands and the City of Kingston. Canadian Wollastonite began production in 2013 and the mine has been in continuous operation since opening.

Canadian Wollastonite currently processes run-of-mine ore products that are sold into metallurgical, agricultural and environmental applications. In 2017–2018, the company developed an effective beneficiation process for the extraction of high-aspect wollastonite and high-grade diopside products from the wollastonite ore. Additional pilot plant tests done in June of 2019 were successful and construction of a beneficiation plant is anticipated to begin in late 2020 or early 2021 (B. Vasily, Canadian Wollastonite, personal communication, January 2020).

Research and development, and marketing are an important part of Canadian Wollastonite's business.

- Since production began in 2013, 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 Ontario and is well situated to supply the eastern Ontario market.
- In 2014, the company successfully introduced wollastonite (calcium silicate) and diopside (calcium magnesium silicate) products into the local Ontario horticultural market, as well as into the northeastern United States as a single source of calcium, magnesium and silica.
- In 2016, the mine's primary ancillary ore—orthogneiss—was approved for use as Class 1 and 2 Railway Ballast.
- In 2016–2017, the company conducted research into the use of 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.
- In 2017, the company received a $450 000 research and development grant over 3 years to study and optimize plant growth and health through improved silicon absorption. Subsequent farm tests showed increased crop yields and quality, and a reduction in pests with the application of wollastonite to the soil. The company now markets crushed wollastonite ore as soil additive through several distributors in southern Ontario. Currently, 15% of production is used in the agricultural sector. The company expects this component to increase over the next few years based on results of research that indicates the ability of wollastonite to improve resistance to biotic and abiotic stresses in plants, and very strong carbon dioxide sequestration results that may allow farmers to monetize carbon credits (B. Vasily, Canadian Wollastonite, personal communication, January 2020).
- In 2017–2018, the company began working with a dimension stone company to investigate the use of the ore as a high-quality polished stone for use as counter tops and tiles. The company anticipates a 20–30% increase in sales of dimension stone in 2020 (B. Vasily, Canadian Wollastonite, personal communication, January 2020).
- In 2019, the company received unanimous approval from Kingston City Council to expand the mining operations onto land within the Kingston city boundary. The wollastonite reserves on the entire property total about 10 million tonnes. However, the company has established

markets for all rock types associated with the deposit, including the orthogneiss wall rock, increasing the total economic resource to about 30 million tonnes (B. Vasily, Canadian Wollastonite, personal communication, January 2020).

Nepheline Syenite

COVIA HOLDINGS CORPORATION – NEPHTON AND BLUE MOUNTAIN MINES

On December 12, 2017, Unimin (a subsidiary of privately owned, Belgium-based, SCR-Sibelco NV) announced that it was merging with Fairmont Santrol, a United States-based, leading provider of high-performance sand used by oil and gas exploration and production companies. The merger, completed on June 1, 2018, formed Covia Holdings Corporation that trades on the New York Stock Exchange under the symbol CVIA (Covia Holdings Corporation, news release, June 1, 2018, www.coviacorp.com).

Nepheline has been mined in the Havelock area for 85 years, with the Nephton Mine beginning in 1935 and Blue Mountain Mine in 1955. Unimin has operated the mine continuously since purchasing the site in 1989. The mine and plant operations currently employ approximately 200 workers.

Nepheline is used in the production of glass, ceramics, paint, fillers, insulation, abrasives and adhesives. It is used to lower the melting temperature of glass and ceramics, 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.

Approximately 75% of the revenue from the Blue Mountain and Nephton operations comes from the paint industry, in which nepheline reduces the need for volatile organic compounds (VOCs) and accounts for nearly 1/3 in weight of the final product (M. Clarkson, Unimin Canada Ltd., personal communication, January 2018).

At the end of 2017, Unimin received final approval for the expansion and modernization of the Blue Mountain operation. On January 3, 2018, Unimin Canada announced that it was going ahead with the $100 million (US) project to increase output capacity while reducing the site's environmental footprint, and to support continued mining, manufacturing and employment at the facility for many more decades. The modernization will enable the optimization of new technologies and practices to reduce noise, dust, lighting, use of water and electricity (S. McShane, Covia Holdings, personal communication, January 2020).

Construction started in January 2018 and is expected to be completed in early 2020. Upon completion, Blue Mountain's sister operation at Nephton will be closed, affecting approximately 100 employees. During the modernization, the Nephton facility will remain fully operational (S. McShane, Covia Holdings, personal communication, January 2020).

The nepheline syenite deposit at Blue Mountain and Nephton strikes over 8 km with a width of 1.7 km. To date, the deposit has been defined to a depth of approximately 175 m and is open at depth. In 2019, the mine extracted approximately 1.45 million short tons from the Nephton Mine, which translated into 598 000 short tons of nepheline syenite products. At current production rates, the mine reserves stand at 20 to 25 years, and the Inferred resources are estimated to last 60 years. The company conducts diamond-drill core exploration and test hole execution on a yearly basis to verify and refine the orebody model (S. McShane, Covia Holdings, personal communication, January 2020).

The Blue Mountain Mine is considered a "world-class" deposit. It is the only nepheline syenite mine in North America and there are only 2 others in the world, located in Russia and Norway.

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 historical producers in southwestern Ontario, only a few produced more than 100 000 t of salt from brine well operations (Hewitt 1962).

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 operations, as warranted by the market demand. Provincial and municipal governments are the main market for de-icing salt. The Ontario Ministry of Transportation reports that its salt usage varies from 500 000 to 600 000 tonnes of salt annually, depending on winter weather conditions (Environment Canada 2012).

In 2019, salt production in Ontario was valued at an estimated $253 million. Salt remains one of the top 10 minerals produced in Ontario by value of production. (S. Jessome, Mineral Sector Analysis and Promotion Unit, ENDM, written communication, February 2020)

Sifto Canada Corporation and the 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, for 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/or evaporation operations (Sangster et al. 2013).

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 International, Inc. (www.compassminerals.com) that trades on the New York Stock Exchange under the symbol CMP.

The Goderich salt mine, located 1800 feet under Lake Huron, is the largest underground salt mine in the world. It has operated since 1959 (having been acquired by Compass Minerals in 1990), has produced over 150 Mt of salt and has defined resources for an additional 120 years of production. The mine produces about 23 000 t of salt per day. About 80% of production is used as road salt for communities around the Great Lakes and along the St. Lawrence Seaway. The remainder is trucked to the Compass Minerals plant less than 4 km away, to be packaged as refined salt for water softener or as sidewalk de-icing salt for distribution and sale at retailers in North America. The salt is also sold in bulk to manufacturers that make plastics, detergents, disinfectants and other important products (*from* www.compassminerals.com).

The Goderich plant has operated since 1867, after an unsuccessful search for oil uncovered a vast bed of rock salt under Goderich. Using mechanical evaporation, the plant produces high-purity, fine- and coarse-grained salt products in packages and in bulk for commercial, agricultural and industrial applications. Sifto Canada currently employs 380 people at its Goderich facilities (Ontario Mining Association, Ontario Mining and Exploration Directory 2019, www.oma.on.ca).

In November 2019, partner companies Hydrostor and NRStor opened a new compressed air, energy storage facility at the Goderich mine. An abandoned solution mine salt cavern at the site of the Sifto brine–table salt plant is used to store compressed air. The facility relies on the electricity price differential between times of low demand and high demand. During low-demand periods, the cavern is “charged” with compressed air and when demand is high, the air is released through turbines which generate electricity. The facility can generate up to 10 megawatts of power, enough to keep the lights on in about

2000 homes, or approximately half the town of Goderich for about five hours (CBC News, "How an old Goderich salt mine could one day save you money on your hydro bill", news article, November 24, 2019, www.cbc.ca).

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 over 230 people and has been in operation since 1955. The mine uses a traditional mining method of drill, blast and muck and is currently mining salt at a level of 290 m beneath the city. The salt produced at the mine is sold as de-icing and industrial salts that are distributed throughout the Great Lakes region. The Windsor evaporation plant produces table salt, pool salt, water softeners and a wide range of products for industrial use. The facility has been in operation since 1928 and currently employs over 100 people (www.windsorsalt.com).

The Ojibway Mine is in the midst of a 5-year expansion program, announced in July 2016, to deepen the mine another 400 feet and extend the mine life to 2063. The $60 million expansion plan is in year 4 of 5 (K+S Windsor Salt, news release, July 25, 2016, www.windsorsalt.com).

The Ojibway Mine produces approximately 2.5 Mt of salt per year. Another 200 000 to 250 000 t of salt are produced annually at the Windsor evaporation plant, where reserves are sufficient for over 20 years (M. Soave, K+S Windsor Salt, personal communication, June 2017).

Gypsum

CGC INC. – HAGERSVILLE MINE

CGC Inc., a subsidiary of United States-based USG Corporation, is an industry-leading manufacturer of building products and innovative solutions, including products for walls, ceiling, flooring, sheathing and roofing.

CGC Inc. (www.usg.com) runs a fully integrated operation in Hagersville, Ontario, transforming the raw product of its mine, on-site into gypsum wallboard and shipping directly from the site by rail throughout Canada. Gypsum mined in Hagersville also replaces, in part, synthetic gypsum that is currently imported from the US for use in CGC's wallboard plants.

Production of gypsum in Hagersville started in the early 1930s and reserves are sufficient for another 45 to 50 years of mining. The gypsum bed mined by CGC ranges in thickness from 0.8 to 1.2 m at approximately 30 m depth. The mine is accessed through a vertical shaft, and a decline that allows ore to be brought out on conveyor to an on-site wallboard plant. The operations employ about 90 full-time workers (M. Horner, CGC Inc., personal communication, September 2018).

Brick and Shale

In 2019, 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 2019 is estimated at $102 million, from the revised figure of $122 million in 2018. (S. Jessome, Mineral Sector Analysis and Promotion Unit, ENDM, written communication, February 2020)

Meridian Brick Ltd. (www.meridianbrick.com) was created in January 2017, through a joint venture between Boral Bricks and Forterra Brick Ltd. The company operates 3 brick plants in Burlington and 1 plant in Aldershot, with shale quarries located at Niagara-on-the-Lake, Burlington and Aldershot. Meridian is Canada's largest brick manufacturer, accounting for about 55% of Canada's total brick production. Meridian Brick employs 150 to 175 people at its 3 clay brick plants and 4 quarries in Burlington, with seasonal variations (Ontario Mining Association, Ontario Mining and Exploration Directory 2019, http://www.oma.on.ca).

The company owns the Aldershot, Burlington and Tansley quarries near Burlington, permitted for annual extraction of 999 999 t, 195 000 t and 300 000 t, respectively. The company also owns the Niagara Quarry near Niagara-on-the-Lake, where permits allow for an annual extraction of 450 000 t (www.ontario.ca/environment-and-energy/find-pits-and-quarries).

For the year of July 2018 to June 2019, revenue from Meridian's North American operations declined by 5% compared to the previous year, reflecting a significant downturn in the Canadian housing market, which has historically contributed a significant portion of the earnings (Boral Limited, Annual Report for the year ended 30 June 2019, www.boral.com).

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. The plant employs about 75 people. The company reported that revenues for the first 9 months of 2019 decreased by 13.5% to $108.7 million compared to $125.6 million for the corresponding period in 2018 in part because of a decrease in residential construction in Ontario (Brampton Brick Limited, Third Quarter Report, 2019, www.bramptonbrick.com).

The company is permitted to extract 540 000 t of Queenston Formation shale annually at its Cheltenham Quarry near Brampton. The company also owns the Hungry Hollow quarries near Lambton Shores, approximately 50 km northeast of Sarnia, where 2 small quarries are permitted for a combined 40 000 t of extraction (www.ontario.ca/environment-and-energy/find-pits-and-quarries).

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 quarries near Georgetown (www.jazbrick.com). The quarries are permitted for combined extractions of 40 000 t of shale annually.

Cement

There are 8 quarries and 6 modern processing plants in southern Ontario between Kingston in the southeast and St. Marys in the southwest. All plants are also operating quarries on site.

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 Mt 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.

Votorantim reported a net revenue increase of 6% in North America for the first 9 months of 2019 ($1.29 billion) over the same period in 2018 ($1.22 billion). The increase was attributed to higher sales volume and increased cement prices (Votorantim Cimentos, Earnings Release, 3Q19, www.stmaryscement.com).

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 105 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.

The company reported a 2.8% increase in North American net sales of cement, aggregates and ready-mix concrete in the first 6 months of 2019 as compared to the same period in year 2018 (LafargeHolcim, Half-Year 2019 Report, www.lafargeholcim.com). There are no public figures reported for the Bath site.

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.

LEHIGH CEMENT COMPANY – PICTON

Lehigh Cement Company is a subsidiary of Lehigh Hanson Canada, which is part of Heidelberg Cement (www.heidelbergcement.com), a German multinational building materials company trading on the Frankfurt Stock Exchange under the symbol HEI. Lehigh Cement operates a limestone quarry and cement plant at Picton that was formerly operated by Essroc Canada Inc.

The Picton Plant is 1 of 6 plants in North America operated by Lehigh. The plant and quarry have been in continuous operation since 1958. The north quarry, north of Highway 49 and accessed through a tunnel underneath the highway, opened in 1982. Lehigh extracts 5000 tons of limestone (and lesser shale) per day, 365 days a year from the north quarry. Reserves stand at 58 years at the current rate of extraction and the resource is sufficient for over 100 years (D. Wight, Lehigh Cement, personal communication, 2017).

The Picton Plant produces both Portland and Masonry cement. The plant is located along Lake Ontario and ships the majority of its production from the facility by company-owned ships. The company also ships bulk and packaged product by truck. The plant's market area is the Great Lakes region of Canada and the United States. Annual production capacity of the facility is approximately 1.2 million tons of clinker and approximately 1.3 million tons of finished product. The facility is currently producing approximately 900 000 tons of finished product. The Picton facility employs 136 employees (D. Wight, Lehigh Cement, personal communication, 2017).

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 from its quarry in Zorra Township southwest of Woodstock. The company employs 50 to 60 people.

Table 1. Mining activity in the Southeastern Ontario District in 2019 (keyed to Figure 1).

No.	Company/Individual (Mine Name)	Township(s) (Commodity)	Mining Activity
1	Coloured Aggregates Inc. (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 site of former Marmoraton iron mine in Marmora township. Burgundy coloured granite and limestone are quarried for use as crushed stone aggregate and decorative stone in Cavendish township.
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. Gabbro 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 t 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.

No.	Company/Individual (Mine Name)	Township(s) (Commodity)	Mining Activity
13	Dufferin Aggregates	Harvey (Limestone)	Grey limestone is extracted for use as armour stone, landscaping stone and crushed stone.
14	Lehigh Cement (Heidelberg Cement Group (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 136 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.
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)	Historical 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 lower member Gull River Formation, upper member 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.

No.	Company/Individual (Mine Name)	Township(s) (Commodity)	Mining Activity
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 for the production of ashlar, flagstone and landscaping stone at the Rideauview and Sloan quarries and red granite is quarried at the Battersea Quarry.
35	Rigbe Quarry	Harvey (Limestone)	Buff limestone is removed for use as weathered armoury and rockery, crushed aggregates and landscape stone.
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	Covia Holdings Corporation (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 2019 (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 in the second year of a 3-year, $150 million project to re-line shaft walls in the 600 m deep mine.

No.	Company/Individual (Mine or Quarry Name)	Township(s) (Commodity)	Mining Activity
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.
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	K+S Windsor Salt 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 2019, please refer to the report of the Petroleum Operations Section (this volume).*

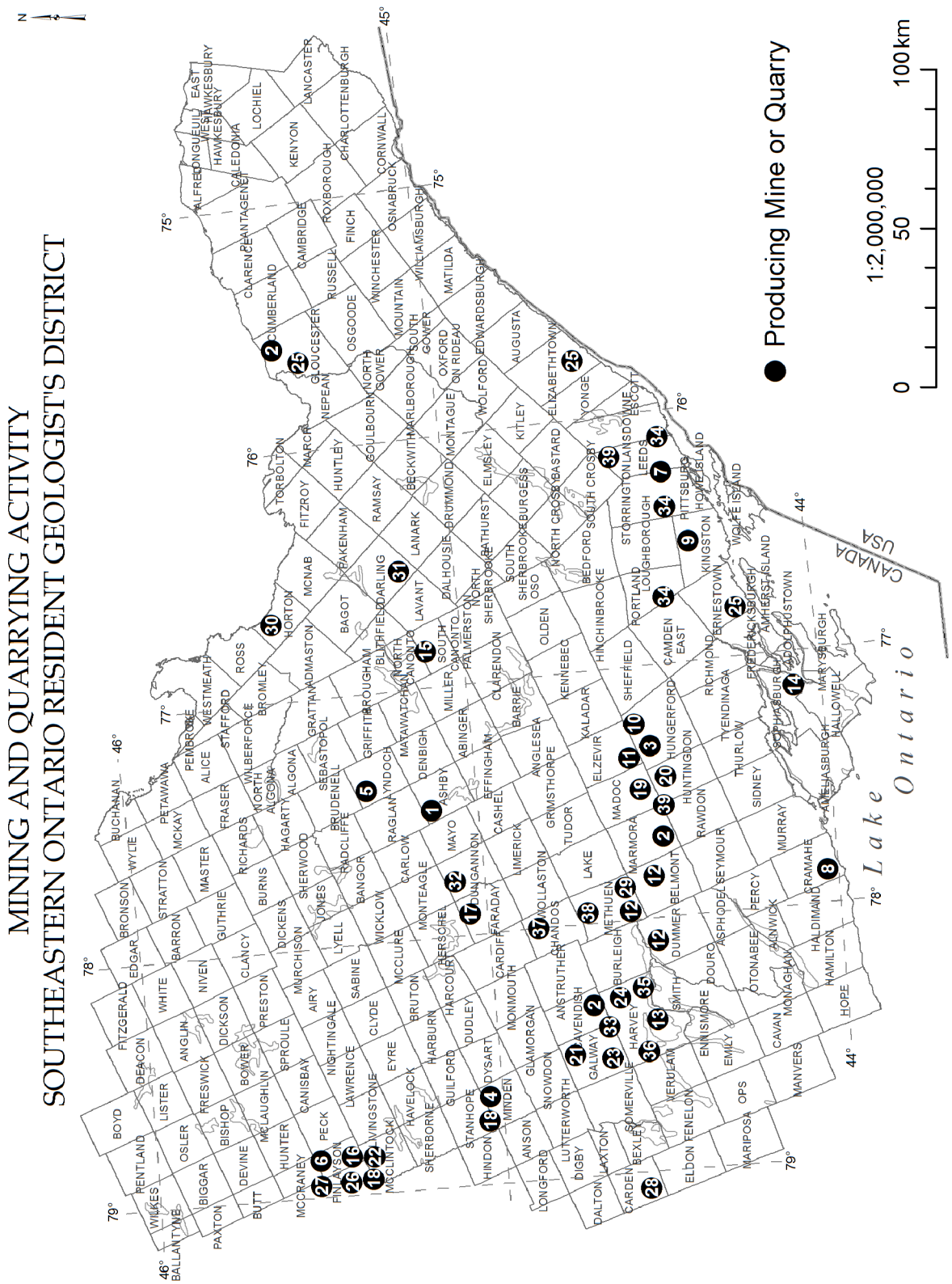

Figure 1. Mining activity in the Southeastern Ontario District in 2019 (keyed to Table 1).

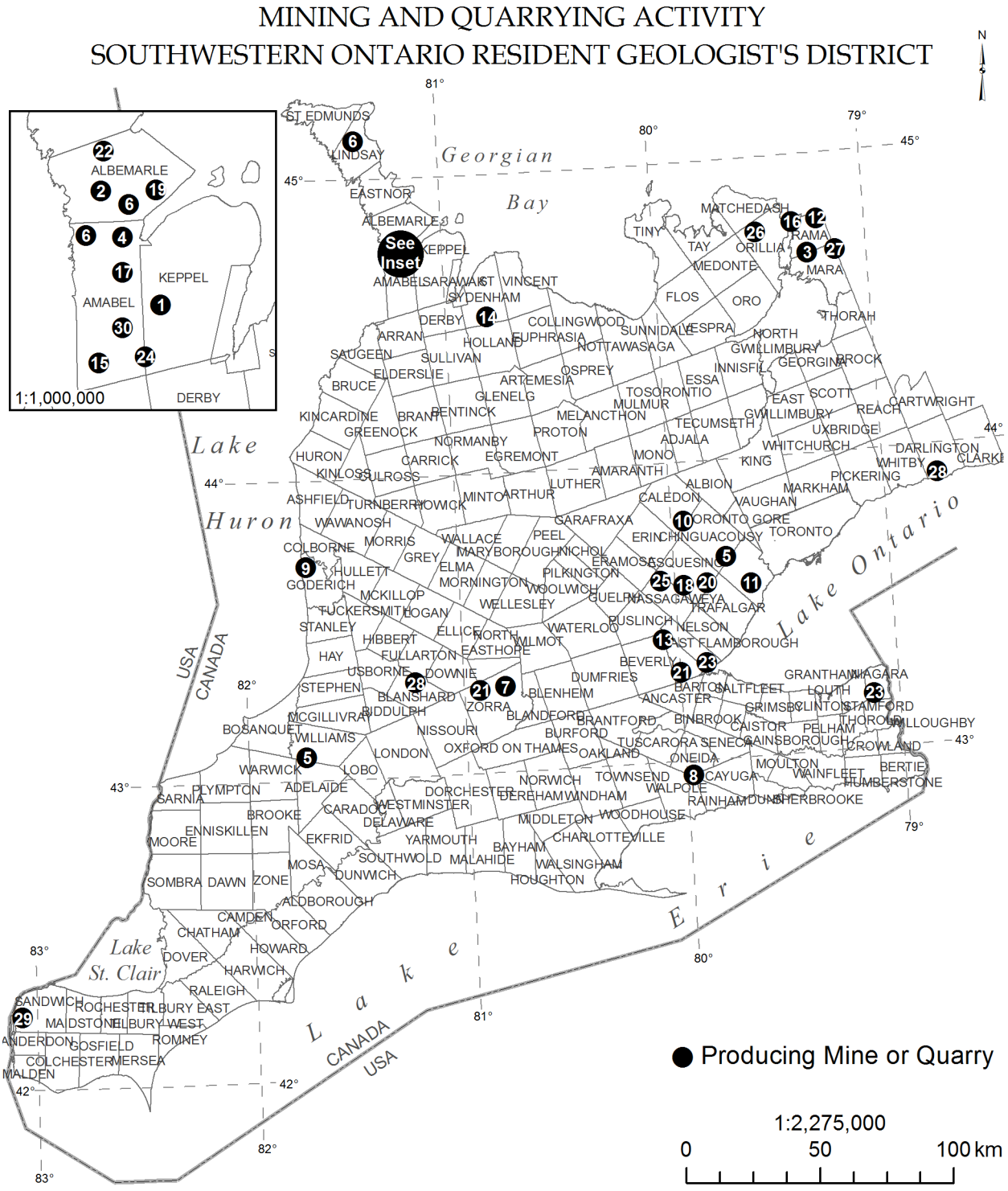

Figure 2. Producing mines and quarries in the Southwestern Ontario District in 2019 (keyed to Table 2).

Dimension and Building Stone

Almost all of southern Ontario's dimension stone production comes from Cambrian and Paleozoic strata. Individual producers are listed in Tables 1 and 2 and the main centres of production are described below.

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 2019, 21 quarries in the County of Bruce and 3 quarries in the neighbouring County of Grey produce dimension stone under the *Aggregate Resources Act* for building, landscaping and flagstone markets. Several other quarries in both counties produce dolostone aggregate and can provide armour stone on demand.

The majority of the quarries in this area are within the Eramosa Member of the Middle Silurian Amabel Formation, which is a grey-brown to black, laminated dolostone interbedded with light brown, thin to thick-bedded dolostone. The stone is sufficiently hard to take a good polish and, although not technically a marble, is often referred to as "Eramosa Marble" in the dimension stone trade (Rowell 2015).

Rowell (2012) identifies provincially significant bedrock resources in the County of Bruce and provides details of national and provincial parks, and physical, cultural and environmental constraints on development, including the Niagara Escarpment Plan, which limit development of resources within that area for dimension stone and aggregate.

ORILLIA AREA QUARRIES

In Rama Township near Orillia, 8 companies operate dimension-stone quarries in limestone of the Paleozoic 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. 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 (Parks 1912; www.historicplaces.ca).

PETERBOROUGH AREA QUARRIES

There has been a long history of dimension-stone production in the Peterborough area. In 2019, 7 companies operated 8 dimension-stone quarries in the Peterborough area.

In 4 of the quarries, limestone of the Paleozoic Gull River Formation is extracted for a variety of applications, including landscape, masonry and armour stone. Thick-bedded limestone of the overlying Bobcaygeon Formation is also quarried and used primarily as aggregate and armour stone. The Parnell Quarry in Galway Township is located on a contact between 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 Pluard quarry in Chandos Township, a blue-grey interlayered marble and amphibolite unit is quarried by W. Brown to produce "Elite Blue" dimension stone (W. Brown, personal communication, 2018).

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

In 2018, Drain Bros. Excavating Ltd. completed construction of a new dimension-stone processing plant on the site of their trap rock quarry and plant at Havelock, near Peterborough. The following information was provided by the company (C. Brown, Drain Bros. Excavating Ltd., personal communication, February 2019).

The facility contains a large 120-inch diameter diamond saw, a smaller 5-axis CNC (Computer Numerical Control) programmable saw, hydraulic guillotines and recently added polisher. The plant was opened for business in December 2018, processing stone from the company's limestone quarry in the Buckhorn area. Drain Bros. is currently expanding its stone sources to include their Smith limestone quarry, Belmont Rose granite quarry and the Havelock basalt quarry. Current products include armour stone, landscaping stone, steps, jumbo flag stone, and full bed depth building stone. With the addition of the new polisher, future products will include polished, honed and antique surfaces for both exterior and interior uses. 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 operates on a computer-guided, mobile frame that will allow automatic cutting of multiple blocks within an area of 16 by 60 feet. The plant operates year-round and adds 12 full-time jobs to the 22 positions currently existing at the Havelock trap rock and ethanol operations.

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

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 (www.rideauinfo.com). 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, 25 km northwest of Kingston, and the McCallum Quarry, 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. Stone from the Petworth Quarry was used in 2017–2018 in the restoration of buildings at the Royal Military College in Kingston (B. Jackson, personal communication, January 2019).

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 many notable projects in Toronto, including Old City Hall, the Ontario Legislature (Queen's Park), pillars at Union Station, and the Timothy Eaton Memorial Church.

Two quarries continue to produce sandstone in the Brampton area. Credit Valley Quarries Co. Ltd. and Hilltop Stone and Supply Inc. produce sandstone for new projects and for the restoration of many historic sandstone buildings in the Greater Toronto Area (www.historicplaces.ca). Products include split-face ashlar, flagstone, random wall stone and landscaping stone.

In southeastern Ontario near Kingston, Nepean Formation (Cambrian) sandstone is quarried by Rideauview Contracts Ltd. 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 ongoing restoration of the Parliament Buildings in Ottawa and the restoration of locks on the Rideau Canal (B. Jackson, personal communication, January 2019).

Trap Rock

There are 5 companies operating trap rock quarries in southeastern Ontario, 4 located near Highway 7 between Peterborough and Tweed and 1 at Seeleys Bay, north of Kingston. 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 use as 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.

I.K.O. 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 has been developed as a source of raw material for mineral wool manufacturing. In 2015, as part of an evaluation of the high-magnesium zone, the company conducted a resampling program on archived diamond-drill core, stored at the ENDM Tweed Drill Core Library, from a past talc exploration program on the property. The company shipped 30 000 t of gabbro to Roxul Inc. in Milton for mineral wool manufacturing tests in 2015. The results were positive and the company has progressively increased shipments to 80 000 t in 2018. Waste rock from the operation in the form of undersize material, totalling about 20 000 t per year, is sold as general construction aggregate. The company also operates several bedrock aggregate quarries in eastern Ontario and employs 25 permanent and 25 seasonal workers (A. Danford, Danford Granite Ltd., personal communication, January 2019).

Canadian Wollastonite produces trap rock from a body of mafic orthogneiss that is in contact with the wollastonite-bearing skarn of the St. Lawrence wollastonite mine at Seeleys Bay. The material has been approved by the Ministry of Transportation for use as a high-strength, high-friction surface aggregate in major highway construction. The stone is also suitable for use in high-strength concrete, as railway ballast, and as rip-rap and gabion stone (www.canadianwollastonite.com).

Calcium Carbonate (Marble)

OMYA CANADA INC. – TATLOCK QUARRY

Omya Canada Inc. (www.omya.com) is a subsidiary of Omya AG, a privately held global producer of industrial minerals headquartered in Switzerland. Worldwide, Omya AG produces mainly fillers and pigments derived from calcium carbonate and dolomite. Omya AG 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. The Tatlock Quarry is permitted for a maximum annual extraction of 4 000 000 t. Together, the Tatlock Quarry and Perth processing plant employ about 92 permanent workers (R. Hughes, Omya Canada Inc., personal communication, December 2018).

EXPLORATION ACTIVITY

Assessment files received for the Southern Ontario Region are listed in Table 3. Exploration activity is listed in Table 4, exploration plans and permits in Table 5 and the locations of new claim registration, exploration projects, and exploration plans and permits are shown in Figure 3. It should be noted that the number of assessment files received does not reflect the amount of exploration work that is carried out in the Southern Ontario 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 2019, most of the exploration activities and expenditures in the Southern Ontario Region were focussed on nickel-cobalt-copper, graphite, gold and zinc as described below.

Use of the outdoor Drill Core Library in Tweed as an exploration tool has increased in recent years, as funding has been lacking for major field exploration projects.

Table 3. Assessment files received in the Southeastern Ontario District in 2019.

Abbreviations

ASSAY ..... Assaying and analysis
BULK ..... Bulk Sampling
DHRLG ..... Drill core relogging
DHRSMP ..... Drill core resampling
INDUS ..... Industrial Mineral Testing and Marketing
ROCK ..... Rock sampling
RRCALC ..... Reserve/Resource Calculations

File Id	Township	Company Filing Report	Year	Work Performed
20000017249	Cavendish, Galway	Peterburton Mineral Corporation	2017–2019	BULK, INDUS, RRCALC
20000017044	Faraday	Skead Holdings Ltd.	2018	ASSAY, ROCK
20000016957	Madoc	Crown William Mining Corp.	2016	ASSAY, DHRLG, DHRSMP
20000017110	Methuen	Trigan Resources Inc.	2017–2018	ASSAY

Table 4. Exploration activity in the Southeastern Ontario District in 2019 (keyed to Figure 3).

Abbreviations

ASSAY ..... Assaying and analysis
BEEP ..... Beep Mat
PROSP ..... Prospecting by licence holder
ROCK ..... Rock sampling
PSTRP ..... Overburden Stripping
SOIL ..... Soil sampling

No.	Company/Individual Property Name	Township (Commodity)	Exploration Activity
1	Ore Chimney Gold Inc. Ore Chimney prospect	Barrie (Au)	ROCK, SOIL
2	R. Waring Anglesea claims	Anglesea (Au)	PROSP, PSTRP, ROCK, ASSAY
3	J. Martin Ashby zinc prospect	Ashby (Zn)	PROSP, BEEP
4	Skead Holdings Ltd. Halls Lake property	Cardiff (U, Th, REE)	PROSP
5	J. Martin Black Mountain graphite prospect	Matawatchan, Miller (graphite)	PROSP, BEEP
6	J. Martin	Mayo, Raglan	PROSP, BEEP

Table 5. Active exploration plans and permits in the Southeastern Ontario District in 2019 (keyed to Figure 3).

No.	Plan/Permit No.	Company/Individual Property Name	Township (Commodity)	Exploration Activity
1	PL-19-000091	Hastings Highlands Resources Ltd.	Wollaston, Limerick	Mechanized stripping pitting and trenching of bedrock geophysical surveys
2	PR-18-000061	R. Waring Waring Creek gold property	Anglesea	Mechanized stripping and channel sampling
3	PL-18-010988	Effingham project	Effingham	Line cutting geophysical surveys

Nickel-Cobalt-Copper

PANCONTINENTAL RESOURCES CORPORATION – McBRIDE PROJECT

Pancontinental Resources Corporation (www.panconresources.com; formerly Pancontinental Gold Corporation) entered into an option agreement with Hastings Highlands Resources Limited in April 2018 to earn up to 76% of the McBride nickel-cobalt-copper project (Pancontinental Resources Corporation, news release, April 26, 2018). A summary of the work done on the McBride project in 2018 is described by Tessier, LeBaron and Smith (2019).

The project is located in Limerick Township and was historically known as the "Macassa copper-nickel deposit". The deposit was discovered in the 1960s and diamond drill tested with more than 90 holes by Macassa Gold Mines Limited and Long Lac Minerals Limited. In 1971, Long Lac estimated a resource of 5.1 Mt, consisting of 3.9 Mt grading 0.82% Ni, 0.054% Co and 0.25% Cu in the North zone and 1.2 Mt grading 0.30% Ni, 0.03% Co and 0.14% Cu in the South zone (Malczak, Carter and Springer 1985).

In March 2019, the company terminated the option on the McBride property.

Gold

R. WARING – WARING MINERALS GOLD PROPERTY

Prospector R. Waring continued exploration of his gold prospects in the area of the Partridge Creek shear zone in western Anglesea and eastern Grimsthorpe townships (R. Waring, Prospector, personal communication, January 2020).

Gold mineralization occurs in several locations on the property within sulphide-bearing, rusty, smoky quartz veins within sheared metavolcanic rocks, possibly associated with second-order structures along the Partridge Creek shear zone (Poulsen 2016). The focus of exploration to date has been the areas of the Main, North and South occurrences (*see* Figure 8 under "Property Examinations", "Waring Creek Gold Prospect, Anglesea Township"). Shallow-dipping, extensional quartz veins at the Main showing have assayed 20 g/t Au (Dowhaluk 1991) and 66 g/t Au (Waring 2016). Waring (2016) also reported assays of 13.3 g/t Au from the North showing and 1.38 g/t Au from the South showing. Also of interest at the South showing is the presence of native bismuth in a quartz vein that assayed >10 000 ppm Bi (R. Waring, Prospector, personal communication, January 2019).

In 2018, Mr. Waring staked additional claims covering the United Reef Petroleums gold occurrence approximately 2 km northwest of the area near the Partridge Creek shear zone (*see* Figure 8 under "Property Examinations", "Waring Creek Gold Prospect, Anglesea Township"). Previous work by Beesley (1999) on the United Reef property gave results of up to 4.5 g/t Au from a sericite-altered quartz porphyry with a stockwork of narrow quartz veinlets and anomalous values of up to 0.27 g/t Au from a

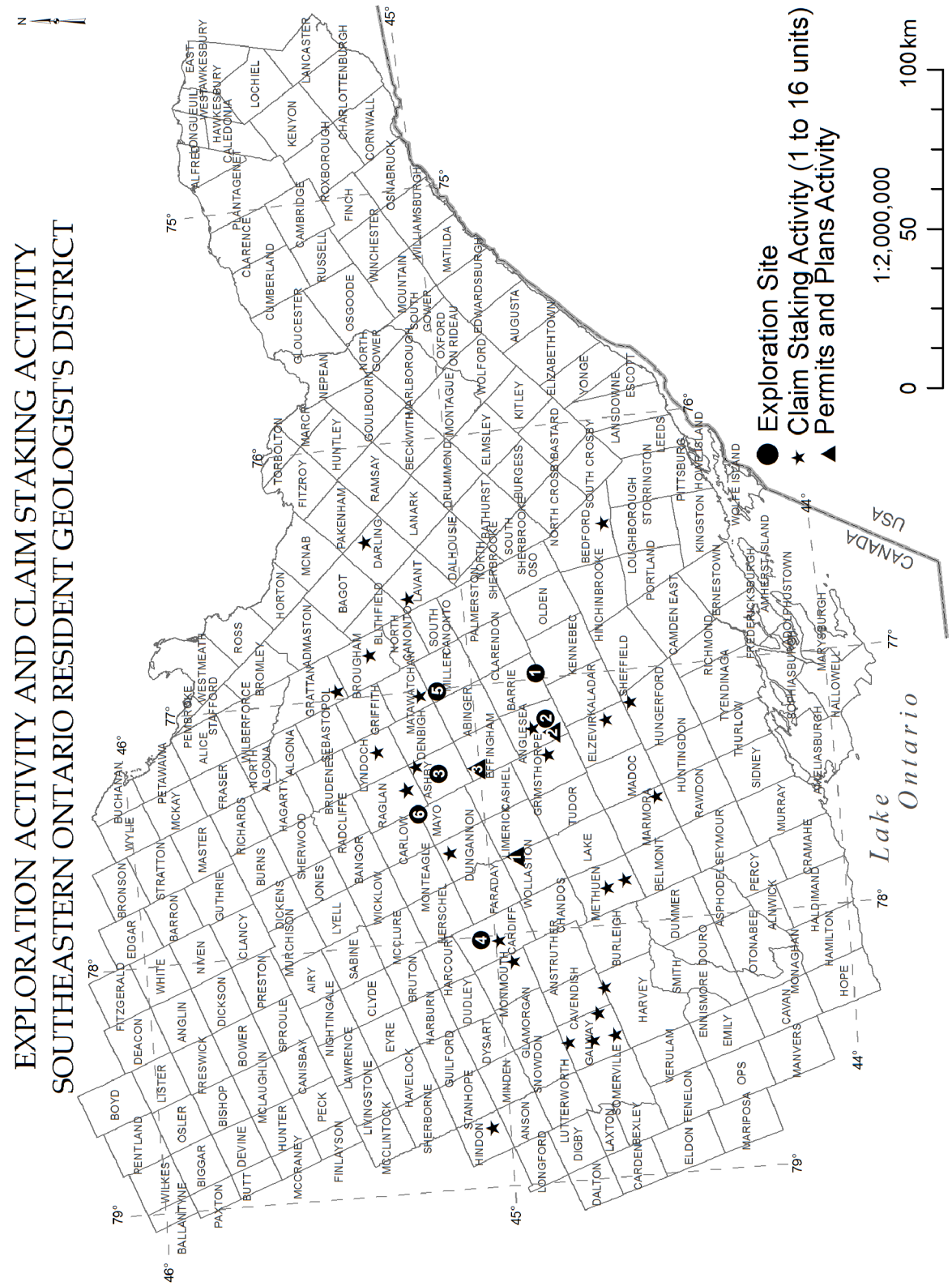

Figure 3. Exploration activity in the Southeastern Ontario District in 2019 (keyed to Tables 4 and 5).

lean, siliceous iron formation. Most of the 2019 exploration program, including stripping and channel sampling, was done on the former United Reef property. Gold mineralization associated with quartz veins in both the lean iron formation and quartz-feldspar porphyry was confirmed by the District Geologist in samples taken during a property visit in 2019. A report on the property examination is included in this report (*see* "Property Examinations", "Waring Creek Gold Prospect, Anglesea Township").

COBALT FRONTENAC GOLD INC. – COBALT–FRONTENAC PROJECT

In September 2018, Cobalt Frontenac Gold Inc. staked 1 claim comprising 25 cells along the south side of Big Gull Lake in concessions I and II, lots 4 to 13 in Barrie Township. The claim covers the Cobalt–Frontenac gold occurrence, which was discovered prior to 1939 and consists of quartz veins with pyrite, pyrrhotite and sphalerite in a shear zone in massive greenstone about 400 feet (122 m) north of the contact with Flinton Group metaconglomerates (Meen 1944).

Homestake Mineral Development Company explored the property from 1986 to 1989, completing soil geochemical, geological, magnetic and VLF–EM surveys. Additional work was recommended to follow up on anomalous gold values in soil (Lloyd and Bending 1989). There is no record of the follow-up work having been completed.

M. Forget conducted soil and lithogeochemical sampling over the property in 2011. Historical trenches were located and sampled, including a zone of up to 30% pyrrhotite several metres wide. No significant gold values were reported and the claims were allowed to lapse (Forget 2012).

In November–December 2018, Cobalt Frontenac Gold Inc. collected 421 soil samples for Mobile Metal Ion (MMI™) analysis, covering approximately 1.5 km of strike length of the unconformity between mafic metavolcanic and metasedimentary rocks of the Grenville Supergroup to the north and conglomerates and quartz-rich metasedimentary rocks of the Flinton Group to the south. Results of the MMI™ survey were obtained in 2019 and indicate a fairly continuous, linear silver-gold anomaly that is roughly conformable to the known and extrapolated location of the Flinton Group–Grenville Supergroup unconformity. Some significant anomalous results were obtained at the eastern limit of the survey area and the survey may be extended to the east in the 2020 field season (G. Smith, Cobalt Frontenac Gold Inc., personal communication, January 2020).

ORE CHIMNEY GOLD INC. – ORE CHIMNEY PROJECT

In 2019, Ore Chimney Gold Inc. entered an option agreement with the owners of the Ore Chimney property, consisting of 3 mining leases in Concession I, lots 34 to 36 in Barrie Township.

The former Ore Chimney Mine first operated in 1909 and was later explored by the Bey Mines Ltd. (1932), East Webb Mines Ltd., Cavalier Mining Corporation Ltd. (1957), Banirwin Mining and Explorations Ltd. (1983) and Sands Minerals Corp. (1987). There was sporadic production from 1909 to the early 1920s and from 1932 to 1936 with the depth of the shaft continuing to 500 feet and development of 2174 feet of underground lateral workings on 7 levels. The deposit consists of a gold- and silver-bearing quartz vein system containing pyrite, chalcopyrite, galena and sphalerite, within hornblende-biotite-garnet schist near the contact between the mafic metavolcanic rocks of the Tudor Formation and the unconformably overlying quartzite and conglomerate of the Flinton Group (Malczak, Carter and Springer 1985).

The most recent exploration program was completed by Vanity Capital Inc. in 2011–2012. A diamond-drilling program, completed in late February 2012, consisted of 16 holes, totalling 768.4 m, and was designed to drill off the "Main Vein" zone, which historically returned significant grades of gold, silver, copper, lead and zinc mineralization. The company reported that 11 of the 16 holes returned significant gold and silver values, although not in economic quantities. The highest gold value obtained was 4.3 g/t Au over

an interval of 0.3 m and the best silver assay was 300 g/t Ag from a 0.3 m sample that also contained 0.456 g/t Au (Sangster et al. 2013).

The 2019 exploration program of Ore Chimney Gold Inc. included a reconnaissance geological survey, location and georeferencing of old trenches and diamond-drill hole collars and a review of historical maps, underground plans and sections, from which a digital three-dimensional model of the deposit was created. Soil sampling was done for MMI™ geochemical analysis on a grid with line spacing of 25 m and sample interval of 20 m. Results are pending (G. Smith, Ore Chimney Gold Inc., personal communication, January 2020).

J. MARTIN AND J. ANDREANA – MAYO AND RAGLAN PROPERTIES

In 2018, prospectors J. Martin and J. Andreana registered 1 single-unit claim in Mayo Township and 2 single-unit claims in Raglan Township. Each claim covers an electromagnetic anomaly identified by an airborne geophysical survey conducted by First Nickel Inc. in 2008 (Ontario Geological Survey 2010). The claims are located in the vicinity of known nickel-copper occurrences associated with the Raglan Hills gabbro complex, described under “Recommendations for Exploration” in Tessier et al. (2017).

In 2019, the prospectors conducted reconnaissance prospecting, Beep Mat and VLF–EM surveys. Results of the 2019 program have not yet been filed for assessment credits ((J. Martin, Prospector, personal communication, January 2020).

Graphite

J. MARTIN AND J. ANDREANA – BLACK MOUNTAIN GRAPHITE PROJECT

In 2019, J. Martin and J. Andreana continued to explore their Black Mountain graphite property in Matawatchan and Miller townships. Work included Beep Mat surveys, prospecting and sampling, primarily in the southern part of the claim group. Flake graphite content between 2 and 4% graphitic carbon (Cg) was confirmed along strike to the southwest of previously known mineralization (J. Martin, Prospector, written communication, January 2020).

The original two-claim group (20 cells after conversion) was staked in 2016 based on new graphite occurrences discovered during mapping by the Ontario Geological Survey (Duguet, Duparc and Mayer 2015). After prospecting along strike to the south in March 2018 and confirming the presence of graphite, an additional 41 single-cell claims were added to the original group to cover a total of 9 km of strike length of the favourable, graphite-bearing units.

Ground magnetic and resistivity surveys were done in the northern part of the claim group in 2017. In 2018, the claim holders conducted prospecting, Beep Mat and VLF–EM surveys in the central and southern parts of the property. Several new graphite showings were identified within a belt of quartz-rich, arkosic metasedimentary rocks containing accessory pyrite, pyrrhotite, biotite, phlogopite, feldspar and garnet. The more sulphide-rich material commonly weathers to a gossan and was mapped by Duguet, Duparc and Mayer as “rusty schist” (*see* Duguet, Duparc and Mayer 2018: map unit 9g).

Graphitic schist with flake graphite content in the range of 2 to 3.5% has been identified over a strike length of about 7.5 km on the Black Mountain claim group. Preliminary prospecting indicates width of the zones is up to 30 m. Canada’s largest past-producing graphite mine, the Black Donald Mine, is located 13 km along strike to the northeast from the Black Mountain property, where the deposit is associated with rusty, pyrite-pyrrhotite-graphite–bearing schists and calc-silicates near the contact with carbonate metasedimentary rocks, similar to the graphite mineralization on the Black Mountain property (Tessier, LeBaron and Smith 2019).

A composite sample of graphitic schist from the central part of the property was submitted to Activation Laboratories Ltd. (Ancaster, Ontario,) for graphite liberation and flake size analysis in 2019. The following results were provided by J. Martin (Prospector, written communication, January 2020):

> The seven samples comprising the composite sample range in graphite content from 1.67% to 3.47% Cg and average 3% Cg. The mineralogical composition of the sample is graphite (3%), quartz (52%), plagioclase (19%), K-feldspar (7%), biotite/phlogopite (4.5%), muscovite (2%), sillimanite/kyanite (3%), iron oxide (4.5%), and other accessory minerals (5%). The graphite flake size distribution is: amorphous (19%), fine (5%), small-medium (15%), large (20%) and jumbo (41%).

Follow-up work in the 2020 field season will focus on locating zones of higher grade graphite mineralization within the 7.5 km long graphitic zone, using Beep Mat, VLF–EM, and possible induced polarization surveys in addition to detailed prospecting and hand-trenching (J. Martin, Prospector, personal communication, January 2020).

Rare Earth Elements

Skead Holdings Ltd. continued prospecting and sampling on their Halls Lake property in Cardiff Township. The primary exploration target on the former uranium mine property is rare earth elements. However, examination of diamond-drill core stored at the Tweed Drill Core Library resulted in the discovery of a previously overlooked flake graphite zone in marble. The company is attempting to delineate the graphite zone on surface. Work to date indicates that the projected surface expression lies beneath overburden (R. MacGregor, Skead Holdings, personal communication, January 2020).

Zinc

In 2018, J. Martin and J. Sneep registered 4 single-unit claim cells in Ashby Township on a zinc prospect that was recommended for exploration by Tessier, LeBaron and Smith (2019) under the heading, “Zinc Prospectivity in Southern Ontario: New Exploration Targets”.

In 2019, the prospectors conducted reconnaissance prospecting, Beep Mat and VLF–EM surveys. Results of the 2019 program have not yet been filed for assessment credits (J. Martin, Prospector, personal communication, January 2020).

Vermiculite

In 2019, Peterburton Mineral Corporation submitted a NI 43-101 Technical Report on the company’s vermiculite project in Galway, Cavendish, Anstruther, Monmouth and Cardiff townships, in Peterborough and Haliburton counties (Figure 4). The property consists of 1108 cell units and 7 mining leases. The report documents exploration work done from 2016 to 2018 by Peterburton MC and summarizes work done by the previous owner of the property, Earth Resources Limited, during 1999–2016. The following information is summarized from Archibald (2019). All tonnage figures are reported in short tons.

A major vermiculite-bearing belt has been traced discontinuously for up to 54 km between Bobcaygeon in the southwest and Bancroft in the northeast. A series of intercalated and fault-truncated vermiculite zones are associated with biotite-rich marbles within nepheline syenite and carbonatite intrusive complexes around the western contact of 2 alkalic complexes: the Anstruther and Cheddar granitic batholiths (*see* Figure 4). Recent work has focussed on 2 zones: Mining Lease 108137 in Cavendish Township, site of the former Regis Resources Inc. vermiculite mine, which operated from 2004 to 2009; and Mining Lease 109334 in Galway Township.

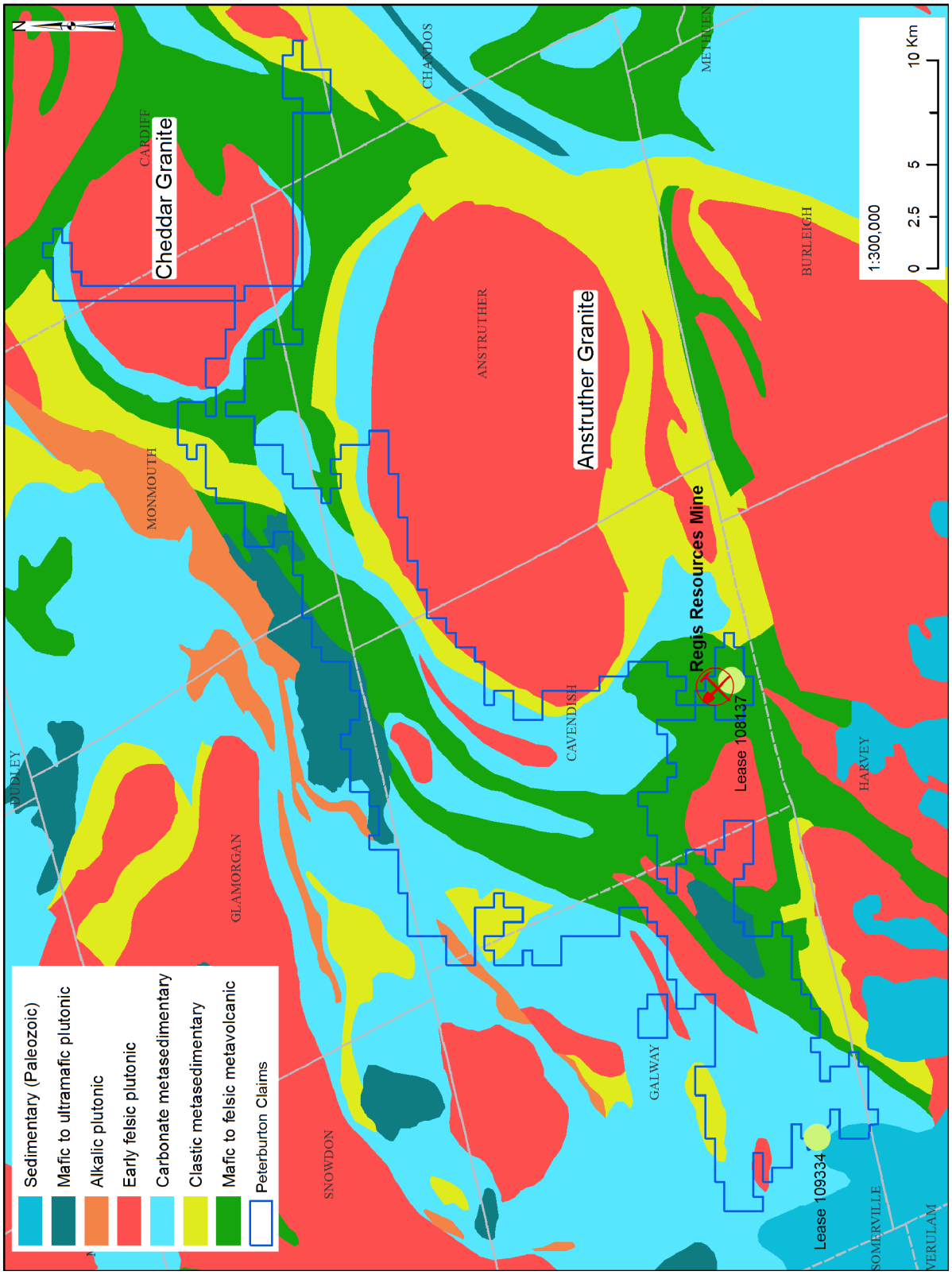

Figure 4. Geology in the area of the Peterburton vermiculite project, Peterborough–Haliburton County; geology *from* Ontario Geological Survey (2011).

In 2016, exploration defined 2 zones with significant tonnage and grade potential on Lease 109334 and an 850-tonne bulk sample was taken. Concentrates of over 70% vermiculite were obtained with primary screening at the excavation site.

In 2017, trenching, pitting and augur-drilling were used to delineate extensions of the production zone excavated by Regis Resources on Lease 108137 and indicate a potential resource (non-NI 43-101 compliant) of 930 000 tons averaging 21.5% vermiculite, sufficient for an additional 3 years of operation at the previous production rate of Regis Resources. Detailed trenching and drilling are required on both properties to fully evaluate the tonnage and grade potential.

Metallurgical tests by the Ontario Research Foundation and by Lakefield Research Laboratories found no asbestos and no fibrous forms of tremolite. The total estimated resource in southwestern Galway Township, including Lease 109334, is over 38 million tons averaging 24% vermiculite (measured and indicated) and 40.7 million tons averaging 23.7% (inferred). The total resource in Cavendish Township is estimated at 1.3 million tons measured and indicated and 3.6 million tons inferred, both averaging 21.4% vermiculite. The resource estimate in Anstruther and Monmouth townships, based on historical work from 1998 to 2003, is about 3 million tons measured and indicated and 3 million tons inferred, both at 21.5% vermiculite.

DISTRICT 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 P.S. LeBaron, *P.Eng*., District Geologist, Acting Regional Land Use Geologist from February to July and Acting Regional Resident Geologist from July through December; D.A. Laidlaw, *P.Geo.*, Regional Land Use Geologist, Acting Land Use Planning and Policy Coordinator from January to July and retired in December; and N. Sabiri, District Geological Assistant from February to December. A.C. Tessier, *P.Geo*., *P.Eng.,* was Regional Resident Geologist from January to June, and A.C. Smith was District Geological Assistant in January and February.

Summer Experience Opportunity (SEO) student, S. Reese, 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 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

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 ENDM Indigenous Consultation and Partnerships 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 by appointment.

Special Projects

In 2018 and 2019, a collection of polished dimension-stone tiles from sampling programs collected by Resident Geologist Program staff throughout the province in the 1980s was transferred from a storage location in Sudbury to the Southern Ontario Regional Resident Geologist's office in Tweed. Most of the samples are from locations in the Southern Ontario Region. The District Geological Assistant and the SEP student catalogued and created images of the samples as part of a program to create a database of Ontario dimension stone prospects.

There are over 6000 mineral occurrences in southern Ontario documented in the Mineral Deposit Inventory (MDI) database (Ontario Geological Survey 2019a). Staff of the Southern Ontario Regional Resident Geologist's office work with the Mineral Deposit Compilation Geoscientist—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 2019 field season, visits were made to 21 MDI locations in southeastern Ontario and 2 sites in northeastern Ontario and the District Geological Assistant updated 36 MDI files.

Some of the field visits were done as part of a field- and research-based project on "VMS Zinc Potential in the Grenville Province, Southern Ontario" undertaken by staff of the Southern Ontario Resident Geologist's office, which is described in "Recommendations for Exploration" in this report.

The Regional Resident Geologist co-supervised, with Dr. G. Olivo, a BSc (Honours) thesis project by R. Culver of Queen's University on the Salerno Lake zinc deposit in southeastern Ontario. Access to drill core from the deposit, stored at the Drill Core Library in Tweed, was provided by staff of the Southern Ontario Resident Geologist's office.

The District Geological Assistant was involved in the implementation of upgrades to the Ontario Mineral Exploration Information System (OMEIS). OMEIS is an intranet-based application launched in 2018 that is used by RGP and Mining Lands staff to maintain and update assessment file and drill-hole data. The second phase of OMEIS was completed in 2019 and focussed on the addition of new data fields to allow for the addition of unique, archival and donated materials stored in RGP offices across Ontario. Details on archival materials will be made available on GeologyOntario in a new searchable database called the Archives of the Resident Geologist Offices (ARGO) once they are catalogued in OMEIS.

First Nations Interactions

In 2019, the Regional Resident Geologist offered a prospecting course to the Algonquins of Ontario. As a result of scheduling and logistical concerns (location, travel considerations), the course was not held and has been deferred to 2020.

The District Geologist gave a presentation and poster with samples display at the Anishinabek Southeast–Southwest Roundtable meetings in Rama in February and July.

The District Geologist and District Geological Assistant staffed a poster and sample display booth at the Algonquins of Ontario Nation Gathering in Bancroft in July.

Mineral Shows, Presentations, Outreach and Field Trips

In March, the Regional Resident Geologist attended the Prospectors and Developers Association of Canada (PDAC) Annual Convention and gave a presentation entitled “Discover the Potential of Northeastern and Southern Ontario”.

In April, the Regional Resident Geologist attended the Ontario Prospectors Exploration Showcase and gave a presentation on Recommendations for Exploration in Ontario’s Northeastern and Southern Districts.

In July, the District Geologist provided field trips on the gold deposits of southern Ontario to staff of Crown William Mining Corporation, Agnico Eagle Mines Limited, Micon International and Orix Geoscience, and gave presentations 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.

In August, staff of the Southern Ontario Resident Geologist’s Office presented a poster and sample display booth at the 4-day Bancroft Gemboree and gave daily presentations on “The Mines of Southern Ontario”. The event attracts over 3000 visitors annually. The District Geologist also assisted in organizing a field trip for the Niagara Peninsula Geological Society.

In September, the District Geologist and District Geological Assistant presented a poster and sample display at the Ancaster Mineral Show and gave presentations on “The Mines of Southern Ontario” to over 200 elementary school students and their teachers. The 3-day show is attended by over 2000 visitors annually.

Drill Core Storage Site

The Resident Geologist’s Office maintains an off-site diamond-drill core storage compound on Hunt Road, approximately 2 km south of Tweed. In addition to core stored on traditional core racks, the site houses over 210 000 m of irreplaceable drill core from southern Ontario, of which about 157 000 m are stacked on pallets and 53 000 m are stored in racks. A smaller collection of core stored in both outdoor and indoor racks is located at the Resident Geologist Office facility in Tweed.

In 2019, staff of the Resident Geologist’s Office provided access to diamond-drill core for H. Lang of Queen’s University for research on zinc mineralization in marble as part of a MSc thesis.

Brushing out and clearing debris from the off-site drill core storage area was done by an external contractor as part of an ongoing maintenance program.

Table 6 provides a five-year summary of program activity.

Table 6. Program activity statistics (five-year summary) for the Southern Ontario Regional Resident Geologist’s office.

Activity	2015	2016	2017	2018	2019
Field Investigations / Property Visits	36	27	57	52	23
Field Trips Given / Field Guides Written	6	7	10	10	4
MDI* Records Revised	351	456	441	0	98
Presentations to Ministry of Municipal Affairs and Housing, Ministry of Natural Resources and Forestry, Ministry of Aboriginal Affairs	7	6	7	0	0
Clients Visits to RGP–Tweed Office	263	226	184	182	102
Drill Core Library Users (Person-days)	69	283	59	179	25
Client Communications / Interactions (Presentations, Poster Sessions)	>3000	>3000	>3000	>3000	>3000

**Ontario Geological Survey (2019a).*

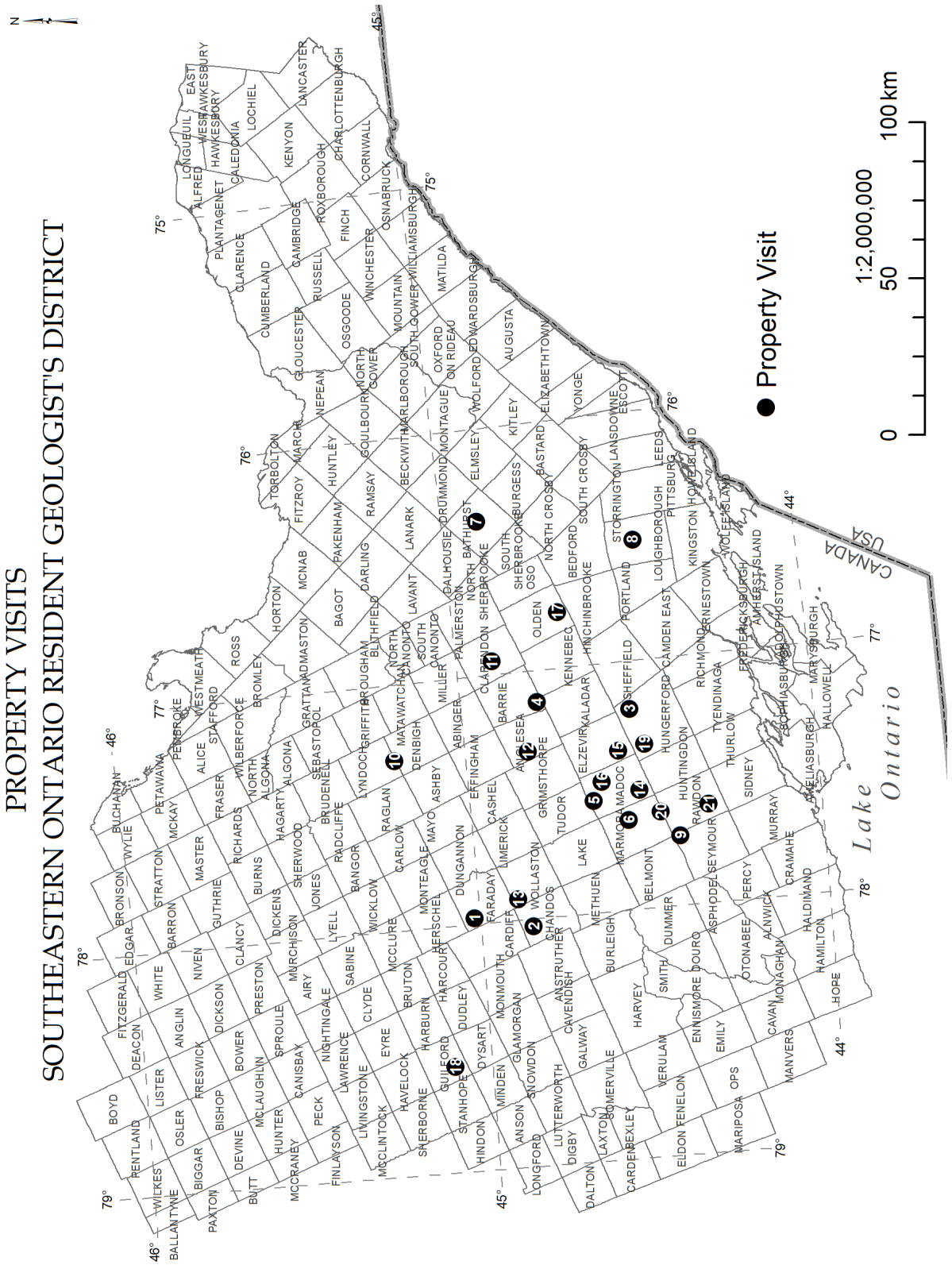

Figure 5. Property visits in the Southeastern Ontario District in 2019 (keyed to Table 7).

PROPERTY EXAMINATIONS

In 2019, a total of 21 properties in the Southern Ontario Region and 2 properties in the Kirkland Lake District were visited by Resident Geologist Program staff; these visits are listed in Table 7.

Table 7. Property visits conducted by the Southern Ontario Resident Geologist's Office staff in 2019 (keyed to Figure 5).

Number	Client – Occurrence	Location (Township)
1	J. Crossing	Faraday
2	Chandos marble	Chandos
3	A. Aboonabi	Hungerford
4	Ore Mountain	Barrie
5	Crown William	Madoc
6	Dingman prospect	Marmora
7	Perth feldspar quarry	Bathurst
8	Lacey mica mine	Loughborough
9	Allan Mills	Seymour
10	Simon copper	Denbigh
11	Boerth gold	Clarendon
12	R. Waring	Anglesea
13	Rollins arsenic	Wollaston
14	O'Hara Mill Conservation Area	Madoc
15	S. Wanner	Elzevir
16	Richardson gold mine	Madoc
17	Long Lake Mine	Olden
18	Minden area soapstone	Somerville, Lutterworth, Guilford
19	Tweed Marble quarry	Hungerford
20	Callaghan Rapids Conservation Area	Rawdon
21	Hoards Creek	Rawdon
	Out of District Properties	
22	Rose zinc occurrence, Kirkland Lake District	McGarry
23	G. Chitaroni trap rock prospect, Kirkland Lake District	Best

Simon Copper Prospect, Denbigh and Lyndoch Townships

On September 27, 2019, the District Geologist examined old trenches, rock dumps and general geology of the Simon copper-zinc prospect in Lyndoch and Denbigh Townships. All UTM co-ordinates reported in the following description are in NAD83, Zone 18. The District Geologist also examined diamond-drill core from the property at the Larder Lake core storage site of Canadian Exploration Services Ltd. on August 14, 2019.

LOCATION AND ACCESS

The Simon property is located about 50 km northeast of Bancroft and 70 km south of Pembroke. The claim group straddles the boundary between Denbigh Township and Lyndoch Township to the north (Figure 6). The property is owned by Canadian Exploration Services Ltd. of Larder Lake, Ontario.

Access is via Highway 41 north from Highway 7 at Kaladar to Denbigh. Continue 4 km past Denbigh to Slate Falls Road; turn left, continue 5.6 km to Snake Rapids Road; continue west and north on logging

road to UTM co-ordinates 319420E 5008400N; park vehicle and walk about 1.2 km west along overgrown logging roads to a small pond at UTM 318347E 5008652N. The south zone is at the northwest edge of the pond and the north zone is located 300 m north from the pond (Figure 7). The B zone, shown on Figure 6, was not examined during the property visit.

EXPLORATION HISTORY

The following record of exploration history on the Simon copper prospect was obtained from a search of assessment files at the Tweed Resident Geologist's Office. The assessment files can also be accessed by entering the assessment file (AFRI) number in the search page of GeologyOntario (www.geologyontario.mndm.gov.on.ca).

- Eugene Simon
  1956: 6 diamond-drill holes (328 m) in the area of copper mineralization exposed in a pit by previous, unknown operators on what is now known as the "north zone" (AFRI# 31F03NW9427)
- Noranda Exploration Company Ltd.
  1962: 13 diamond-drill holes (763 m) (AFRI# 31F03NW9426)
  1994: 2 diamond-drill holes (406 m) (AFRI# 31F03NW0001)
- Pelangio Mines Inc.
  2000: 3 diamond-drill holes (486 m) on the "south zone" (AFRI# 31F03NW2004)
  2003: airborne magnetic and electromagnetic surveys (AFRI# 31F03NW2007)
  2004: ground pulse electromagnetic survey; 5 diamond-drill holes (1008 m) (AFRI# 31F03NW2009)
- Adroit Resources Inc.
  2006: ground magnetic and electromagnetic surveys (AFRI# 20000002442)
  2007: 20 diamond-drill holes (3029 m) (AFRI# 20000002779)
  2008: 13 diamond-drill holes (2600 m) (AFRI# 20000005865)
- Canadian Exploration Services Ltd. (F. Ploeger)
  2018: re-logging and sampling of diamond-drill core (AFRI# 20000015540)

REGIONAL GEOLOGY

The Simon copper prospect is located in the Bancroft terrane of the Central Metasedimentary Belt, Grenville Province (Easton and Fyon 1992). The Bancroft terrane is dominated by calcitic and dolomitic marbles and quartzofeldspathic gneisses derived from siliceous, clastic sedimentary rocks, all of which are preserved at lower to upper amphibolite-facies metamorphism; however, amphibolitic mafic metavolcanic rocks occur as a minor component within structural complexes in Denbigh and Lyndoch townships (Easton 1992). The complex that hosts the Simon copper prospect was termed the "Slate Falls Synform" by Evans (1964) and the "Slate Falls Complex" by Lumbers (1982). The Slate Falls Complex, as mapped by Lumbers and Vertolli (2001), is dominated by gneissic granitic to dioritic intrusive rocks but contains remnants of older metavolcanic and associated metasedimentary belts (*see* Figure 6).

PROPERTY GEOLOGY

The geology in the area of the north and south zones of the Simon copper prospect is shown in Figure 7. The following description of the property geology is summarized from Taner (2008).

The most common rock type in the vicinity of the Simon prospect is amphibolite, which varies from black, fine- to medium-grained and weakly foliated to layered, strongly foliated rock composed essentially of hornblende and plagioclase with locally abundant garnet, biotite and quartz (Photo 1). Accessory minerals include titanite, epidote, apatite, chlorite carbonate, pyrite, pyrrhotite, and magnetite. The quartz feldspar paragneiss is a fine-grained, white to buff rock consisting of quartz, plagioclase and minor biotite. The gabbro has a similar appearance to the amphibolite because it is also black and foliated and consists of a coarse-grained aggregate of plagioclase, hornblende and relict pyroxene. The amphibolite and paragneiss units strike roughly north-northeast and dip about 45° to the east. Other lithologies intersected in diamond-drill holes, but not observed during the property examination, include granitic gneiss, granitic pegmatite and marble (Taner 2008).

MINERALIZATION

The south zone occurs at the contact between amphibolite and paragneiss (*see* Figure 7). Trenches that exposed the mineralization are largely overgrown and filled with debris. Material from the trenches is piled in a large rock dump, about 10 m in diameter at the northern edge of a pond (Photo 2). The dump material is very deeply weathered and friable, consisting of iron oxides with minor pyrite, chalcopyrite and sphalerite in chloritic, biotitic amphibolite (sample SC-19-1).

On the eastern side of the dump area is an outcrop of gossanous quartz-phlogopite-rich metasedimentary rock. One sample was observed to contain a 2 cm, angular clast of granitic composition, possibly indicating a pyroclastic origin for the metasediment (sample SC-18-2).

An example of the south zone massive sulphides containing chalcopyrite, sphalerite and pyrrhotite in diamond-drill core is shown in Photo 5 (*see* "Recommendations for Exploration" "Volcanogenic Massive Sulphide Zinc Potential in the Grenville Province, Southeastern Ontario"). Diamond drilling has indicated that the host rock for the sulphide mineralization is primarily the amphibolite unit. Diamond-drill sections in Taner (2008) show that the paragneiss unit appears to be discontinuous and may not be significant with respect to the mineralization at depth.

Photo 1. Left: Fine-grained, weakly foliated amphibolite and **right**: strongly foliated, garnetiferous amphibolite gneiss in Adroit Resources Inc. diamond-drill hole SC-18 (2007), Simon copper prospect; core diameter 4 cm; photos by P.S. LeBaron, 2019.

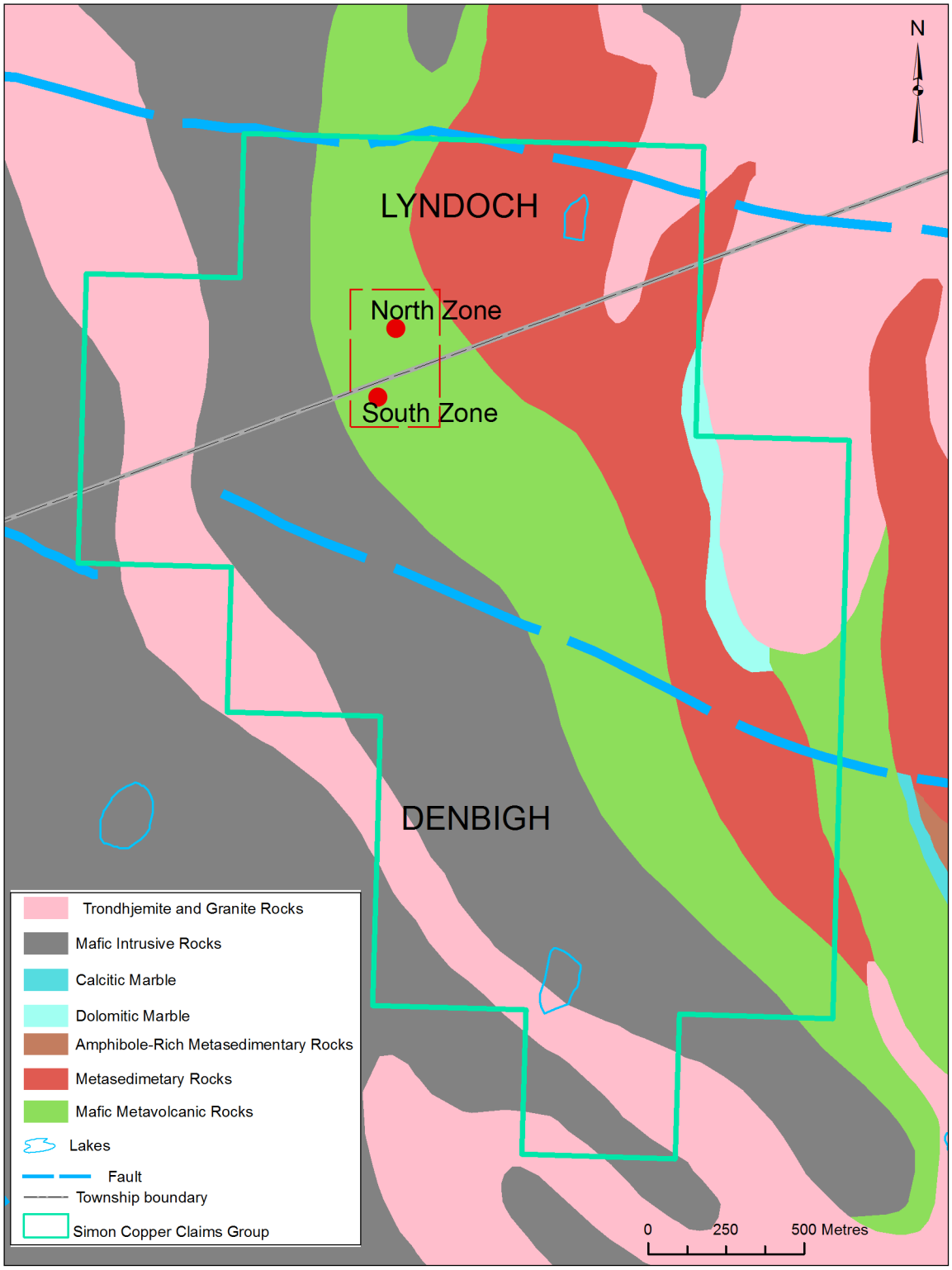

Figure 6. Geology in the area of the Simon copper prospect, Denbigh and Lyndoch townships; geology *from* Lumbers and Vertolli (2001); area of Figure 7 is outlined by thin, dashed red line.

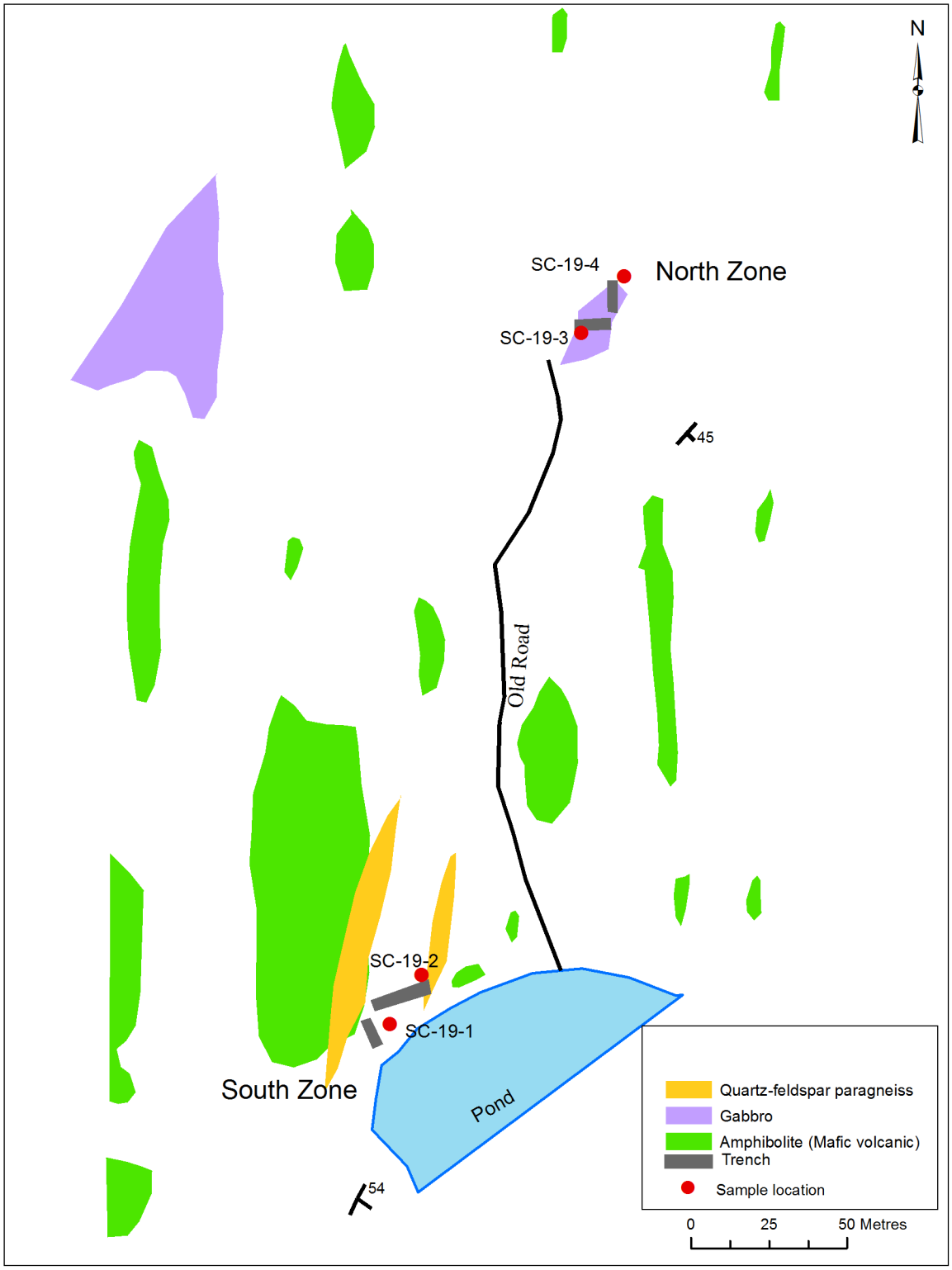

Figure 7. Geology and sample locations, Simon copper prospect, south zone and north zone; geology *from* Carter (1984).

Table 8. Assay results for samples from the Simon copper prospect; samples collected by P.S. LeBaron, September 2019.

Sample	Easting (m)	Northing (m)	Ag (ppm)	Au (ppm)	Cu (ppm)	Zn (ppm)	Co (ppm)	Mo (ppm)	Ni (ppm)
SC-19-1	318347	5008652	25.23	0.221	>12 000	398	4.2	5.41	4
SC-19-2	318342	5008660	<0.2	0.003	169	73	2.8	0.66	2
SC-19-3	318425	5008917	0.29	0.003	2658	35	233.8	12.86	36
SC-19-4	318428	5008920	0.94	0.076	1981	27	28.0	6.54	4

***Notes**: UTM co-ordinates in NAD83, Zone 18; analyses by Geoscience Laboratories, Sudbury.*

The north zone trenches expose a narrow (0.3–1 m) zone of semi-massive, coarse-grained magnetite containing minor chalcopyrite and pyrite in a fine- to medium-grained matrix of quartz, plagioclase, amphibole, garnet and biotite. The north zone has previously been reported to be hosted by gabbro (Filo 2005; Carter 1984). Analysis of samples SC-19-3 and SC-19-4 (Table 8), collected from the north zone during this property visit, indicate higher cobalt, molybdenum and nickel content than in samples from the south zone, suggesting a possible magmatic component from the host gabbro. However, the logs for 2 diamond-drill holes in the north zone by Adroit Resources Inc. in 2008 describe the host rocks as amphibolite gneiss, gneiss, and garnet-rich amphibolite gneiss (Taner 2008), suggesting that north zone may also include the amphibolite units of the south zone.

Photo 2. Rock dump from trenches of the south zone, Simon copper prospect; UTM co-ordinates 318347E 5008652N. Photo by P.S. LeBaron, 2019.

The B zone was discovered by Adroit Resources Inc. by diamond drilling an electromagnetic target to the south of the south zone (*see* Figure 6) in 2008. It consists of a zone of semi-massive sulphides from 2 to 10 m wide containing pyrrhotite, pyrite and chalcopyrite, hosted by garnet-bearing amphibolite gneiss. The best intersections (core length) are 1.73% Zn and 0.5% Cu over 8.33 m and 1.33% Zn and 0.37% Cu over 13.2 m.

A resource estimate of 253 000 short tons averaging 1.09% Cu from the work done by Noranda Exploration Limited in the 1960s has not been revised by Adroit Resources Inc. based on their diamond drilling in 2007–2008 (Taner 2008).

SUMMARY

The Simon copper prospect hosts multiple zones of sulphide mineralization containing copper and zinc. Diamond drilling has been concentrated in 3 zones: the north, south and B zones. The stratiform nature of the mineralization and the presence of amphibolitic mafic metavolcanic rocks and quartzofeldspathic gneiss suggests a volcanogenic origin for the sulphide mineralization (Carter 1984). The presence of a minor sulphide lens intersected in the hanging wall of the south zone also suggests that there may be potential for stacked or *en échelon* lenses of massive sulphides in the area (Filo 2005).

Waring Creek Gold Prospect, Anglesea Township

On August 30, 2019, the District Geologist and the Geological Assistant accompanied R. Waring of Waring Minerals Inc. on a geological examination of the Waring Creek gold prospect in Anglesea Township, part of a large claim group covering about 50 km^2 that extends south and west from Skootamatta Lake into Grimsthorpe Township.

LOCATION AND ACCESS

The area in the vicinity of Killer Creek in concessions XII and XIII, lots 25 and 26 in Anglesea Township, was examined by the District Geologist in 2015 and reported on by Sangster et al. (2016). Since that time, the Waring Creek claim group has been extended to cover the area of the former United Reef Petroleums gold occurrences in concessions XIII and XIV, lots 27 to 29 in Anglesea Township, which was the focus of the current property examination.

Access to the northern part of the project area is by the Hughes Landing Road, leading westward a distance of 10 km from Highway 41 at Cloyne, and an additional 10 km westward on logging roads to the claim group.

EXPLORATION HISTORY

Although arsenopyrite occurrences with minor gold content were discovered in the eastern part of Anglesea Township in the early 1900s (Meen 1944), very little exploration work has been recorded in the area of the Waring Creek property prior to the 1980s.

In 1986, reconnaissance prospecting by United Reef Petroleums Limited resulted in the discovery of gold mineralization in the northwestern corner of Concession XIV, Lot 27 (Figure 8: *see* “Au” symbols also labelled “URP”). An assay of 0.19 ounces per ton gold (6.3 g/t Au) was obtained from a grab sample of a felsic rock unit at least 3 m wide that is in contact with rusty, mafic metavolcanic rocks (Johnson 1988). The company subsequently staked a group of 20 claims in concessions XIII to XV, lots 25 to 28, covering part of the present Waring Creek project area, and completed magnetometer and VLF–EM geophysical surveys, trenching and stripping (Johnson 1988).

In 1989, H. Dowhaluk began a reconnaissance mapping and prospecting program in the area of the United Reef Petroleums discovery. After a sample from a narrow quartz vein returned an assay of 0.674 ounces per ton gold (22.5 g/t Au), he staked a group of 12 claims in concessions XII and XIII, lots 25 to 28, and completed magnetometer and VLF–EM surveys, geological mapping and hand stripping (Dowhaluk 1991).

In 1999, T. Beesley conducted geological mapping, stripping, channel sampling, and a soil geochemical survey on 2 claims covering the United Reef Petroleums gold occurrences (Beesley 1999). Best results from channel sampling were 2.65 g/t Au over 0.2 m and 4.55 g/t Au over 0.15 m obtained from adjacent samples of quartz vein in quartz porphyry.

R. Waring staked the initial Anglesea Township claim group in late 2014 and 2015. He began prospecting in 2015 in the area of the Dowhaluk gold occurrence and increased the area of the claim group to the present size during 2016–2019. Work has included prospecting, trenching, stripping, channel sampling and minor core sampling with a hand-held, battery drill and core bit. Work prior to 2019 focussed on the eastern area in the vicinity of the Partridge Creek shear zone and, in 2019, on the western area, covering the United Reef Petroleums occurrences (*see* Figure 8).

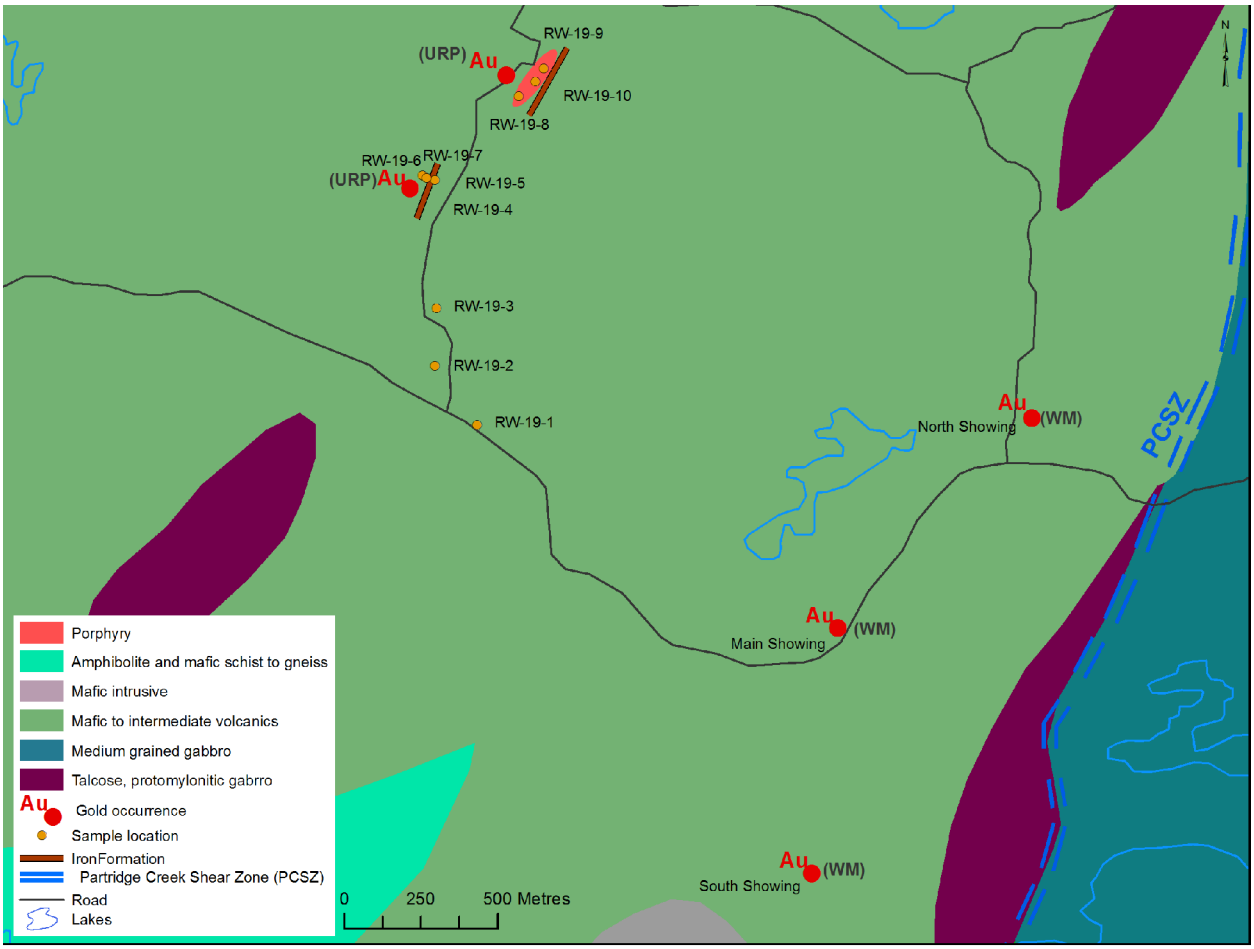

Figure 8. Geology and sample locations, Waring Creek gold prospect; geology *modified from* Easton (2001); Waring Minerals gold (North, South and Main) showings are *from* Poulsen (2016). Abbreviations for gold occurrences: WM = Waring Minerals, URP = United Reef Petroleums.

REGIONAL GEOLOGY

The geology and mineral occurrences of Grimsthorpe Township and the western part of Anglesea Township are described by Easton and Ford (1994). The most recent geological map of the area by the Ontario Geological Survey (Easton 2001) includes the northern part of the Waring Creek project area. The following description of the geology of the area is summarized from Easton and Ford (1994).

The project area lies within the Grimsthorpe domain of the Elzevir terrane in the Central Metasedimentary Belt. The stratigraphic sequence consists of older tholeiitic mafic metavolcanics and intrusions of the Canniff Complex, overlain by a younger sequence dominated by volcaniclastic rocks of the Grimsthorpe Group. The metavolcanic rocks have been intruded by the Killer Creek gabbro, which was, in turn, intruded by the Elzevir tonalite at 1270 Ma and by the Skootamatta syenite at 1085 Ma. The Canniff and Weslemkoon tonalites (Elzevir Suite) also intruded the metavolcanic sequence.

A series of older, protomylonitic gabbros and metavolcanic rocks occurs within the Canniff Complex along the margin of the Canniff tonalite. Several talc occurrences are hosted by these gabbros in a narrow belt along the southern and western margins of the Elzevir tonalite. Easton and Ford (1994) suggest that, based upon field and geochemical observations, the Canniff Complex may represent a partially preserved ophiolite fragment that predates the Grenville Supergroup.

The Partridge Creek shear zone (PCSZ), a north-northeast-trending deformation zone up to 100 m wide, follows the western margin of the Killer Creek gabbro.

PROPERTY GEOLOGY

In the eastern area of the property, the PCSZ separates mafic metavolcanic and volcaniclastic rocks to the west from the Killer Creek gabbro to the east. Talcose, protomylonitic gabbro occurs along the western margin of the Killer Creek gabbro in the vicinity of the PCSZ and as isolated lenses within the metavolcanic rocks sequence to the west. Several auriferous quartz veins have been discovered, hosted by metavolcanic rocks within about 600 m of the PCSZ (Figure 9: *see* "Recommendations for Exploration" "Volcanogenic Massive Sulphide Zinc Potential in the Grenville Province, Southeastern Ontario"). The following description of the quartz vein at the Dowhaluk occurrence, summarized from Sangster et al. (2016), is typical of the extensional quartz veins from which most of the significant gold assays in the eastern area have been obtained.

A quartz vein up to 40 cm wide occurs in strongly sheared, brecciated volcaniclastic rock exposed in the side of a small gravel pit adjacent to the access road at 315488E 4966754N (*see* Figure 8: "Main Showing"). The host rock exhibits strong chlorite-sericite alteration and a yellow-brown gossan resulting from pervasive iron carbonate alteration. The quartz varies from clear and glassy to smoky grey, with yellow and brown iron oxide coating and staining. Only trace amounts of pyrite were observed. Dowhaluk (1991) reported an assay of 0.674 ounces per ton gold (22.5 g/t Au) from a grab sample of vein material. R. Waring reported an assay of 66.6 g/t Au from the same quartz vein (Waring 2016). The host rocks strike at 340° and dip 85° to the east; the crosscutting quartz vein strikes 110° and dips 30° south. A series of parallel quartz veins less than 1 cm thick, spaced at 2 to 10 cm, is exposed in the 1 m thickness of the outcrop.

On the northeast side of a small creek about 1 km north of the Dowhaluk occurrence (315973E 4967441N), a 50 cm wide quartz vein is exposed in a trench in which numerous blocks of similar quartz occur in sandy overburden which contains abundant chlorite and phlogopite grains (*see* Figure 8: "North Showing"). The vein material is white to smoky quartz with iron oxide staining and rare seams and patches of pyrite. Wall rock is strongly foliated, chloritic, mafic metavolcanic rock. R. Waring obtained an assay of 13.3 g/t Au and 37.6 g/t Bi from a grab sample of quartz vein material at this site (Breedvelt 2019).

Table 9. Assay results for samples from the Waring Creek gold prospect; samples collected by P.S. LeBaron, August 2019.

Sample	Easting (m)	Northing (m)	Host Rock	Mineralization	Au (ppm)	Bi (ppm)
RW-19-1	314713	4967513	mafic schist	rusty quartz vein, trace pyrite	0.008	0.2
RW-19-2	314621	4967706	black shale	graphitic, gossan, 3% pyrite	0.02	0.6
RW-19-3	314583	4967899	quartz porphyry	rusty quartz vein, trace pyrite	0.003	0.09
RW-19-4	314638	4968307	siliceous iron formation	rusty quartz vein, trace pyrite	0.002	0.05
RW-19-5	314613	4968320	siliceous iron formation	rusty quartz vein, trace pyrite	4.37	29.06
RW-19-6	314610	4968323	siliceous iron formation	rusty quartz vein, trace pyrite	5.17	23.38
RW-19-7	314619	4968315	siliceous iron formation	rusty quartz vein, trace pyrite	0.011	0.26
RW-19-8	314840	4968573	quartz porphyry	rusty quartz vein, trace pyrite	3.005	15.77
RW-19-9	314901	4968660	quartz porphyry	rusty quartz vein, trace pyrite	0.014	0.07
RW-19-10	314880	4968619	quartz porphyry	rusty quartz vein, trace pyrite	0.133	4.34

Notes: *UTM co-ordinates in NAD83, Zone 18; analyses by Geoscience Laboratories, Sudbury.*

The South Showing quartz vein (*see* Figure 8), located about 500 m south of the Main Showing, is about 40 cm wide, within iron carbonate-altered mafic metavolcanic rock near the contact with pyritic, rusty schist to the west. Waring Minerals has obtained assays of up to 8.6 g/t Au with over 1% bismuth from this vein (Breedvelt 2019).

The western area is dominated by chloritic, mafic metasedimentary rocks; polymictic, poorly sorted conglomerates and/or agglomerates; graphitic and pyritic shale; rusty-weathering, lean, siliceous iron formation, containing minor magnetite-rich bands; and fine-grained, pale grey, quartz porphyry dikes containing quartz eyes up to 2 mm diameter in a siliceous and weakly sericitic matrix. Gold-bearing quartz veins occur in both siliceous, lean iron formation and in quartz porphyry dikes.

Photo 3 shows a narrow (15 cm), extensional quartz vein exposed in a trench at 314638E 4968307N. The vein strikes about 060° and dips about 40° to the southeast. The host rocks are boudinaged lenses of rusty-weathering, siliceous iron formation (sugary-textured quartz, minor magnetite) up to 2 m wide in mafic schist. Minor centimetre-scale quartz veins occur parallel to the foliation, striking 010° and dipping about 80° east. This outcrop area was stripped and sampled by Beesley (1999), with the highest assay being 227 g/t Au from the iron formation. The vein exposed by Waring Minerals was not exposed in the 1999 stripping program and has returned assays of up to 67.6 g/t Au from grab samples and a channel sample with 4.91 g/t Au over a width of 2.2 m (Breedvelt 2019). Additional stripping about 10 m up-slope from this quartz vein has exposed a vein with similar width and attitude which may be the up-dip extension of the same vein. The upper vein was sampled by the District Geologist (Table 9: samples RW-19-5 and RW-19-6) and returned assays of 4.37 and 5.17 g/t Au, respectively.

About 400 m to the northeast of the iron formation trench is an area of quartz porphyry dikes intruding metaconglomerate and siliceous iron formation (314840E 4968573N). Old trenches and channel sample cuts in the quartz porphyry are remnants of work done by United Reef Petroleums (Johnson 1988) and Beesley (1999). Photo 4 shows the intensely fractured nature of the porphyry and the network of quartz veins that have intruded along the fractures. The quartz veins are up to 20 cm wide, with trace to 3% pyrite concentrated in rusty seams in the quartz and at contacts with the host rock. A sample of quartz vein material assayed 3.005 g/t Au (*see* Table 9).

SUMMARY

Auriferous quartz veins occur in at least 3 different host rock types on the Waring Creek property:

1. in metavolcanic rocks in the eastern part of the property that exhibit strong deformation, carbonate alteration, quartz veining and local sulphide mineralization, possibly associated with hydrothermal activity focussed by the PCSZ. Gold mineralization occurs in rusty, smoky quartz veins within sheared metavolcanic rocks, possibly associated with east-to-west cross structures in the vicinity of the PCSZ (Sangster et al. 2016). The best values have come from shallow-dipping, late, extensional veins that crosscut the foliation of the host rock.
2. as extensional quartz veins within siliceous, lean iron formation and interlayered metaconglomerate in the western part of the property
3. as a network of veins within quartz porphyry dikes that have intruded the metaconglomerate–iron formation–mafic schist sequence in the western part of the property

As indicated by the results of sample analyses from the current property visit (*see* Table 9), and as reported by Waring Minerals (Breedvelt 2019), there is an association of high bismuth content with the gold mineralization in both the extensional quartz veins and in the porphyry-hosted veins. The significance of the gold-bismuth association is not known at this time, but it may point to a common source for the origin of the gold-bearing hydrothermal fluids or to a common primary source of the gold that was concentrated and deposited by the hydrothermal system(s). Extensional quartz veins in the eastern and western parts of the property have a similar attitude and mineralization and may represent the same gold mineralizing event.

Photo 3. Shallow-dipping, extensional quartz vein in siliceous iron formation, Waring Creek gold prospect (UTM 314638E 4968307N); hammer is resting on the plane of the quartz vein, vein is about 15 cm thick. Photo by P.S. LeBaron.

The Waring Creek project area covers a considerable extent of the PCSZ and the belt of metavolcanic and metasedimentary rocks to the west, both of which host gold mineralization and have had very little previous exploration for gold. Detailed prospecting, geological mapping and soil geochemical surveying are recommended to delineate the most prospective areas for gold mineralization on this large property. A ground magnetic survey is recommended to assist in the lithological and structural interpretation.

Photo 4. Quartz veins in quartz porphyry, Waring Creek gold prospect (UTM 314840E 4968573N); hammer is 35 cm long. Photo by P.S. LeBaron.

RECOMMENDATIONS FOR EXPLORATION

Volcanogenic Massive Sulphide Zinc Potential in the Grenville Province, Southeastern Ontario

Note: The following recommendation is modified from *LeBaron (2020a).*

Past production of zinc in southern Ontario is limited to the Long Lake zinc mine, a small, high-grade, marble-hosted deposit that produced 100 000 tonnes of ore averaging 11.6% Zn from 1973 to 1974 (Carter 1984). Several other carbonate-hosted zinc prospects in southern Ontario, thought to be of sedimentary exhalative origin, are described by Tessier, LeBaron and Smith (2019). Zinc occurrences are also associated with stratabound, pyritic sulphides in siliceous metasedimentary rocks within or proximal to volcanic sequences, indicating a potential for volcanogenic massive sulphide (VMS) zinc mineralization in the Grenville Province of southeastern Ontario. The geology of southeastern Ontario and locations of the major stratabound, volcanic-associated sulphide deposits are shown in Figure 9.

GEOLOGY OF VOLCANIC-ASSOCIATED SULPHIDE DEPOSITS, SOUTHEASTERN ONTARIO

The stratabound sulphide deposits are iron rich with lesser zinc, copper, gold and silver mineralization in which sulphides form massive to disseminated layers and lenses conformable with foliation and lithologic layering in the host rocks. Pyrite and, less commonly, pyrrhotite are the primary sulphides, with locally significant amounts of sphalerite and chalcopyrite. Most are hosted by siliceous, clastic metasedimentary rocks with or without interlayered carbonate metasedimentary rocks, in proximity to a metavolcanic sequence. The host rock sequence may include mafic to felsic metavolcanic or volcaniclastic rocks (including rusty schists), pyritic and/or graphitic argillite, and garnetiferous amphibolite (Carter 1984).

Although there has been no past production of zinc in southeastern Ontario from a VMS-type deposit, a significant past producer is located within the Grenville Province on Grand Calumet Island, Quebec, about 1 km east of the Ottawa River (*see* Figure 9). The Calumet zinc deposit produced 4 million tonnes of ore averaging 5.8% Zn, 1.6% Pb, 70 g/t Ag and 3 g/t Au between 1942 and 1968 (Sangster 1970). The deposit lies within a package of mafic gneisses with arc-tholeiite geochemical affinities and biotite-sillimanite quartzofeldspathic gneisses which structurally overlie calcitic and dolomitic marbles (Easton 2014). Migmatitic gneisses in the mine sequence contain garnet, cordierite and gahnite. The host rocks, alteration assemblage and metallic minerals (sphalerite, galena and pyrrhotite) are consistent with a VMS origin of the deposit (Easton 2014).

Carter (1984) documents 35 stratabound sulphide deposits in southeastern Ontario. Two deposits are zinc prospects and several others were mined as pyrite orebodies to produce sulphur and sulphuric acid prior to 1920. The major zinc prospects and 2 of the pyrite-producing areas are described below.

- The Simon zinc-copper prospect in Lyndoch Township consists of several zones of massive to semi-massive sulphides totaling about 300 000 tonnes, averaging 1.1% Cu, 4 to 5% Zn and 15 g/t Ag (Taner 2008). It is hosted by amphibole-rich and quartz-feldspar-biotite-rich gneisses and is considered to be of VMS origin (Carter 1984). The main sulphide lens averages about 3 m thick, 180 m long and continues from surface to a depth of at least 100 m. Pyrrhotite is the predominant sulphide in the Simon prospect, with lesser amounts of chalcopyrite and sphalerite (Photo 5).
- The Deer Lake zinc-copper-silver prospect in Belmont Township consists of disseminated sulphides in a unit of rusty schist up to 50 m thick which was tectonically thickened in the nose of a syncline to form a mineralized zone 200 to 250 m wide and up to 600 m long at surface. The zone occurs at the contact between a major volcanic sequence and overlying carbonate and siliciclastic sedimentary rocks. The mineralized sequence, lying above submarine basalts and subordinate intermediate pyroclastic rocks, includes laminated mudstones, siltstones, pelitic sandstones and felsic tuffs, with minor interbeds of magnetite iron formation, chert, and thin seams of graphite. Pyrite, pyrrhotite, and minor sphalerite and chalcopyrite are disseminated throughout the metasedimentary rocks in amounts ranging from 5 to 25%. Between 1956 and 1968, all 8 diamond-drill holes that tested the zone encountered mineralization throughout the entire length, with values ranging up to 0.1% Cu, 1.13% Zn and 0.5 ounce per ton silver (17 g/t Ag) (Carter 1984).

  Four volcanic cycles have been identified in the Belmont Township area. The Deer Lake prospect is situated within Cycle III; however, stratiform sulphides within rusty metasedimentary rocks in the upper parts of Cycles I and II are also anomalously enriched in base and precious metals (Bartlett and Moore 1985).
- The Madoc Township pyrite mines, the Blakely and Canadian Sulphur Ore, operated between 1908 and 1919. The 2 mines are about 2 km apart, and both are hosted by a succession of volcaniclastic metasedimentary rocks, felsic to intermediate metavolcanic rocks, garnetiferous

amphibolite and rusty schists. Coarse felsic and intermediate pyroclastic rocks occur near both deposits at the top of a thick sequence of mafic metavolcanic rocks of the Tudor Formation (Carter 1984). Semi-massive pyrite, combined with fine-grained quartz, occurs in lenses up to 9 m wide and 20 m long. Although the sulphide zones were reported to be barren of other base and precious metals during the time of mining operations, Verschuren (1984) reported the presence of banded pyrite and sphalerite with significant jamesonite in a prospect pit about 70 m south of the Blakely open pit, from which a selected sample of heavily mineralized material assayed 1.3 ounces per ton silver (44.5 g/t Ag), 0.03 ounce per ton gold (1.0 g/t Au), 8.96% Zn and 0.34% Sb.

- The Hungerford pyrite area hosted 3 past-producing mines, located along the Sulphide Road about 7 to 10 km east of the village of Tweed. The Ontario Sulphur, Hungerford and Canada mines operated between 1903 and 1924 along a common horizon of sulphide-bearing, quartzofeldspathic gneiss between underlying mafic, locally pillowed metavolcanic rocks and overlying siliceous, calcitic and dolomitic marble. The Hungerford deposit was the largest, consisting of 3 parallel lenses of massive pyrite, the largest of which was from 1.8 to 6.7 m wide, mined over a length of 190 m to a depth of 175 m (Hopkins 1916).

INDICATOR MINERALS

Regional metamorphism in the Grenville rocks of southeastern Ontario ranges from greenschist to granulite facies (Easton 1992). Primary alteration halos, such as argillic, sericitic and chloritic, are associated with VMS hydrothermal systems and may be subsequently altered by moderate- to high-grade regional metamorphism. The resulting metamorphic mineral assemblages may indicate proximity to a hydrothermal system and can be vectors to a VMS deposit. For example, suites of upper greenschist to amphibolite-facies minerals, including chloritoid, garnet, staurolite, kyanite, andalusite, phlogopite and gahnite (zincian spinel), and upper amphibolite- to granulite-facies minerals, such as sillimanite, cordierite, orthopyroxene and orthoamphibole, can define VMS hydrothermal alteration zones.

Aluminous minerals (garnet, chloritoid, staurolite, kyanite, andalusite and sillimanite) commonly occur close to high temperature alteration pipes (Dusel-Bacon 2012).

Easton (2018) reported on the discovery of peraluminous sapphirine in metamorphosed paragneiss of the Pakenham structure, a broad domal structure in the Sharbot Lake terrane in the Carleton Place area (*see* Figure 9). The mineral is typically associated with ultra-high temperature metamorphism and this is the first occurrence reported from the Central Metasedimentary Belt of the Grenville Province. Based on the chemical and mineralogical composition of the host rock, determined from additional sampling and analysis done in 2019, Easton (2019) suggests that the occurrence may indicate the distal part of a hydrothermal alteration system associated with volcanogenic massive sulphides. This interpretation is supported by the presence of other sulphide mineral occurrences with anomalous copper and zinc content along the southern margin of the Pakenham structure (Easton 2019).

DISTRIBUTION OF METAVOLCANIC ASSEMBLAGES

Easton (1992) subdivided the volcanic and volcaniclastic rocks into 5 main assemblages, based upon rock type, chemistry, related plutonic rocks, associated mineralization and geochronology (Table 10). Figure 9 shows the distribution of the various metavolcanic assemblages in southeastern Ontario. Assemblages V2 and V4 are more likely to host VMS deposits, with V3 and V5 more favourable for copper-nickel and gold deposits (Easton 1992). The V2 assemblage includes bimodal volcanic sequences, some of which are FII and FIII rhyolites, which are commonly associated with Archean VMS deposits (Easton 2017).

SUMMARY

Stratabound sulphide deposits and occurrences, some of which are zinc-bearing, associated with volcanic assemblages and near volcanic–metasedimentary contacts in southeastern Ontario have been recognized as being of volcanogenic origin. There has been little exploration for zinc deposits since the 1970s, and very little modern exploration directed at the VMS model. Detailed prospecting, combined with geochemical and geophysical surveys in the vicinity of known occurrences and in extensions of the host rock sequences may assist in locating additional sulphide-rich zones, including barren iron sulphides which may be vectors to zinc mineralization.

Alteration assemblages including garnet, gahnite, cordierite, sillimanite and other aluminous minerals may indicate zones of hydrothermal alteration associated with VMS deposits in areas of moderate to high-grade regional metamorphism.

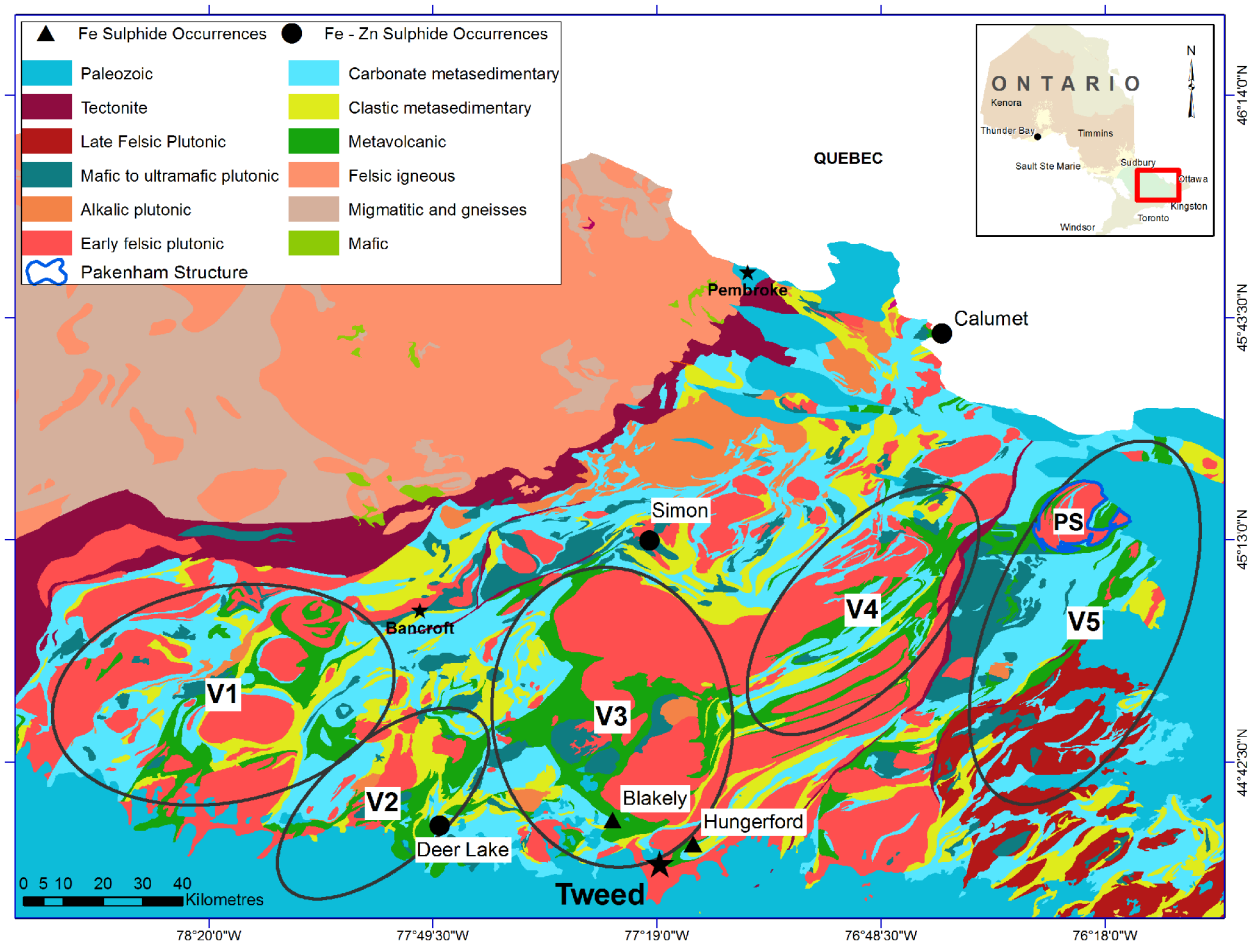

Figure 9. Geology of southeastern Ontario showing locations of major iron and zinc sulphide deposits and distribution of volcanic assemblages referred to in Table 10. Geology *from* Ontario Geological Survey (2011); volcanic assemblages (V1 to V5) *from* Easton (1992). Abbreviation: PS = Pakenham structure.

Table 10. Characteristic features of volcanic and volcanic–plutonic assemblages in the Grenville Province of southeastern Ontario (*from* Easton 1992).

Assemblage	Description	Age (Ma)	Tectonic Setting
V1	Basalt, dacite-rhyolite, pyroclastic rocks, related volcaniclastic rocks, tholeiitic to slightly alkalic chemistry. Mineralization: pyrite, rusty schists and black shales associated with the metavolcanics rocks locally show a variety of metal enrichment, including gold, copper, zinc. May be distal equivalent of assemblage V2.	?	?
V2	Basalt, andesite, dacite, rhyolite, abundant felsic pyroclastic rocks, related andesitic and dacitic volcaniclastic rocks; tholeiitic and calc-alkalic. Mineralization: pyrite, copper-zinc; associated rusty schists and black shales locally show a variety of metal enrichment, including gold, copper, lead, zinc, silver.	Volcanism 1260–1248 Plutonism 1245–1240	Back-arc and/or arc
V3	Basalt, gabbro sills, gabbro and pyroxenite plutons, mafic volcaniclastic sedimentary rocks, tholeiitic chemistry. Associated with gabbro-diorite-tonalite complexes and tonalite-granodiorite plutons; pillowed flows typically with very thin selvages; includes much of the classic Tudor Formation. Mineralization: gold, talc, copper, potential for copper-nickel.	Volcanism 1290–1285 Plutonism 1280–1270	Basal arc? and/or oceanic?
V4	Basalt, andesite, dacite, rhyolite, abundant pyroclastic rocks, volcaniclastic sedimentary rocks and quartzofeldspathic metasedimentary rocks; tholeiitic basalts and calc-alkalic, intermediate to felsic rocks. Mineralization: copper-zinc-pyrite.	<1270?	Arc and/or back-arc?
V5	Basalt, gabbro sills, mainly flows, minor mafic pyroclastic rocks, some exhalative rocks including black shales, sulphide-facies iron formation, pillowed flows typically with very thin selvages. Associated with gabbro-diorite intrusions; could be similar to V3, but not associated with large tonalite-granodiorite plutons. Mineralization: gold (particularly in deformed rocks), copper-zinc-pyrite; many zinc deposits are associated with dolomite marbles overlying the metavolcanics.	?	?

Photo 5. Massive sulphide intersection with pyrrhotite (brown), chalcopyrite (yellow) and sphalerite (dark grey) in Adroit Resources Inc. diamond-drill hole SC-20 (2007), Simon copper prospect, Lyndoch Township; from a section averaging 1.28% Cu and 0.38% Zn over 7.25 m (Parry and Kleinboeck 2007); photo by P.S. LeBaron, August 2019.

Southern Ontario Stone: The Original "Green" Building Material

Note: The following recommendation is modified from *LeBaron (2020b).*

Dimension stone production in southern Ontario began during early European settlement of the province (Goudge 1938) and increased rapidly with the construction of the Rideau and Welland canals from local sandstone and limestone in the early 1800s (Hewitt 1964a). The stone industry in southern Ontario remains strong, with 60 quarries producing stone from both Paleozoic and Precambrian rocks, primarily for small building stone blocks (ashlar), flagstone, landscaping stone, polished tiles and armour stone (Tessier et al. 2019).

Southern Ontario is well situated with respect to excellent transportation networks (roads, rail and Great Lakes shipping) and is close to large residential markets in eastern Canada and the northeastern United States.

MARKET OUTLOOK

A new report on the global dimension stone market by Technavio Research states that the global construction stone market is anticipated to expand at a compound annual growth rate of 4% during the period 2019–2023, in part because of the growing emphasis on construction practices and their impact on the environment (Technavio 2018; Technavio, news release, November 20, 2018, www.businesswire.com/news/home/20181120005442, accessed October 22, 2019).

ADVANTAGES OF NATURAL STONE

The properties of durability, high strength, low maintenance cost, high thermal mass (contributes to passive heating and cooling) and the potential for recycling as building stone or aggregate are factors in the increasing preference for stone in construction projects (Marketwatch, news release, April 2019, "Construction Stone Market 2019 to Rise at CAGR of 9% Through 2023: Global Industry Overview By Size, Share, Trends, Growth Factors, Historical Analysis and Industry Segments Poised for Rapid Growth", www.marketwatch.com, accessed October 22, 2019).

Leadership in Energy and Environmental Design (LEED) is a rating system for construction projects that awards points for reaching environmental standards with respect to site selection, water and energy efficiency and materials selection. The Canada Green Building Council provides links to government rebates and incentives that are designed to encourage LEED practices (www.cagbc.org/CAGBC/Programs/LEED/Incentives). One of the criteria for accumulating LEED points is the use of local building products, to reduce environmental impacts resulting from transportation. The local "region", as defined by LEED Canada, extends to a radius of 800 km from the project site (Canada Green Building Council, "LEED Canada For New Construction and Major Renovations 2009, Rating System", www.cagbc.org | LEED | LEED Canada Rating System | Building Design and Construction, *see* LEED Canada NC 2009 and LEED Canada CS 2009 Rating System *under* Rating System and Reference Guide). All stone quarried in southern Ontario, between Windsor and Cornwall (800 km) and from Lake Erie to Sudbury (500 km) qualifies for LEED points as construction material for projects located within the southern region.

DIMENSION STONE POTENTIAL IN SOUTHERN ONTARIO

Dimension stone quarries are licenced and regulated under the *Aggregate Resources Act*, administered by the Ministry of Natural Resources and Forestry. Private land must be acquired by purchase or by agreement with a landowner for extraction under the *Aggregate Resources Act*. On Crown land, a mining claim must be registered and brought to Mining Lease under the *Mining Act* prior to issuance of an aggregate licence (www.ontario.ca/page/aggregate-resources).

Figure 10 shows the distribution of active dimension stone quarries and the general geology of southern Ontario. The 3 major geological subdivisions within southern Ontario—the Central Gneiss Belt (CGB), Composite Arc Belt (CAB) and the Paleozoic rocks (P) of the St. Lawrence Platform (Johnson et al. 1992)—each have distinct potential for dimension stone based upon predominant lithologies and structural history, as outlined below.

Paleozoic

The highest concentration of dimension stone quarries in southern Ontario is in the Owen Sound to Wiarton area on the Bruce Peninsula (*see* Figure 10). Most quarries are within the Eramosa Member of the Middle Silurian Amabel Formation, a laminated dolostone. Although not technically a marble, the stone is often referred to as "Eramosa Marble" in the dimension stone trade (Rowell 2015).

The minor escarpment along the northern boundary of the Paleozoic bedrock area that extends from Kingston to Orillia area is host to several clusters of limestone dimension stone quarries. The preferred stone is limestone of the Ordovician Gull River Formation, a white-weathering, compact limestone that is well-represented in the buildings of Queen's University and the Royal Military College in Kingston, as well as in many municipal buildings and churches throughout southern Ontario (LeBaron and Williams 1990). The quarries are concentrated in the Orillia, Buckhorn, Tweed and Kingston areas.

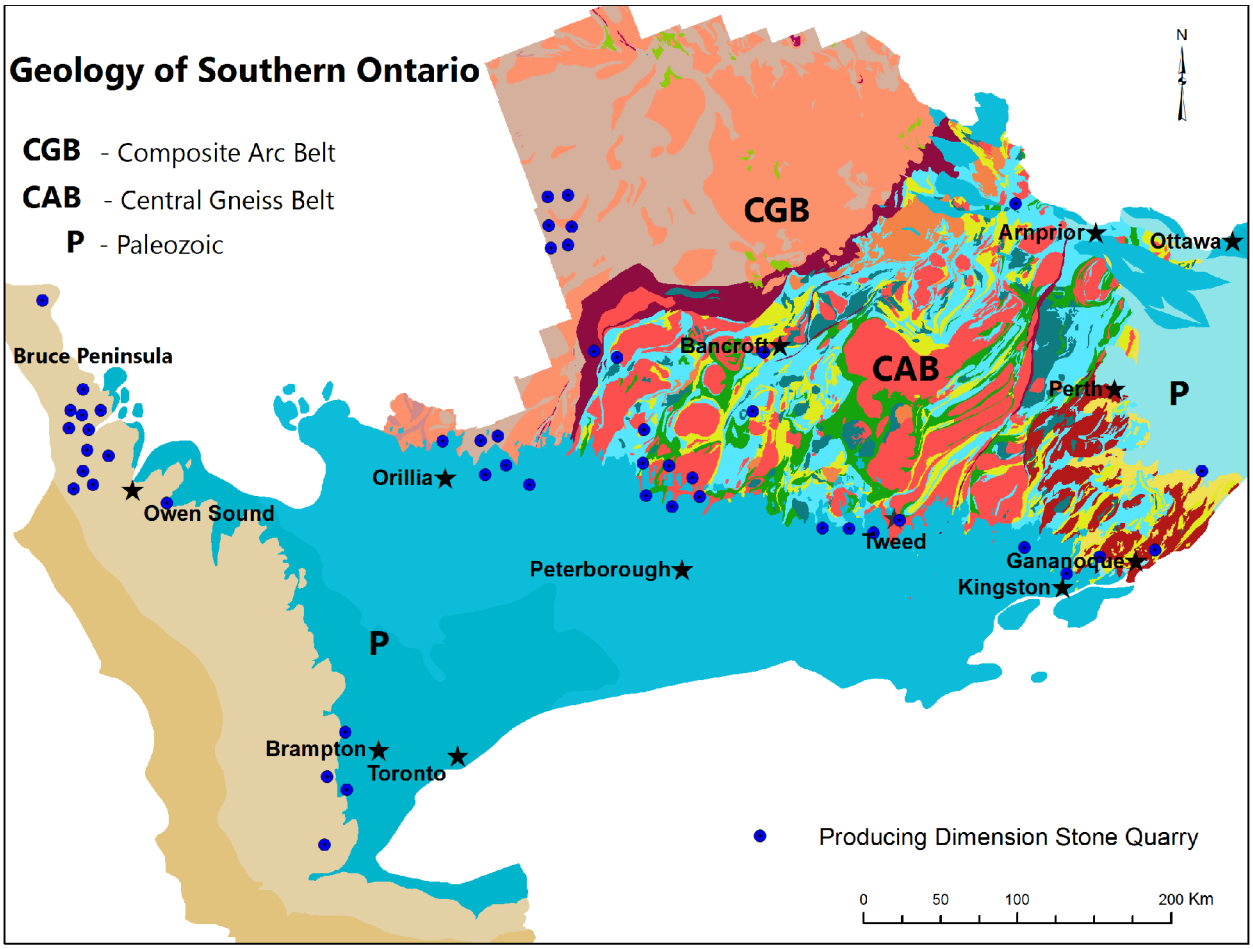

Figure 10. Geology of southern Ontario showing locations of producing dimension stone quarries. Geology *from* Ontario Geological Survey (2011); geological subdivisions *from* Easton (1992); quarry locations *from* Tessier et al. (2019).

Sandstone of the Lower Devonian Whirlpool Formation is quarried in the Brampton area west of Toronto. Locally known as Credit Valley stone, it was used in the construction of the Parliament Buildings at Queen's Park in Toronto (Parks 1912). Sandstone is also quarried near Kingston from the Cambrian Nepean Formation at the base of the Paleozoic sequence and is exposed in many locations along the Paleozoic–Precambrian boundary south of the Composite Arc Belt in the Kingston area and north of the Composite Arc Belt in the Brockville–Perth areas (Keith 1949; Keith et al. 1946).

Composite Arc Belt

Precambrian granitic intrusive rocks and marbles have been quarried for dimension stone in the Composite Arc Belt of southern Ontario (*see* Figure 10).

Granite was quarried on islands in the St. Lawrence River near Gananoque in the late 1800s and used in the construction of Boldt Castle (https://boldtcastle.wordpress.com). Pink to dark red granite was quarried for dimension stone near Lyndhurst and Battersea, north of Gananoque, intermittently into the 1980s (LeBaron et al. 1990). The Gananoque area lies within the Frontenac terrane of the Composite Arc Belt, an area of granulite-facies metamorphism (Easton 1992). The high metamorphic grade reflects temperatures and pressures which may have produced partial melting of the rocks, allowing late tectonic plutons to intrude under low stress conditions and resulting in relatively limited joint patterns (LeBaron et al. 1990). The granitic and syenitic plutons of the Frontenac terrane are host to several former producers and are recommended for exploration for dimension stone.

Marble dimension stone was produced in the Arnprior area approximately during 1840–1900 and was used in the Parliament Buildings in Ottawa (Forsythe and Forsythe 2015). The Bancroft area was also an important marble quarrying centre from 1908 to about 1950, supplying much of the marble used for interior trim in the Parliament Buildings in Toronto and Ottawa (Hewitt 1964b).

Interest in marble quarrying was renewed in the 1960s and quarries were opened near Tweed and at Tatlock, north of Perth. The Tweed quarry, with a variety of white to green mottled marbles, was opened by the Ontario Marble Company and operated intermittently from 1963 to 1998 (Mineral Deposit Inventory file# MDI31C11SW0004, Ontario Geological Survey 2019a). Polished stone panels from the quarry were used for interior walls of the Canada Trust Building in Toronto and the Royal Alberta Museum in Edmonton (Ontario Marble Company, undated brochure, Resident Geologist's Office, Tweed). The Omega marble quarry produced blocks of banded white, blue and pink marble during 1962–1971, marketed under the trade name, "Rideau Blue" (Storey and Vos 1981; Photo 6). The marble belts of the Composite Arc Belt host calcitic and dolomitic marbles with a wide range of colours and textures.

Central Gneiss Belt

The Central Gneiss Belt (*see* Figure 10) consists mainly of upper amphibolite and granulite facies, quartzofeldspathic gneisses, predominantly of igneous origin with subordinate paragneiss (Easton 1992). Numerous quarries have operated in the gneissic rocks since at least 1925, producing flagstone, landscaping stone and building stone (Hewitt 1964c). Several quarries continue to operate in the southern part of the Central Gneiss Belt (*see* Figure 10).

NEW POTENTIAL – THIN STONE VENEER

Thin stone veneer is split-face stone cut to a thickness of about 2 to 4 cm that gives the appearance of natural stone blocks at a much lower cost and weight than standard 10 to 15 cm thick ashlar (Penn 2006). Many deposits of limestone, dolostone, sandstone and gneiss in southern Ontario that may be unsuitable for large quarry block extraction due to excessive jointing may be suitable for thin stone production (Sangster et al. 2007).

There is potential for multiple products from a dimension stone operation. Waste rock from a granite dimension stone quarry may have use as construction or road-surfacing aggregate. Waste rock from marble and gneiss quarries that may not meet construction aggregate specifications has potential for use as decorative aggregate, particularly in the case of white or coloured marbles.

SELECTED SOUTHERN ONTARIO DIMENSION STONE PUBLICATIONS

The following reports document the results of several dimension stone studies conducted through the 1980s and 1990s by staff of the Resident Geologist Offices. The studies included both research and field investigations; sample cutting and polishing; and ASTM (American Society for Testing and Materials) testing for physical properties of the samples and provide more detailed recommendations for exploration. Details about these publications are provided under "References".

- *Gneisses of the Parry Sound–Muskoka Area: Flagstone Resources*
  by C.R. Fouts and C. Marmont (1989)
- *Building Stone Potential in Eastern Ontario*
  by P.S. LeBaron, C.P. Verschuren, V.C. Papertzian and P.W. Kingston (1990)
- *Carbonate Building Stone Resources of the Lake Simcoe–Kingston Area, Southeastern Ontario*
  by P.S. LeBaron and D.A. Williams (1990)
- *Building Stone, Feldspar and Limestone Resources in Central Ontario*
  by C.R. Marmont (1991)
- *Dimension Stone: A Guide to Prospecting and Developing*
  by V.C. Papertzian and D.G. Farrow (1995)

Photo 6. "Rideau Blue" marble, Omega marble quarry; section with water applied to enhance colour is about 1 m wide (photo by P.S. LeBaron).

OGS ACTIVITIES AND RESEARCH BY OTHERS

Geological mapping and related projects in southern Ontario by staff of the Earth Resources and Geoscience Mapping Section, Ontario Geological Survey, continued during the 2019 field season.

In the eastern part of the Central Metasedimentary Belt, Grenville Province, mapping and sampling were done by R.M. Easton as follow-up to a 1:50 000 scale bedrock mapping project in the Carleton Place map area that was initiated in 2017. Results of laboratory work done in 2018 revealed that the geological history of the Sharbot Lake domain in the Carleton Place area is much older and more prolonged than previously suspected. The implications of the results with respect to the geological history and mineral potential of the area are presented in the following article in *Summary of Field Work and Other Activities, 2019* (Ontario Geological Survey 2019b):

- Geological History at *Circa* 1290 Ma of the Composite Arc Belt, Grenville Province, as Revealed by New Mapping and Geochronological Results from the Carleton Place Area; by R.M. Easton and S.L. Kamo

Other OGS studies related to Paleozoic geology and energy studies, Quaternary geology, aggregate resources and groundwater resources in southern Ontario were in progress in 2019. Detailed descriptions of the following projects are included in *Summary of Field Work and Other Activities, 2019* (Ontario Geological Survey 2019b):

Surficial Mapping and Sampling

- Quaternary Sediment Mapping in the City of Ottawa, Eastern Ontario; by R.P.M. Mulligan
- Aggregate Resources in the County of Haldimand, Southern Ontario; by L.A. Handley

Paleozoic Geology and Energy Studies

- Paleozoic Geology of Eastern Ontario: Arnprior–Quyon Area; by C. Béland Otis
- Karst Map of Southern Ontario: An Update; by F.R. Brunton

Groundwater Studies

- Regional Groundwater Systems Mapping in the County of Simcoe, Southern Ontario: Second Phase of Field Work; by E.H. Priebe, R.P.M. Mulligan, A.F. Bajc, A.M. Cartier and A.K. Burt
- West Ottawa Groundwater Study; by T. Di Iorio, R.A. Harrison, T. Al, A. Majury and S.M. Hamilton

Several other OGS publications related to geoscience projects in southern Ontario were released in 2018 and are listed, with other publications acquired in 2019 for the Southern Ontario Resident Geologist Office library, in Table 11.

Table 11. Publications received by the Southern Ontario Regional Geologist office in 2019.

Title	Author(s)	Type and Year of Publication
Recommendations for Exploration 2018–2019	Ontario Geological Survey	Ontario Geological Survey, Recommendations for Exploration, 2019
Subglacial Bedforms in Southern Ontario: From Flood Paths to Flow Sets	Eyles, N., Mulligan, R.P.M., Paulen, R.C. and Sookhan, S.S.	Ontario Geological Survey, Open File Report (OFR) 6348, 2019
Regional-scale Groundwater Geoscience in Southern Ontario: An Ontario Geological Survey, Geological Survey of Canada, and Conservation Ontario Geoscientists Open House	compiled by Russell, H.A.J., Ford, D., Holysh, S. and Priebe, E.H.	Ontario Geological Survey, Open File Report 6349, 2019
Report of Activities 2018, Resident Geologist Program, Southern Ontario Regional Resident Geologist Report: Southeastern and Southwestern Ontario Districts, and Petroleum Operations Centre	Tessier, A.C., LeBaron, P.S., Smith, A.C., Laidlaw, D.A., Bousquet, P. and Fortner, L.	Ontario Geological Survey, Open File Report 6356, 2019
Aggregate Resources Inventory of the County of Peterborough, Southern Ontario	Hahn, K.E. and Handley, L.A.	Ontario Geological Survey, Aggregate Resources Inventory Paper (ARIP) 105, 2019
Summary of Field Work and Other Activities, 2019	Ontario Geological Survey	Ontario Geological Survey, Open File Report 6360, 2019
High-Resolution Seismic Reflection Profiles for Groundwater Studies in the Niagara Peninsula Region, Ontario	Dietiker, B., Pugin, A.J-M., Burt, A.K., Crow, H.L., Cartwright, T. and Brewer, K.	Ontario Geological Survey, Open File Report 6358, 2019
Geological, Geochemical, Geophysical and Petrographic Data from the Perth Area, Grenville Province, Southeastern Ontario	Easton, R.M.	Ontario Geological Survey, Miscellaneous Release—Data (MRD) 351, 2019
Three-Dimensional Mapping of Surficial Deposits in the Southern Part of the County of Simcoe, South-Central Ontario	Bajc, A.F., Mulligan, R.P.M. and Dodge, J.E.P.	Ontario Geological Survey, Groundwater Resources Study 18, 2019
Three-Dimensional Geological Model of the Paleozoic Bedrock of Southern Ontario	Carter, T.R., Brunton, F.R., Clark, J.K., Fortner, L., Freckelton, C.N., Logan, C.E., Russell, H.A.J., Somers, M., Sutherland, L. and Yeung, K.H.	Ontario Geological Survey, Groundwater Resources Study 19, 2019
Ontario Precambrian Bedrock Magnetic Susceptibility Geodatabase for 2001 to 2017	Biswas, S.	Ontario Geological Survey, Miscellaneous Release—Data 273–Revision 2, 2019
Geochronology Inventory of Ontario	Ontario Geological Survey	Ontario Geological Survey, GeochrON, 2019
Minerals of the Grenville Province, New York, Ontario and Québec	Robinson, G.W., Chiarenzelli, J. and Bainbridge, M.	Schiffer Publishing, 2019

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 2019. 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. W.M. Schwerdtner (University of Toronto) and Dr. T. Rivers (Memorial University of Newfoundland) continued their long-range lithostructural research studies in the Grenville Province of Ontario with 2 projects:
    - A regional study of late-orogenic cross-folding in the Ontario portion of the Ottawa River gneiss complex, was initiated in 2018 to study the lithostructural effects of the Rigolet orogenic phase on kilometre-scale cross-folds in the Grenville Front tectonic zone, North Bay and Sudbury regions. Field work continued in 2018 with detailed examination of, and structural measurements in, polydeformed gneisses in the Grenville Front tectonic zone, especially along major highways and other paved roads in the Field, Marten River and River Valley areas.
    - A field-based study of banded gneisses in the Grenville Front tectonic zone and well-exposed walls of Grenvillian lithotectonic boundaries in the Ontario portion of the Ottawa River gneiss complex began in 2018. The initial objective was to constrain the deformation path of banded gneisses characterizing the walls of the Composite Arc Belt boundary, the Allochthon Boundary, most subdomain boundaries of the Algonquin and Muskoka domains, and the Grenville Front tectonic zone between the towns of Marten River and Wanup. In 2019, field work consisted of a detailed examination and structural analysis of banded gneisses in the Grenville Front tectonic zone, Field, Marten River and River Valley areas; and the Algonquin and Muskoka domains, greater Bracebridge, Burk's Falls and Huntsville areas and southwest Algonquin Park. Special attention was paid to clean road cuts with exposures of straight gneiss.
- R. Culver completed an undergraduate honours thesis on the Salerno Lake zinc deposit in Snowdon Township, under the co-supervision of Dr. G. Olivo at Queen's University and A.C. Tessier (Southern Ontario Regional Resident Geologist, ENDM) in 2019. The project studied the stratigraphic sequence using petrographic and lithogeochemical analyses.
- H. Lang of Queen's University is researching the mineralization styles of zinc in the high-grade metamorphosed marbles of the Proterozoic Grenville Province as part of a MSc thesis, supervised by Dr. G. Olivo. The study includes comparison of 2 deposits through field mapping, drill core logging, lithogeochemical, petrographic and microprobe analyses, as well as the use of Leapfrog® to make a three-dimensional model of one of the deposits. Results will be integrated with literature review to better understand the effects of metamorphism on zinc mineralization in the Grenville marble units, and to provide guidelines for future exploration.

MINERAL DEPOSITS NOT BEING MINED

Tables 12 through 20 list currently inactive mineral deposits with identified resources and past-producing mineral occurrences.

Table 12. Historical production of gold – Southeastern Ontario District.

Mine	Township	Operating Years	Tons Milled	Ounces of Gold Produced	Grade (ounces gold /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	1893–1894	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 13. Historical 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 14. Historical 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

Mine	MDI Number	Township	Operating Years	Total Production (Tons)
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).

Table 15. Historical 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 16. 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
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

***Sources:** "MDC 20" = Carter, Colvine and Meyn (1980); "MP 161" = LeBaron et al. (1993); "MRC 11" = Shklanka (1968); "OFR "5515" = Carter (1984).*
(Publication series 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 historical figures and do not follow the required disclosure for reserves and resources as outlined in National Instrument 43-101.*

Table 17. Titanium, tantalum and REE occurrences (*compiled from* MDI database: Ontario Geological Survey 2019a) – 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
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

Name	Township	MDI File #	Commodity	Deposit Status
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 the complete MDI files are located at RGP office in Tweed.*

Table 18. Uranium deposits not currently being mined in the Southeastern Ontario District.

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 t 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 and 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

Sources: *"MDC 23" = Masson and Gordon (1981); "MRC 4" = Hewitt (1967); "OFR 5311" = Gordon, Rybak and Robertson (1981); "OFR 5635" = Menard (1987).*
(Publication series 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 historical 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 Southeastern Ontario District. (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 Name Township	MDI File Number (Southern Ontario No.)	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	MRC 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	MRC 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	MRC 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	MRC 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, p.104
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	MRC 11, p.314
Buckhorn deposit Bagot Township	MDI31F07NE-00069 (SO 0362)	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 Name Township	MDI File Number (Southern Ontario No.)	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 (NO 129)	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 (SO 1466) MDI31C09NW-00011 (SO 1469)	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 (SO 0223)	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 (SO 0882)	I	Gold	Total geological reserve of 758 000 tons grading 0.14 ounces per ton Au	OFR 5808, p.71

***Sources:** "MRC 11" = Shklanka (1968); "MRC 12" = Shklanka (1969); "MDC 18" = Gordon et al. (1979); "MDC 20" = Carter, Colvine and Meyn (1980); "MDC 33" = MacKinnon and LeBaron (1992); "MP 161" = LeBaron et al. (1993); "OFR 5515" = Carter (1984); "OFR 5715" = MacKinnon (1990); "OFR 5808" = LeBaron (1991); "OFR 5943" = Kingston, Papertzian and Sangster (1996); "OFR 5945" = Rogers (1996); "OFR 5958" = Kingston and Papertzian (1997); "OFR 6296" = Sangster et al. (2014).*

(Publication series 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 historical figures and do not follow the required disclosure for reserves and resources as outlined in National Instrument 43-101.*

Table 20. Mineral deposits not currently being mined in the Southwestern Ontario District.

Abbreviations

AF ..... Assessment Files
AR ..... Annual Report
CAMH ..... *Canadian and American Mines Handbook* [*since* 2004–2005]
CMH ..... *Canadian Mines Handbook* [*up to and including* 2003–2004]
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
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 $\times 10^6$ t of sandstone)	N/A	IMR 9, p.29	Inactive
Big Creek 1 (40J/03SE)	Silica	14.6 m thick @ 34.4 m (10 $\times 10^6$ 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

***Sources:** "IMR 9" = Hewitt (1963); "OFR 5861" = Russell (1993).*

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

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 in 2019 by Peter LeBaron, *P.Eng*., from February to June, and Deborah A. Laidlaw, *P.Geo*., from July to December.

The boundaries of the Regional Land Use Geologists' regions are indicated on Figure 11.

Figure 11. Extent of the Regional Land Use Geologists' ("RLUG") 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
- 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 2019, 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 Energy, Northern Development and Mines (ENDM) 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; 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 was not called to provide input into the development of Forest Management Plans in 2019.

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).

MUNICIPAL AND PRIVATE LANDS

The Ministry of Energy, Northern Development and Mines supports municipal and private land-use planning through the One Window Planning Service, led by the Ministry of Municipal Affairs and Housing (MMAH). 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. In 2019, the government committed to the review of the PPS and is seeking feedback on proposed policy changes to

- encourage the development of an increased mix and supply of housing
- protect the environment and public safety
- reduce barriers and costs for development and provide greater predictability
- support rural, northern and Indigenous communities
- support the economy and jobs
- maintain protections for the Greenbelt

As a participant in MMAH'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

- 56 consent (severance) applications in 13 lower-tier municipalities
- 12 Official Plans and related planning initiatives (such as zoning by-laws and subdivision approvals) in 16 communities
- 7 new draft Official Plans or Official Plan updates

The municipalities involved in these planning initiatives are listed in Table 21.

Table 21. Municipal planning initiatives with ENDM input, southern Ontario, 2019.

Consent (Severance) and Subdivision Applications
Consent, Brudenell, Township of
Consent, Camden East, Township of (33)
Consent, Glamorgan, Township of
Consent, Kaladar, Township of
Consent, Leeds, Township of (2)
Consent, Madoc, Township of (2)
Consent, McClintock, Township of
Consent, North Burgess, Township of (3)
Consent, North Elmsley, Township of
Consent, Ramsey, Township of (2)
Consent, Ross, Township of (3)
Consent, Sheffield, Township of (5)
Consent, South Crosby, Township of

Official Plans and Related Initiatives Under Development
Callander, Municipality of
Dysart et al, United Townships of
Gananoque, Town of
Gordon/Barrie Island, Municipality of
McMurrich/Monteith, Township of
Prescott, Town of
Rideau Lakes, Township of

Completed Official Plans and Related Initiatives
Grey, County of
Haldimand, County of
Halton, Regional Municipality (RM) of; Peel, RM of; York, RM of; Toronto, City of; Hamilton, City of
Hastings, County of
Huron, County of
Kingston, City of
McMurrich/Monteith, Township of
Niagara-on-the-Lake, Town of
Peel, Regional Municipality of (2)
Peterborough, City of
Renfrew, County of

Other Activities

The southern Regional Land Use Geologist also undertook other related work in 2019, as outlined below.

GEOSCIENCE INTEGRATION PLAN

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 ENDM and an interministerial 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 options for a geoscience integration plan are being prepared. Some options being considered are the development of a geoscience lens to promote and support the use of geoscience in decision-making processes and a Communities of Practice to improve communication and collaboration among geoscientists throughout government.

The southern Regional Land Use Geologist participated on the committee by attending teleconferences and providing input to geoscience-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 (www.ontario.ca/page/class-environmental-assessments-approved-class-ea-information), 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 2019, feedback was provided for reviews of the following 4 Class EA projects within southern Ontario:

- water storage facility expansion in Amaranth Township, Dufferin County
- bridge construction in Belleville
- bus rapid transit project in the Durham–Scarborough region
- transmission facilities in St. Clair Township

CONFERENCE

The southern Regional Land Use Geologist attended the Professional Geoscientists of Ontario Conference in Toronto.

MINERAL DEPOSIT COMPILATION GEOSCIENTIST—NORTHEASTERN ONTARIO

The Mineral Deposit Compilation Geoscientists (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 Energy, Northern Development and Mines is using the most up-to-date information in making land-use planning and policy decisions. Records for certain areas are reviewed and updated in support of bedrock geology mapping and other field work conducted by the Earth Resources and Geoscience Mapping Section (ERGMS) of the Ontario Geological Survey. For 2019, S.L.K. Hinz was northeastern Ontario MDCG.

The MDI database is a dynamic compilation of over 19 000 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 additional tools for making mineral discoveries in Ontario.

As described below, MDI record information was provided during 2019.

- Timmins District:
  - complete updates were compiled and entered for Benton, Clergue, Esther and Heenan townships
  - MDI records compilation for land-use planning decisions in the Timmins District
- Sault Ste. Marie District:
  - updates focussed on areas of increased mining and exploration activity
  - 1 new MDI was added based on a property visit completed during the summer of 2018
  - MDI records compilation for land-use planning decisions in the Sault Ste. Marie District
- Kirkland Lake District:
  - some production numbers in the Cobalt area were updated
  - compilation and synthesis of MDI points in the northern part of the district following a field visit by RGP staff
  - 1 new MDI record was added based on a property visit completed during the summer of 2019
  - MDI records compilation for land-use planning decisions in the Kirkland Lake District
- Sudbury District:
  - complete township updates were compiled and entered for Hart and Ermatinger townships
  - other miscellaneous MDI points were updated following requests by ERGMS staff
  - MDI records compilation for land-use planning decisions in the Sudbury District
- Southern Ontario Region (Southeastern Ontario and Southwestern Ontario districts):
  - updates focussed on zinc properties visited and described in 2018 by Southern Ontario RGP staff
  - Methuen Township is in the process of being completed and updated

Total contributions to the MDI database in 2019 included 247 updated records, 22 records deleted and 7 new records. A breakdown of the provincial records revised by office is provided in Table 22.

Table 22. Mineral Deposit Inventory records revision in northeastern and southern Ontario in 2019.

Resident or District Office	Updates	Deletions	New
Kirkland Lake	42	8	1
Sault Ste Marie	18	3	1
Southern Ontario	58	2	2
Sudbury	25	8	0
Timmins	104	1	3
Total	247	22	7

The publicly available version of the MDI database is updated monthly 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. The activity reports on mineral exploration, available using the OGSEarth application, includes monthly and year-to-date listings of the MDI records that have been updated.

ACKNOWLEDGMENTS

The authors would like to thank all producers, exploration companies, prospectors and developers who provided access to their operations or supplied information throughout 2019. Strong communication links between stakeholder groups and government ministries are essential for effective program delivery and, ultimately, to improve the delivery of government services.

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Ontario

Ministry of Natural Resources and Forestry

Petroleum Operations Section—2019

by

L. Fortner

2020

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Petroleum Operations Section—2019

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INTRODUCTION

The small increase in drilling frequency in Ontario, which included 3 oil and gas exploration wells in 2018, did not continue into 2019.

Produced oil volumes in Ontario dropped 5.8% from 53 623 m^3 in 2017 to 50 532 m^3 in 2018. Audited and confirmed oil production volumes for 2019 were not available at the time this report was created.

Produced natural gas volumes in Ontario dropped 3.5% from 136 873 261 m^3 in 2017 to 132 064 026 m^3 in 2018. Audited and confirmed gas production volumes for 2019 were not available at the time this report was created.

The annual decline in oil and natural gas production in Ontario 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. In turn, it is long-term pressure on oil and natural gas prices that has almost entirely eliminated new petroleum drilling in the province.

ACTIVITY

A total of 5 licences to drill new wells were issued by the Ministry of Natural Resources and Forestry in 2019. An additional 4 licences were issued in 2019 for plugging only, and 4 licences issued to operate or perform work on existing wells.

Drilling of new wells in Ontario had decreased to an historic low of 4 in 2017, but increased to 10 in 2018, primarily as a result of a campaign to drill new natural gas storage wells. There were, however, 3 new oil and gas exploration wells in 2018. There had only been 2 exploration wells drilled in total from 2014 to 2017, inclusive. Unfortunately, exploration activity diminished again to only 1 new exploration well drilled in 2019.

No new oil or gas development wells were reported in 2018 or 2019.

Cambrian Play

The only exploration well drilled in 2019 targeted the Cambrian interval in the Municipality of Chatham–Kent. This was only the third well drilled to test Cambrian strata in Ontario since 2013. Information on this new well remains confidential.

No development wells were drilled to the Cambrian in 2019. The last development well drilled to this target was completed in 2014; which had been the first since 2010.

Ordovician Play

There have been no exploration or development wells drilled to test the Ordovician interval since 2014.

Silurian Sandstone Play

No exploration wells have targeted Silurian sandstone units since 2011.

There were no development wells drilled for Silurian sandstones in 2019. The last new well to exploit the Silurian sands was completed in 2017 as a private gas producer.

Silurian Carbonate Play

No exploration wells were drilled for Silurian Guelph Formation reef and/or Salina Group targets in 2019. The 1 exploration well attempted and plugged in 2018 had been the first since 2013.

There have still been no development wells drilled for this interval since 2013.

Devonian Play

No exploration wells targeted the Devonian play in 2019. The 1 exploration well drilled and plugged in 2018 was the first intended to test Devonian strata since 2013.

No development wells were drilled for the Devonian interval in 2019, with the last occurring in 2014.

EXPLORATION TRENDS

The decade-long oversupply from the United States continues to weigh on North American natural gas prices and suppress interest in exploration and development activity in Ontario. The more recent oversupply of oil from United States shale development has also been contributing to pressure on commodity prices and operator finances. The increase in activity reported in 2018 was not sustained in 2019 and does not currently appear to have been the beginning of a revived upward trend.

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.*

ISSN 1484-9402 (print)
ISBN 978-1-4868-4245-2 (Print)

ISSN 1916-6168 (online)
ISBN 978-1-4868-4246-9 (PDF)