LIMESTONE INDUSTRIES OF ONTARIO

Volume I — Geology, Properties and Economics

Paleozoic Geology of Ontario

Precambrian Carbonate Resources

Properties, Specifications and Uses

Production, Economics and Markets

Volume II — Limestone Industries and Resources of Eastern and Northern Ontario

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Volume III — Limestone Industries and Resources of Central and Southwestern Ontario

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Limestone Industries of Ontario

Volume III — Limestone Industries and Resources of Central and Southwestern Ontario

Prepared for the Aggregate Resources Section,
Land Management Branch, Ontario Ministry of Natural Resources

by
Derry Michener Booth and Wahl
and
Staff of the Engineering and Terrain Geology Section, Ontario Geological Survey,
Ministry of Northern Development and Mines

1989

Ontario

Ministry of Natural Resources
Vincent G. Kerrio
Minister

Ministry of Northern Development and Mines
Sean Conway
Minister

Printed in Ontario, Canada

ISBN 0-7729-3533-5 (3v. set)
ISBN 0-7729-3536-x (v. 3)

Current publications of the Ontario Ministry of Natural Resources, and price lists, are obtainable through the Ministry of Natural Resources Public Information Centre, Room 1640, Whitney Block, 99 Wellesley St. West, Toronto, Ontario M7A 1W3 (personal shopping and mail orders).

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Parts of this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

Derry Michener Booth and Wahl and Ontario Geological Survey
1989: Limestone Industries of Ontario, Volume III — Limestone Industries and Resources of Central and Southwestern Ontario; Ontario Ministry of Natural Resources, Land Management Branch, 175p.

Cover photo of St. Marys Cement plant is courtesy of St. Marys Cement.

Acknowledgments

The authors are indebted to industry personnel and landowners who allowed close examination of their properties, and who generously provided product lists and plant flowcharts.

The members of the study's steering committee made a valuable contribution to the study by guiding the authors, providing materials and reviewing the report.

A large study such as this is completed only through the efforts of many people. The geological/mining engineering firm, Derry Michener Booth and Wahl, was the lead consultant and was responsible for the plant inventory and descriptions. Staff who prepared the material included David Wahl, Martin Taylor, Wes Roberts and Charles Pitcher, with the assistance of W.G. Wahl, Wahlex Ltd., G. Robert Guillet, Consultant, and Jack Kriens, IMD Laboratories. Don Hains of Hains Technology Associates was responsible for the material on commodities and economics of the limestone industries. Mr. Hains and Mr. W.G. Wahl prepared the plant descriptions for cement, lime and fillers operations.

Staff of the Engineering and Terrain Geology Section, Ontario Geological Survey of the Ministry of Northern Development and Mines prepared the geological description of each site as well as the regional descriptions of the geology of limestone and related carbonate rocks in Volume I. This work was supervised by Dr. Owen White, Chief, Engineering and Terrain Geology Section, and Mike Johnson, Acting Supervisor, Paleozoic/Mesozoic Geology Sub–Section. Staff involved in preparing the site descriptions included Dr. Max Vos, Rainer Wolf, Ruth Bezys, Derek Armstrong, Julie Stevenson–Demeester, Val Mazur, and Chris Fouts. Dr. Peter Telford of the Mineral Development and Lands Branch, Ministry of Northern Development and Mines assisted in the interpretation of geological data and the review of the report.

The project was initiated by the Aggregate Resources Section, Ministry of Natural Resources, under the direction of Dale Scott. Geoff Bell was the project coordinator and report editor.

Preface

Products from the limestone industries find their way into many of the items that are essential to our modern way of life. In one way or another, the output of the various members of the limestone industries is used in constructing or manufacturing items as diverse as office towers, homes, transportation networks, steel, glass, paper, or rubber products.

This report examines Ontario's limestone industries from two perspectives: the geological resource, including limestone, dolostone, marble and carbonatites; and secondly, the various industries which rely on these resources to manufacture products which are vital to Ontario's economy. These products include construction aggregate, cement, lime, fillers and extenders, building stone and pulverized stone.

In order to undertake a study on such a large and important economic sector, a steering committee was struck to formulate the terms of reference for the study and guide the research and field work through to the report stage. Members of the steering committee were:

- Dale Scott, Chairman, Ministry of Natural Resources
- Norris Walker, Aggregate Producers' Association of Ontario
- Vic Perry, Canadian Portland Cement Association
- Don Stonehouse, Energy Mines and Resources Canada
- Dr. Owen White, Ministry of Northern Development and Mines
- Dr. Peter Telford, Ministry of Northern Development and Mines
- Dr. Max Vos, Ministry of Northern Development and Mines
- Mike Johnson, Ministry of Northern Development and Mines
- Zoltan Katona, Ministry of Transportation
- Chris Rogers, Ministry of Transportation
- Geoff Bell, Executive Secretary, Ministry of Natural Resources

The study brings together the most up to date geological information pertaining to carbonate rocks and describes the current operations of the members of the limestone industry. In addition, information on the economics of the various commodities is presented in order to give a more complete picture of this resource activity. Field work and data compilation were performed in 1986 and 1987. The authors have attempted to incorporate changes in plant design and ownership up until summer 1988.

The geological and plant site descriptions are organized based on the Ministry of Natural Resources administrative districts. This approach was taken to accommodate the multi-commodity nature of the industry, as well as to facilitate review of the material. This format also allows district updates of activity to be produced easily at a future date.

Metric units are used in the geological descriptions throughout the report, and in parts of the plant and operations descriptions. Since plant equipment is normally sized in Imperial units, these measurements have not been converted to metric units for ease of presentation.

Contents

Part 1
Central Ontario

Lindsay and Minden Districts

INTRODUCTION

For the purpose of this study, the limestone quarries occurring in Lindsay and Minden Districts will be discussed together.

Lindsay District is situated in the Central Region of southern Ontario bounded by Lake Ontario on the south, Maple District on the west, Minden and Bancroft Districts on the north and Tweed and Napanee Districts on the east.

Minden District is situated in the Algonquin Region of southern Ontario and adjoins Lindsay District to the south. It is bounded on the west by the Huronia District, Bracebridge and Algonquin Districts on the north and by Bancroft District on the east.

The combined Lindsay and Minden Districts include all or portions of Victoria, Peterborough, Haliburton and Northumberland Counties, and the Regional Municipality of Durham. A total of 45 quarry properties have been documented in the combined districts including 22 in Minden and 23 in Lindsay (Appendix IV, Volume I). Eleven sites were examined in detail during the study and include:

L–1	*St. Marys Cement Company – Bowmanville Quarry and Plant (active)*
L–2	*Miller Paving Limited – Dalrymple Quarry (active)*
L–3	*Gormley Aggregates Limited – Carden Quarry (active)*
L–4	*Cedarhurst Crushing & Quarries Ltd. – Coboconk East Quarry (active)*
L–5	*Britnell Quarry (abandoned)*
L–6	*Nelson Windover – Nichols (Flynns Turn) Quarry (intermittent)*
L–7	*Ormell Sand and Gravel Limited – Harvey Quarry (active)*
L–8	*Nelson Windover – Home (Buckhorn) Quarry (intermittent)*
L–9	*Eldred W. Payne – Warsaw Quarry (intermittent)*
L–10	*Harnden and King Construction (Ontario) Limited – Havelock Quarry (intermittent)*
L–11	*Bolenders Limited – Eagle Lake Marble Quarry (active)*

REGIONAL GEOLOGY

The northeastern part of Minden District is underlain by Precambrian rocks of Grenville age, predominantly clastic metasediments, metavolcanics and associated calcitic and dolomitic marbles. A single active quarry, the Eagle Lake Marble Quarry (L–11) exposes Grenville marbles.

Lindsay District and the adjacent southern Minden District extend southwards from the Kawartha Lakes area to Lake Ontario. Between Whitby and Cobourg the study area encompasses parts of Victoria, Peterborough, and Northumberland Counties, and Durham Region (Figure L–0–1). The main geomorphic features in the districts are the Oak Ridges Moraine, the Peterborough Drumlin Field, which together occupy much of the area. Other features are the Kawartha Lakes in the north, Rice Lake in the east, and the Lake Ontario shoreline to the south.

Most of the area is underlain by rocks of Paleozoic age, with some Precambrian rocks present in the north. The Paleozoic–Precambrian contact approximately follows the northern boundary of the Lindsay District with some inliers of Precambrian and outliers of Paleozoic rocks occurring on either side of this contact. The contact is usually delineated by a northward facing limestone scarp on or near the southern shores of the Kawartha Lakes.

The Paleozoic rocks occurring in the Lindsay District range in age from Middle to Upper Ordovician and include (in ascending order): Shadow Lake, Gull River, Bobcaygeon, Verulam, and Lindsay Formations (see Figure L–0–2).

The Shadow Lake Formation usually consists of a basal conglomerate overlain by arkosic sandstones and shales. It varies in thickness from zero, where it is absent over Precambrian topographic highs, up to 10 m thick where it infills lows in the Precambrian surface. There are only small scattered exposures of the Shadow Lake Formation in the Lindsay and Minden Districts, and there are no quarries which expose this formation.

Overlying the Shadow Lake Formation is the Gull River Formation, which outcrops in southern Minden and northern Lindsay Districts as a narrow band along the southern shores of the Kawartha Lakes, and forms the main rock unit in the Paleozoic outliers. There are numerous quarries utilizing the Gull River in these districts, including several small building stone operations.

The Gull River Formation is subdivided in two members, based on the definition of Williams (in prep.) and the exposure in the Marmora Pit (TW–1), which is in the adjacent Tweed District to the east. This differs from the three–fold subdivision proposed by Liberty (1969), which was used for the quarry descriptions in the Huronia District to the west. The Gull River Formation (as used in this report) varies in thickness from 10 to 30 m with the lower member varying the most.

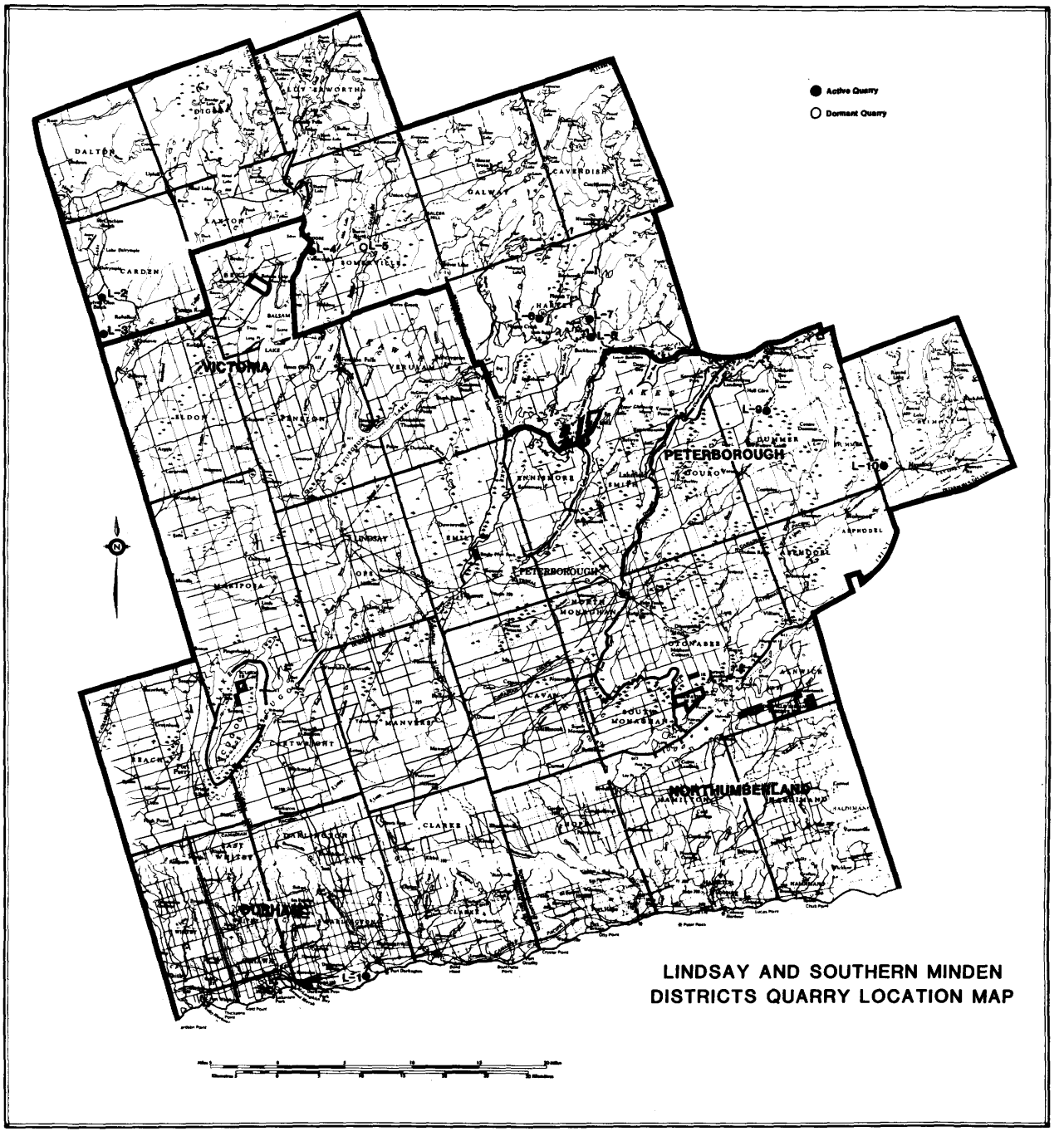


Figure L-0-1. LINDSAY AND SOUTHERN MINDEN DISTRICTS QUARRY LOCATION MAP.

The lower member of the Gull River Formation is best exposed by the 7.3 m section in the old Britnell Quarry (L-5), northeast of Balsam Lake. The lower 2.8 m in this quarry consist of red, fine-crystalline dolostone and limestone which has been called the "Red Pamelia" by the building stone trade. The upper 4.5 m in the quarry are a grey, microcrystalline to fine-crystalline limestone.

The thin, upper member is poorly exposed because of the easily eroded nature of its thin-bedded, shaly

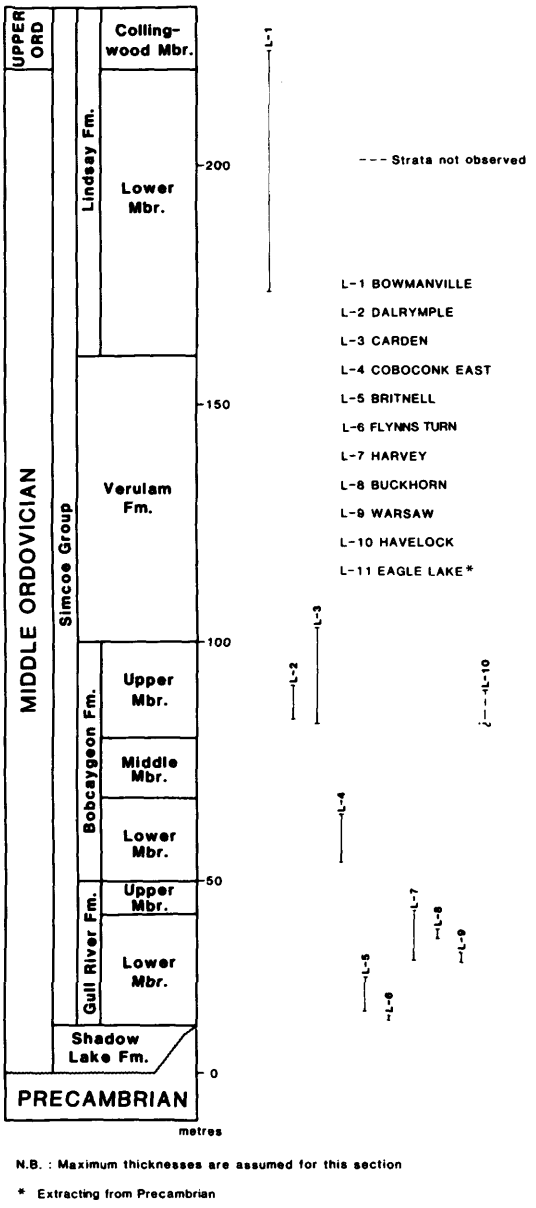


Figure L-0-2. STRATIGRAPHIC COLUMN SHOWING PRINCIPAL QUARRIES OF LINDSAY AND MINDEN DISTRICTS.

limestone. No quarries in these districts expose the upper member.

The Bobcaygeon Formation is subdivided into three members, based on their shale content (Williams, in prep.). The lower and upper members generally have minor amounts of interbedded shale whereas the middle member has more significant amounts. The limestones of the lower member consist of thick to massive beds of microcrystalline limestone and medium to thick beds of medium- to coarse-grained calcarenites. The limestones of the middle and upper members are thin- to medium-bedded, fine- to medium-crystalline limestone and medium-grained calcarenitic limestone. The formation may be up to 50 m thick in the Lindsay District.

The lower member of the Bobcaygeon Formation is exposed in the Coboconk East (L-4) Quarry. Unpublished drillhole logs from near the Coboconk East Quarry (L-4) (D.A. Williams, personal communication, 1986) indicate that thin-bedded shaly limestone, interbedded dolostones and limestones, and shales and conglomerates (the upper and lower members, Gull River Formation, and Shadow Lake Formation, respectively, in descending order) underlie the thick- bedded limestone exposed in the quarry.

The middle member is not exposed in any quarries in Lindsay District or the southern part of Minden District.

In the Carden Quarry (L-3), 16.8 m of the upper member are exposed and overlain by 3.2 m of the Verulam Formation. The medium-grey, thin-to medium-bedded, fine- to medium-crystalline limestones to coarse-grained calcarenites contain abundant bryozoans and some brachiopods and rugose corals. Shale partings are generally thin throughout the member except for increasingly thicker shale partings below the Verulam Formation contact. The upper member is also well exposed in a 6.7 m section in the Dalrymple Quarry (L-2).

The contact between the Bobcaygeon and (overlying) Verulam Formations can be seen in the Carden Quarry (L-3) where 3.2 m of the Verulam Formation cap the quarry.

The Verulam Formation consists of thin-bedded, interbedded limestone, shaly limestone, and shale. The limestones vary from evenly textured, fine-crystalline to medium- to coarse-crystalline bioclastic beds. Parts of the formation weather to a distinctive blue-grey, although it usually weathers medium to light grey. The formation is up to 60 m thick in the Lindsay District.

Although the Verulam Formation underlies much of the Lindsay District, exposures of this formation are not abundant. The Carden Quarry (L-3) is the only operating quarry in which the rock is seen. Several abandoned quarries in the district expose the Verulam Formation, including the Lakehurst, Peterborough North and Lakefield Quarries (*see* Appendix IV, Volume I).

Overlying the Verulam Formation is the Lindsay Formation which underlies the southern portion of Lindsay District. The Lindsay Formation is subdivided into two members (Russell and Telford, 1983) in which the nodular limestone of the lower member, as used in this report, corresponds to the Lindsay Formation as defined by Liberty (1969). The black shales of the upper, Collingwood Member had been assigned to the lower member of the Whitby Formation by Liberty (1969). Recent subsurface studies of this part of the section

(Johnson et al., 1983) suggest that the black shales of the Collingwood Member can be incorporated into the Lindsay Formation as the upper member because of the highly calcareous nature of the shales and the apparently conformable contact between the two units (Russell and Telford, 1983).

The lower member of the Lindsay Formation has a total thickness of approximately 60 m. It consists mainly of grey to brown, fine–crystalline, medium–to thick–bedded, nodular limestone. The upper member of the Lindsay Formation is the Collingwood Member which underlies only the very southern portion and is the youngest unit in the Lindsay District. It is a calcareous, petroliferous black shale with a rich invertebrate fossil fauna, characterized by abundant trilobites which are concentrated into thin bioclastic beds. The contact between the lower and Collingwood members of the Lindsay Formation also marks the contact between the Middle and Upper Ordovician in Central Ontario.

The Bowmanville Quarry (L–1) is the only active quarry in Ontario which exposes the contact between the Middle Ordovician lower member and the Upper Ordovician Collingwood Member of the Lindsay Formation. In this very large quarry, the 4.3 m of black shale of the Collingwood Member overlie 42.7 m of nodular limestones of the lower member, Lindsay Formation.

LIMESTONE INDUSTRIES

The limestone industries of the Lindsay and Minden Districts include production of cement, aggregate, building stone and marble chips.

Stone production in 1986 for the area amounted to approximately 2,450,000 tonnes. Nearly half of the stone was produced in the County of Victoria. The majority was produced by Gormley Aggregates Limited –Carden Quarry (L–3) and was used in the construction industry as road and concrete aggregate.

The Regional Municipality of Durham accounted for much of the remaining production. All of the stone was produced by St. Marys Cement Company from their Bowmanville Quarry and was consumed internally in the production of approximately 456,000 tonnes of cement (Ontario Mineral Score, 1987).

Stone production in 1986 for the County of Peterborough amounted to about 95,000 tonnes. The majority of the stone was produced by Ormell Sand and Gravel Limited – Harvey Quarry (L–7) and Harnden and King Construction (Ontario) Limited – Havelock Quarry (L–10) and was consumed in the construction industry as road and concrete aggregate. Building stone accounted for about 650 tonnes.

Stone production in the County of Haliburton in 1986 was approximately 7,000 tonnes, the majority being produced by Bolenders Limited – Eagle Lake Marble Quarry (L–11). The marble is used for landscaping stone, poultry grit, stucco and sand traps for golf courses.

L–1 ST. MARYS CEMENT COMPANY – BOWMANVILLE QUARRY AND PLANT

LOCATION AND OWNERSHIP

St. Marys Cement Company operates a quarry and a two–kiln wet process cement plant south of Highway 401 at Bowmanville, approximately 68 km east of Toronto (Figure L–1–1).

The operations are located in Lots 12–17, Broken Front Concession, Town of Newcastle (Darlington Township), Regional Municipality of Durham.

The quarry licence covers an area of 252.38 ha. The cement plant began production in November, 1968, with a single kiln and was expanded in 1974 with the addition of a second kiln. Current annual cement capacity is 650,000 tonnes. At the time of printing the company had announced a further expansion of the plant.

GEOLOGY

The quarry exposes 50.3 m of the Middle to Upper Ordovician Lindsay Formation (Figure L–1–2), the uppermost lift of 4.3 m consisting of the Collingwood Member. This is the only operating quarry in southern Ontario where the Collingwood Member is exposed.

The lower three lifts expose 46.0 m of the lower member which, in this quarry, consists of interbedded bioclastic calcarenites, microcrystalline limestones and grey–green calcareous mudstones. The mudstones and calcarenites occur mostly in the lower portion of the quarry. The upper part of this member is primarily a microcrystalline limestone.

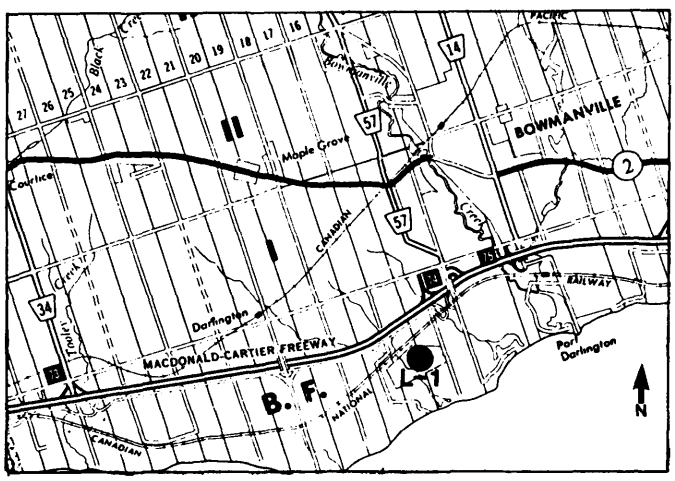


Figure L–1–1. LOCATION MAP FOR BOWMANVILLE QUARRY.

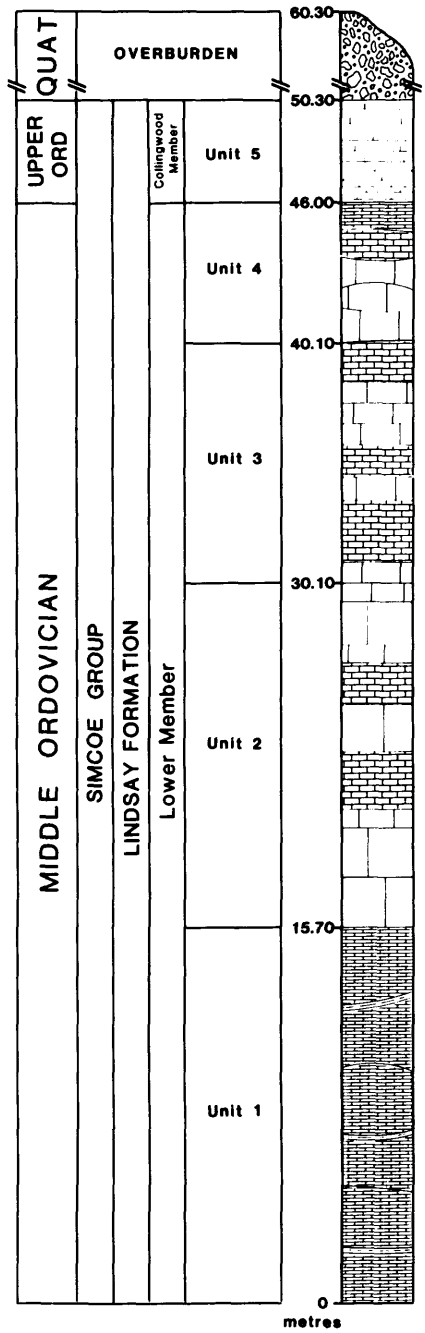


Figure L-1-2. STRATIGRAPHIC COLUMN FOR BOWMANVILLE QUARRY.

The overlying Upper Ordovician Collingwood Member consists of a calcareous, petroliferous, black shale. The shales are profusely fossiliferous and the quarry is well known for its excellent trilobite fossils. Vertical joints are well developed in the upper lift of the quarry. The glacial overburden around the quarry varies from 7 to 11 m thick.

Geological Section

Thickness

UNIT 5 Lindsay Formation, Collingwood Member *4.3m*

Calcareous shale: black, weathers light grey; very fissile and platy when weathered, thick bedded, blocky appearance on fresh surfaces; some coarser grained laminae with fossil debris; strong petroliferous odor; prominent jointing (near vertical) occurring approximately every metre; rare iron staining; very fossiliferous, with trilobites most abundant; lower contact of unit sharp and irregular at top of third lift.

UNIT 4 Lindsay Formation, lower member *5.9m*

Limestone: medium to dark brown, weathers light grey; microcrystalline to very fine crystalline; medium to thick (20-60 cm) bedded, becomes thinner at top of unit, sharp, very irregular, undulatory contacts; very nodular appearance due to rubbly weathering; upper half of unit contains seven prominent shale beds (2 to 10 cm thick); rare, thin, coarser grained beds, usually with fossil debris; fossiliferous including trilobites and brachiopods, rare rugose corals; lower contact of unit sharp.

UNIT 3 Lindsay Formation, lower member *10.0m*

Limestone: dark grey, weathers light grey; microcrystalline, with irregular patches of coarse-grained calcarenites; medium to thick bedded (10 to 70 cm), sharp, slightly irregular contacts with some minor shale partings; nodular texture throughout unit, commonly associated with patches of calcite crystals; shale beds are more abundant upwards and two very prominent shale beds occur at the top of unit; very fossiliferous with abundant trilobites and brachiopods; lower contact of unit gradational, at top of 2nd lift.

UNIT 2 Lindsay Formation, lower member *14.4m*

Limestone: medium to dark brown, weathers mottled light grey and green, and grey-brown; microcrystalline limestone and coarse-grained calcarenites; medium to thick bedded (10-100 cm), sharp, slightly irregular contacts, rarely welded contacts; most beds in unit weather into nodules; fossiliferous with abundant brachiopods, trilobites, and rugose corals on bedding planes of the microcrystalline limestones, and abundant fossil fragments in calcarenites; lower contact sharp, at top of 1st (lowest) lift.

UNIT 1 Lindsay Formation, lower member *15.7m*

Interbedded limestone and mudstones:

calcareous mudstones - grey, weathers green-grey; thin bedded (3-6 cm), contacts are irregular and undulatory; nodular appearance due to draping of mudstones over coarser calcarenite beds; fossils present on bedding planes;

bioclastic limestones - medium to dark brown, weathers grey-brown; coarse to very coarse crystalline; thin bedded (3-6 cm), in beds that pinch and swell, sharp irregular contacts; very fossiliferous (brachiopods and trilobites, some crinoidal debris);

microcrystalline limestones - dark grey, weathers light grey; thin bedded (about 5 cm); barren of fossils;

in upper part of unit, mudstones decrease in abundance and the unit becomes mainly interbedded calcarenites and microcrystalline limestones; calcite mineralization present along vertical fractures.

Total thickness *50.3m*

In 1979 an exploration diamond drill program was carried out within the licence area and St. Marys Cement

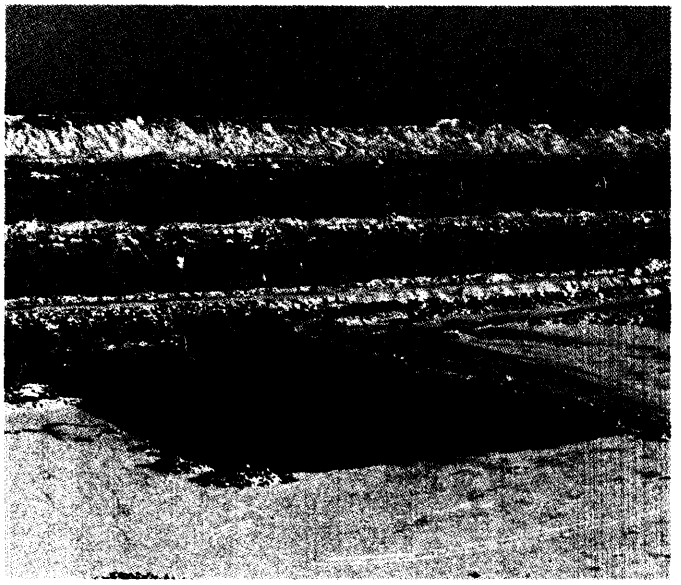


Photo L-1-1. VIEW OF THE QUARRY SHOWING THE THREE BENCHES; BOWMANVILLE QUARRY.

reports that the chemical analyses of drill core, from hole 79-1 (Table L-1-1), are representative of the chemical composition of the underlying stratigraphy.

QUARRY OPERATION

The quarry operates on three 16.7 m benches. The quarry provides a natural cement stone through blending of the high, medium and low carbonate rock representative of the various benches. Drilling is by a 12.7 cm hydraulic rotary drill on a 4.3 m x 4.9 m pattern using a slurry plus AN/FO at a rate of 0.15 kg/t. Two 10 yd. 992 CAT loaders are used to load five 45-ton rear-dump Euclid trucks which deliver the stone to the primary crusher. The stone is separated by carbonate content at the blasting site.

Table L-1-1. TYPICAL CHEMICAL ANALYSES (%) OF DRILL CORE FROM HOLE 79-1.

	10-55 ft.	55-110 ft.	110-165 ft.	165-220 ft.	220-305 ft.
Loss	36.65	34.99	34.99	35.68	34.47
SiO_2	11.82	13.82	13.82	11.50	14.18
Al_2O_3	3.37	3.34	3.77	3.22	4.18
Fe_2O_3	1.0	1.12	1.36	1.44	1.49
CaO	43.36	43.23	41.54	43.69	41.59
MgO	1.82	1.96	2.13	1.68	1.64
SO_3	.31	.34	.64	1.19	.88
Na_2O	.16	.16	.18	.12	.12
K_2O	.83	.89	.97	.83	1.07
P_2O_5	.065	.037	.045	.052	.050
TiO_2	.18	.17	.18	.15	.17
Cl	.032	.079	.095	.090	.067
F	.021	.019	.026	.019	.021
C_3S	62.6	46.9	36.8	66.8	31.3
C_3A	7.1	7.0	7.7	6.1	8.6
C_4AF	3.3	3.4	4.1	4.4	4.5

PROCESSING

Primary crushing is achieved by a 54 in. Traylor gyratory crusher having a capacity of 900 tons per hour. The crushed material is separated by carbonate designation and transferred via a feeder/conveyor system to a rock storage area.

Material reclaimed from the rock storage area is processed through a closed circuit secondary 450 KW Pennsylvania 3-hammer crusher which reduces the material to -3/4 in. size at a rate of 500 tons per hour. The screening and conveying systems allow the rock to be separated by calcium carbonate content, and stored in feed silos adjacent to the raw mill operation. Special high carbonate rock from Coboconk, Ontario is used as a calcareous component for the manufacture of low alkali cements.

Blending of the stone and raw grinding takes place in an F.L. Smidth 12 ft. x 34 ft. ball mill. The raw grind slurry is pumped to one of three storage tanks. The two original tanks built in 1967 are 25 ft. high x 80 ft. diameter and hold approximately 735,000 gallons.

The plant has two identical F.L. Smidth kilns, one built in 1964 and the other in 1973. Each kiln is 485 ft. long and 15 3/4 ft. in diameter at the feed end and 14 ft. diameter at the discharge end. Both kilns are coal fired and each has a capacity of 1,000 tons per day. Coal is dried and powderized in an F.L. Smidth ball mill.

Clinker cooling is by a Folax grate cooling system for kiln #1 and a planetary cooling system for kiln #2.

Cooled clinker is transported by belt conveyor to either a 45,500 tonne storage silo or to four 1,400 tonne feed storage silos. It is drawn from these locations by conveyor and fed to either of two identical F.L. Smidth ball mills with the addition of 5% gypsum. The 2,750 hp. mills are of the 2 chamber type and have overall dimensions of 12 ft. x 34 ft. O-SEPA air classifiers are used in closed circuit with the finish mills, which have a combined capacity of 2,270 tonnes per day. Finished cement is transferred to the storage silo by pneumatic fluxo pumps.

The 11 main and 2 interstice cement storage silos have a total storage capacity of 70,000 tons. Shipping is primarily by bulk truck, with rail loading also available.

Dust control is effected by 31 bag type dust collectors installed throughout the plant. Electrostatic precipitators supplied by Joy Manufacturing are fitted to the kilns to clean exit gases. Bag-type dust collectors are fitted to the two finish mills to clean exhaust gases.

Photo L-1-2. ST. MARYS CEMENT, BOWMANVILLE PLANT *(Courtesy St. Marys Cement Co.)*.

The cement plant is controlled by a Bailey Meter Abacus digital system installed in 1973. This system is interfaced with a Bailey Meter 750 Data Logger analog system installed in 1968.

The company has a wharf facility to receive coal, gypsum and slag, and to ship clinker. Slag is dried and crushed for aggregate use in a ready-mix plant located adjacent to the cement plant.

PRODUCTS

Normal Portland
High Early Strength Portland
Sulfate Resisting Portland
Moderate Portland
Low Heat of Hydration Portland
Masonry Cement

REFERENCES

Hewitt and Vos, 1972, p.42-43
Winder et al., 1975, p. 138
Kobluk and Brookfield, 1982, p.29-30
Russell and Telford, 1983
ARIP 94, 1984, pp.13, 21

MAPS

None

L-2 MILLER PAVING LIMITED — DALRYMPLE QUARRY

LOCATION AND OWNERSHIP

The Dalrymple Quarry is located 3 km south of Dalrymple, in Lots 8-12, Concessions 2 and 3, Carden Township, Victoria County (Figure L-2-1). The quarry licence covers an area of 332.1 ha and production of crusher run and clear stone was started in 1986 by the present operator, Miller Paving Limited. The annual capacity of the quarry has not yet been established but is estimated to be in a range of 100,000 to 250,000 tonnes. Testing of the quarry stone is presently underway to determine the potential for the production of high grade asphalt and concrete stone products. The major market for the quarry products is in eastern Toronto, with all shipping by truck (contracted).

GEOLOGY

The 6.7 m deep quarry exposes limestones of the upper member, Bobcaygeon Formation. The beds of fine- to medium-crystalline limestones thin from 40-50 cm thick in the lower unit to 5-15 cm thick in the upper unit. Glacial overburden around the quarry is less than 1 m thick.

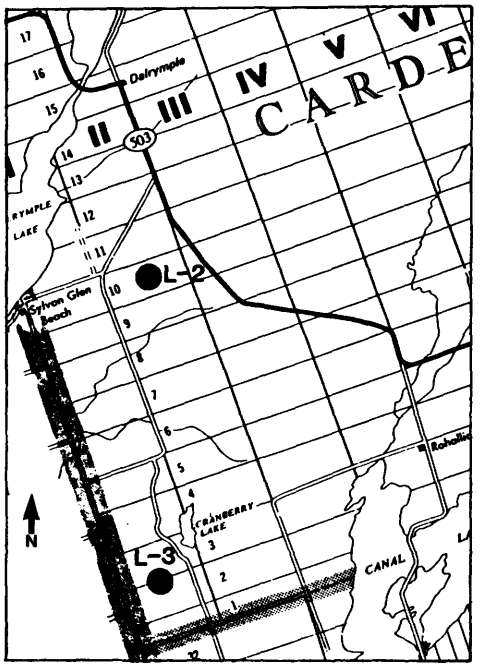


Figure L-2-1. LOCATION MAP FOR DALRYMPLE QUARRY.

Geological Section

		Thickness
UNIT 2	*Bobcaygeon Formation, upper member*	*5.5m*

Limestone: light to medium grey, weathers light grey; fine crystalline, with rare beds of coarse-grained calcarenites; thin to medium bedded (5–15 cm), sharp, irregular contacts which cause beds to pinch and swell, with shale partings up to 2 cm thick; upper 50 cm of unit lighter grey, coarse-grained calcarenite; small patches of calcite crystals rare; very fossiliferous, and abundant burrows, especially on bedding planes; lower contact of unit sharp at base of lowest shale parting.

UNIT 1	*Bobcaygeon Formation, upper member*	*1.2m*

Limestone: mottled medium grey-brown and medium brown, weathers same; very fine and medium crystalline; thick bedded (40–50 cm), sharp and planar contacts with no shale partings; uppermost bed a 5 cm thick, very coarse-crystalline, bioclastic limestone with a very irregular basal contact; abundant calcite crystals, commonly as recrystallized brachiopod shells; fossiliferous with rare brachiopods and gastropods, abundant fossil fragments, and abundant burrows.

Total thickness	*6.7m*

QUARRY OPERATION

The quarry is opened on a single lift of 6.7 m and drilled on a 2.7 m x 2.7 m pattern with 7.6 cm diameter blast holes. Shot rock is loaded and hauled by a Fiat–Allis FR35 (6 1/2 yd.) loader to a portable crushing and screening plant (in–pit). Primary crushing is by a 36 in. x 54 in. impact crusher. The crushed stone feeds a scalping screen followed by a Pioneer 5 ft. x 16 ft. double–deck screen, producing clear and crusher run stone. Oversize from the Pioneer screen is sent for secondary crushing by a Nordberg 4 1/2 ft. cone crusher, producing HL8 and screenings.

PRODUCTS

Crusher Run
Clear Stone
HL8
Screenings

REFERENCES

ARIP 48, 1981, p. 19

MAPS

None

L-3 GORMLEY AGGREGATES LIMITED — CARDEN QUARRY

LOCATION AND OWNERSHIP

The Carden Quarry is located 11 km south of Dalrymple in Lots 1 to 4, Concession 1, Carden Township, Victoria County (Figure L–3–1). The quarry has been active since February of 1977, opened and operated by the present owner, Gormley Aggregates Ltd. The Carden

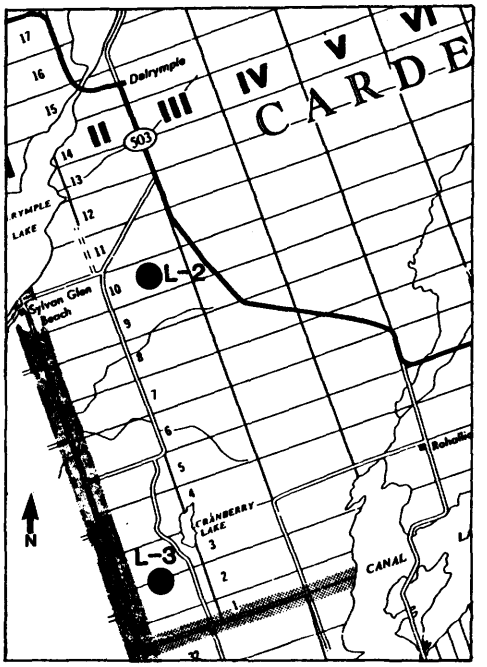


Figure L-3-1. LOCATION MAP FOR CARDEN QUARRY.

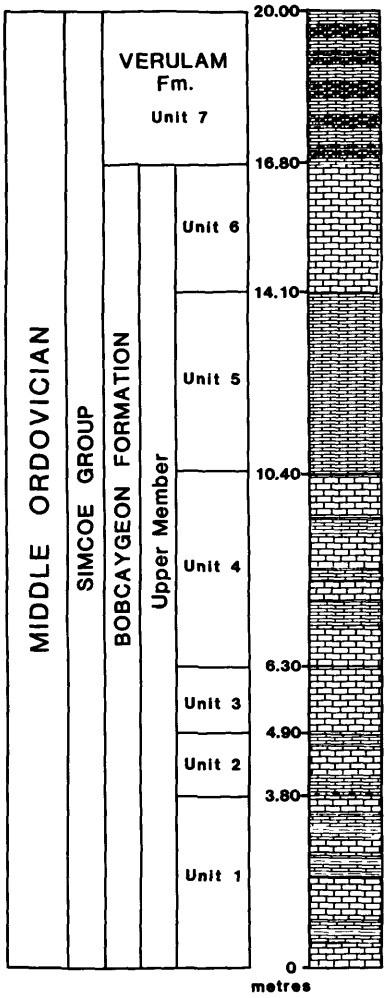


Figure L-3-2. STRATIGRAPHIC COLUMN FOR CARDEN QUARRY.

Quarry operates year round and has a licensed area of 218.4 ha. Stone produced at the quarry is primarily used to supply markets in the eastern region of Toronto. All shipping is by truck (contracted) within an average delivery distance of 100 km.

GEOLOGY

The two lifts in the quarry expose 20.0 m of section, with 16.8 m of limestones of the Bobcaygeon Formation (upper member) underlying 3.2 m of limestone and shale of the Verulam Formation (Figure L-3-2). The medium-bedded, relatively shale-free, fine- to medium-crystalline limestones and interbedded coarse-grained calcarenites, typical of the upper member of the Bobcaygeon Formation, gradually become thinner bedded with shale interbeds increasing in thickness and frequency to the top of the quarry. The overlying 3.2 m of the Verulam Formation consist of thin-bedded limestones that are interbedded with 2–5 cm thick intervals of shale. Glacial overburden around the quarry is generally less than 0.5 m thick.

Geological Section

Thickness

UNIT 7 Verulam Formation *3.2m*

Interbedded limestone and shale: medium grey, weathers light grey to light brown in upper 0.5 m; alternating fine and coarse crystalline; thin bedded (2-10 cm) limestone, shale beds thinner (2-5 cm) than limestone beds, sharp, planar and slightly irregular contacts; fossiliferous with abundant brachiopods and fossil fragments; lower contact of unit sharp, at base of soft recessive shale bed.

UNIT 6 Bobcaygeon Formation, upper member *2.7m*

Limestone: light grey-brown, weathers same; medium to coarse crystalline; medium bedded (10–15 cm), sharp, slightly irregular contacts; sparsely fossiliferous, some burrows; lower contact of unit sharp and planar.

UNIT 5 Bobcaygeon Formation, upper member *3.7m*

Limestone: light grey-brown to medium grey, weathers same; alternating fine and coarse crystalline; thin bedded (5 cm), sharp contacts, with shale partings up to 1 cm thick; 70 cm above base of unit 10 cm thick bed of very coarse-grained calcarenite with dark grey and black patches, possibly of bitumen; calcite crystals occur in small patches; fossiliferous with abundant brachiopods, some bryozoans, and some burrows; lower contact of unit sharp at base of 8 cm thick, recessive shale bed.

UNIT 4 Bobcaygeon Formation, upper member *4.1m*

Limestone: medium grey-brown, weathers light grey-brown; alternating fine and coarse crystalline; thin bedded (5–10 cm), sharp, irregular contacts, with minor shaly partings; 1 m above base of unit in coarse-grained calcarenite is a 6 cm thick interval with black chert nodules; 1.3 m above base of unit is a light grey-green, soft, recessive shale; calcite-filled vugs in some coarser crystalline beds; intraclasts of fine-crystalline limestone in coarser crystalline beds; fossiliferous with some brachiopods, rare bryozoans and abundant burrows, especially on bedding planes; lower contact of unit sharp at top of lower lift.

UNIT 3 Bobcaygeon Formation, upper member *1.4m*

Limestone: light grey, weathers lighter grey; fine to medium crystalline; medium bedded (15 cm), sharp, irregular contacts; several beds of coarse-grained calcarenites scattered throughout unit (2 cm thick bed 5 cm above base, 10 cm thick bed 1.0 m above base, 10 cm thick bed 1.3 m above base); the bed at top of unit very coarse-grained calcarenite, with abundant fossil fragments, and large, black chert nodules; small calcite crystals throughout unit; sparsely fossiliferous with rare brachiopods; lower contact of unit sharp, at a thin shaly limestone parting.

UNIT 2 Bobcaygeon Formation, upper member *1.1m*

Limestone: light grey, weathers same; fine crystalline; thin bedded (5–10 cm), sharp, very irregular contacts; 20 cm above base of unit is a soft, recessive shale, 5 cm thick; small vugs present, some filled with calcite crystals; fossiliferous with abundant brachiopods and bryozoans, burrows rare; lower contact sharp at base of thin, shaly limestone parting.

UNIT 1 Bobcaygeon Formation, upper member *3.8m*

Limestone: light grey-brown, weathers grey-brown to light brown; medium crystalline; thin to medium bedded (5-25 cm), sharp, irregular contacts with very thin, dark grey shaly limestone partings; near top of unit is a 5 cm thick coarse-grained calcarenite with a sharp erosional base; small vugs filled with calcite crystals present in some beds; fossiliferous with abundant bryozoans (*Prasopora*), brachiopods, rugose corals, and some burrows.

Total thickness *20.0m*

QUARRY OPERATION

The quarry is presently worked on a single lift of 9.45 m to 14.6 m using a 3.7 m x 3.7 m drill pattern with 10.2 cm diameter blast holes. Drilling is done by an ROC812HCS Atlas Copco. Normal quarry conditions are dry; a 6 in., 30 hp. Flygt submersible pump handles all quarry dewatering (run-off). AN/FO is used as much as possible for blasting, initiated with electric caps. Shot rock is loaded by two 8 yd. Michigan L320 loaders.

PROCESSING

The broken rock is dumped into a primary 53 in. x 48 in. Cedarapids single impeller crusher, which reduces the rock to -8 in. This product is carried by 36 in. conveyor and a stacker to a surge bin that feeds a 5 ft. x 12 ft. double-deck screen. Plus 5 in. oversize from this screen is routed to either a gabion stone stockpile or a 36 in. x 45 in. Cedarapids twin impeller secondary crusher (Figure L-3-3).

Plus 7/8 in. stone from the screen is fed to a second double-deck screen, which routes the +2 1/2 in. oversize to a Spokane vertical impact crusher. The product of the Spokane crusher joins that of the secondary Cedarapids crusher. Minus 2 1/2 in. intermediate stone is either stockpiled as 2 in. clear or added to the crusher run blending belt. The fines from this second screen are added to the fines from the first screen, blended and stockpiled as 3/4 in. or 2 in. crusher run.

The products of the two secondary crushers are fed to twin 6 ft. x 16 ft. Dillon screens, from which a +1 1/8 in. oversize is returned to the Spokane crusher. From the first deck, a 3/4 in. clear stone is produced, second deck produces HL8, or the product is rescreened on a 4 ft. x 8 ft. double-deck Dillon screen to produce 3/8 in. clear and HL8. The fines from the two Dillon screens are added to the blending belt conveyor and sent to the

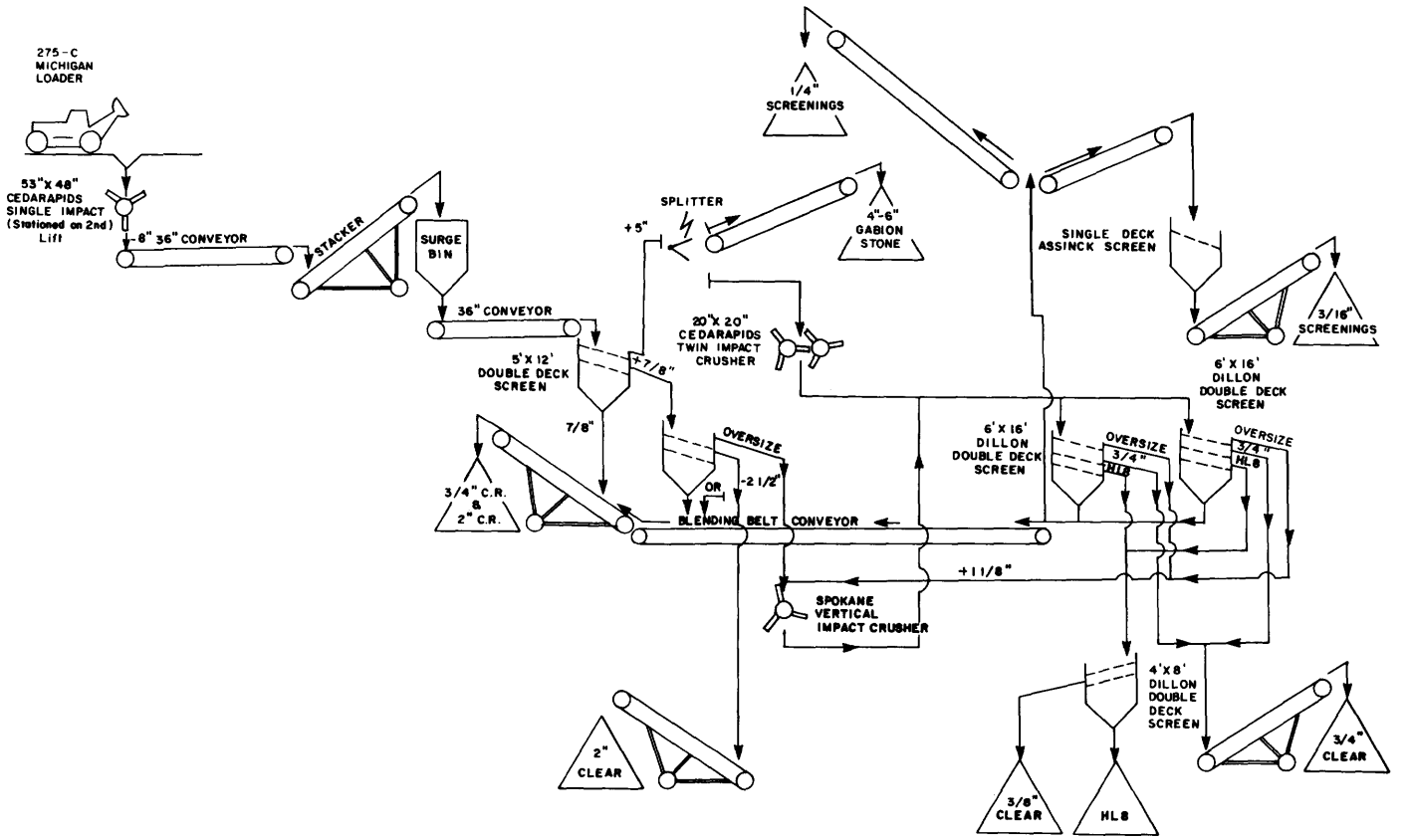


Figure L-3-3. PROCESS FLOW SHEET FOR CARDEN QUARRY.

crusher run stockpiles or stockpiled as 1/4 in. screenings or rescreened by a 4 ft. x 12 ft. Assinck screen to produce −3/16 screenings.

PRODUCTS

Gabion Stone
Shot Stone
2 in. Crusher Run
3/4 in. Crusher Run
HL3, HL8
Riprap
2 in. Clear
3/4 in. Clear
3/8 in. Clear
1/4 in. Screenings
3/16 in. Screenings

REFERENCES

ARIP 48, 1981, p. 19

MAPS

None

L-4 CEDARHURST CRUSHING & QUARRIES LTD. — COBOCONK EAST QUARRY

LOCATION AND OWNERSHIP

The Coboconk East Quarry is located within the village of Coboconk on Highway 35, in Lots 37 and 38, Front Range Concession, Somerville Township, Victoria County (Figure L-4-1). The property has intermittently produced lime since the turn of the century, and was purchased in 1972 from Indusmin Ltd. by the present owner and operator, Cedarhurst Crushing & Quarries Ltd., a subsidiary of K. J. Beamish Construction Co. Ltd. of Thornhill, Ontario.

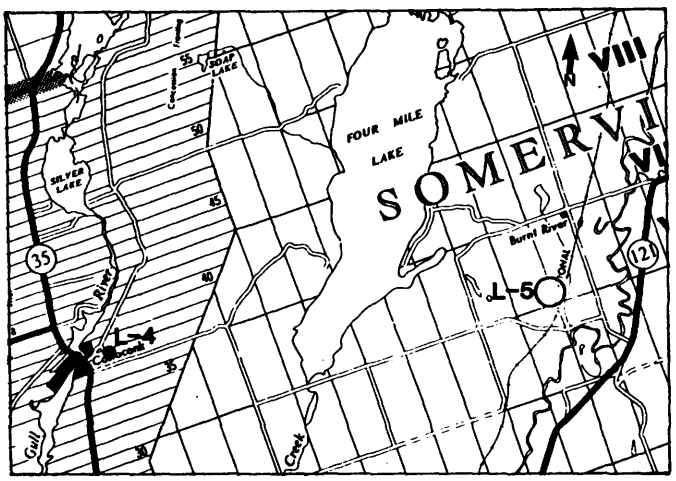


Figure L-4-1. LOCATION MAP FOR COBOCONK EAST QUARRY.

No significant quantity of aggregate stone was extracted from the Coboconk Quarry until 1986. The quarry is scheduled to steadily expand production levels.

On the western side of Highway 35, just south of Coboconk, is the abandoned Coboconk West Quarry (Goudge, 1938) which exposes a similar section to the East Quarry. The old lime kilns still stand near the western quarry.

GEOLOGY

The 9.5 m deep Coboconk East Quarry exposes thick-bedded limestones which are assigned to the lower member, Bobcaygeon Formation, as defined by Williams (in prep.). Liberty (1969, p. 156-157) had placed the lower part of the quarry section into the upper member of the Gull River Formation. The strata in the quarry consist of grey-brown, thick-bedded, microcrystalline (commonly with a lithographic texture) to medium-crystalline limestones, with intervals of medium-to coarse-grained calcarenites. Most beds are moderately fossiliferous. Glacial overburden on the crest of the hill where the quarry is located is generally less than 1.0 m thick.

Geological Section

Thickness

UNIT 4 Bobcaygeon Formation, lower member *2.7m*

Limestone: medium grey, weathers light grey to light brown at top; fine to medium crystalline; thin bedded (5-10 cm), upper beds thinner bedded, with sharp, very irregular contacts, some stylolitic; 80 cm thick interval, 1.3 m above base, with very thin beds of medium grey, very fine-crystalline limestone; uppermost 60 cm, medium- to coarse-grained calcarenite; small calcite-filled vugs present in some beds; very fossiliferous; lower contact of unit sharp and irregular.

UNIT 3 Bobcaygeon Formation, lower member *3.5m*

Limestone: dark grey and grey-brown, weathers same; fine to coarse crystalline, becoming coarser crystalline at top of unit; thin to medium bedded (5-15 cm), with sharp, irregular contacts, commonly coated with thin, black organic-rich layers; numerous small, calcite-filled vugs and patches in coarser crystalline horizons; rare, large calcite-filled vugs in uppermost 40 cm; fossiliferous, with abundant bryozoans, brachiopods and crinoidal debris; horizontal burrows common on bedding plane surfaces; lower contact of unit sharp and irregular.

UNIT 2 Bobcaygeon Formation, lower member *1.0m*

Limestone: medium grey-brown, weathers grey-brown; very coarse-grained calcarenite; medium bedded (10-20 cm) with sharp irregular contacts, commonly with thin, black organic-rich coatings; small calcite-filled vugs abundant; numerous indeterminant fossil fragments; lower contact of unit varies from sharp, slightly irregular to gradational over 5 cm.

UNIT 1 Bobcaygeon Formation, lower member *2.3m*

Limestone: dark grey-brown, weathers medium grey-brown; microcrystalline, with a lithographic texture; thick bedded (30–60 cm), sharp, stylolitic contacts, commonly coated with a thin, black organic-rich layer; 20 cm thick bed, 1.9 m above base of unit, of very coarse-grained calcarenite; small patches of calcite crystals ("birdseye" texture) common, especially in lower part of unit.

Total thickness *9.5m*

QUARRY OPERATION

The quarry is currently excavated on a single lift of 9.1 m, over an area of about 4 ha. Drilling and blasting is subcontracted. A drill pattern of 2.4 m x 2.4 m with 7.6 cm diameter blast holes is used.

Crushing equipment includes a 30 in. x 42 in. Pioneer jaw and LJ Standard and LJ Shorthead cone crushers (with screens).

PRODUCTS

Riprap
Granular "A"
1 1/4 in. Clear
1/2 in. Clear
3/4 in. Clear
Screenings
Shot Stone
HL 8
HL 3

REFERENCES

Goudge, 1938, p. 198–201
Okulitch, 1939
Caley and Liberty, 1952b, p. 7
Hewitt, 1960, p. 42–44
Hewitt, 1964a, p. 28
Mirynech and Liberty, 1964, p. 28–29
Schoft, 1966, p.27
Liberty, 1969b, p. 155–158
Sabina, 1970, p. 148
Winder and Sanford, 1972, p.55

MAPS

Caley and Liberty, 1952a, GSC Map 52-31A
Liberty, 1969a, GSC Map 1228A

L-5 BRITNELL QUARRY

LOCATION AND OWNERSHIP

This abandoned quarry is located in Lot 13, Concession 6, Somerville Township, Victoria County, 1 km south of the village of Burnt River (Figure L–5–1). It is a very old quarry dating back to the turn of the century when it was used for building and crushed stone (Parks, 1912).

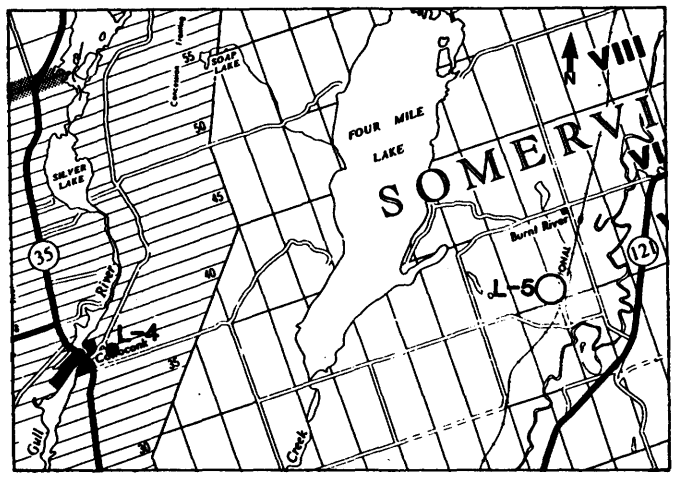


Figure L-5-1. LOCATION MAP FOR BRITNELL QUARRY.

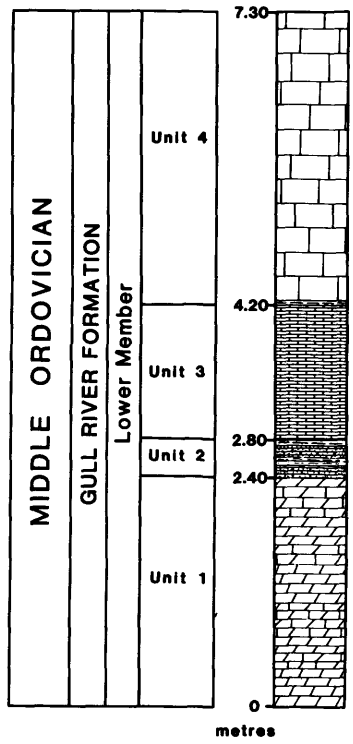


Figure L-5-2. STRATIGRAPHIC COLUMN FOR BRITNELL QUARRY.

GEOLOGY

The geological section consists of 7.3 m of dolostone and limestone of the lower member, Gull River Formation (Figure L–5–2). Due to their distinctive red colour, the rocks in the lower portion of this quarry have been re-

ferred to by the building stone trade as the "Red Pamelia" stone, and were primarily used for building stone. Glacial overburden around the quarry is generally less than 1 m thick.

Geological Section

		Thickness
UNIT 4	*Gull River Formation, lower member*	*3.1m*

Limestone: light to medium grey and light grey-brown, weathers light grey, upper 0.5 m weathers into rubble; microcrystalline with a lithographic texture; thick bedded (40–70 cm), sharp, planar to stylolitic contacts; 0.7 m thick bed, 1.8 m above base of unit, of medium grey, fine-crystalline limestone; small patches of calcite crystals; thin coatings of glauconite on bedding planes, stylolites and burrows; sparsely fossiliferous, with some burrows also; lower contact of unit sharp at 1 cm thick shaly limestone bed.

UNIT 3	*Gull River Formation, lower member*	*1.4m*

Limestone: light to medium grey, weathers cream to light grey; microcrystalline, with a lithographic texture, thin (3–10 cm) and very evenly bedded, sharp, stylolitic contacts or with very thin shale partings; lower contact of unit sharp at recessive, soft green shale bed.

UNIT 2	*Gull River Formation, lower member*	*0.4m*

Interbedded shale and sandy limestone: alternating red and green, weathers same; fine-crystalline limestone with very coarse-grained quartz sand; very thin bedded (1–3 cm) with sharp, planar contacts; lower contact of unit sharp and planar.

UNIT 1	*Gull River Formation, lower member*	*2.4m*

Interbedded dolostone and calcareous dolostone: red to reddish grey, weathers red to reddish brown: "Red Pamelia" stone; fine crystalline; medium bedded (10–30 cm), sharp, planar contacts with occasional very thin dolomitic shale partings; lower 0.5 m covered by talus.

Total thickness	*7.3m*

REFERENCES

Parks, 1912, p. 225–227
Goudge, 1938, p. 201
Caley and Liberty, 1952b, p. 7
Hewitt, 1964b, p. 25
Liberty, 1969b, p. 98

MAPS

Caley and Liberty, 1952a, GSC Map 52–31A
Liberty, 1969a, GSC Map 1228A

L-6 NELSON WINDOVER — NICHOLS (FLYNNS TURN) QUARRY

LOCATION AND OWNERSHIP

The Nichols Quarry is located along Highway 36, 6 km west of Flynns Turn in Pt. Lot 21, Concession 13, Harvey Township, Peterborough County (Figure L–6–1). The quarry was opened in 1975 by the present owner and operator Nelson Windover, and is licensed for an area of 13 ha. The quarry is presently producing small amounts of building stone and is opened over an area of less than 0.5 ha to a depth of 1.0 m.

GEOLOGY

The 1 m deep excavation exposes limestone and red and green sandy, dolomitic limestone from the lowermost Gull River Formation. Overburden is thin.

Geological Section

		Thickness
UNIT 1	*Gull River Formation, lower member*	*1.0m*

Limestone and sandy dolomitic limestone: red to reddish brown and green; fine to medium crystalline with coarse, well-rounded quartz grains; beds up to 30 cm thick, which may weather into 5 cm thick platy sheets in places.

Total thickness	*1.0m*

QUARRY OPERATION

Overburden is removed by a front end loader. Drilling and blasting is not performed at the quarry as all material is extracted by ripping, using a John Deere 690 backhoe (1 1/2 yd.). The stone ranges in colour from light grey to orange, pink and green and in thickness from 5 cm to 15 cm. The ripped stone is loaded by backhoe into a Volvo 1920 (4 1/2 yd.) front end loader. The stone is then dumped, hand sorted and loaded back into the Volvo bucket. The final building stone product is then transferred to tandem trucks for delivery.

REFERENCES

None

MAPS

Carson, 1980, OGS Map P.2337

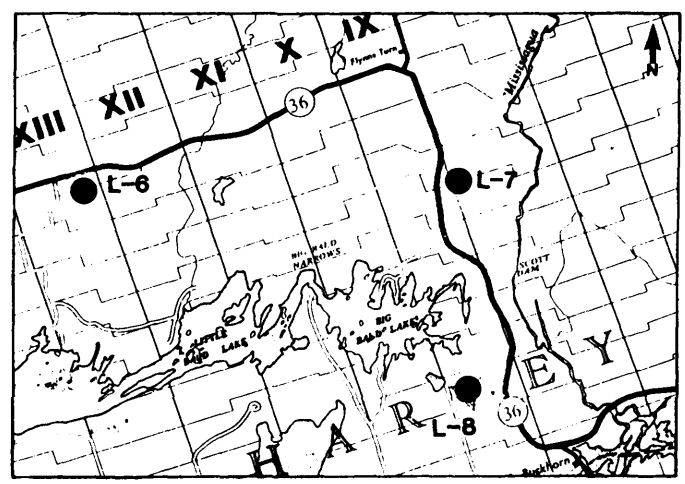


Figure L-6-1. LOCATION MAP FOR NICHOLS (FLYNNS TURN) QUARRY.

L-7 ORMELL SAND AND GRAVEL LIMITED — HARVEY QUARRY

LOCATION AND OWNERSHIP

The Harvey Quarry is located 1 km south of Flynns Turn in Lot 17, Concession 9, Harvey Township, Peterborough County (Figure L-7-1). The quarry was opened in 1985 by the present operator, Ormell Sand and Gravel Limited and is licenced over an area of 27 ha.

The quarry principally supplies aggregate within a radius of approximately 40 km (Peterborough area).

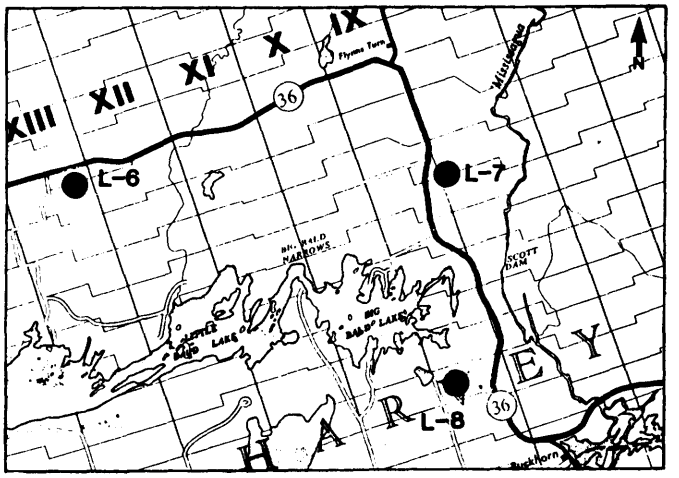


Figure L-7-1. LOCATION MAP FOR HARVEY QUARRY.

GEOLOGY

The quarry is located at the south end of a small Paleozoic outlier informally referred to as the Flynns Turn outlier. The 8.2 m face consists entirely of limestone of the lower member of the Gull River Formation. The medium to dark grey, microcrystalline limestone beds are separated by very thin, dark grey, soft, recessive shale partings. Bedding thickens from 30 to 60 cm at the base of the quarry to 80 cm at the top, though blasting in the quarry has commonly split these thicker beds into thinner (10 to 20 cm) horizons. The limestone contains numerous calcite patches typical of "birdseye" texture, and also small, shiny, black, organic-rich patches, associated with black coatings on the bedding planes. Glacial overburden around the quarry is less than 1.0 m thick.

Geological Section

		Thickness
UNIT 2	*Gull River Formation, lower member*	*5.1m*

Limestone: medium to dark grey, weathers grey to light brown; microcrystalline with a lithographic texture; medium to thick bedded (40-80 cm), some contacts stylolitic, others with very thin shale partings; abundant calcite-filled vugs and burrows; small, shiny, black patches throughout, probably bitumen; sparsely fossiliferous with rare corals; lower contact of unit sharp and planar.

Photo L-7-1.
PORTABLE PROCESSING PLANT; HARVEY QUARRY.

UNIT 1 Gull River Formation, lower member *3.2m*

Limestone: medium grey, weathers same; microcrystalline with a lithographic texture; thick bedded (30 to 60 cm), sharp contacts with thin, dark grey, soft and clay-like, shale intervals; rare patches of calcite crystals ("birdseye texture"); numerous small diffuse dark grey to black patches, probably bitumen.

Total thickness *8.3m*

QUARRY OPERATION

The quarry is opened on a single lift of 8.2 m, with a drill pattern of 2.1 m x 2.1 m and 63.5 mm diameter blast holes. Drilling and blasting is contracted, but crushing and screening is performed by Ormell Sand and Gravel Limited from April to November, using portable facilities at the quarry.

PRODUCTS

Gabion Stone
3/4 in. Clear
HL 8
HL 7
HL 4
HL 3

REFERENCES

None

MAPS

Carson, 1980, OGS Map P.2337

L-8 NELSON WINDOVER — HOME (BUCKHORN) QUARRY

LOCATION AND OWNERSHIP

The Home Quarry is located in Pt. Lot 12, Concession 9, Harvey Township, Peterborough County (Figure L-8-1), and was opened in 1962 by the present owner and operator, Nelson Windover. The Home Quarry is licensed for an area of 2 ha. The quarry is presently producing small amounts of building stone and has a disturbed area of 0.5 ha, to a depth of about 1.9 m.

The quarry is located just northwest of two old, abandoned building stone quarries (Winder, 1954b) that supplied stone for construction of the Trent Canal.

GEOLOGY

The 1.9 m face consists of limestone from the lower member of the Gull River Formation. Overburden averages about 0.7 m in thickness.

Geological Section

Thickness

UNIT 2 Gull River Formation, lower member *1.0m*

Limestone: light to medium grey, weathers same; microcrystalline, with a lithographic texture; single bed with numerous stylolites; abundant burrows, filled with a greenish brown, fine-crystalline dolomitic limestone; lower contact of unit sharp.

UNIT 1 Gull River Formation, lower member *0.9m*

Limestone: medium grey-brown, weathers same: fine to medium crystalline; thick bedded (40-45 cm), which easily splits into thin beds (3 to 6 cm thick); scattered large vugs, filled or partially filled with calcite, some also with pyrite or gypsum crystals.

Total thickness *1.9m*

QUARRY OPERATION

Overburden is removed by loader. Drilling and blasting is not performed at the quarry; a John Deere 690 backhoe (1 1/2 yd.) extracts the stone by ripping. The stone is layered in various thicknesses and qualities; it is white to grey and can be very hard. The top three layers, 3 cm, 7.5 cm and 35.5 cm in thickness, are used mainly for retaining wall stone while the bottom (approximately ten) layers, ranging in thickness from 5 to 20 cm are used for fireplace fireboxes (high temperatures). The ripped stone is loaded by a backhoe to a Volvo 1920 (4 1/2 yd.) front end loader and then dumped, hand sorted, and loaded back into the Volvo bucket. The sorted stone is loaded into tandem trucks for delivery.

PRODUCTS

Retaining wall stone
Fireplace firebox stone

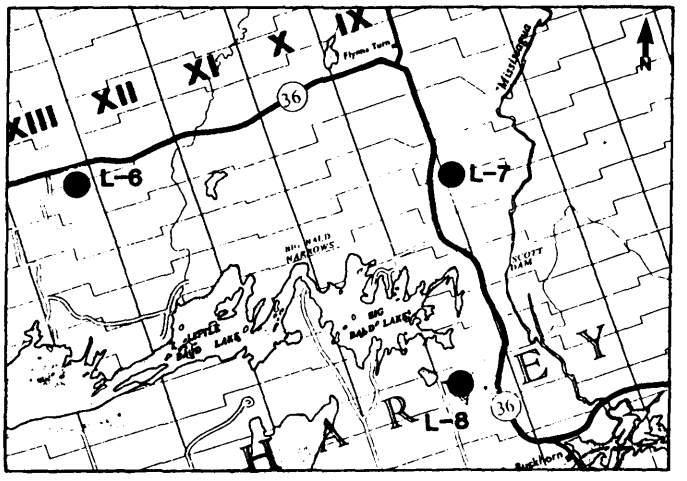


Figure L-8-1. LOCATION MAP FOR HOME (BUCKHORN) QUARRY.

REFERENCES

None

MAPS

Winder, 1954b, GSC Map 53–27A (adjacent quarries)

L-9 ELDRED W. PAYNE — WARSAW QUARRY

LOCATION AND OWNERSHIP

The Warsaw Quarry is located 9 km northeast of Warsaw in the east half of Lot 21, Concession 4, Dummer Township, Peterborough County (Figure L–9–1). The quarry was opened in 1970 by the present owner and operator, Eldred W. Payne, and is licenced for an area of 11.34 ha. The Warsaw Quarry produces specialty stone products.

GEOLOGY

The shallow, 0.6 m deep quarry in the lower member of the Gull River Formation, exposes a single bed of microcrystalline limestone. A thin shaly dolostone parting caps the limestone bed. Numerous thin calcite veins, trending northeast–southwest, cross the quarry floor with an average 2 m spacing. Overburden ranges in thickness from about 5 cm to 90 cm.

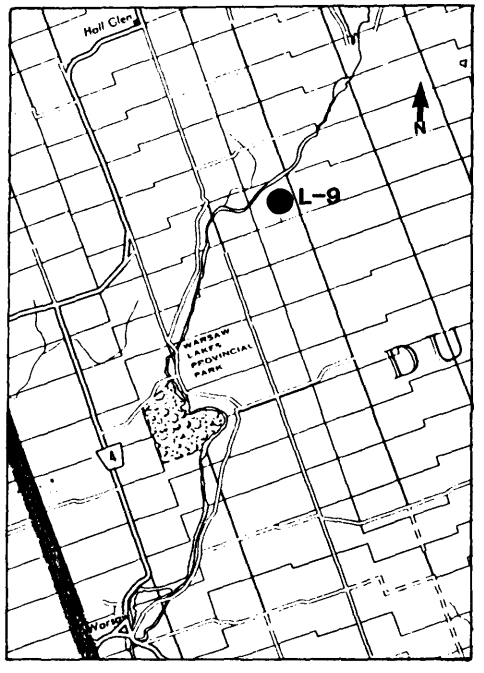


Figure L-9-1. LOCATION MAP FOR WARSAW QUARRY.

Photo L-9-1. TYPICAL QUARRY RUN MATERIAL; WARSAW QUARRY.

Geological Section

	Thickness
UNIT 1 Gull River Formation, lower member	*0.6m*
Limestone: light grey to grey-brown, weathers light grey; microcrystalline, with a lithographic texture, and scattered patches of very fine crystalline; single bed which splits into two in places; at the top is a thin, light brown silty dolostone parting; numerous, thin vertical calcite veins trending SW–NE with approximately 2 m of separation across quarry floor.	
Total thickness	*0.6m*

QUARRY OPERATION

The quarry has been opened over an area of about 2 ha to a depth of 0.6 m. All stone is extracted by ripping using a John Deere 450–C front–end loader (reinforced bucket). Explosives are not used at the quarry as blasting has been shown to have a deleterious effect on the structural strength of the stone.

Several layers of various thicknesses exist over the 0.6 m quarry depth; each layer is extracted for a particular specialty stone product. The ripped stone is sized by hand into the various products.

PRODUCTS

Shoreline stone
Gabion stone
Retaining wall stone
Patio stone
Driveway stone

REFERENCES

ARIP 25, 1980, p. 18

MAPS

None

L-10 HARNDEN AND KING CONSTRUCTION (ONTARIO) LIMITED — HAVELOCK QUARRY

LOCATION AND OWNERSHIP

The Havelock Quarry is located 3 km west of Havelock in Lots 8 and 9, Concession 11, Belmont Township, Peterborough County (Figure L-10-1). The quarry is owned by Mr. Ted Smith and is operated by Harnden and King Construction (Ontario) Limited.

The quarry is licensed over an area of 56.7 ha. The Havelock Quarry was opened in 1979 by Harnden and King Construction and is operated on an intermittent basis.

GEOLOGY

At the time of the field work, the quarry was partially flooded and only 2 m of coarse-crystalline limestone were exposed above the water level. The thin-bedded nature of the exposed limestone suggests that these strata occur in either the middle or upper members of the Bobcaygeon Formation, but the restricted section available makes an exact determination difficult. Overburden averages approximately 1.2 m in thickness.

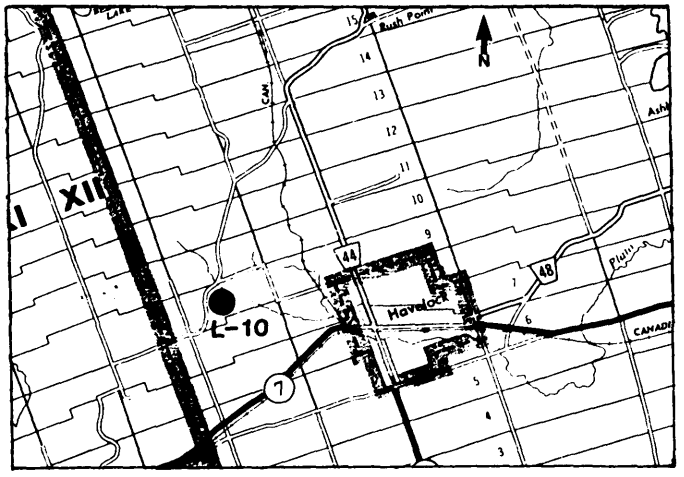


Figure L-10-1. LOCATION MAP FOR HAVELOCK QUARRY.

Geological Section

	Thickness
UNIT 1 Bobcaygeon Formation	*2.0m*
Limestone: medium grey, weathers light to medium grey to blue-grey; coarse crystalline with patches of coarse-grained calcarenite; thin bedded (5-10 cm); very fossiliferous bioclastic limestone.	
Total thickness	*2.0m*

QUARRY OPERATION

The quarry has supplied gabion stone for lakeshore protection in the Cobourg area. Other products include clear and crusher run stone products. Core sampling and testing of the lower (future) level has indicated stone suitable to produce HL4 asphalt stone. A single lift is presently opened to a depth of 7.6 m over dimensions of about 50 m x 100 m.

PRODUCTS

Gabion stone
Crusher run
Clear stone

REFERENCES

None

Maps

None

L-11 BOLENDERS LIMITED — EAGLE LAKE MARBLE QUARRY

LOCATION AND OWNERSHIP

Bolenders Limited - Eagle Lake Marble Quarry is located in Minden District on Lot 25, Concession 4, Guilford Township, Haliburton County.

GEOLOGY

The Eagle Lake Quarry has been opened in the steep west face of a ridge of white, coarse-crystalline Grenville dolomitic marble which hosts black lenses of amphibolite. Minor minerals present include diopside, phlogopite, pyrite, tremolite, serpentine and actinolite. The ridge strikes north-south and dips to the west at 40°.

The physical properties for the marble are reproduced from D.F. Hewitt (1964d, p.17) as follows:

Compressive strength,	MPa	
	Maximum	90
	Minimum	85
	Average	87
Absorption		0.13%
Bulk Specific Gravity		2.84
Kg/m^3		2,825
Abrasive hardness		20.5

QUARRY OPERATION

The quarry has been developed by drilling and blasting. The drilling is accomplished with a Gardner–Denver air track. The blasted rock is loaded at the face by a front end loader and transported by truck to the processing plant.

PROCESSING

The stone is dumped into a primary jaw crusher which reduces the material to –4 in. The stone is further reduced by a secondary jaw crusher, and a tertiary cone crusher which is in closed circuit with triple–deck vibrating screens. The sized products are stored in separate bins and shipped by truck in bags or in bulk.

Production from the quarry is used for landscaping stone and poultry grit. Finer sizes find markets in stucco and sand traps on golf courses.

PRODUCTS

5/8 in. Marble Chips
3/8 in. Marble Chips
1/4 in. Marble Chips
3/16 in. Marble Chips
1/8 in. Marble Chips
No. 5 Granule
No. 6 Sand

REFERENCES

Hewitt 1964c, p.17

Huronia District

INTRODUCTION

Huronia District is the northernmost district in the Central Region of southern Ontario, adjoining the Districts of Owen Sound to the west, Cambridge and Maple to the south, Minden to the east, and Bracebridge and Parry Sound to the north. The northwest corner of Huronia District is bounded by the waters of Georgian Bay.

Thirty-three quarries in Huronia District are documented in the quarry inventory (*see* Appendix IV, Volume I); six are currently active, three report intermittent production with the balance representing past producing quarries of geological significance.

All of the active and intermittently active quarries, along with several quarries of geological significance, were visited during the study and include the following:

H-1	*McKean Quarries Limited - Duntroon Quarry (active)*
H-2	*Duntroon Quarry (abandoned)*
H-3	*Allan G. Cook Ltd. - Coldwater (Waubaushene) Quarry (active)*
H-4	*Ministry of Transportation - Medonte (Coldwater) Quarry (intermittent)*
H-5	*Nelson Aggregate Company - Uhthoff Quarry (active)*
H-6	*Fowler Construction Co. Ltd. - Woods (Longford) Quarry (active)*
H-7	*Rama Township Quarry (intermittent)*
H-8	*Mara Limestone Aggregates Ltd. - Gamebridge Quarry (active)*
H-9	*Standard Aggregates Ltd. - Brechin Quarry (active)*
H-10	*C. S. Speiran - Speiran Quarry (intermittent)*

REGIONAL GEOLOGY

The Huronia District extends southward from the southeastern end of Georgian Bay to the Orangeville area, encompassing most of Simcoe and Dufferin Counties (Figure H-0-1). The main geomorphic features of the district are the Niagara Escarpment to the west, Georgian Bay in the north, and Lake Simcoe in the east. The area possesses a varied, glacially formed terrain. The Niagara Escarpment is the most prominent bedrock feature, and rises over 200 m above the area to the east.

The thickness of the Quaternary deposits in the district thickens gradually southwestward towards the Escarpment. In the northernmost part of the district a narrow belt of Precambrian rocks is directly overlain by a thin glacial cover.

The Huronia District is underlain by Precambrian, Ordovician and Silurian rocks (Figure H-0-2). Rocks of the Precambrian outcrop in the northernmost portion of the district where limited amounts of aggregate and dimension stone are extracted from several quarries.

The irregular Precambrian-Paleozoic contact has a relief of several metres. Both inliers of Precambrian rock in the Paleozoic and small outliers of Ordovician rocks on the Precambrian surface occur adjacent to the boundary between the Precambrian and Paleozoic. The Coldwater Quarry (H-3) of A.G. Cook Ltd. is located on one of the larger Paleozoic outliers, north of Waubaushene.

The Paleozoic strata underlying the area east of the Niagara Escarpment in the Huronia District consist of Middle to Upper Ordovician rocks. The following units are present (in ascending order): Shadow Lake, Gull River, Bobcaygeon, Verulam, Lindsay, Blue Mountain, Georgian Bay and Queenston Formations.

The Shadow Lake Formation ranges in thickness from zero, where it is absent over Precambrian topographic highs, to 12 m where it infills Precambrian lows. It commonly consists of a basal conglomerate which is overlain by greenish grey, coarse-grained, calcareous sandstone or sandy limestone. The upper part of the formation may also contain red and green sandy shales. The Shadow Lake Formation is not actively quarried in Huronia District although it does occur on the floor of the Rama Township Quarry (H-7).

Overlying the Shadow Lake Formation are the Middle Ordovician limestones collectively referred to as the Simcoe Group, which include (in ascending order): the Gull River, Bobcaygeon, Verulam, and Lindsay Formations.

The Gull River Formation in this district has been subdivided into the lower, middle and upper members by Liberty (1969b). The lower member is up to 15 m thick and is characterized by fine-crystalline, grey to greenish grey, dolomitic limestones and calcareous dolostones. The middle member is 8 to 9 m thick and consists of microcrystalline limestone (commonly with a lithographic texture), which is light grey to white in colour. Common in the middle member are small patches of calcite crystals termed "birdseye" texture. The upper member is up to 3 m thick and consists of grey, microcrystalline to fine-crystalline limestone. East of Huronia District, the upper member of the Gull River Formation has been included with the lower member of the overlying Bobcaygeon Formation, as redefined by Williams (in prep.).

The Gull River Formation is extensively quarried in the Huronia District. Strata of the Gull River Formation can be observed in the Coldwater (H-3), Medonte

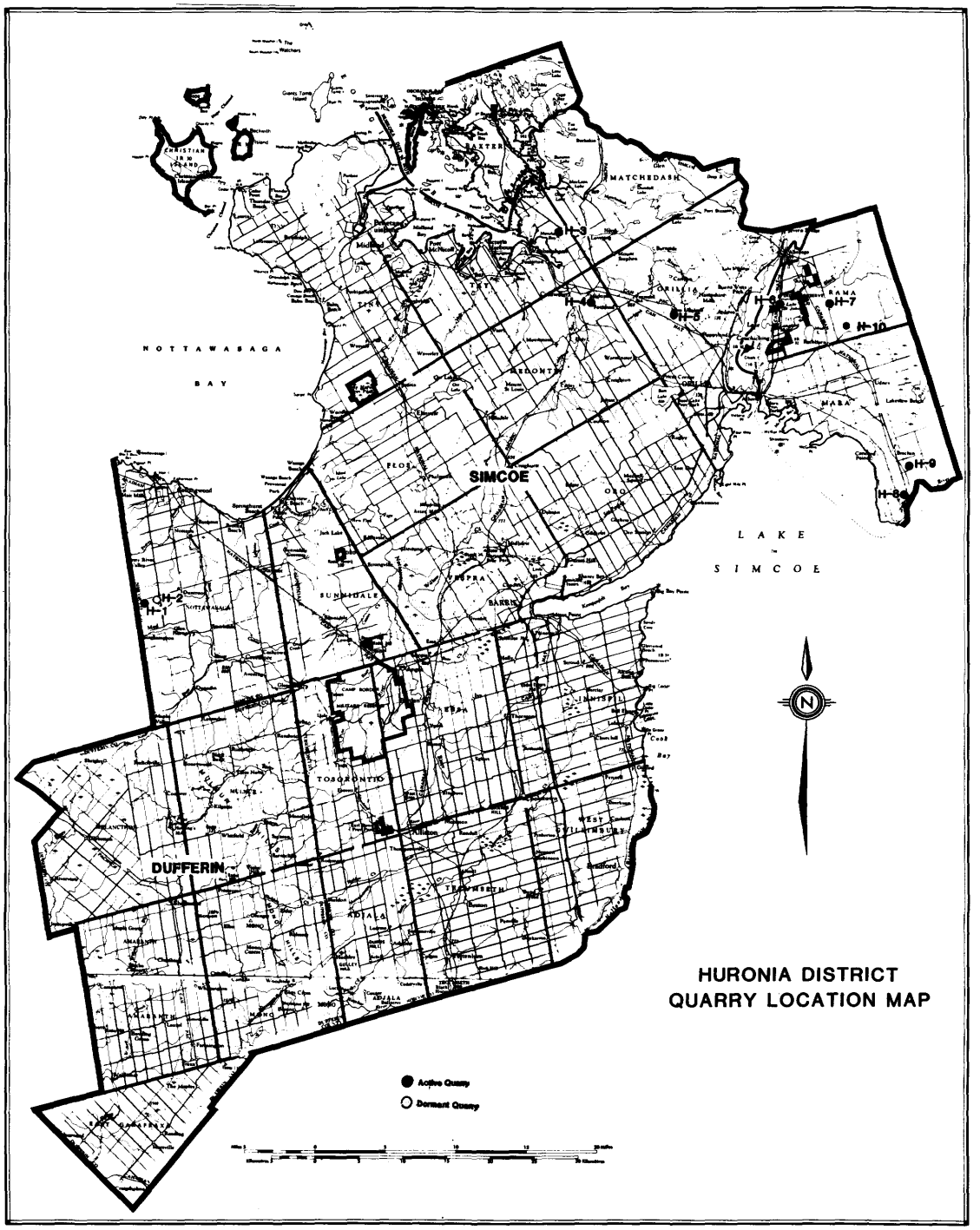


Figure H-0-1. HURONIA DISTRICT QUARRY LOCATION MAP.

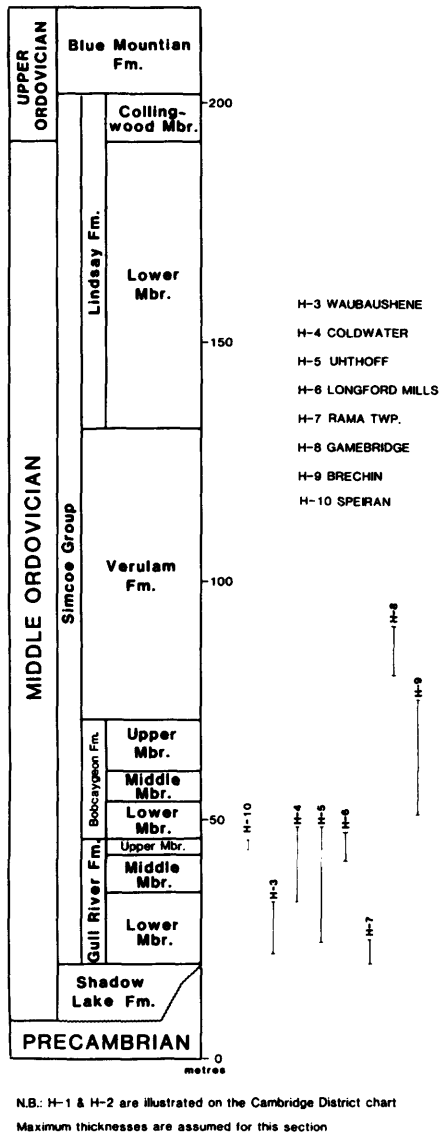


Figure H-0-2. STRATIGRAPHIC COLUMN SHOWING PRINCIPAL QUARRIES OF HURONIA DISTRICT.

(H–4), Uhthoff (H–5), and Woods (H–6) quarries, which are all worked for crushed stone. South of the Woods Quarry are a string of abandoned, building stone quarries which were known for "Rama" stone and the "Longford" stone. The "Rama" stone is a buff dolostone of the lower member, Gull River Formation and the "Longford" stone is a white, high calcium, microcrystalline limestone which has a smooth lithographic texture, of the middle member, Gull River Formation.

The Bobcaygeon Formation overlies the Gull River Formation with a prominent contact (Liberty, 1969b) in the Huronia District. The lower contact of the Bobcaygeon Formation occurs where grey, fine– to coarse–crystalline, very fossiliferous limestone overlies the uppermost microcrystalline limestone of the Gull River Formation. This contact can be observed in the Medonte (H–4) and Uhthoff (H–5) quarries.

The Bobcaygeon Formation has been subdivided into the lower, middle and upper members (Liberty, 1969b). The lower member consists of 8 m of grey, fine– to coarse–crystalline, fossiliferous limestone and coarse–grained calcarenites. The middle member consists of about 6 m of grey and brown, microcrystalline to very fine–crystalline, sparsely fossiliferous limestone. The upper member consists of about 11 m of grey to bluish grey, fine– to medium–crystalline limestone alternating with coarse–grained calcarenites which have a granular appearance. The Brechin Quarry (H–9) exposes the most complete section of the Bobcaygeon Formation in this district.

The Verulam Formation which overlies the Bobcaygeon Formation was previously subdivided into upper and lower members by Liberty (1969b), but in this report no subdivisions have been made. The strata of the formation consist of interbedded grey, fossiliferous, thin–bedded limestone and dark grey shale. The Verulam Formation is exposed in the Gamebridge Quarry (H–8) and the upper portion of the Brechin Quarry (H–9).

Overlying the Verulam Formation are thin–bedded, nodular limestones of the Lindsay Formation, which is about 60 m thick. The Collingwood Member, a black calcareous shale (Russell and Telford, 1983), is exposed around Collingwood and forms the upper part of the Lindsay Formation. There are no quarries presently utilizing the limestones of the Lindsay Formation in the Huronia District, although there are some old abandoned quarries in the Collingwood area.

The limestones of the Simcoe Group are overlain by blue–grey shales of the Upper Ordovician Blue Mountain Formation (Russell and Telford, 1983), which are exposed near Collingwood. The shales are not quarried in the Huronia District.

The shales of the Blue Mountain Formation are overlain by the interbedded limestone and shale of the Georgian Bay Formation. In the Huronia District these strata occur underneath thick glacial overburden in the southwestern part of the district.

The red shales of the Upper Ordovician Queenston Formation, which overlie the Georgian Bay Formation, form the base of the Niagara Escarpment. These red shales are quarried in many localities along the escarpment, mainly as a raw material for the brick and ceramic industry.

The Silurian strata, which form the Niagara Escarpment in the western part of the district, are described in the discussion on the Cambridge and Owen Sound districts in which the Escarpment also occurs. In the Huronia District there is only one quarry presently operating in the Silurian rocks. This is the McKean–

Duntroon Quarry (H–1) which exposes up to 12 m of the Amabel Formation. The Amabel Formation in this quarry is a massive, irregular–bedded, fine– to coarse–crystalline, biohermal dolostone. An abandoned quarry (H–2), just east of the McKean–Duntroon Quarry, exposes the Queenston, Whirlpool and Manitoulin Formations.

LIMESTONE INDUSTRIES

The principal limestone industry in Huronia District is limestone aggregate production, from armour stone down to agricultural lime and screenings. Small amounts of building stone are produced from the Speiran Quarry (H–10).

Stone production is restricted to Simcoe County and totalled approximately 4,626,000 tonnes in 1986 (1987 Ontario Mineral Score). Of this total, over two–thirds was produced from the Uhthoff Quarry (H–5) and the Brechin Quarry (H–9). The aggregates produced were used for road, construction and asphalt aggregate.

H–1 McKEAN QUARRIES LIMITED — DUNTROON QUARRY

LOCATION AND OWNERSHIP

The Duntroon Quarry is located approximately 4 km west of Duntroon in Lot 24, Concession 12, Nottawasaga Township (Figure H–1–1), and is owned and operated by McKean Quarries Limited which is a division of Seeley and Arnill Construction Ltd. The licensed area of the quarry is 49.81 ha. The quarry has been in operation since 1963 and now includes a large asphalt plant also operated by McKean Quarries Limited.

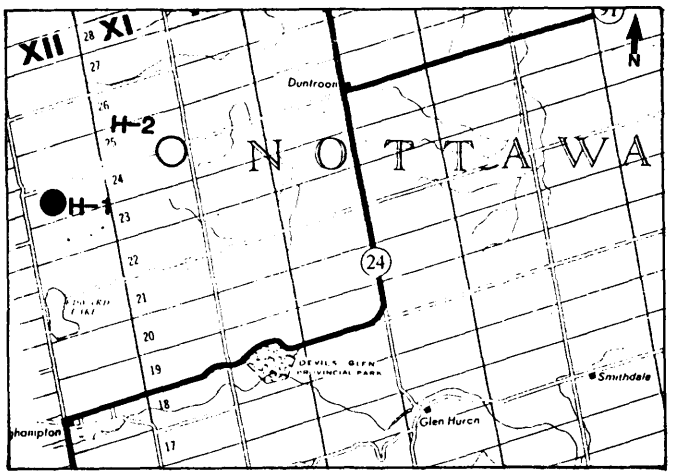


Figure H–1–1. LOCATION MAP FOR DUNTROON QUARRY.

GEOLOGY

This quarry is one of the few quarries opened on the Niagara Escarpment in the Collingwood–Nottawasaga area. This quarry exposes 7 m to 12 m of the Amabel Formation, here a biohermal dolostone. The vertical face is very irregular because of its massive biohermal nature and the related flank beds which are more evenly bedded and rubbly. Overburden averages 1 m and is used in reclamation of worked–out quarry areas.

Geological Section

		Thickness
UNIT 1	*Amabel Formation*	*7–12m*

Biohermal dolostone: blue–grey to cream, with pink and green colouring in places, weathers buff with rust staining; fine to coarse crystalline; thick to massive bedded with flanks of bioherms medium bedded, contacts are very irregular and undulating; scattered pink coloured dolomite crystals; very vuggy and porous appearance; some bituminous partings present at the base; mottled appearance; fossils present include abundant crinoids (in lenses), stromatoporoids (more abundant at top and cone–shaped: up to 5 x 20 cm), corals and rare nautiloids and brachiopods, some bioturbation; rare silicification of fossils.

QUARRY OPERATION

The quarry currently operates from the middle of March through to the middle of December; product shipping operates on a year round basis.

The quarry is currently producing from a single lift exposing an average 10 m working face. The rock is drilled with rotary drills and blasted with AN/FO using high explosives in the bottom of the holes. The broken rock is excavated and delivered to the primary crusher by a front end loader.

PROCESSING

A single impeller Cedarapids 5248 impact crusher equipped with a vibrating grizzly reduces the quarry run to approximately –8 in. This material is delivered to the stockpile area by a conveyor belt and radial stacking conveyor. The stockpile is recovered through a "below ground" draw point and conveyed to a primary screening tower where the material is passed over two double–deck 3 ft. x 16 ft. primary screens. The screen oversize is Granular "A" and is stockpiled by a stacking conveyor. Depending on the screen selection a –2 in. + 7/8 in. Group 4 clear aggregate can also be produced in addition to the Granular "A" material. It is also possible by screen selection and blending to produce a 2 in. crusher run or 3/8 in. C–gravel. Products are conveyed to a radial luffing stacking conveyor for stockpiling. The screen oversize is conveyed to the secondary screening and crushing plant where the material is passed over a double–deck vibrating screen in closed circuit with a Pulvamatic impact crusher. Depending on the screen selection, 3/4 in. clear stone and 1/4 in. screenings, 2 in. clear stone and 1/4 in. screenings or –7/8 in. +1/4 in.

clear stone and 1/4 in. screenings can be produced. The 1/4 in. screenings can be separated on an additional screen into −1/4 in. +8 mesh asphalt sand and −8 mesh agricultural lime. The −7/8 in. +1/4 in. clear stone can be separated on a washing screen into −3/4 in. clear concrete stone, −5/8 in. +1/4 in. washed HL4 and −7/8 in. +5/8 in. or −1/2 in. +1/4 in. HL3. These products are stockpiled or stored in individual bins.

The stone products used in the asphalt plant, a Barber-Greene 6500 lb. batch unit, are transported by truck to separate stockpiles next to the plant.

Armour stone can be produced by selecting suitable blocks from shot rock in weights of up to 8 tons.

Other specialty products are riprap and gabion stone. Coarse stone is selected from shot rock by front end loader and hauled to a special 5 ft. x 16 ft. Assinck Bros. two step grizzly screen with adjustable spacer bars. Riprap is made in the following size ranges: 10 in. x 30 in., 8 in. x 24 in. and 6 in. x 12 in. Gabion stone is produced in 6 in. x 8 in. and 4 in. x 6 in. sizes. Undersize from the grizzly screen is −4 in. and is diverted to the discharge belt of the primary impact crusher.

PRODUCTS

Armour Stone
Riprap 10 in. x 30 in., 8 in. x 24 in., and 6 in. x 12 in.
Gabion Stone 4 in. x 6 in. and 6 in. x 8 in.
2 in. Crusher Run
Granular "A"
−2 in. + 7/8 in. Group 4 Clear
2 in. Clear Stone
3/4 in. Clear Stone
−7/8 in. + 1/4 in. Clear Stone
3/8 in. C-Gravel
HL4
HL3
1/4 in. Screenings
Asphalt Sand
Agricultural Lime

REFERENCES

Hewitt, 1964a, p. 57-58
Vos, 1969, p.59
Hewitt and Vos, 1972, p. 53

MAPS

Telford, 1976a, ODM Map 2341

H-2 DUNTROON QUARRY

LOCATION AND OWNERSHIP

This small abandoned quarry is located 2.5 km west of Duntroon on the edge of the Niagara Escarpment in Lot 24 (E$^1/_2$), Concession 11, Nottawasaga Township, Simcoe County (Figure H-2-1).

GEOLOGY

The quarry is geologically significant because it exposes 10.3 m of the Queenston, Whirlpool and Manitoulin Formations. Below the quarry floor, the red calcareous shales of the Queenston Formation are exposed and are overlain by calcareous sandstones of the Whirlpool Formation (3 to 4 m). The Whirlpool Formation is in turn overlain by 6.3 m of the Manitoulin Formation, a calcareous dolostone.

Geological Section

		Thickness
UNIT 2	*Manitoulin Formation*	*6.3m*

Calcareous dolostone: grey to medium grey, weathers buff; subcrystalline to very fine crystalline; thin to medium bedded (5 to 10 cm), contacts are sharp and slightly irregular; white chert nodules are present in the upper 1.5 m and are usually about 3 cm in diameter; calcite present in vugs; some stylolites; mottled appearance; rare brachiopods; lower 0.5 m consists of interbedded shales, sandstones and dolostones; the lower contact is sharp.

UNIT 1	*Whirlpool Formation*	*4.0m*

Calcareous sandstone: green-grey, weathers grey; fine grained; thin to medium bedded; unit is very poorly exposed; some rip-up clasts at the top of the unit; rib and furrow structure can be seen on bedding planes; lower contact is obscured by rubble, although the Queenston Formation shale is exposed in an adjacent outcrop below the quarry floor.

Total thickness	*10.3m*

REFERENCES

Vos, 1969, p. 59

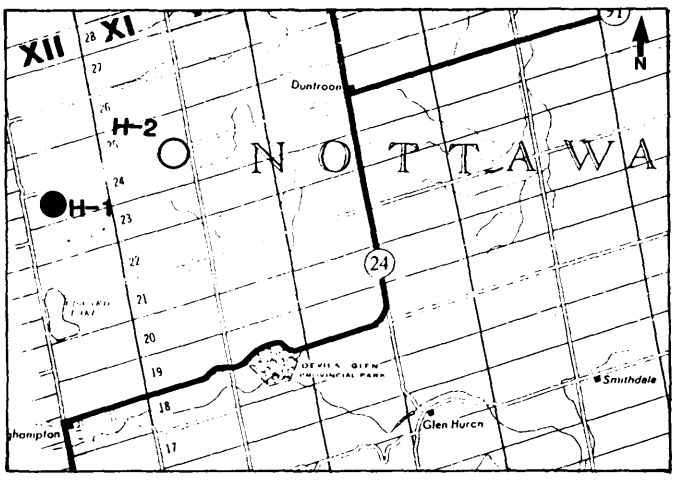


Figure H-2-1. LOCATION MAP FOR DUNTROON QUARRY.

MAPS

Telford, 1976a, ODM Map 2341

H-3 ALLAN G. COOK LTD. — COLDWATER (WAUBAUSHENE) QUARRY

LOCATION AND OWNERSHIP

The Coldwater Quarry is located 7 km north of the Village of Coldwater, in Lots 8, 9, 10 and part of Lot 11, Concession 14, Tay Township, Simcoe County (Figure H-3-1). The quarry was opened in 1968 by the present owner and operator Allan G. Cook Ltd., and is licensed for a total of 270.0 ha.

The quarry supplies aggregate products in a region generally defined by the cities of Barrie and Orillia and the towns of Parry Sound and Midland. The Coldwater Quarry has supplied a considerable quantity of aggregate products for construction and maintenance of Highways 400 and 69 and locally supplies limestone for township roads, tile filter beds and shoreline protection.

The quarry normally operates during the period April to mid-December. Approximately one-quarter of the quarry production is used by A. G. Cook Ltd. to supply their construction projects and asphalt plant.

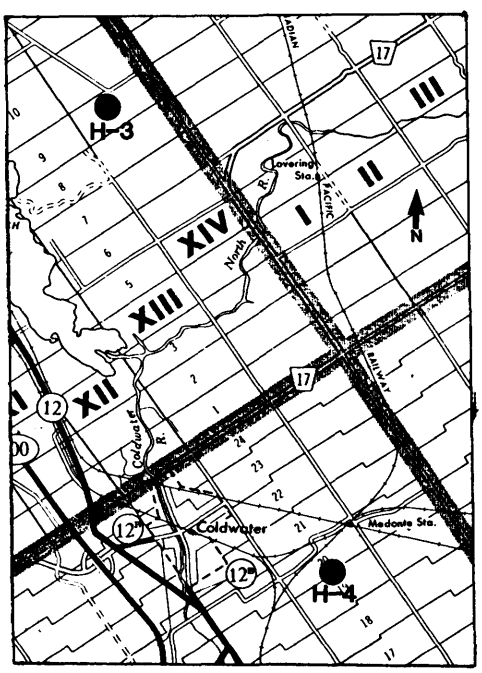


Figure H-3-1. LOCATION MAP FOR COLDWATER (WAUBAUSHENE) QUARRY.

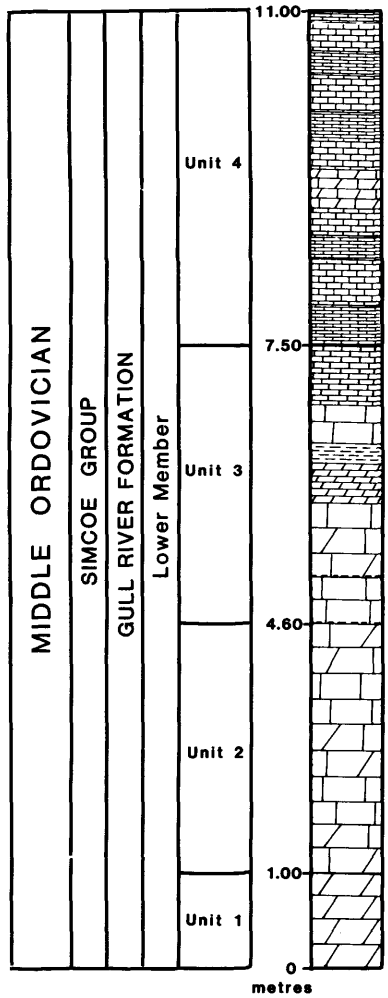


Figure H-3-2. STRATIGRAPHIC COLUMN FOR COLDWATER (WAUBAUSHENE) QUARRY.

GEOLOGY

The quarry is located in a Paleozoic outlier of the Gull River Formation on the Precambrian rocks and exposes 11.0 m of the lower member of the Gull River Formation (Figure H-3-2). A water-filled sump reveals that strata below the main quarry floor consist of silty and sandy dolostone. The underlying Shadow Lake Formation occurs just below the exposed section in the quarry (based on drill hole logs in Koniuszy and Rogers, 1983). The lower part of the face exposes 5.1 m of interbedded limestone, dolomitic limestone and dolostone, capped by a 30 cm thick interval of light green dolostone which includes 8 cm of soft green shale. The upper 4.9 m consists of interbedded dolomitic limestone and limestone, commonly with light green glauconite present as a coat-

ing on fossils or on bedding planes. Glacial overburden is less than 0.5 m thick around the quarry.

Geological Section

		Thickness
UNIT 4	*Gull River Formation, lower member*	*3.5m*

Limestone: mottled light grey and medium grey-brown, weathers same; microcrystalline with a lithographic texture; thin to medium bedded (5-10 cm, rarely 30 cm) with sharp, irregular contacts; green coatings on some fossils; abundant burrows, some are lighter grey due to dolomitization; lower contact is sharp, irregular.

UNIT 3	*Gull River Formation, lower member*	*2.9m*

Limestone and dolomitic limestone:light brown to light grey; weathers same; microcrystalline to very fine crystalline; medium to thick bedded (15-50 cm), with beds thicker at base of unit and thinning upwards; sharp contacts, some irregular with very thin shale partings; at 1.2m above base of unit is a 30 cm thick, thin-laminated, very soft, recessive green dolostone; near top of unit are two intraformational conglomerates, 10 cm thick, with clasts up to 5 cm in diameter of microcrystalline limestone and rare bioclasts; rare brachiopods near top of unit; lower contact of unit sharp and irregular; top of lower lift 1.5 m above base of unit at top of green dolostone.

UNIT 2	*Gull River Formation, lower member*	*3.6m*

Interbedded limestone and dolomitic limestone: light brown to medium grey, weathers light brown to light grey; limestone microcrystalline to very fine crystalline, with a lithographic texture; dolomitic limestone very fine crystalline, with some terrigenous material, from mud to sand sized; medium to thick bedded (20-40 cm); dolomitic limestone is thin-laminated in some beds; sharp contacts, some with very thin, light green shale partings; patches of calcite crystals common in dolomitic limestone; small, disseminated and euhedral pyrite crystals; lower contact of unit sharp and planar, possibly erosional, marked in places by euhedral pyrite crystals up to 5 mm in diameter.

UNIT 1	*Gull River Formation, lower member*	*1.0m*

Dolostone: light green to grey, weathers light green; very fine crystalline with silt to very fine-grained sand; thick bedded (40-50 cm), beds contain stylolites which weather into thin, platy fragments; sharp, planar contacts; small pyrite crystals scattered through most beds; top of unit at floor of quarry, this unit above water level in sump.

Total thickness	*11.0m*

QUARRY OPERATION

The quarry has a disturbed area of about 40 ha and is excavated in four lifts to a total depth of about 11.0 m. The first lift of 4.9 m is used to supply asphalt and concrete stone products and is mined down to the green shale layer known as the "green marker". The second lift (0.6 m) is used to produce crusher run stone and includes approximately 0.15 m of the green shale marker, 0.15 m shale transition stone, and about 0.3 m of dolomitic limestone. The third lift of 3.0 m is used to produce asphalt and concrete stone products. The fourth (bottom) lift of 1.8 m is used to produce crusher run material.

A drill pattern of 2.7 m x 2.7 m is used with a 7.6 cm diameter blast hole on the 1st, 3rd and 4th lifts. On the short second lift (0.6 m) a drill pattern of about 2.1 m x 2.1 m with 7.6 cm diameter blast holes is used; holes are loaded with a single cartridge of Tovex 2000 and initiated with an electric cap.

PROCESSING

A 5 1/2 yd. Volvo 4600 is used to load two 35-ton Haulpak trucks for haulage to the 36 in. x 42 in. Cedarapids double impeller primary crusher. The crushed rock is sent to a surge pile and fed by a 36 in. vibrating feeder to the tunnel conveyor and one 5 ft. x 12 ft. screen and one 1 ft. x 4 ft. screen producing gabion stone, 1 in. crusher run and intermediate material that is recrushed in two 48S Telsmith cone crushers. Stone leaving the cone crushers is then sent to a 5 ft. x 12 ft. double-deck Tyrock 900 screen producing +3 1/2 in. oversize, 2 in. clear and -1 3/4 in. stone. The -1 3/4 in. product is sent to an 8 ft. x 20 ft. Simplicity screen producing +1 1/2 in. and -3/4 in. clear stone; the -3/4 stone is sent to an 8 ft. x 20 ft. Simplicity screen producing HL4, HL3 and HL6 as required. The -5/16 is sent to a screening pile for stockpile. All oversize and products not required are sent to the Pulvamatic crusher. All stone is stockpiled by radial stacking conveyors.

PRODUCTS

Armour Stone
Gabion Stone
4 in. x 6 in.
6 in. x 12 in.
2 in. Crusher Run
1 1/2 in. Crusher Run
7/8 in. Crusher Run
5/8 in. Crusher Run
2 in. Clear Stone
1 in. Clear Stone
3/4 in. Clear Stone
HL6
HL4
HL3
3/8 in. Chips

REFERENCES

Hewitt and Vos, 1972, p.18-19
Koniuszy and Rogers, 1983

MAPS

None

H-4 MINISTRY OF TRANSPORTATION — MEDONTE (COLDWATER) QUARRY

LOCATION AND OWNERSHIP

The Medonte Quarry is located 2 km east of Coldwater in Lots 19 and 20, Concession 13, Medonte Township, Simcoe County (Figure H-4-1). The quarry is used intermittently by the Ministry of Transportation as a source for crushed stone. The quarry was previously operated by Coldwater Crushed Stone Ltd. and Limestone Products Ltd.

GEOLOGY

The 14.15 m deep quarry exposes limestones and dolostones of the lower, middle and upper members of the Gull River Formation, and the lower member, Bobcaygeon Formation (as defined by Liberty, 1969b), in a single lift (Figure H-4-2). There are 3 to 4 m of glacial overburden at the top of the quarry, which has been excavated into a hillside.

The lower member of the Gull River Formation is exposed below the main quarry floor in a 2 m deep drainage ditch at the quarry's east end. The exposed strata consist mainly of dolostone. The upper contact of the member is marked by a 10 cm thick soft, recessive, plastic clay which weathers green.

The microcrystalline limestones of the middle member displays various hues of grey, including two intervals

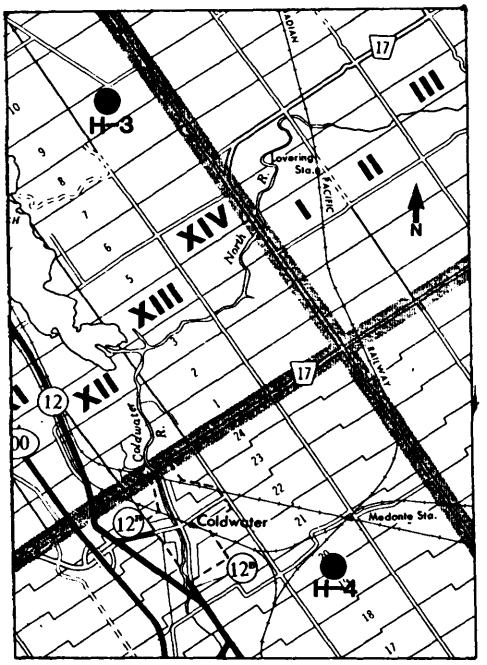


Figure H-4-1. LOCATION MAP FOR MEDONTE (COLDWATER) QUARRY.

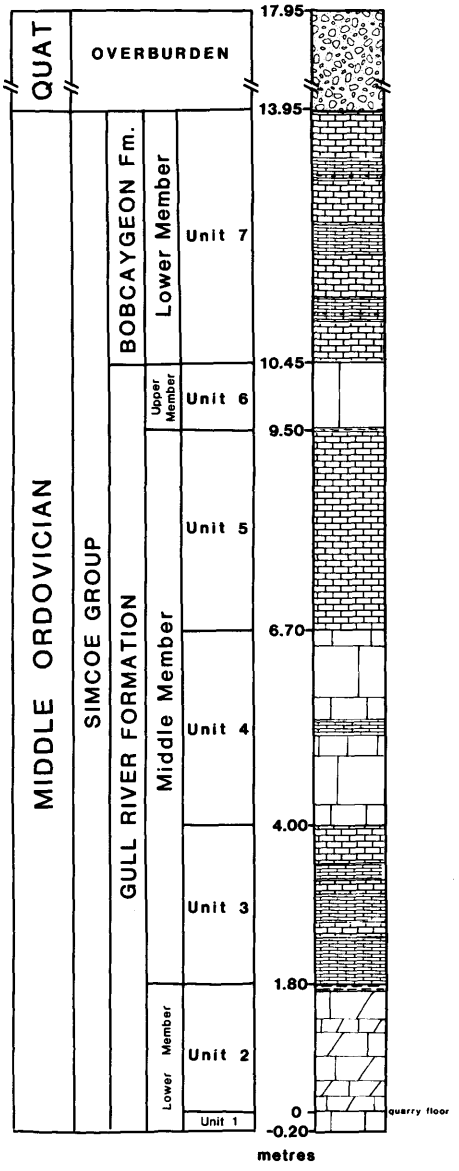


Figure H-4-2. STRATIGRAPHIC COLUMN FOR MEDONTE (COLDWATER) QUARRY.

that weather white. The beds commonly have a lithographic texture with well developed "birdseye" textures and are commonly disrupted by numerous stylolites. The upper contact of the member is marked by a 10 cm thick recessive shale bed which weathers into a plastic clay.

The upper member is only 1 m thick in this quarry and consists of microcrystalline limestone. White and black chert occur in the member as nodules and discontinuous beds. The upper contact of the Gull River Formation is sharp and irregular in some parts of the quarry,

but in other parts it appears to be transitional with the overlying strata.

The 3.5 m thick lower member of the Bobcaygeon Formation typically contains medium- to coarse-grained calcarenites interbedded with fine- to medium-crystalline bioclastic limestones. Some of the calcarenites display small-scale crossbedding.

Geological Section

Thickness

UNIT 7 Bobcaygeon Formation, lower member *3.5m*

Limestone: light to medium grey, weathers medium to dark grey, with a rubbly and pitted appearance; fine to medium crystalline, with some medium- to coarse-grained calcarenites; thin to medium bedded (5-20 cm) with sharp, slightly irregular, stylolitic contacts or with rare, thin, discontinuous shale partings; very fossiliferous and bioclastic; lower contact of unit sharp and irregular in places, transitional in others.

UNIT 6 Gull River Formation, upper member *0.95m*

Limestone: light grey, weathers medium grey; microcrystalline, with a lithographic texture; single bed; white and black chert in irregular patches and discontinuous beds 60 to 70 cm above base of unit; rare brachiopods near top; lower contact of unit sharp at a 10 cm recessive shale bed which weathers into a plastic clay.

UNIT 5 Gull River Formation, middle member *2.8m*

Limestone: light grey, weathers light to medium grey; microcrystalline with a lithographic texture; medium bedded (20-25 cm); sharp, planar contacts; stylolites common throughout beds; some intraformational conglomerates with clasts up to 3 mm in diameter, glauconite and hematite coatings on some clasts; small patches of calcite crystals ("birdseye" texture) present; rare, small pyrite crystals; lower contact sharp and planar.

UNIT 4 Gull River Formation, middle member *2.7m*

Limestone: very light grey to cream, weathers very light grey to white; microcrystalline with a lithographic texture; thick bedded (30-60 cm) with sharp, rarely stylolitic contacts; stylolites are common throughout beds and increase in abundance upwards; intraformational conglomerates with subrounded, disc-like clasts, some with original laminations; interbeds of thin-bedded, white microcrystalline limestone, commonly containing vertical calcite-filled burrows (*Skolithos*); small patches of calcite crystals ("birdseye" texture) present; rare, small pyrite crystals; lower contact of unit sharp and planar.

UNIT 3 Gull River Formation, middle member *2.2m*

Limestone: light brown, weathers dark to medium grey; microcrystalline with a lithographic texture; thin to medium bedded (5-20 cm) with thicker (30-50 cm) beds towards top of unit; sharp, planar contacts, some stylolitic with very thin, light green shale partings; small patches of calcite crystals ("birdseye" texture) present and thin calcite-filled veins trending northeast; lower contact of unit sharp and planar, at top of green silty dolostone bed at base of very soft, recessive clay bed; main quarry floor at 0.4 m above base of unit.

UNIT 2 Gull River Formation, lower member *1.8m*

Dolostone: light grey-green, weathers buff to grey-green; very fine crystalline with some terrigenous silt; medium to thick bedded (10-50 cm) with sharp and planar contacts; unit includes beds which vary from thin bedded and recessive to thick bedded and conchoidally fractured; lower contact of unit sharp.

UNIT 1 Gull River Formation, lower member *0.2m*

Limestone: light brown, weathers medium grey; microcrystalline with a lithographic texture; one bed 20 cm thick; rare patches of calcite crystals; scattered chert nodules; units 1 and 2 occur below main quarry floor in drainage ditch and very old section of quarry.

Total thickness *14.15m*

REFERENCES

Liberty, 1953b, p.3
Hewitt, 1960, p.29-31
Liberty, 1969b, pp.3, 22-31, 98, 124

MAPS

Liberty, 1953a, GSC Map 53-16
Liberty, 1969a, GSC Map 1228A

H-5 NELSON AGGREGATE COMPANY — UHTHOFF QUARRY

LOCATION AND OWNERSHIP

This very large quarry is located 10 km northwest of Orillia, near the hamlet of Uhthoff in Lots 7, 8, 9, and 10, Concessions 3, 4, and 5 N.D., Orillia Township, Simcoe County (Figure H-5-1).

The quarry is owned and operated by Nelson Aggregate Company and has a nominal annual capacity of 2,000,000 tonnes. The quarry is served by Canadian Pa-

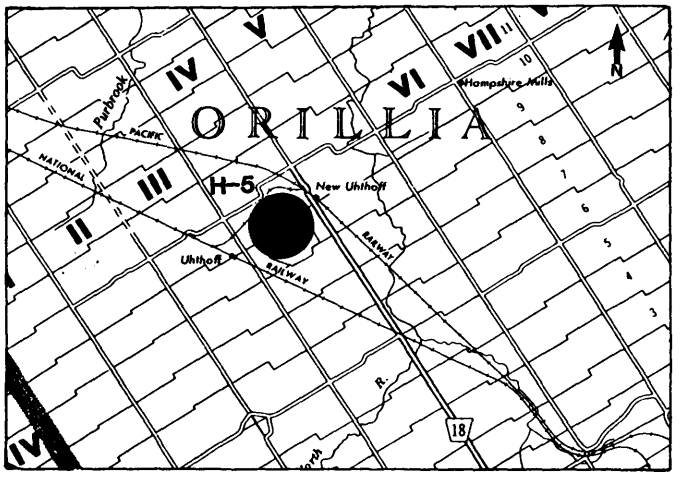


Figure H-5-1. LOCATION MAP FOR UHTHOFF QUARRY.

cific and Canadian National rail lines, and by truck haulage. The quarry licence covers an area of 362.68 ha.

GEOLOGY

The 24.5 m deep quarry exposes an excellent section of the lower, middle and upper members of the Gull River Formation and the lower member of the Bobcaygeon Formation (Figure H-5-2), as defined by Liberty (1969b). Three lifts have been excavated.

In the quarry the lower member, Gull River Formation, consists of 10.4 m of very fine- to medium-crystalline interbedded dolostone and limestone. The 7.45 m thick middle member consists of microcrystalline, light grey to cream limestone which exhibits a lithographic texture. The upper member consists of 2.3 m of light to medium grey, microcrystalline limestone.

The contact between the Gull River and Bobcaygeon Formations is placed at the lowest occurrence of coarse-grained calcarenites and is transitional over approximately 1 m. The lower member of the Bobcaygeon Formation, as defined by Liberty (1969b), is a light grey, medium- to coarse-crystalline, very fossiliferous limestone. There are 2.3 m of Bobcaygeon Formation overlying a total of 22.25 m of Gull River formation in this quarry. The glacial overburden around the quarry is up to 4 m thick.

Geological Section

Thickness

UNIT 9 Bobcaygeon Formation, lower member *2.3m*

Limestone: light to medium grey, weathers same; medium- to coarse-grained calcarenites; medium to thick bedded (20-40 cm) with stylolitic contacts; lower portion of unit consists of alternating microcrystalline and coarse-crystalline limestone, may be transitional to upper Gull River Formation, 1 m above base of unit is a 3 cm thick, very soft, recessive bed of plastic clay; rare, small patches of calcite crystals; fossiliferous, with corals, stromatoporoids, and brachiopods most common, burrows also abundant; lower contact of unit sharp and irregular, appears erosional in places.

UNIT 8 Gull River Formation, upper member *2.3m*

Limestone: light to medium grey, weathers same; microcrystalline; medium bedded (10-30 cm), stylolitic contacts, some with thin dark grey, shaly limestone partings; small patches of calcite crystals ("birdseye" texture) present; fossiliferous, with abundant corals (*Tetradium*), fossil fragments and burrows; lower contact of unit sharp and planar.

UNIT 7 Gull River Formation, middle member *2.6m*

Limestone: light to medium brown, mottled dark grey, some beds white to cream, weathers same; microcrystalline, with a lithographic texture; medium bedded (15-30 cm) with sharp, planar and stylolitic contacts, rare interbeds of thin-bedded (2-5 cm), recessive shaly limestone; upper 1 m is a distinctively white to cream, medium- bedded microcrystalline limestone with a lithographic texture which contains abundant burrows; small patches of calcite crystals ("birdseye" texture) present; rare, small pyrite crystals; sparsely fossiliferous with ostracods present

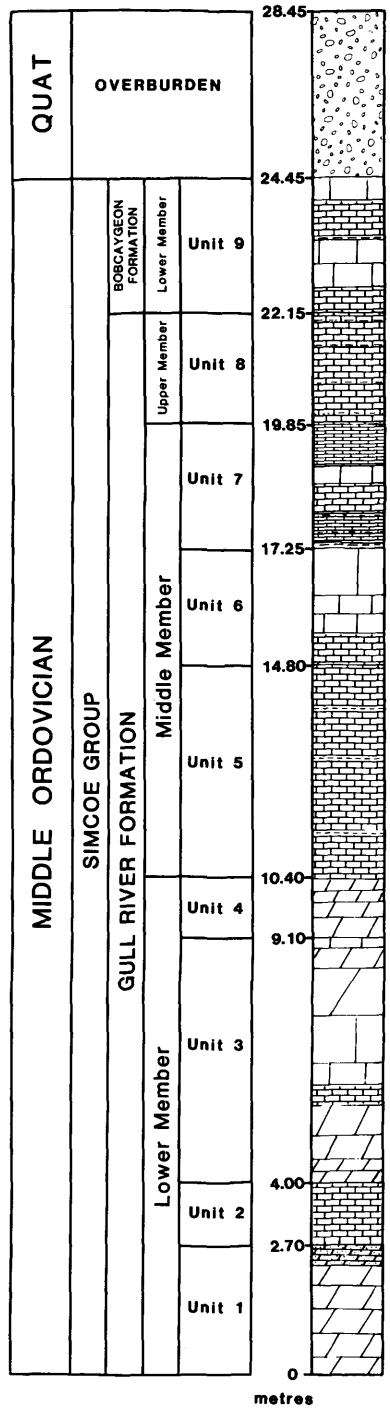


Figure H-5-2. STRATIGRAPHIC COLUMN FOR UHTHOFF QUARRY.

0.7–1.6 m above base of unit; lower contact of unit sharp at a 2 mm shale bed.

UNIT 6 Gull River Formation, middle member 2.45m

Limestone: light brown, upper 75 cm white, weathers same; microcrystalline with a lithographic texture; medium to thick bedded (15–75 cm), stylolitic contacts; upper 0.75 m is a distinctive white, microcrystalline limestone with a lithographic texture which contains abundant stylolites; small patches of calcite crystals ("birdseye" texture) present; rare small pyrite crystals; abundant small black, irregular shaped patches which appear to be burrows coated with bitumen; lower contact of unit sharp and planar, at top of 2nd lift.

UNIT 5 Gull River Formation, middle member 4.4m

Limestone: light to medium brown and grey, weathers same; microcrystalline, with a lithographic texture; medium bedded (15–20 cm), sharp, planar or stylolitic contacts, some with thin shale partings; stylolites abundant throughout some beds; 3.2 m above base of unit intraformational conglomerates with light grey, microcrystalline clasts common; 0.5 m above base of unit 30 cm thick light green, laminated, silty dolostone; small patches of calcite crystals ("birdseye" texture) present; fossiliferous, brachiopods most abundant and some burrows on bedding planes; lower contact of unit sharp, at top of lower lift.

UNIT 4 Gull River Formation, lower member 1.3m

Dolostone: medium grey-brown to light green, weathers light to medium brown, upper 40 cm light green; fine to medium crystalline; medium bedded (20–30 cm), sharp and planar contacts; abundant burrows on bedding planes; lower contact sharp and irregular, to stylolitic.

UNIT 3 Gull River Formation, lower member 5.1m

Interbedded limestone and dolostone: mottled grey and brown, weathers same; limestone microcrystalline, dolostone fine to medium crystalline; medium to thick bedded (10–60 cm), sharp, irregular, stylolitic contacts; small patches of calcite crystals ("birdseye" texture) present; glauconite coating fossils and bedding planes; interval with abundant white chert as nodules and discontinuous beds 4.0 m above base of unit; fossiliferous in limestones, abundant brachiopods, cephalopods, bivalves, and burrows on bedding planes; lower contact of unit sharp at main quarry floor.

UNIT 2 Gull River Formation, lower member 1.3m

Limestone: light grey, weathers same; microcrystalline to very fine crystalline; medium bedded (10–20 cm), sharp, slightly irregular contacts; intraformational conglomerate 40 cm above base of unit with light to dark grey clasts of microcrystalline limestone and patches of calcite crystals; rare small pyrite crystals; sparsely fossiliferous with ostracod fragments and abundant burrows; lower contact of unit sharp and irregular.

UNIT 1 Gull River Formation, lower member 2.7m

Dolostone: light grey, weathers light green-grey; very fine to fine crystalline, upper 40 cm contains medium- to coarse-grained, well rounded, quartz sand grains; medium to thick bedded (30–50 cm), sharp, planar to undulatory contacts: small pyrite crystals in lowest 30 cm; small, open vugs common; sparsely fossiliferous; Units 1 and 2 exposed above water level in sump.

Total thickness 20.45m

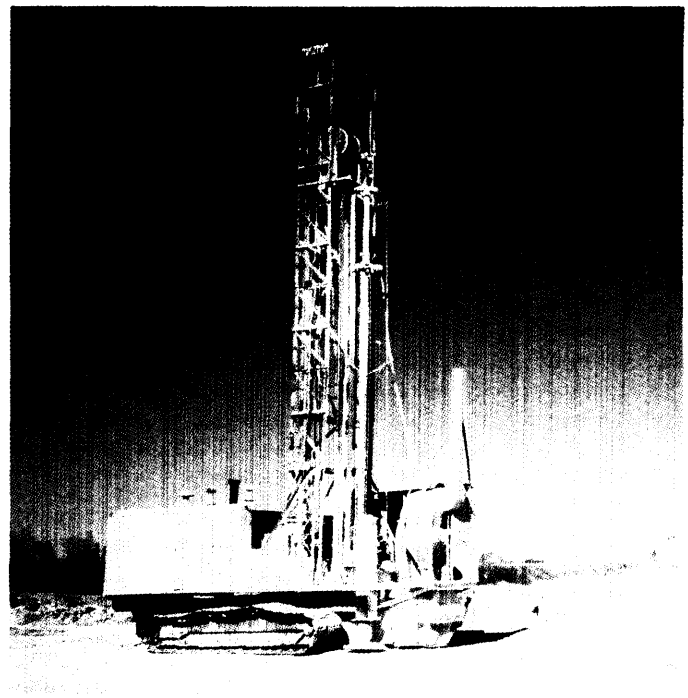


Photo H-5-1. BUCYRUS-ERIE 40R ROTARY DIESEL DRILL AT THE UHTHOFF QUARRY.

QUARRY OPERATION

The Uhthoff quarry is one of the largest quarries in the Province of Ontario; over 35,000,000 tonnes of aggregate material have been extracted since the quarry was opened.

The quarry is worked on three lifts of 9.7 m, 4.4 m and 6.4 m. Stone extracted from the upper and lower lifts is used to produce asphalt and concrete stone products; the middle lift is used to produce granular products.

Drilling is performed by a Bucyrus–Erie 40R Rotary diesel drill, using a 171 mm bit on a 5.5 m x 5.5 m pattern. Large diameter water gel explosives are used at the toe of the hole with AN/FO as column load. The blasted stone is loaded by two Cat 988B loaders into three 40–ton Terex 3307 and four 35–ton Euclid 201 haulage trucks. The haulage distance from the quarry face to primary crushing is about 1,500 m.

PROCESSING

The process flow sheet is shown on Figure H–5–3. The blasted stone is dumped into either a 36 in. Allis–Chalmers gyratory crusher, feeding a –10 in. surge pile or a 40 in. x 48 in. Buchanan jaw crusher, feeding a –12 in. 60 tonne surge tank. Material from the surge tank is conveyed to the Crusher Run plant and a Tyler 800 double–deck screen, producing either –12 in. + 6 in. and –6 in. + 4 in. gabion stone, or routing that coarse material

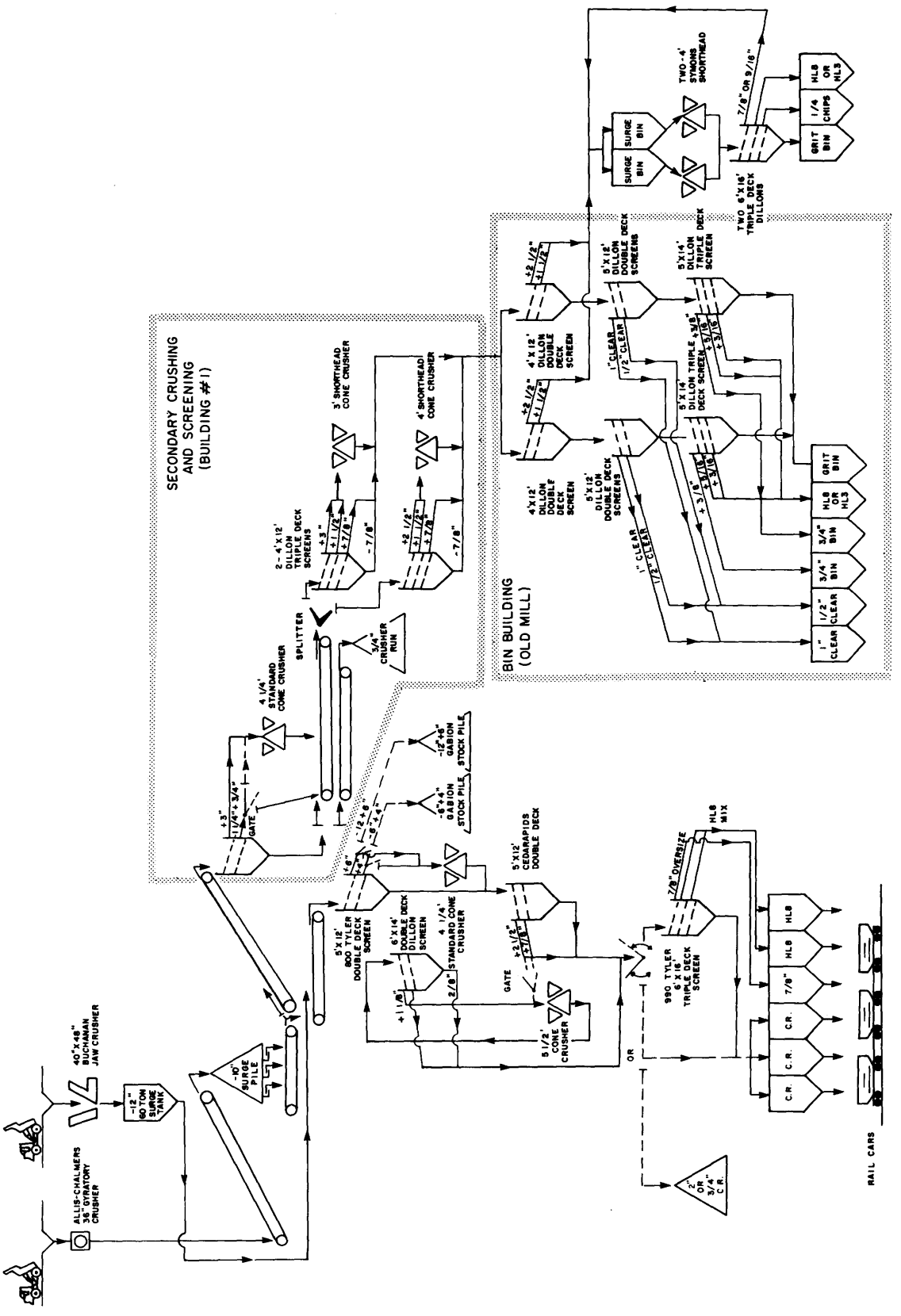


Figure H-5-3. PROCESS FLOW CHART FOR UHTHOFF QUARRY.

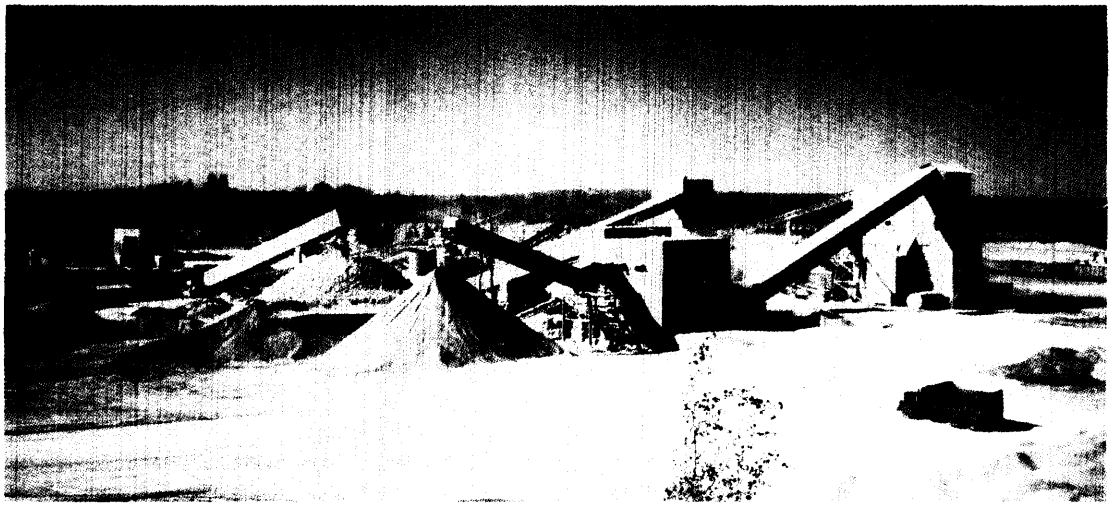


Photo H-5-2. UHTHOFF QUARRY PROCESSING PLANT, SHOWING RAIL LOAD-OUT (RIGHT).

through a 4 1/4 ft. standard cone crusher before rejoining the fines from the Tyler screen. This −4 in. material is sent to a 5 ft. x 12 ft. Cedarapids double–deck screen, from which + 2 1/2 in. and − 2 1/2 in. +7/8 in. stone can be sent for final screening with the −7/8 in. fines or routed by a gate to a 5 1/2 ft. cone crusher. If the +7/8 in. stone is recrushed, the product is sorted by a 6 ft. x 14 ft. double–deck Dillon screen. Plus 1 1/8 in. material is returned to the cone crusher while −1 1/8 in. +7/8 in. and −7/8 in. material is sent for final screening. This final screening is done in the Crusher Run bin building and incoming stone can be diverted as 3/4 in. or 2 in. crusher run to a stockpile or bin storage, or sent to a 6 ft. x 16 ft. triple–deck Tyler 990 screen, producing septic stone (+7/8 in.), HL8 mix and screenings. These products are stored in bins and can be directly loaded to rail cars.

Material in the −10 in. surge pile can be either processed as above or sent to Building #1 for secondary crushing and screening. There, a double–deck screen separates +3 in. stone for recrushing in a 4 1/4 ft. standard cone; −3 in. +3/4 in. stone is sent for recrushing or direct screening, and −3/4 in. is sent for direct screening or stockpiling as 3/4 in. crusher run. The material from the cone crusher is added to the direct screening feed, and sent to either of two 4 ft.x 12 ft. triple–deck Dillon screens. One screen feeds +3 in. and +1 1/2 in. oversize to a 3 ft. shorthead cone crusher, the other feeds +2 1/2 in. and +1 1/2 in. oversize to a 4 ft. shorthead cone, the products of both cone crushers being added to the −1 1/2 in. +7/8 in. and −7/8 in. material from the screens and sent to the Bin Building (Old Mill) for final screening.

The incoming feed at the Bin Building goes to either of two 4 ft. x 12 ft. double–deck Dillon screens, producing +2 1/2 in. oversize that is sent to a surge bin; −2 1/2 in. + 1 1/2 in. that goes to the surge bin or a 2 in. clear bin; and −1 1/2 in. fines that are fed directly to a pair of 5 ft. x 12 ft. double–deck Dillon screens. These screens produce +1 in. material to a surge bin or 1 in. clear bin, −1 in. +5/8 in. to surge bin or 3/4 in. clear bin, and −5/8 in. fines to a pair of 5 ft. x 14 ft. triple–deck Dillon screens. The triple–deck screens produce +3/8 in. stone, sent to the 3/4 in. bins, HL3 or HL8, and screenings (to the grit bin). The + 2 1/2 in. stone in the surge bin is fed to two 4 ft. Symons shorthead cone crushers and sent to two 6 ft. x 16 ft. triple–deck Dillon screens. A +7/8 in. or + 9/16 in. oversize is returned to the Symons cone crushers while HL3 or HL8, 1/4 in. chips and screenings are separated and sent to bin storage.

PRODUCTS

Gabion Stone
  −12 in. + 6 in. and −6 in. + 4in.
Riprap 6 in. −12 in.
2 in. Crusher Run
3/4 in. Crusher Run
Granular "A"
2 in. Clear
1 in. Clear
3/4 in. Clear
Screenings
Shot Rock
HL3, HL4, HL6, HL8
1/4 in. Chips
3/8 in. Chips
Agricultural Lime

REFERENCES

Caley and Liberty, 1950c, p.6
Hewitt, 1960, p.31–35
Hewitt, 1964a, p.28
Liberty, 1969b, pp.98, 101
Hewitt and Vos, 1972, p.28–29

Ryell et al., 1974
Dolar-Mantuani, 1975, p.8-22

MAPS

Caley and Liberty, 1950b, GSC Map 50-11A
Liberty, 1969a, GSC Map 1228A

H-6 FOWLER CONSTRUCTION CO. LTD. — WOODS (LONGFORD) QUARRY

LOCATION AND OWNERSHIP

The Woods Quarry is located near Longford Mills on Simcoe Rd. 44, in Lots 26-29, Broken Front Concession, Rama Township, Simcoe County (Figure H-6-1). The quarry was first opened in the early 1900s and is the northernmost of a string of quarries, now abandoned, that were once important sources of building stone (Parks, 1912; Goudge, 1938). The "Longford" and "Rama" stones were the most important and were used for the construction of commercial buildings in Toronto. Detailed descriptions of some of the old quarries are presented by Hewitt (1960; 1964b). The quarry was licensed in 1979 to the present owner and operator, Fowler Construction Co. Ltd. The quarry licence covers 25.87 ha.

GEOLOGY

The geological section in the quarry consists of 5.1m of the middle and upper members, Gull River Formation, which are overlain by 0.3m of lower Bobcaygeon Formation (Liberty, 1969b). Green dolostones of the lower member, Gull River Formation, occur just below the quarry floor. The middle member consists of medium-bedded, microcrystalline limestone. The upper member is a thin- to medium-bedded, microcrystalline to fine-crystalline limestone which is, in part, transitional to the overlying Bobcaygeon Formation. The lower member, Bobcaygeon Formation, is a thin-bedded, coarse-crystalline limestone interbedded with coarse-grained calcarenites. Glacial overburden around the quarry is less than 0.5 m thick.

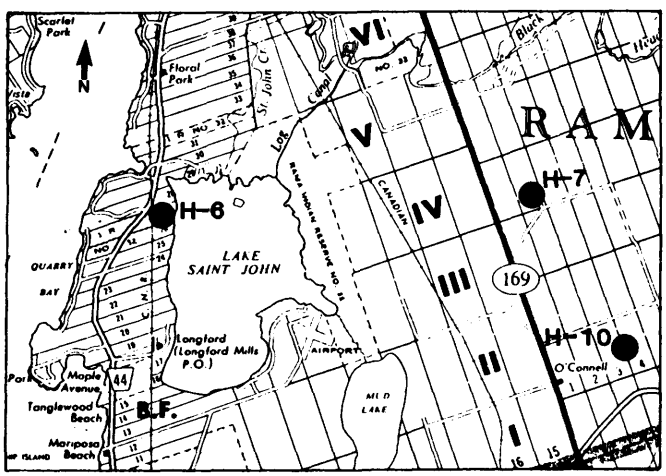


Figure H-6-1. LOCATION MAP FOR WOODS (LONGFORD) QUARRY.

Geological Section

		Thickness
UNIT 4	*Bobcaygeon Formation, lower member*	*0.3m*

Limestone: light grey-brown; weathers light brown; coarse to very coarse crystalline; also coarse-grained calcarenites present; thin bedded (5-10 cm), sharp contacts; fossiliferous with all types present; distribution of unit is patchy due to irregular topography around quarry; lower contact of unit sharp and irregular.

UNIT 3	*Gull River Formation, upper member*	*2.0m*

Limestone: mottled light grey and light brown, weathers dark grey; microcrystalline to fine crystalline; medium to thick bedded (10-40 cm), sharp, irregular, stylolitic contacts in places; thin intervals of coarse-crystalline limestone; sparsely fossiliferous with some burrows present; unit is transitional from Gull River to Bobcaygeon Formation; lower contact of unit sharp and irregular.

UNIT 2	*Gull River Formation, middle member*	*1.2m*

Limestone: white to cream to medium grey, weathers same; microcrystalline, with a lithographic texture; medium to thick bedded (20-40 cm), stylolitic contacts and numerous stylolites within beds; abundant, small patches of calcite crystals ("birdeye" texture); sparsely fossiliferous; lower contact of unit sharp at base of 2 cm thick soft, recessive green shale.

UNIT 1	*Gull River Formation, middle member*	*1.9m*

Limestone: light brown, weathers light grey-brown; microcrystalline, with a lithographic texture; medium bedded (20-30 cm), stylolitic contacts; throughout unit several thin interbeds of light green, shaly limestone, medium to coarse crystalline, with abundant ostracods; abundant patches of calcite crystals ("birdseye" texture).

Total thickness	*5.4m*

QUARRY OPERATION

The quarry has a disturbed area of about 5 ha, on a single lift of up to 5.7 m.

Drilling and blasting is performed by Fowler Construction Co. Ltd. A drill pattern of 2.4 m x 2.7 m is used with a 63.5 mm blast hole diameter. AN/FO is used as the explosive charge wherever possible but when encountering wet conditions, Powerfrac stick powder is used to achieve good fragmentation.

PROCESSING

A Cat 980C loader is used to haul shot rock to the primary crusher, a Cedarapids 27 in. x 42 in. jaw feeding a secondary 54 in. Eljay cone crusher. The stone is screened beside the Eljay cone, producing HL4, Granular "A", and oversize that is sent to an 18 in. x 30 in. Pioneer roller crusher. The roller crusher is equipped

with a 5 ft. x 18 ft. screen which produces 1 in. clear, 3/4 in. clear, and Granular "A".

PRODUCTS

Granular "A"
1 in. Clear
3/4 in. Clear
HL4

REFERENCES

Parks, 1912, p.229–231
Goudge, 1938, p.135–138
Caley and Liberty, 1950c, p.7
Hewitt, 1960, p.37–40
Hewitt, 1964b, p.31–37
Liberty, 1969b, p.98

MAPS

Caley and Liberty, 1950b, GSC Map 50–11A
Liberty, 1969a, GSC Map 1228A

H-7 RAMA TOWNSHIP QUARRY

LOCATION AND OWNERSHIP

This small quarry, 3.5 km east of Lake St. John, is operated intermittently by Rama Township with portable equipment. It is located in Lot 2, Concession E, Rama Township, Simcoe County (Figure H–7–1).

GEOLOGY

The geological section consists of 5.0 m of limestones and dolomitic limestones of the lower member of the Gull River Formation (Figure H–7–2). Green sandy limestone of the Shadow Lake Formation is exposed in the quarry floor. Glacial overburden around the quarry is less than 0.5 m thick.

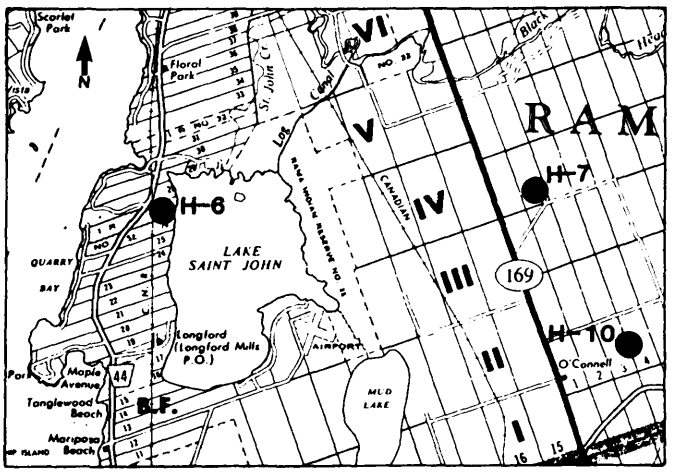


Figure H-7-1. LOCATION MAP FOR RAMA TOWNSHIP QUARRY.

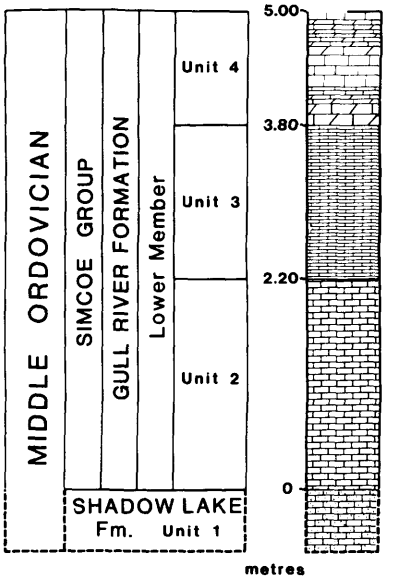


Figure H-7-2. STRATIGRAPHIC COLUMN FOR RAMA TOWNSHIP QUARRY.

Geological Section

Thickness

UNIT 4 Gull River Formation, lower member *1.2m*

Limestone and dolomitic limestone: mottled light grey and grey-brown, weathers light grey and brown; dolomitic limestone is fine crystalline; limestone is microcrystalline with a lithographic texture; thin to medium bedded (5–15 cm), with sharp, slightly irregular, stylolitic contacts; small patches of calcite crystals ("birdseye" texture) present, some with small gypsum crystals in centre; rare burrows; lower contact of unit sharp and planar.

UNIT 3 Gull River Formation, lower member *1.6m*

Limestone: light grey, weathers same; microcrystalline to very fine crystalline; thin bedded (5–10 cm), stylolitic contacts; light green glauconite coats burrows, fossils and bedding planes; small patches of calcite crystals ("birdseye" texture) common; small pyrite crystals present rarely; white, brittle chert nodules in upper 50 cm; fossiliferous with abundant brachiopods, crinoidal debris and burrows; lower contact of unit sharp and planar.

UNIT 2 Gull River Formation, lower member *2.2m*

Limestone: light grey to light grey-brown, weathers light grey; microcrystalline to very fine crystalline with a lithographic texture in places; medium bedded (15–30 cm), with sharp, planar, sometimes stylolitic contacts; glauconite coats fossils and lines burrows; small patches of calcite crystal ("birdseye" texture) common; fossiliferous with many fragments and burrows; lower contact of unit sharp and planar at quarry floor.

UNIT 1 Shadow Lake Formation (quarry floor)

Sandy limestone: light green, weathers same; very fine-crystalline limestone with medium- to coarse-grained quartz; unit is only exposed in patches around quarry floor.

Total Thickness 5.0m

CHEMICAL ANALYSES

Components in Percent			
SiO_2	4.60	CaO	47.7
Al_2O_3	2.06	L.O.I.	40.9
Fe_2O_3	0.94	TOTAL	99.93
MgO	3.73		

Source: Hewitt and Vos, 1972, p.39.

REFERENCES

Hewitt and Vos, 1972, p.38–40

MAPS

None

H-8 MARA LIMESTONE AGGREGATES LTD. — GAMEBRIDGE QUARRY

LOCATION AND OWNERSHIP

The Gamebridge Quarry, located 1 km northwest of Gamebridge in Lots 11 and 12, Concession A, Mara Township, Simcoe County (Figure H-8-1), is owned and operated by Mara Limestone Aggregates Ltd. and is licensed for 90.23 ha. The quarry now covers an area of 8 ha and produces road construction aggregates from a single lift of 10.5 m.

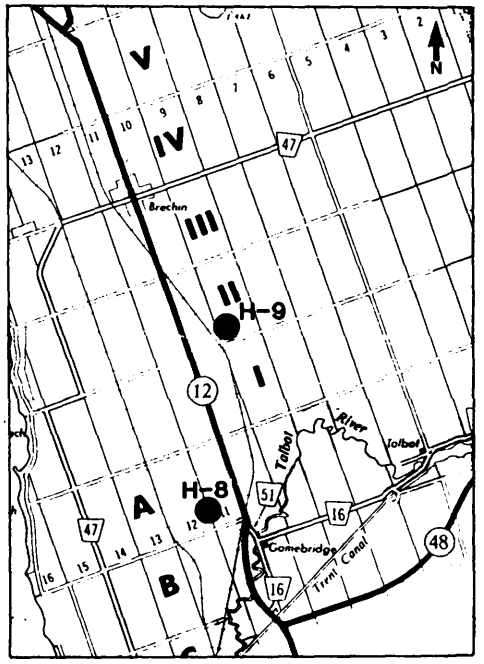


Figure H-8-1. LOCATION MAP FOR GAMEBRIDGE QUARRY.

GEOLOGY

The 10.5 m deep quarry extends into a low escarpment of thin-bedded limestone, shaly limestone and shale of the Verulam Formation. The medium to dark grey limestone beds range from very fine-crystalline limestone to very coarse-grained calcarenites, with most beds consisting of medium to coarse-grained bioclastic limestone. The shaly limestone and shale beds are usually firm and only rarely form recessive units. As this rock is very fossiliferous and the fossils are well preserved, it is a popular site for fossil collectors. Glacial overburden around the quarry is usually less than 1 m thick.

Geological Section

Thickness

UNIT 1 Verulam Formation 10.5m

Interbedded limestone, shaly limestone, and shale: medium to dark grey, weathers light to medium grey, tan in uppermost metre; limestone ranges from very fine crystalline to very coarse-grained calcarenite, usually a medium- to coarse-grained bioclastic limestone; limestone thin bedded (5–10 cm); shale and shaly limestone thinner bedded (3–5 cm); sharp, planar to irregular contacts; some coarser grained beds with small patches of calcite; very fossiliferous (including the bryozoa *Prasopora*; the brachiopods *Zygospira*, *Stegerhyncus*, *Sowerbyella*, and several strophomenids; crinoidal debris; trilobite fragments; and a large number of indeterminant fragments).

Total thickness 10.5m

CHEMICAL ANALYSES

Components in Percent			
Metres above floor 5.5–10.5		Metres above floor 0–5.5	
SiO_2	15.2	SiO_2	17.2
Al_2O_3	3.34	Al_2O_3	4.56
Fe_2O_3	1.37	Fe_2O_3	1.72
MgO	1.28	MgO	2.09
CaO	42.1	CaO	39.0
P_2O_5	0.08	P_2O_5	0.11
SO_3	0.88	SO_3	1.28
L.O.I.	35.3	L.O.I.	33.3
Total	99.5	Total	99.3

Source: Hewitt and Vos, 1972, p.29.

QUARRY OPERATION

Drilling and blasting is performed by the company, using a 2.44 m x 2.44 m drill pattern with 7.6 cm diameter holes. AN/FO is used as the explosive agent and is initiated with electric blasting caps.

PROCESSING

Shot rock is hauled by a single Trojan 175 (7 yd.) loader and two Komatsu 600 (6 yd.) loaders to the primary crusher, a Cedarapids impactor. The crushed stone is fed

Photo H-8-1. PRIMARY FEED HOPPER AND PORTABLE CEDARAPIDS IMPACTOR CRUSHER; GAMEBRIDGE QUARRY.

to a Tyler double-deck screen which produces 3/4 in. or 2 in. crusher run and a +2 in. oversize that is sent to two Skoda (4 ft.) cone crushers. Stone from the cone crushers is processed by two inclined Simplicity screens, producing 3/4 in. clear, HL 3, HL 6, and screenings.

PRODUCTS

2 in. Crusher Run
3/4 in. Crusher Run
3/4 in. Clear
HL3
HL6
Screenings

REFERENCES

Goudge, 1938, p.138-140
Caley and Liberty, 1950c, p.7
Liberty, 1969b, p.49
Hewitt and Vos, 1972, p.29
Waddington, 1980
Kobluk and Brookfield, 1982, p.38

MAPS

Caley and Liberty, 1950a, GSC Map 50-11B
Liberty, 1969a, GSC Map 1228A

H-9 STANDARD AGGREGATES LTD. — BRECHIN QUARRY

LOCATION AND OWNERSHIP

The Brechin Quarry is located 2 km southeast of Brechin in Lots 7, 8, 9 and 10, Concessions 1 and 2, Mara Township, Simcoe County (Figure H-9-1). The quarry

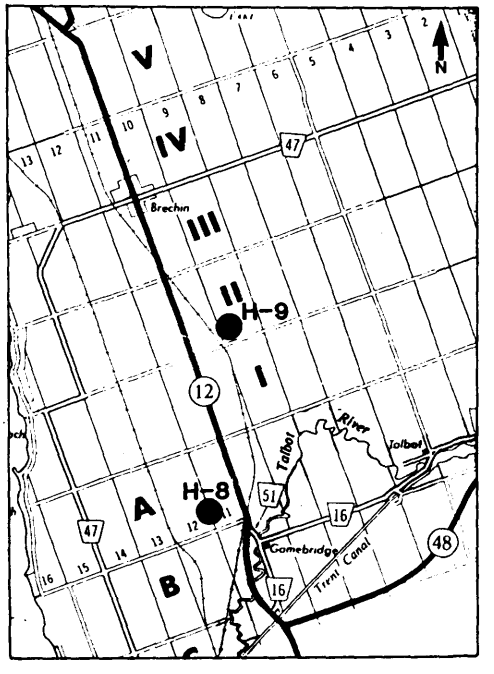


Figure H-9-1. LOCATION MAP FOR BRECHIN QUARRY.

was opened in 1974 and has a licensed area of 331.85 ha. Standard Aggregates Ltd., the owner and operator of the quarry, ships much of the quarry production by contracted trailer trucks to the Toronto area.

GEOLOGY

The three lifts of the quarry expose 21.5 m of limestones of the Bobcaygeon Formation overlain by 3.3 m of the

Verulam Formation (Figure H–9– 2). For the most part, the Bobcaygeon is a light to dark grey, sometimes brown limestone which weathers light grey. It is fine to coarse crystalline and medium bedded with sharp, slightly irregular bedding contacts separated by thin shale partings. It is very fossiliferous and is intensively burrowed. There are some distinctive coarse–grained beds which contain black chert nodules, rip up clasts, and abundant fossil fragments. Small calcite crystals occur as patches and infilling small vugs.

The 3.3 m thick exposure of the Verulam Formation in this quarry consists of light to medium grey interbedded limestone and shale. The limestones are fine to medium crystalline and thin to medium bedded. The formation is very fossiliferous with brachiopods and bryozoans (e.g. *Prasopora*) most abundant. Glacial overburden around the quarry is thin.

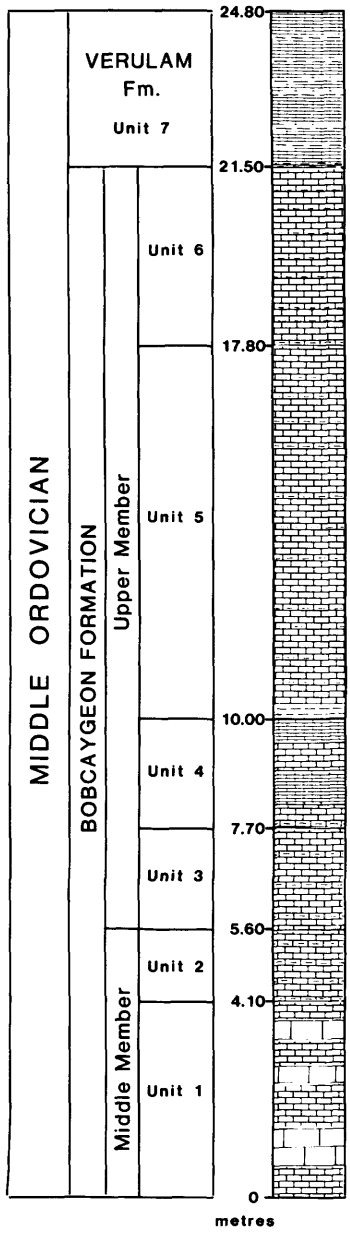


Figure H–9–2. STRATIGRAPHIC COLUMN FOR BRECHIN QUARRY.

Geological Section

Thickness

UNIT 7 Verulam Formation *3.3m*

Interbedded limestone and shale: light to medium grey, weathers grey to grey-brown; fine to medium crystalline; thin bedded (5–8 cm), with thinner (2–5 cm) shale interbeds; upper 2 m of unit with even thinner (2–4 cm) limestone beds; fossiliferous with abundant bryozoans (e.g. *Prasopora*) in lower 1.3 m of unit and abundant brachipods and burrows throughout; lower contact of unit sharp and planar at base of 3 cm thick shale bed.

UNIT 6 Bobcaygeon Formation, upper member *3.7m*

Limestone: medium grey, weathers same; medium crystalline; medium bedded (10–15 cm), sharp, irregular contacts with rare, shaly limestone partings less than 2 cm thick; very fossiliferous with abundant brachiopods, crinoidal debris, bryozoans (*Prasopora* very abundant); fossils mostly on bedding planes; lower contact of unit sharp at base of a 2 cm thick shaly limestone bed, which in turn is overlain by a 3 cm thick shale bed that contains numerous discrete burrows.

UNIT 5 Bobcaygeon Formation, upper member *7.8m*

Limestone: medium to dark grey, weathers lighter grey; medium to coarse crystalline; medium bedded (20–25 cm), sharp and planar to slightly irregular contacts; 80 cm above base of unit is a thick, recessive, soft shale which is continuous around the quarry; some thin, fine-crystalline limestone beds occur throughout the unit which are a lighter grey, with upper contacts gradational and in rare cases lower contacts appear erosional; unit is very fossiliferous with many burrows also present; floor of upper lift covered with large megaripples of coarse-grained calcarenite.

UNIT 4 Bobcaygeon Formation, upper member *2.3m*

Limestone: medium grey, weathers light grey; very fine to fine crystalline; thin to medium bedded (5–15 cm), very irregular, discontinuous contacts; some interbeds of coarse-grained calcarenites with internal slumping, rip-up clasts, very abundant fossil fragments, large black chert nodules up to 5 cm thick, and with very sharp, irregular, erosional basal contacts; fossiliferous with abundant brachiopods, gastropods throughout unit; lower contact of unit sharp at thin shaly limestone bed.

UNIT 3 Bobcaygeon Formation, upper member *2.1m*

Limestone: grey-brown to medium grey, weathers light grey-brown; very fine to coarse crystalline; medium bedded (15–20 cm), sharp contacts with up to 3 cm thick shaly limestone partings; some alternating coarse-grained calcarenites and very fine-crystalline beds with very sharp, irregular, erosional basal contacts, with burrows extending down into underlying bed from surface; very fossiliferous.

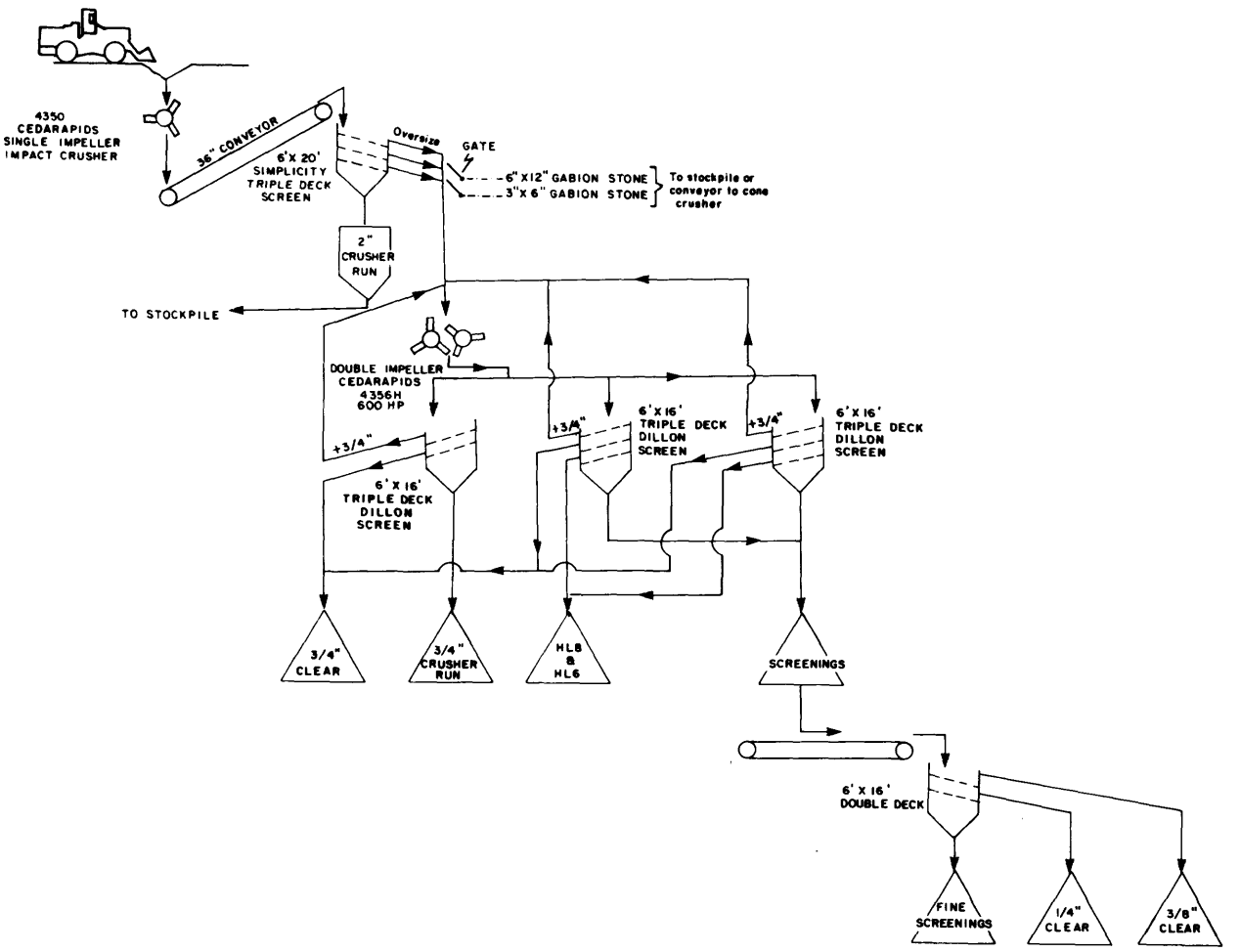


Figure H-9-3. PROCESS FLOW SHEET FOR BRECHIN QUARRY.

UNIT 2 Bobcaygeon Formation, middle member *1.5m*

Limestone: medium to dark grey, weathers medium grey; fine to medium crystalline; medium bedded (10-15 cm), sharp, very irregular contacts due to thin, platy, shaly limestone partings; numerous thin intervals of microcrystalline limestones and very coarse-grained calcarenites; very fossiliferous especially on bedding planes; lower contact of unit sharp, at base of 2 cm thick shale bed.

UNIT 1 Bobcaygeon Formation, Middle Member *4.1m*

Limestone: light to dark grey and light grey-brown, weathers light grey, fine to medium crystalline; medium to thick bedded (20-40 cm), sharp, irregular contacts; upper 1m contains irregular microcrystalline limestone patches; rare vugs filled with calcite crystals; fossiliferous.

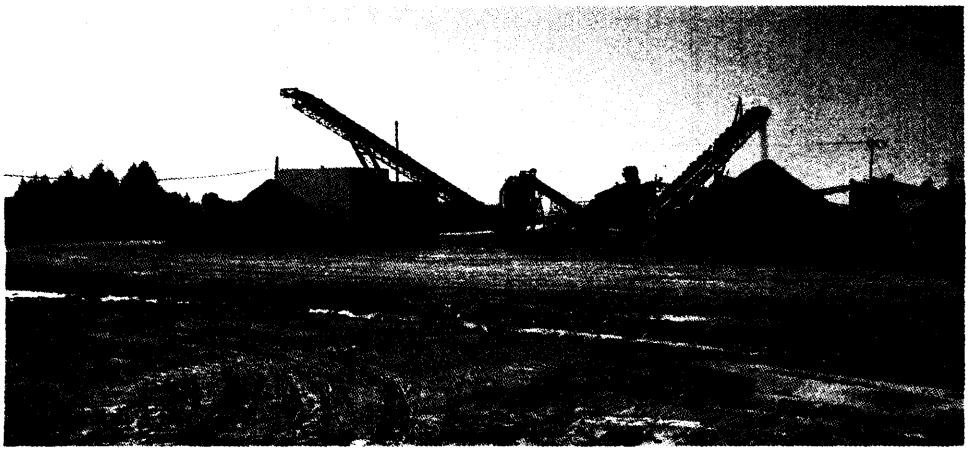
Total thickness *24.8m*

QUARRY OPERATION

The quarry is excavated on 12.4 m benches and reaches a depth of 24.8 m on the north and west faces. The eastern quarry face is currently mined on the second bench (12 m to 24 m depth) for the extraction of concrete stone products. A third bench is in the initial stages of development (6.1 m, 1 lift) and will ultimately reach a depth of 36.6 m.

Drilling is carried out with an Atlas Copco hydraulic drill. An 11 ft. x 11 ft. drill pattern with 4 in. diameter drill holes is used. Blast holes are loaded with AN/FO and initiated by electric blasting caps.

Photo H-9-1.
BRECHIN QUARRY PROCESSING FACILITIES.



PROCESSING

The process flow sheet is shown on Figure H-9-3. Blasted stone is hauled by Cat 992 and 988B loaders to the primary crusher (5348 Cedarapids single impact) located within the pit. The crushed stone is conveyed by a 36 in. belt to a 6 ft. x 20 ft. Simplicity triple-deck screen producing +12 in. oversize to a secondary crusher (4350 Cedarapids double impact), 6 to 12 in. and 3 to 6 in. gabion stone to stockpiles or the secondary crusher, and 2 in. crusher run to a stockpile. The secondary crushed stone is screened by three 6 ft. x 16 ft. Dillon triple-deck screens. Two of the screens produce +3/4 in. oversize that is returned to the secondary crusher, 3/4 in. clear stone, HL8 or HL6, and screenings. The third screen produces 3/4 in. crusher run. The screening stone can be separated if required by a 6 ft. x 16 ft. double-deck screen into 3/8 in. chips and fine screenings.

PRODUCTS

Gabion Stone – 12 in. + 6 in.
Gabion Stone – 6 in. + 3 in.
2 in. Crusher Run
3/4 in. Crusher Run
3/4 in. Clear
3/8 in. Clear
1/4 in. Clear
HL6
HL8
Screenings

REFERENCES

None

MAPS

None

H-10 C.S. SPEIRAN — SPEIRAN QUARRY

LOCATION AND OWNERSHIP

The Speiran Quarry is located in Lots 3 and 4, Concession B, Rama Township, Simcoe County, about 1 km east of Highway 169 (Figure H-10-1). The quarry is intermittently operated by the owner, Carson S. Speiran.

GEOLOGY

The quarry exposes surface-weathered limestones of the Gull River Formation. The limestone is thick bedded (20-30 cm) with numerous superimposed partings at intervals of 2-8 cm, along which the slabs may tend to break. The limestone is microcrystalline and pale grey in colour, weathering to grey-white. A uniform, flat quarry floor reveals a regular pattern of vertical joining in east-

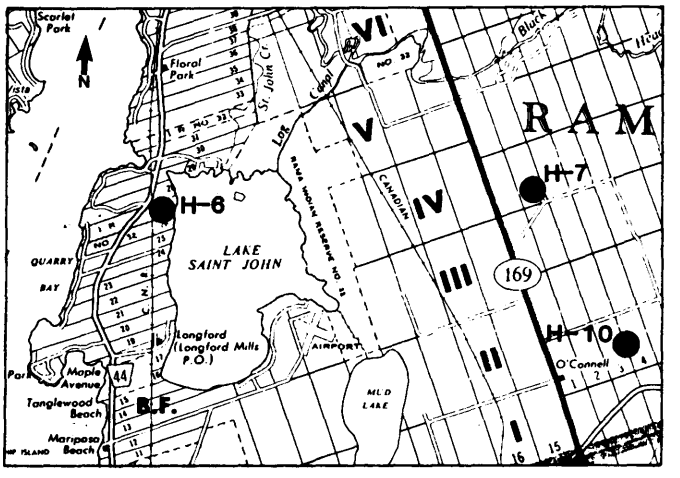


Figure H-10-1. LOCATION MAP FOR SPEIRAN QUARRY.

Photo II-10-1. BLOCKS OF GULL RIVER FORMATION LIMESTONE AT THE SPEIRAN QUARRY.

west and north–south directions, spaced at 1 m and 1–3 m, respectively.

QUARRY OPERATION

Extensive shallow excavations covering several hectares are located on a broad flat limestone plain. Only the top 50 cm of the thick and eroded limestone slabs are taken, for use as landscape stone in rock gardens and retaining walls. Quarrying is accomplished solely by forklift and front–end loader.

REFERENCES

None

MAPS

None

Maple District

INTRODUCTION

Maple District is situated in the Central Region of southern Ontario, bounded on the east by the Lindsay District, on the south by Lake Ontario, on the west by the Cambridge District and on the north by the Huronia District, and includes Metropolitan Toronto, all of the Regional Municipalities of Peel and York, and the western part of Durham (Figure MA-0-1).

The St. Lawrence Cement Company Inc. (site no. MA-1) operates a cement manufacturing plant in Mississauga (Clarkson) which was visited during the study.

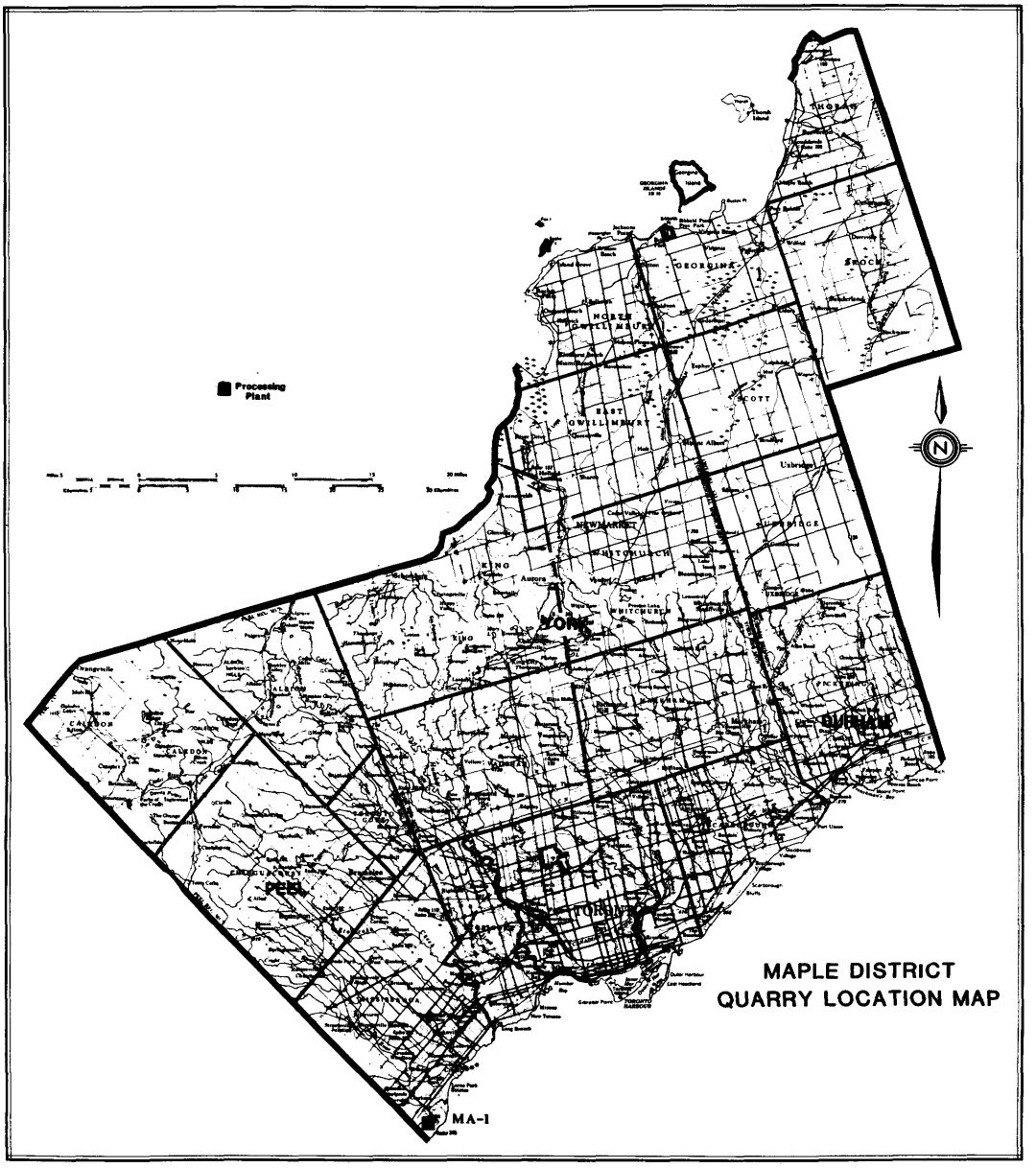


Figure MA-0-1. MAPLE DISTRICT QUARRY LOCATION MAP.

Nine inactive quarries in Maple District are documented in Appendix IV of Volume I.

REGIONAL GEOLOGY

Paleozoic strata present within Maple District range in age from Middle Ordovician to Middle Silurian. Apart from exposures of Silurian age rocks along the Niagara Escarpment, which crosses the extreme western portion of the district, and scattered outcrops of Ordovician age rocks in the Lake Simcoe area, these strata are poorly exposed. This is a result of the nearly flat–lying nature of the strata and the thick Quaternary deposits which cover the central portion of the district. Ordovician units present in this district are (in ascending stratigraphic order): the Verulam, Lindsay, Blue Mountain, Georgian Bay and Queenston Formations. Details of these units can be found in the introduction chapter and in the geological introduction to the Huronia District. Silurian age units present along the Niagara Escarpment include: the Whirlpool, Manitoulin, Cabot Head, Fossil Hill and Amabel formations. For details of these units see the geological introduction to the Cambridge District.

LIMESTONE INDUSTRIES

The principal limestone industry in the Maple District is cement. Cement production in 1985 was approximately 1,360,300 tonnes (1986 Ontario Mineral Score) and was produced by the St. Lawrence Cement Company Inc. at their Mississauga (Clarkson) plant (MA–1).

MA–1 ST. LAWRENCE CEMENT COMPANY INC. — MISSISSAUGA (CLARKSON) PLANT

LOCATION AND OWNERSHIP

The St. Lawrence Cement Company Inc. operates a 1.9 million tonnes per year cement plant at Mississauga (Clarkson). The plant was originally built in 1956 and is located immediately north of Highway 2, approximately 1 km west of Southdown Rd. The plant is the largest cement operation in Canada and includes one dry process and two wet process kilns.

RAW MATERIAL RECEIVING/STORAGE

Limestone for the plant is received by ship from the St. Lawrence Cement Co. quarry at Ogden Point (Colborne), Ontario (site NP–1, Volume II). Stone is unloaded from self–unloading vessels onto a 1,680 m long, 3,000 tonnes/hr. HTS covered belt conveyor. The limestone averages –200 mm in size. The stone is conveyed to the back of the plant where it is piled by a rotating stacker. The storage area holds approximately 1 million tonnes of stone that is reclaimed by means of an underground tunnel system.

The stone from Ogden Point yields a clinker with a C_3S of 70%. Supplemental shale is ripped at the plant site from a small quarry and stored adjacent to the limestone pile. The company is gradually reducing the amount of shale used and replacing it with coal ash. Currently, approximately 12% coal ash is used in place of the shale.

Type 2 cement and low alkali cement production require the use of a limestone sweetener. High calcium limestone screenings from BeachviLime Ltd. in Beachville, Ontario are used to supplement the raw feed. This material is received by truck or rail. Gypsum is received by boat, truck or rail and stored in the open adjacent to the limestone.

All of the kilns are coal fired, although oil and natural gas are available as stand–by fuels. Coal is received from self–unloading vessels onto a 1,680 m long, 2,000 tonnes/hr. HTS covered belt conveyor. This conveyor leads to a 385 m long, 2,000 tonnes/hr. Stephens–Adamson belt conveyor located at the rail siding. (Some coal is also received by rail.) There is provision for 100,000 tonnes of open storage for coal. Reclamation of the coal from storage is by means of an underground tunnel belt conveyor that transfers the coal to the preparation plant.

Other raw materials such as mill scale, silica sand, etc. are received by truck and placed in storage silos.

RAW GRINDING/MIXING

Limestone and other raw materials from storage are transferred by belt conveyor to a 315 tonnes/hr. 8.2 m x 1.7 m Aerofall dry autogenous ball mill for crushing. The crushed stone is passed through a series of cyclones with the tailings going to two 90 tonnes/hr. 3.0 m x 8.5 m Allis–Chalmers regrind mills. A Joy Manufacturing Co. electrostatic precipitator is attached to the Aerofall mill, the precipitated material being returned to the Aerofall mill. Material from the regrind mills is passed to four raw meal storage silos, 56.3 m high x 13.3 m diameter, of 8,100 tonnes capacity each.

Limestone may also be reclaimed and processed to 15.2 mm size through a 315 tonnes/hr. Pennsylvania impact crusher. This material along with other raw materials, is then passed to three 2.4 m x 11.3 m 54 tonnes/hr. Allis–Chalmers slurry mills for further grinding. Screenings from the Aerofall mill may also be used in the slurry grinding process. The finished slurry is pumped to four 7.6 m high x 24.2 m diameter Dorr–Oliver slurry basins. Each basin contains 3,534 m^3 of slurry.

At the present time low alkali and other special cements are made using the wet process kilns. The company is installing equipment and modifying the process to enable the manufacture of cements on the dry kiln. This will require the use of larger benches at the Ogden Point quarry to yield a natural cement stone, as well as the use of $CaCl_2$ in the raw mix to volatize the alkalis during

clinker formation. The wet process kilns will be placed on stand–by and used as reserve manufacturing capacity when the modifications to the quarry and the plant are complete.

KILNS

Coal for all of the kilns is prepared in a KVS 32 tonnes/hr. 3.9 m x 5.8 m coal mill rated at 1,119 kw. The coal is processed to 90% passing 200 mesh. The company has experimented extensively with the use of refuse derived fuel and burning of solvents and waste oils. These experiments have proven to be highly successful and may eventually result in the use of fuel substitutes for approximately 15–20% of total fuel requirements. Currently, coal requirements are approximately 900 tonnes/day.

There are two Allis–Chalmers wet process oil–fired kilns. Each kiln measures 123 m long x 4.0 m – 3.5 m diameter. Each kiln is rated at 900 tonnes/day capacity and has two 75 kw drives. Clinker is discharged to a 720–990 tonnes/day Fuller cooler which is fitted with a Lurgi gravel bed filter.

Raw meal from the storage silos is passed to the dry kiln which is fitted with a Fuller–Humboldt twin suspension 4–stage preheater/precalciner system each rated at 2,100 tonnes/day. Raw meal leaves the first stage at 560°C and leaves the fourth stage at 880°C. The preheater is equipped with a 10% by–pass system but is normally run at 4–5% by–pass due to the 0.5% Cl_2 content in the Ogden Point limestone. The preheater/precalciner is equipped with two Joy Manufacturing electrostatic precipitators, and is fitted with a 26.1 m high x 3.96 m diameter conditioning tower and an SF Products precipitator.

The dry process kiln is a 84.1 m x 5.2 m Fuller–Traylor rotary unit rated at 4,500 tonnes/day. Available capacity has averaged 4,200 tonnes/day. Clinker is cooled in a Fuller cooler measuring 3.0 m x 7.6 m and 3.6 m x 21.3 m, with total capacity rated at 4,200 tonnes/day. The kiln is fitted with a Lurgi gravel bed filter.

Cooled clinker from both the wet and dry kilns is transferred by bucket elevator to a clinker storage building or clinker storage silos. The clinker storage building is fitted with an 18–ton Provincial Engineering bucket crane on a 36.5 m span. The storage silos measure 61 m high x 33.5 m diameter and hold 76,500 tonnes each.

FINISH GRINDING

Clinker is reclaimed from storage and processed in a series of finish mills. There are five Allis–Chalmers 3.0 m x 8.5 m mills rated at 933 kw, each with a capacity of 33 tonnes/hr. There is also a larger Allis–Chalmers mill measuring 3.96 m x 12.8 m and rated at 2,984 kw and 80 tonnes/hr.; and a 3.18 m x 17.1 m Aerofall mill rated at 6,528 kw with a capacity of 170 tonnes/hr. Total cement grinding capacity is rated at 2.5 million tonnes per year. The mills are fitted with air classifiers in closed circuit. There are five Sturtevant separators of 4.8 m diameter rated at 93 kw, two Combustion Engineering separators measuring 5.5 m and rated at 187 kw each, and two GATX–Fuller separators measuring 6.7 m and rated at 112 kw each. The ground cement is cooled in nine F.L. Smidth cement coolers measuring 1.9 m diameter. Each cooler has a capacity of 90 tonnes/hr. and is rated at 45 kw.

PACKING

Finished cement for truck bulk shipping is transferred to storage in 4 silos. Two of the silos measure 58.1 m high x 15.8 m diameter and hold 13,500 tonnes each; the other two silos measure 61.2 m high x 18.3 m and hold 20,000 tonnes each. Two 32–tonne Streeter Amet scales are associated with the silos.

Cement storage for shipment in bags and by bulk rail and truck consists of 20 silos measuring 16.5 m high x 11.6 m diameter, each holding 1,350 tonnes. There are five Consolidated–Bathurst Packaging bag packing machines.

Facilities are available for shipment of cement by boat. Finished cement is recovered from storage and transferred by pneumatic screw pump, conveyor, and air slide for loading at the dock. Clinker may also be shipped by boat. The clinker is recovered from storage and transferred by a 1,680 m long, 2,000 tonnes/hr. HTS conveyor to the shiploader on the dock.

Cambridge District

INTRODUCTION

The Cambridge District is situated in the Central Region of southern Ontario and includes all or portions of Brant, Dufferin, Oxford and Wellington Counties and the Regional Municipalities of Halton, Hamilton–Wentworth and Waterloo, as shown in Figure CB–0–1.

Twenty quarry properties are currently licensed for limestone/dolostone extraction in the Cambridge District; ten are active at the present time. The balance of the properties represent past–producing quarries or those properties identified for future production. The majority of the quarries are located along the Niagara Escarpment and include several of the largest in southern Ontario.

A total of sixty–six quarries have been identified in the district (Appendix IV, Volume I). All of the quarries currently in production and those past–producing quarries of geological significance were visited during the study and include the following:

- *CB–1* *Guelph Correctional Centre Quarry (abandoned)*
- *CB–2* *Guelph Dolime Ltd. – Quarry and Lime Plant (active)*
- *CB–3* *United Aggregates Ltd. – Acton Quarry (active)*
- *CB–4* *Dufferin Aggregates – Milton (Dufferin) Quarry (active)*
- *CB–5* *Halton Crushed Stone Ltd. – Halton Quarry (active)*
- *CB–6* *Milton Limestone – Milton Quarry (active)*
- *CB–7* *Nelson Aggregate Co. – Nelson Quarry (active)*
- *CB–8* *Old Nelson Quarry (abandoned)*
- *CB–9* *Flamboro Quarries Ltd. (active)*
- *CB–10* *Clappison's Corners Quarry (abandoned)*
- *CB–11* *Steetley Lime and Aggregates Division – Dundas Quarry (active)*
- *CB–12* *Taro Aggregates – Stoney Creek Quarries (active)*
- *CB–13* *Waterford Sand and Gravel Ltd. – Vinemount Quarry (active)*

The Cambridge plant of Arriscraft Corp. (CB–14) was also visited.

REGIONAL GEOLOGY

The dominant geomorphic features in the Cambridge District are the north–south trending Niagara Escarpment, Lake Ontario to the east, the deeply incised Grand River valley at Elora–Fergus, and the Dundas Valley located at the west end of Lake Ontario. The Niagara Escarpment provides excellent exposure of Middle Silurian stratigraphy, consisting predominantly of dolostones and dolomitic limestones. The easily eroded underlying Ordovician shales produce an irregular terrain at the base of the Escarpment and eastward to the shoreline of Lake Ontario. West of the Escarpment, Quaternary cover becomes progressively thicker and outcrops become sparse. Scattered bedrock exposures occur near Paris, Boston Creek and Mineral Springs (in the southwest corner of the District), along the Grand, Speed and Eramosa River valleys (in the west–central portion), and around Rockwood and Acton. Consequently, most major operating quarries are located along the Niagara Escarpment, except for the Guelph Dolime Quarry (CB–2), located next to the Speed River in Guelph and the Flamboro Quarries Ltd. Quarry (CB–9) in Flamborough, which operate in areas of thin overburden cover.

The oldest unit which subcrops in the Cambridge District is the Upper Ordovician Georgian Bay Formation. It consists of green–grey to blue shales with interbeds of green–grey siltstones and grey argillaceous limestones. The unit outcrops along the shoreline of Lake Ontario and in steep–sided stream valleys. The Upper Ordovician Queenston Formation gradationally overlies the Georgian Bay Formation, consists predominantly of red, hematitic shale and forms the majority of the bedrock east of the Escarpment. This formation is quarried extensively for the manufacture of ceramic products and bricks and is overlain sharply and disconformably by the Lower Silurian Cataract Group.

The Cataract Group consists of four formations (in ascending stratigraphic order): the Whirlpool, Manitoulin, Cabot Head, and Grimsby. They respectively consist of grey–brown, quartz sandstone; grey–brown, argillaceous dolostones; grey–green shales with interbeds of fine–crystalline limestones and occasional siltstones; and fine–grained red sandstones with interbedded shales. The Whirlpool Formation is quarried extensively for building stone in the region from Limehouse north to Terra Cotta. The Cabot Head Formation is exposed in the Dufferin Quarry (CB–4) by a deep pit which was excavated for the primary crusher, and in the Halton Quarry (CB–5) where the formation is exposed in a sump pit. The Cataract Group is overlain by the Clinton Group which consists of five formations (in ascending stratigraphic order): the Thorold, Reynales, Irondequoit, Rochester and Decew. These formations include, respectively, fine–grained sandstones; fine–crystalline dolostones with irregular shale partings; limestones; shales with interbeds of fine–crystalline limestones and dolostones; and very fine–crystalline dolostones. The Reynales Formation changes character northward in the district to

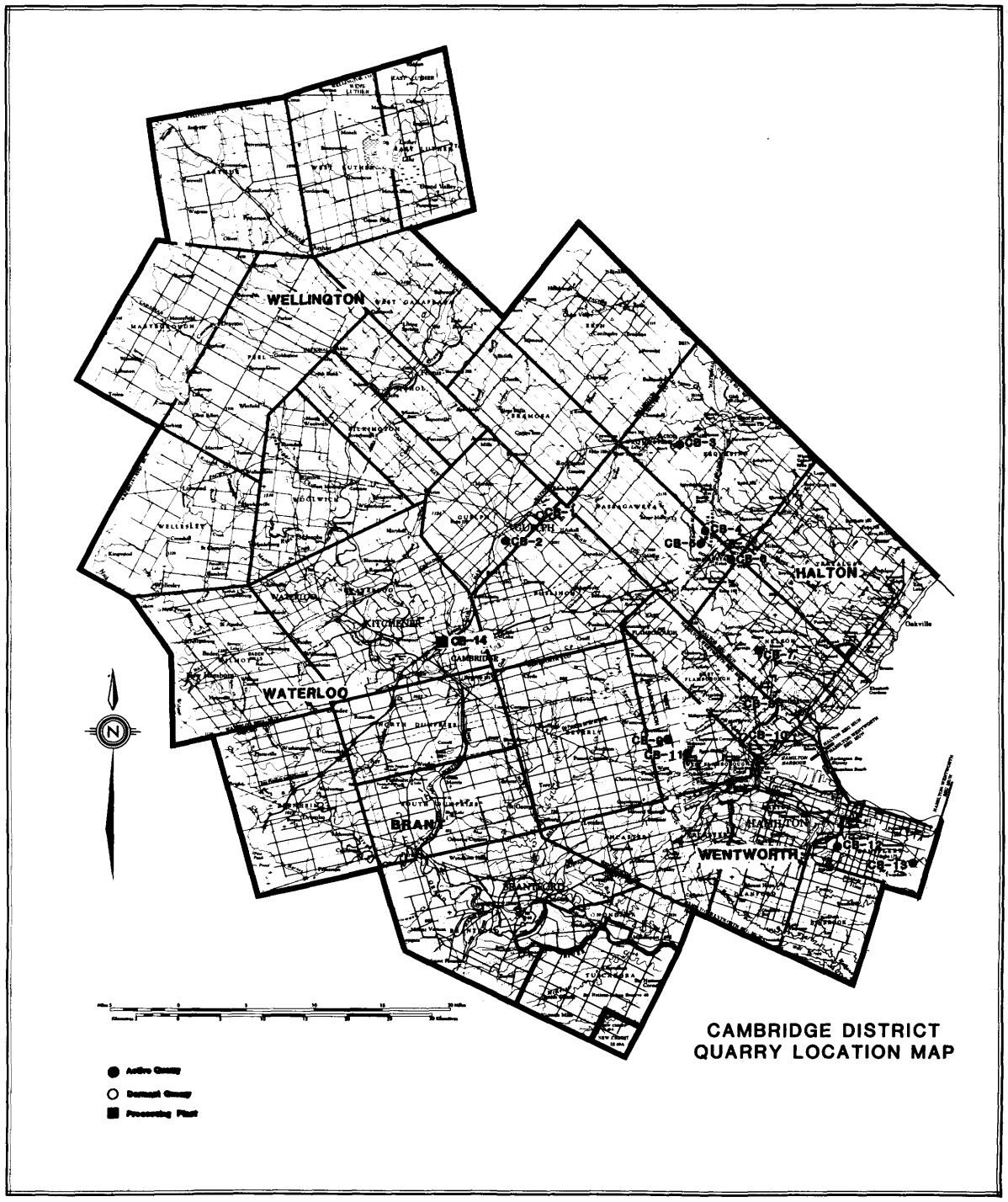


Figure CB-0-1. CAMBRIDGE DISTRICT QUARRY LOCATION MAP.

a brown, fine– to coarse–crystalline fossiliferous dolostone. This is similar to the Fossil Hill Formation, the approximate stratigraphic equivalent found on the Bruce Peninsula. The Reynales is seen in both active and abandoned quarries where excavations were deepened for the emplacement of sumps. The abandoned Clappison's Corners (CB–10) and Old Nelson (CB–8) quarries expose sections through the Reynales, Irondequoit, Rochester and Lockport/Amabel Formations.

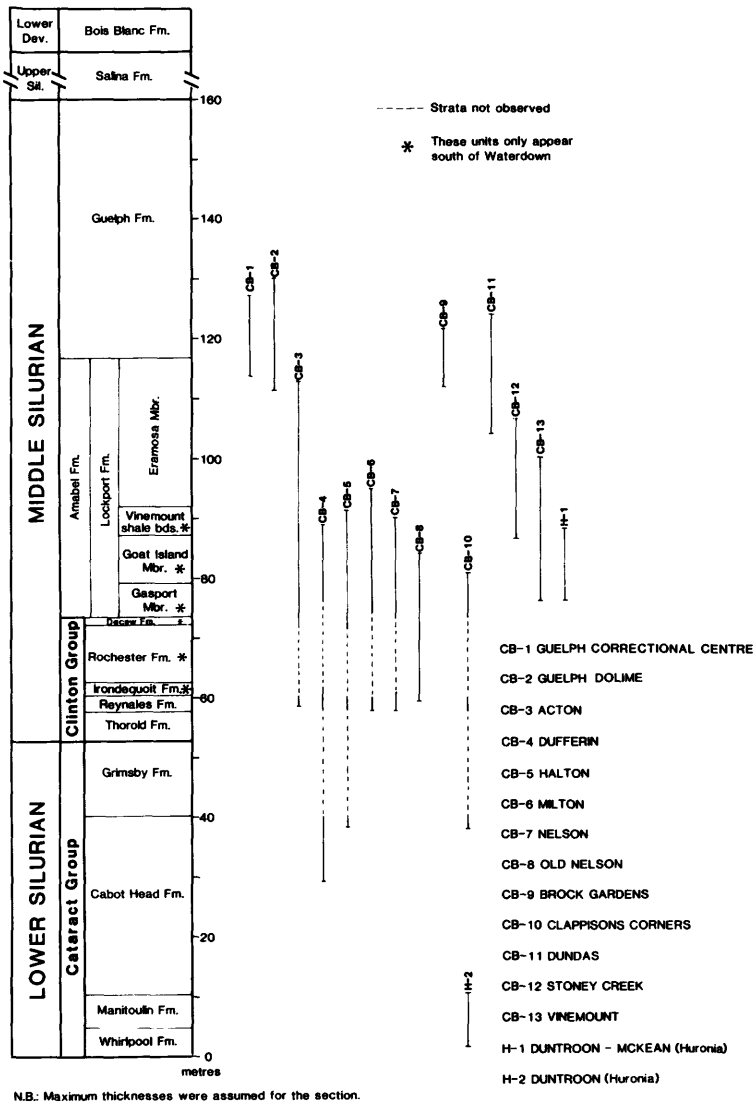


Figure CB-0-2. STRATIGRAPHIC COLUMN SHOWING PRINCIPAL QUARRIES OF CAMBRIDGE DISTRICT.

Sharply and conformably overlying the Clinton Group are the Lockport and Amabel Formations. From Niagara Falls to Waterdown (north of Hamilton), the Lockport Formation can be subdivided into three members (in ascending order); the Gasport, Goat Island and the Eramosa. These rocks consist of fossiliferous dolostones, very fine-crystalline cherty dolostones, argillaceous dolostones with shaly partings and dark grey-brown, bituminous, very fine-crystalline dolostones. In the southwestern area of this district, the Vinemount shale beds are found near the base of the Eramosa Member. The sequence is well exposed at the Vinemount Quarry (CB-13). Also, good outcrop exposures of the Lockport Formation occur in road-cuts along Highway 20 at Stoney Creek, and Highway 403 in Hamilton. The Flamboro Quarries Ltd. (CB-9), Dundas (CB-11), Vinemount (CB-13), and Stoney Creek (CB-12) quarries are the only active quarries in the district utilizing the Lockport Formation.

North of Waterdown, a significant facies change occurs in the well-bedded dolostones, limestones and shales of the Irondequoit to Goat Island sequence. These rocks are replaced by the Amabel Formation, which consists of an irregular, massive- or thick-bedded, medium- to coarse-crystalline dolostone, characterized by reefal or biohermal massive-bedded structures. The Old Nelson Quarry (CB-8) provides the most southerly exposure of the Amabel Formation. The Eramosa Member exists as the uppermost unit in the Lockport Formation

to the south and the Amabel Formation to the north. Most of the quarries in the Cambridge District (see Figure CB–0–2) have targeted the Amabel and Lockport Formations for their operations. The maximum thickness in the district for the Amabel is 40 m in the Acton Quarry (CB–3).

Overlying the Eramosa Member is the Middle Silurian Guelph Formation, a medium– to massive–bedded, sucrosic dolostone. Outcrops are numerous and occur along the Grand River gorge between Fergus and Elora, in the vicinity of Troy and Rockton, in the former towns of Galt and Preston (along the Grand River), and around Hayesland and Glenchristie. The underlying contact with the Eramosa Member is sharp and disconformable at the abandoned Guelph Correctional Centre Quarry (CB–1), whereas at the active Guelph Dolime (CB–2) and Stoney Creek (CB–11) Quarries, the contact is transitional. One other quarry, the Flamboro Quarries Ltd. Quarry (CB–9), presently extracts the Guelph Formation which is also exposed by numerous abandoned quarries in the district.

The overlying Upper Silurian Salina Formation, a grey shale and argillaceous dolostone with abundant gypsum seams, is located in the subsurface and outcrops along the Nith and Grand Rivers near Paris, and around Caledonia. Occurring in the southwest corner of the district are the Upper Silurian Bass Islands Formation, a fine–crystalline dolostone, and the youngest Paleozoic unit of the district, the Lower Devonian Bois Blanc Formation, which is a cherty, fossiliferous bioclastic, argillaceous limestone. Both these formations only exist in the subsurface.

All operating quarries in the Cambridge District utilize material from either the Amabel and Lockport Formations or the Guelph Formation for road construction, asphalt, concrete aggregate and crushed stone, except for the Guelph Dolime Quarry (CB–2) where high purity dolostones of the Guelph Formation are extracted for the manufacture of dolomitic lime, and the Dundas Quarry (CB–11) where Guelph and Lockport (Eramosa) dolostones are extracted for aggregates and dolomitic lime.

LIMESTONE INDUSTRIES

The principal limestone products in the Cambridge District are construction aggregate and lime–metallurgical–chemical stone. Stone production in 1986 for the district exceeded 17,000,000 tonnes and was principally used in the construction industry as road and concrete/asphalt aggregate and for the production of lime.

Approximately 13,400,000 tonnes were produced in the Regional Municipality of Halton and includes production from United Aggregates Ltd. – Acton Quarry (CB–3), Dufferin Aggregates – Milton (Dufferin) Quarry (CB–4), Halton Crushed Stone Ltd. – Halton Quarry (CB–5), Milton Limestone –Milton Quarry (CB–6) and Nelson Aggregate Co. – Nelson Quarry (CB–7).

Production from the Regional Municipality of Hamilton–Wentworth is a distant second at approximately 3,400,000 tonnes principally derived from Flamboro Quarries Ltd. (CB–9), Steetley Lime and Aggregates Division – Dundas Quarry (CB–11), Taro Aggregates – Stoney Creek Quarries (CB–12), and Waterford Sand and Gravel – Vinemount Quarry (CB–13). The balance of the production is derived from Wellington County principally from Guelph Dolime Ltd. – Quarry and Lime Plants (CB–2).

Lime production, in 1986, for the district is reported to be over 274,000 tonnes and includes production from Guelph Dolime Ltd. (CB–2) and Steetley Lime and Aggregates Division (CB–11) (Ontario Mineral Score, 1987).

CB–1 GUELPH CORRECTIONAL CENTRE QUARRY

LOCATION AND OWNERSHIP

This abandoned quarry is located on the property of the Guelph Correctional Centre (Figure CB–1–1).

GEOLOGY

The quarry face exposes the contact between the thin–bedded, brown–black, highly bituminous dolostone and arenaceous dolostone of the Eramosa Member (Amabel Formation) and the Guelph Formation (Middle Silurian). The Guelph is a brown, massive fine– to medium–crystalline, vuggy, fossiliferous dolostone. It has a petroliferous odor and in places is reefy. Fossils found include ostracods, brachiopods, corals and shell frag-

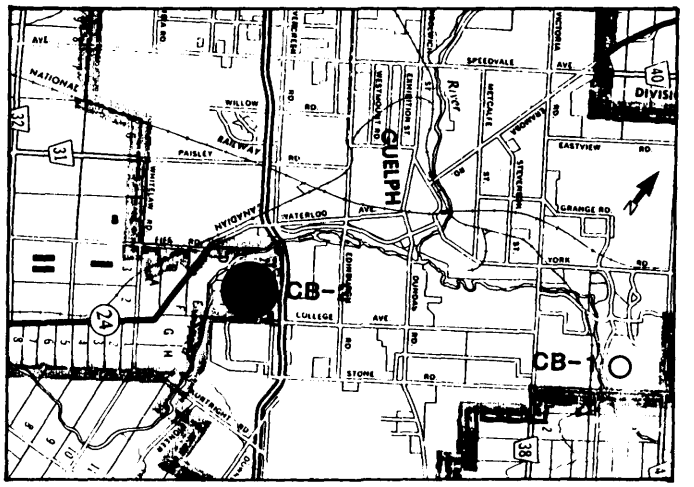


Figure CB-1-1. LOCATION MAP FOR GUELPH CORRECTIONAL CENTRE QUARRY.

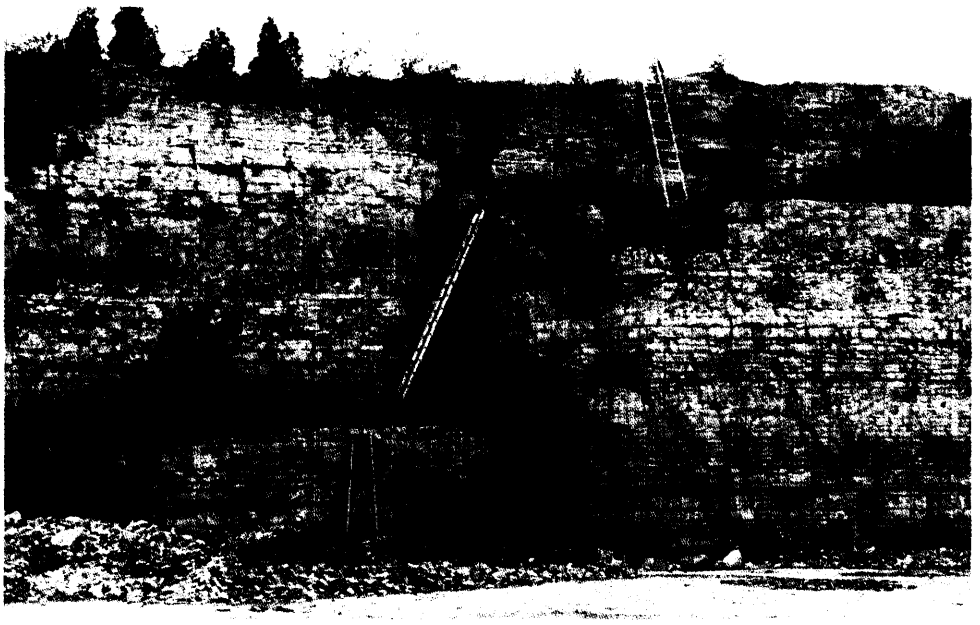


Photo CB-1-1. GUELPH AND AMABEL FORMATIONS IN THE NOW ABANDONED GUELPH CORRECTIONAL CENTRE QUARRY.

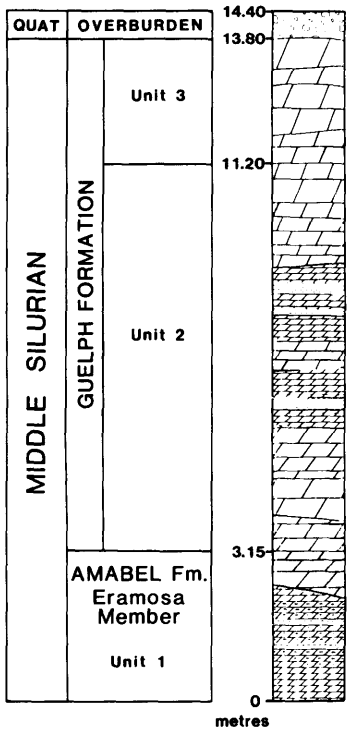


Figure CB-1-2. STRATIGRAPHIC COLUMN FOR GUELPH CORRECTIONAL CENTRE QUARRY.

ments. Abundant conulariids (some up to 17 cm long) were found on the quarry floor. In total, 13.8 m of strata are exposed (Figure CB–1–2).

Geological Section

Thickness

UNIT 3 Guelph Formation *2.6m*

Dolostone: light brown to buff, weathers same; fine to medium crystalline, coarse crystalline in fossil zones; medium to thick bedded, sharp contacts, undulatory; porous, vuggy; abundant reefal debris (crinoids, solitary corals, brachiopods); gradational lower contact.

UNIT 2 Guelph Formation *8.05m*

Dolostone with shaly partings: light brown to black, weathers buff to light grey; fine crystalline; variable bedding (0.05 to 1.0 m), irregular contacts with shaly partings; black to cream coloured chert nodules, iron staining on shale beds, sphalerite and calcite crystals; shale partings display ostracods, brachiopods, trilobite fragments, bryozoa and lenses of bitumen filled corals; lower contact is sharp.

UNIT 1 Amabel Formation, Eramosa Member *3.15m*

Dolostone: black to light brown, weathers blue-grey, shaly, fine to medium crystalline; thin to medium bedded (2 to 35 cm); sharp contacts, undulatory bedding with shaly partings; chert nodules occur in lenses which contain abundant fossil material, calcite and sulphide mineralization are also present, large conulariids (up to 17 cm long) are present along bedding planes in the quarry floor.

Total thickness *13.8m*

REFERENCES

Goudge, 1938, p. 292–293

Caley, 1941a, pp. 25, 64
ARIP 88, 1985, p. 20

MAPS

Caley, 1941d, GSC Map 624A
Telford, 1976b, ODM Map 2342

CB-2 GUELPH DOLIME LTD. — QUARRY AND LIME PLANT

LOCATION AND OWNERSHIP

Guelph DoLime Ltd., a subsidiary of Dofasco Inc., operates a quarry and dolomitic lime plant on the east side of Highway 24, east of the Speed River, on the southwest fringe of the City of Guelph (Figure CB-2-1). The property comprises parts of Lots 1 to 5 in Concessions 4 and 5, Division G, in the Township of Guelph, County of Wellington.

The company has provided the following chronological list of events in the 155 year history (to 1987) of this property:

1832 -Property owned by a Mr. Wingfield.

1837 -John Howitt acquired 320 ha.

1872 -Father Hamel worked what was then known as the Priest Quarters.

1880 -1900 - George Kennedy operated the quarry

1902 -Quarry operated by Father Doyle prior to its sale to the Christie-Henderson Company.

1906 -Steam boiler installed for power supply.

1907 -First hydrate produced.

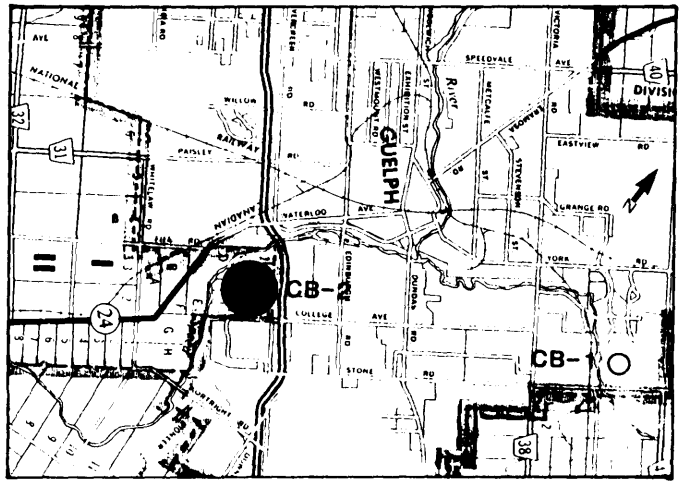


Figure CB-2-1. LOCATION MAP FOR GUELPH QUARRY.

1911 -Steam introduced into kilns.

1912 -Electricity brought to plant.

1914 -Company merged into Standard White Lime Company.

1924 -First steel-shelled kilns installed.

1925 -Mill destroyed by fire, and rebuilt.

1927 -Sixty-five people employed, working the quarry by hand and loading the kilns manually. The process included a two-cycle hydrator and Raymond mill and the kilns were fired by wood.

1931 -Only thirty employed due to reduced market accompanying the depression. Operation purchased by Canadian Gypsum Company on April 1st. Wages were 35¢ per hour. Plant capacity was 40 tonnes per day using five kilns.

1941 -Plant capacity increased to 86 tonnes per day using eight kilns.

1952 -Three new kilns added.

1954 -One new kiln added.

1959 -Two new kilns added.

1978 -Operation purchased by BeachviLime (Dofasco) on March 1st.

1979 -Installation of forced air fans on twelve kilns increased production from 225 tonnes to 340 tonnes per day. Work force increased to 62.

1980 -New screening plants installed. One kiln automated to continuous production. Replaced an apron feeder with a vibrating feeder. Installed a second pan conveyor in the grinding room. New power house constructed.

1982-1983 - Installed new Pay conveyor system in the lime plant.

1985 -Replaced the stone conveyor system from the primary crusher to the kilns.

1986 -Plant capacity increased to 360 tonnes per day using 10 kilns. Work force comprised 45 hourly workers and 8-10 salaried staff.

1987 -New emission control systems planned for the lime kilns.

Guelph Dolime Ltd. also own a quarry and lime plant located in Lots 1, 2 and 3, Concession 4, Puslinch Township. This property has been inactive for several years but was previously operated by Domtar Inc. A description of the quarry geology and plant is found in Hewitt, 1960, p. 123.

Geology

Two lifts are present, which expose some 16 m of Middle Silurian Guelph Formation, and about 3 m of Amabel Formation (Figure CB-2-2). The Amabel Formation

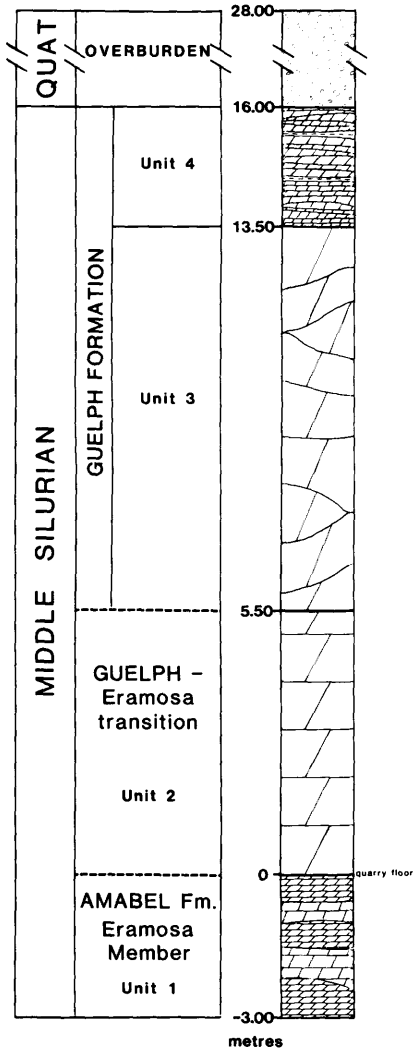


Figure CB-2-2. STRATIGRAPHIC COLUMN FOR GUELPH QUARRY.

(Eramosa Member) forms the floor of the quarry (exposed in the sump) and consists of thin-bedded bituminous dolostone. This rock is coarse crystalline and dark brown. Overlying this are 5.5 m of transitional Eramosa-Guelph Formation dolostones. They are typically grey-green, medium-crystalline, massive, fossiliferous dolostones which are less bituminous than the underlying rocks. These rocks are overlain by a pure, white to buff in colour, fine- to medium-crystalline, massive and thin-bedded dolostone, of the Guelph Formation. Overburden, consisting largely of coarse sand, is 8 m to 12 m thick.

Photo CB-2-1. UPPER SECTION OF THE EXPOSED GUELPH FORMATION IN THE GUELPH DOLIME QUARRY.

Geological Section

		Thickness
UNIT 4	*Guelph Formation*	*2.5m*

Dolostone: white-buff, weathers light buff; fine to medium crystalline; thin bedded (4 to 20 cm), contacts are irregular and undulatory; fossil debris in bands, rare gastropods; minor shaly laminae; lower contact is gradational.

UNIT 3	*Guelph Formation*	*8.0m*

Dolostone: white, weathers light buff; fine crystalline; massive with draping structures that pinch and swell; calcite crystals in vugs; pelecypods, gastropods and stromatoporoids are present and can occur abundantly in some zones as reefal debris; lower contact is gradational.

UNIT 2	*Guelph and Amabel Formation, (Eramosa Member) Transition*	*5.5m*

Dolostone: light grey, weathers green-grey; medium crystalline; massive bedding; calcite crystals in vugs; fossils present include abundant stromatoporoids and algal ripups, rare corals, gastropods and bryozoa; strong bituminous odour on fresh surface; the lower half of this unit is darker in colour than the overlying half; reefal in places; lower contact is gradational.

UNIT 1	*Amabel Formation, Eramosa Member*	*3.0m*

Dolostone: dark brown, weathers light brown; coarse crystalline; thin to medium bedded (5 to 55 cm), sharp undulatory contacts; calcite, pyrite and sphalerite present; very petroliferous odour on fresh surface; stylolites present.

Total thickness	*19.0m*

QUARRY OPERATION

The Guelph Quarry is located east of the plant and occupies about half of the 100 ha property. Quarry production averages 125 tonnes per hour.

Overburden is removed by front end loader and trucks. A 19 m section of dolostone is worked in two lifts. Drilling is accomplished with an Ingersoll–Rand wagon drill equipped with a 7.5 cm bit. Holes are spaced on a 3 m square grid pattern. Dynamite and prilled ammonium nitrate are the blasting agents. A 5–yd P&H electric shovel loads two 25–ton Terex trucks for delivery to the primary crusher.

PROCESSING

The –12 in. crusher discharge is conveyed to a surge pile and reclaimed by conveyor to a double–deck scalping screen with 3 1/2 in. and 1 1/2 in. openings. The oversize stone (3 1/2 in. to 12 in.) is kiln–feed for the ten vertical stack kilns now in use. These are gas–fired and have a total capacity of 360 tonnes per day.

The –3 1/2 in. stone is screened into various products for construction aggregate, agricultural dolostone, and flux for steel making. Calcined stone is also used for steel making and for fibreglass in lump or pebble form. Finer calcined products are used as masons, finishing or industrial quicklime and further grindings results in superfine products for the same markets.

Some of the crushed calcined lime is combined with a measured amount of water in a hydrator to produce hydrated lime. Further grinding and air separation produces a range of hydrated products for masonry and finishing purposes, and for agricultural and industrial uses.

PRODUCTS

Raw Stone:

Agricultural dolostone
Construction aggregate
Industrial stone (steel industry)

Calcined Stone

Lump or pebble (fibreglass and steel industry)
Masons lime
Finishing lime
Industrial quicklime

Hydrated Stone

Masons hydrated lime
Finishing hydrated lime
Agricultural hydrated lime
Industrial hydrated lime

REFERENCES

Goudge, 1938, p. 291–292
Hewitt, 1960, p.124
Hewitt, 1964a, p.57
Vos, 1969, p. 50
Hewitt and Vos, 1972, p. 49
ARIP 88, 1985, p. 20
Sabina, 1986, p. 130

MAPS

Caley, 1941d, GSC Map 624a
Telford, 1976b, ODM Map 2342

CB–3 UNITED AGGREGATES LTD. — ACTON QUARRY

LOCATION AND OWNERSHIP

This quarry is one of the largest in Ontario and is located on the brow of the Niagara Escarpment, 2 km east of Acton in Lots 21 to 24, Concessions 3 and 4, Town of Halton Hills (formerly Esquesing Township) Regional Municipality of Halton (Figure CB–3–1). The Acton Quarry dates back to the turn of the century and until 1930 was operated for the production of dolomitic lime by the Toronto Lime Company. The quarry was re–opened in 1963 by Acton Limestone Quarries Ltd. From 1967 to 1985 the quarry was operated by Indusmin Ltd. and was purchased in June of 1985 by the present owner and operator, United Aggregates Ltd. The quarry licence covers an area of 232.88 ha.

GEOLOGY

The quarry exposes over 40 m of Middle Silurian dolostones of the Amabel and Reynales Formations (Figure CB–3–2).

The section presents a sequence of massive, lenticular and thinner–bedded interlenticular strata of the

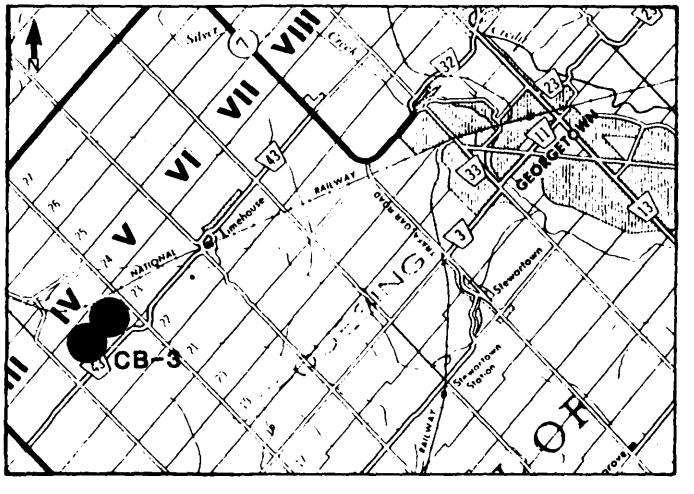


Figure CB–3–1. LOCATION MAP FOR ACTON QUARRY.

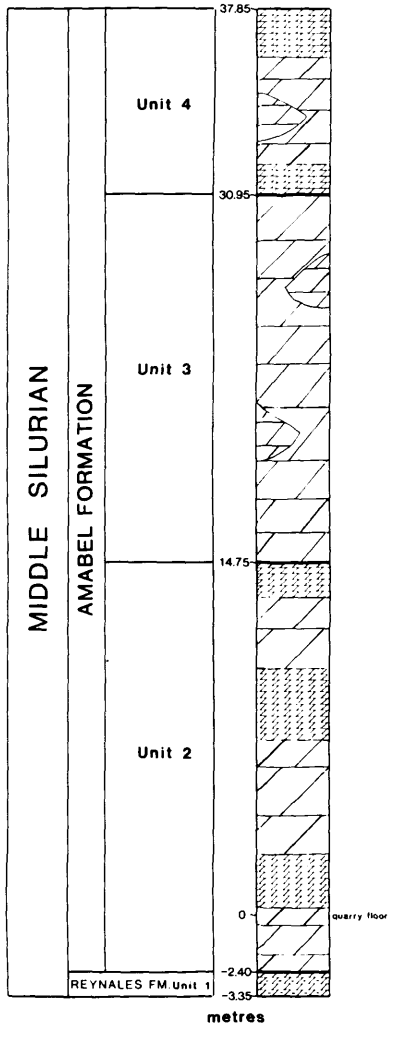


Figure CB-3-2. STRATIGRAPHIC COLUMN FOR ACTON QUARRY.

Amabel Formation, overlying 0.95 m of thin-bedded dolostones of the Reynales Formation. The rocks are mostly medium to coarse crystalline, cream grey and richly fossiliferous. The bedrock surface is locally irregular, and good reef flanks are evident in some parts of the quarry. Overburden averages about 2.5 m in thickness.

Geological Section

Thickness

UNIT 4 Amabel Formation *6.9m*

Dolostone: cream white-buff, weathers buff; fine to coarse crystalline; both massive, lenticular and thin bedded (0.2 to 1.0 m), contacts pinch and swell and are undulatory; calcite crystals in fossil molds; richly fossiliferous with crinoids, brachiopods, bryozoans and gastropods; some draping occurs, gradational lower contact.

UNIT 3 Amabel Formation *16.20m*

Dolostone: white-grey, weathers white-buff, medium crystalline; massive bedded, sharp irregular contacts; calcite in vugs (5 by 10 cm); abundant crinoids; abundant grey bands and stylolites; porous; some draping present; gradational lower contact (colour change).

UNIT 2 Amabel Formation *17.15m*

Dolostone: grey to brown-grey, weathers grey; fine to coarse crystalline; thin to massive bedded (0.15 to 1.5 m), irregular contacts with clay partings; calcite in vugs and sphalerite in lenses; abundant crinoids and rare brachiopods; porous; large reefal masses which drape over from Unit 3; grey colour banding present; sharp lower contact due to colour change.

UNIT 1 Reynales Formation *0.95m*

Dolostone: dark green-grey, weathers same; fine crystalline; thin bedded (4 to 7 cm), undulatory contacts; interbedded with shale; fossil trails present; lower contact is water covered.

Total thickness *41.2m*

QUARRY OPERATION

The quarry operates 12 months a year and is presently worked on two lifts. The 15 m face being worked to the north and east represents the second or lower lift, and the 26 m face being worked to the south and west is the combination of the second lift and the original 11 m upper lift. The 15 m face is advancing towards the processing plant. The blasted stone is loaded by a Cat 992C 13.8 yd. loader into two Euclid B85 (85-ton) trucks and/or two Euclid R50 (50-ton) trucks and is currently hauled approximately 1.7 km to the primary crusher feed hopper. Ramp design alterations are planned that would reduce the haulage distance to about 1 km.

A drilling pattern of 7 m x 7.6 m is used; 25 cm diameter holes are drilled to 0.9 m subgrade with a Bucyrus-Erie 50R rotary drill. The blast holes are loaded with bulk aluminized AN/FO and straight AN/FO, leaving a 4 m collar. The holes are initiated top and bottom by non-electric delay caps, and 11b. primers are used. Blasting occurs twice a week and is monitored for vibrations.

PROCESSING

The plant capacity is in excess of 2.5 million tonnes of crushed aggregate annually. The process flow sheet for the plant is shown on Figure CB-3-3.

The blasted stone can be dumped either directly into the primary feed hopper, or onto a double deck grizzly that produces riprap stone and feeds the finer materials to the primary crusher.

The primary crusher is a 54 in. x 74 in. Allis-Chalmers jaw, producing -9 in. material that is conveyed to a surge pile. Three Syntron feeders recover the stone from the surge pile and convey it to a 5 in. scalping screen. This screen routes +5 in. material to a Telsmith F66 cone crusher, the product going to a triple deck Vibra King screen. Plus 7/8 in. oversize is sent to a second Telsmith

Photo CB-3-1.
FACE AT ACTON QUARRY, SHOWING MASSIVE, LENTICULAR REEFAL STRUCTURES (RIGHT, TOP) AND THINNER-BEDDED, FLANKING STRATA (LEFT, BOTTOM).

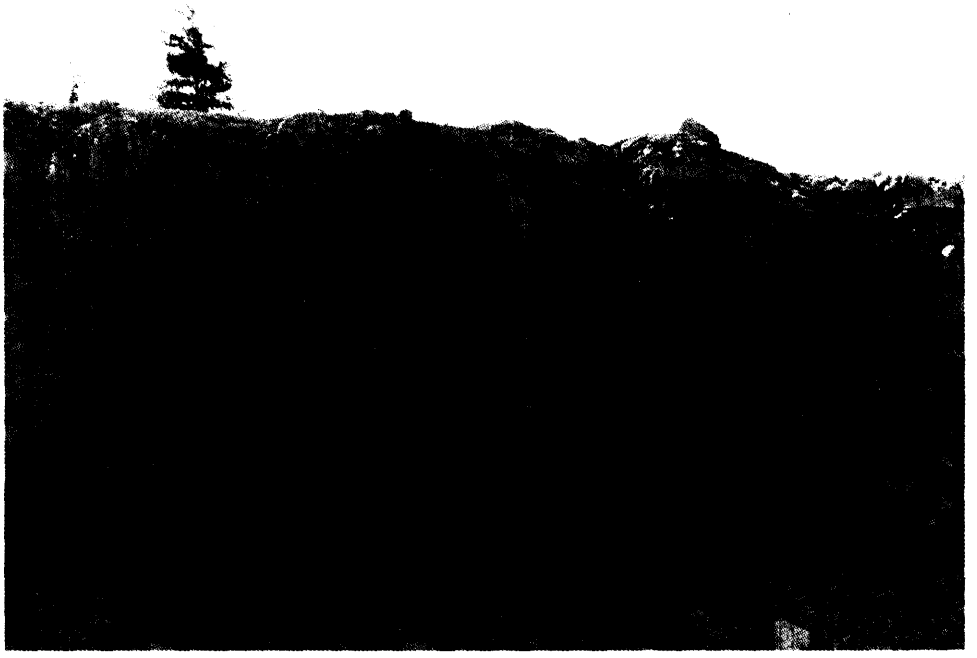


Photo CB-3-2. BUCYRUS-ERIE 50R ROTARY DRILL ON LIFT 2 AT ACTON QUARRY (LOOKING NORTHEAST).

Photo CB-3-3. PROCESSING CONTROL TOWERS AT ACTON QUARRY (LOOKING NORTHEAST).

F66 cone crusher and −7/8 in. material is sent to a 6 ft. x 20 ft. Hewitt–Robins double deck screen. The −5 in. material that passed the scalping screen is sent to two double deck Vibra King screens that add −7/8 in. material to the Hewitt–Robins screen and send +7/8 in. oversize to a Hazemag CHOV/K impact crusher. The Hewitt–Robins screen produces −1/4 in. fines that go to a 70–tonne truck loadout bin and −7/8 in. + 3/16 in. stone that is stockpiled.

Material leaving the second Telsmith and the Hazemag crushers (−2 1/2 in.) is carried by a conveyor to the first control tower, where the stone is sent to two 5 ft. x 16 ft. Vibra King triple deck screens. From these screens, +2 in. oversize is returned to the second Telsmith cone for recrushing; −2 in. + 7/8 in. is sent to a surge bin or directly to a stockpile; −7/8 in. is sent to a surge bin or directly to a stockpile; −7/8 in. + 1/4 in. is sent to the second control tower or a stockpile; and −1/4

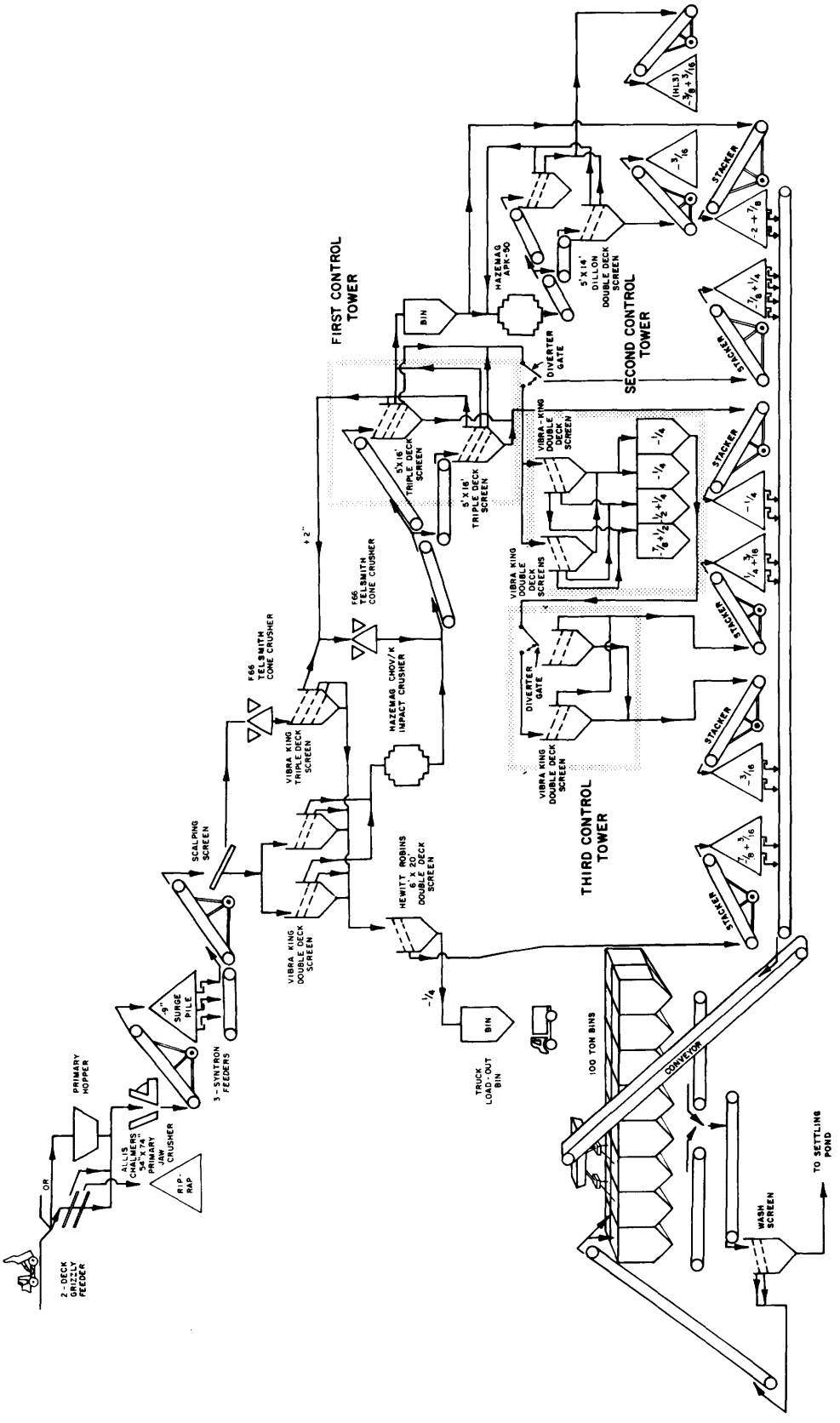


Figure CB-3-3. PROCESS FLOW SHEET FOR ACTON QUARRY.

in. fines are sent to a stockpile. In the second control tower, two Vibra King double deck screens separate −7/8 in. + 1/2 in. and −1/2 in. +1/4 in. fines that are sent to the third control tower. In the third tower, two Vibra King double deck screens produce −1/4 in. +3/16 in. and −3/16 in. material.

The −2 in. + 7/8 in. stone from the first tower can be sent from the surge bin for tertiary crushing by a Hazemag APK−50 impeller crusher, and screening by two double deck Dillon screens, one 6 ft. x 16 ft. and the other 5 ft. x 14 ft. These screens produce −3/8 in. + 3/16 in. (HL3) and −3/16 in. fines.

A 42 in. reclaiming conveyor is installed in a tunnel beneath the 50,000 tonne stockpiles and is supplied by Syntron feeders. The stone can be automatically blended and conveyed for storage in sixteen 100−tonne bins. Stone from any of these bins can be sent to the washing plant and returned to the appropriate bin. All product shipping is by truck though rail facilities do exist at the site.

PRODUCTS

Armour Stone
Riprap 12 in. x 24 in.
Riprap 10 in. x 12 in.
Gabion Stone 4 in. x 8 in.
Gabion Stone 3 in. x 5 in.
2 in. Crusher Run
3/4 in. Crusher Run
Granular "A"
2 in. Clear
1 1/2 in. Clear
7/8 in. Clear
1/4 in. Screenings
3/16 in. Screenings
HL8
HL3

REFERENCES

Goudge, 1938, p. 237−238
Caley, 1940, p. 103
Hewitt, 1964a, p. 53−55
Vos, 1969, p. 46−47
Hewitt and Vos, 1972, p. 50−51
ARIP 46, 1983, p. 14
Sabina, 1986, p. 130−131

MAPS

Caley, 1941d, GSC Map 624A
Telford, 1976b, ODM Map 2342
Bond et al., 1976, ODM Map 2337

CB−4 DUFFERIN AGGREGATES — MILTON (DUFFERIN) QUARRY

LOCATION AND OWNERSHIP

The Milton Quarry, owned and operated by Dufferin Aggregates, a division of St. Lawrence Cement Inc., is located 4 km northwest of Milton in the Towns of Halton Hills and Milton, Regional Municipality of Halton (Figure CB−4−1). The quarry opened in 1962 at the base of the Escarpment. In 1975 the new plant started producing aggregates in its present location. The site of the old plant has been rehabilitated and now provides a park−like setting for an employee "chalet", baseball diamonds and a small trout pond. The Milton quarry has the largest production in Ontario and operates year−round.

The highly automated crushed stone plant is the largest in Ontario and has a capacity of 2,000 tonnes per hour through the primary crusher and the truck loadout system. The quarry licence covers an area of 434.87 ha.

GEOLOGY

The 15.8 m deep Milton Quarry exposes coarse−crystalline, grey−buff, thick− to massive−bedded and fossiliferous dolostones of the Middle Silurian Amabel Formation. Below the quarry floor, argillaceous units are exposed in a crusher pit. They include 4.0 m of the Reynales Formation, a dolostone with shaly partings, and 11.0 m of the Cabot Head Formation, a red and green shaly dolostone. In total, 34.8 m of section are exposed in the quarry (Figure CB−4−2). Overburden averages 1.5 m in thickness.

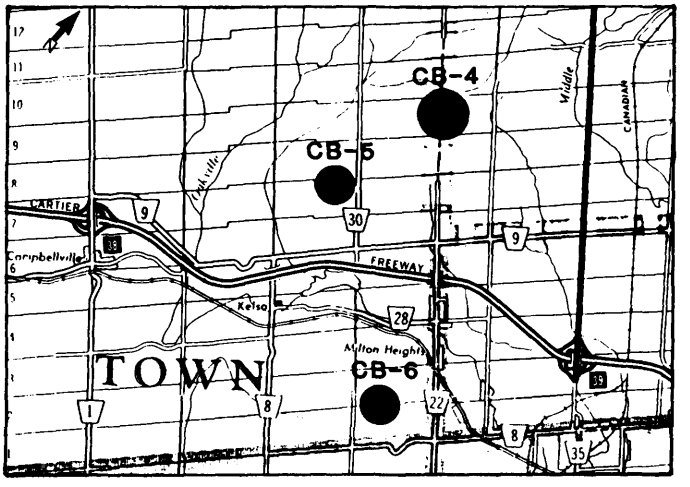


Figure CB−4−1. LOCATION MAP FOR MILTON (DUFFERIN) QUARRY.

Geological Section

Thickness

UNIT 4 Amabel Formation *6.8m*

Dolostone: cream to light grey, weathers buff to light brown; coarse to very coarse crystalline; thin bedded, sharp, slightly irregular contacts; calcite and dolomite crystals in vugs; abundant reefal debris, very fossiliferous (large crinoids, brachiopods, gastropods, and solitary corals); sharp, undulatory lower contact.

UNIT 3 Amabel Formation *9.0m*

Dolostone: cream, weathers buff-grey; coarse to very coarse crystalline; massive, undulatory bedding; very porous with calcite and dolomite crystals in vugs; very fossiliferous (same as unit 4); hummocky quarry floor is lower contact.

UNIT 2 Reynales Formation *4.0m*

Dolostone with shaly partings: green-blue to grey, weathers buff-brown; fine crystalline; thin bedded, contacts are sharp with shaly partings and are bioturbated; unit grades to a shalier and thinner dolostone down section; faint dark laminations; calcite and dolomite in vugs, pyrite in fossil molds; abundant fossil fragments; lower contact is sharp.

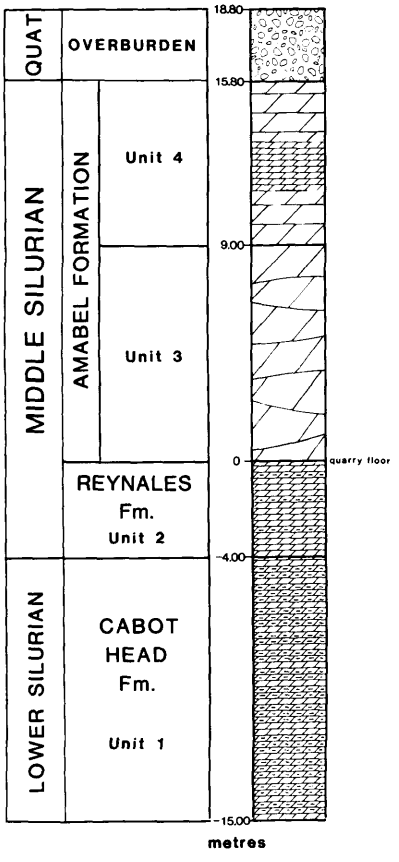


Figure CB-4-2. STRATIGRAPHIC COLUMN FOR MILTON (DUFFERIN) QUARRY.

UNIT 1 Cabot Head Formation *11.0m*

Shaly dolostone: dark red-brown, weathers red and green; fine grained; thin bedded with sharp, irregular contacts; very fossiliferous (bryozoans, brachiopod, and crinoid debris); lower contact not exposed.

Total thickness *34.8m*

QUARRY OPERATION

The quarry is presently excavated over an area of 130 ha, mining a single lift of 6.7 m to 24.4 m (averaging 18.3 m). The overburden is removed using two 1 1/4 yd. JD 790 backhoes and four 35-ton Euclid trucks. Drilling of the irregular, stripped surface is performed by an Ingersoll-Rand DM50 and DM4A Drillmaster, boring 200 mm diameter holes with Hughes HH44 Tri-cone bits. Holes are drilled to an average depth (depending on the face height) of 18.3 m plus 1.2 m subgrade, on a 5.8 m x 6.4 m pattern. Each hole incorporates a liner and is toe loaded with 125 kg of 10% ALAN/FO resulting in 4.6 m of column rise and the remainder is loaded with AN/FO, except for a 3.7 m collar. A Noner bottom hole primer extends to the toe and is initiated at the top by a Noner ms connector. An average shot of about 20 holes in a single row breaks about 32,000 tonnes of rock. Every shot is recorded on a OZA INSTATEL seismograph. Blasted stone is loaded by a 17 yd. RH 120C hydraulic excavator into five 85-ton Terex 33-11B trucks for haulage to the primary crusher (approximately 600 m). The O & K excavator is assisted by a Cat 992B (10 yd.) loader for clean up after blasting, handling oversize and occasionally loading trucks.

Mobile Equipment

Clearing –	contract cutting
Stripping –	2 – John Deere 1 1/4 yd.
	4 – 35-ton Haulage trucks
Drilling –	1 – Ingersoll-Rand DM50 Drillmaster Rotary Drill
	1 – Ingersoll-Rand DM4A Drillmaster Rotary Drill
Loading –	2 – Caterpillar 992B Loaders – 10 cu. yd.
Excavator –	1 – 17 cu. yd. RH 120C O & K
Pit Hauling –	6 – 85-ton Terex 33-11B Haulage Trucks
Stockpiling –	2 – 50-ton Euclid Haulage Truck
	3 – 35-ton Euclid Haulage Trucks
Shipping –	2 – Fiat-Allis 945B Loaders – 6 cu. yd.
	6 – Fiat-Allis FR35 Loaders

PROCESSING

The process flow sheet for the plant is illustrated on Figure CB-4-3.

The haulage trucks dump their loads from two sides into a 36 ft. x 45. ft. ground level feed hopper of the 54 in. x 74 in. Allis-Chalmers primary gyratory crusher. An Erie Strayer rock grapple, operated from a Demag 15-ton bridge crane, is used for positioning large rock. Material passing through the crusher enters a feed bin

Photo CB-4-1. O & K (17 YD.) HYDRAULIC EXCAVATOR LOADING 85-TON TEREX TRUCK AT THE WORKNG FACE OF THE MILTON (DUFFERIN) QUARRY; PROCESSING FACILITY IN BACKGROUND (LOOKING NORTHEAST).

then through a Syntron feeder and discharges on a 48 in. belt which carries the stone above ground to the 60,000 tonne surge pile.

The surge pile has a live storage capacity of 18,000 tonnes (–6 in. material), reclaimable through three Syntron feeder openings. At the secondary building the –6 in. stone is scalped on a pair of 6 ft. x 16 ft. Hewitt–Robins Vibrex double deck screens. At these screens, 4 in. to 6 in. gabion stone can be removed from the process, and the +2 1/4 in. oversize from these screens is sent to a 17 in. x 84 in. Allis–Chalmers Hydrocone secondary crusher.

The –2 1/4 in. material passing through the bottom decks of the screens is chuted to a second set of 6 ft. x 16 ft. screens in the secondary building. The –2 1/4 in. + 7/8 in. material from these screens is discharged onto a 60 in. conveyor and transferred to the classification building. The –7/8 in. material from the screens is discharged to the crusher run pile using a 24 in. stacker.

The main conveyor (60 in. wide), rated at 3,000 tonnes per hour, discharges the –2 1/4 in. stone into a hopper from which it is withdrawn by a Syntron feeder rated at 1,450 tonnes per hour to the north pair and by gravity overflow to the south pair of a bank of six 8 ft. x 20 ft. Hewitt–Robins double deck Vibrex screens. This begins two duplicate processing flows which are independent of each other.

The +2 1/4 in. oversize from these screens (originating from the 84 in. Allis–Chalmers cone) is discharged onto a 30 in. transverse conveyor and from it to a 48 in. conveyor leading back to the crusher section for feed to the tertiary crushers. The option is also available to return the 2 in. stone and 1 1/2 in. stone from the 8 ft. x 20 ft. screens for tertiary crushing. The –2 1/4 in. size from these screens continues through the mill to two banks of four 8 ft. x 20 ft. Hewitt–Robins double deck screens that produce stone sizes from +7/8 in. (1 1/2 in. stone) to –3/16 in. screenings.

Material returning for tertiary crushing is discharged into the 1,650 tonne capacity tertiary crusher feed silo, 30 m high and 12 m in diameter and of reinforced concrete construction.

Three Syntron vibrating feeders feed a pair of 5 in. x 84 in. Allis–Chalmers hydrocone crushers set at 3/4 in., and one 5 1/2 ft. Nordberg Short Head cone crusher set at 1/2 in. The material from these crushers is discharged onto the 60 in. conveyor for transport to the classification building.

Under the truck–loading bin structure are 24 air–operated bin gates, two under each side of the six major bin compartments. There are also 12 Syntron feeders, one under each side of the six major bins, for feeding single sizes or any desired blend onto two parallel loadout conveyors. Presently, one conveyor serves truck loadout and the other the two washing facilities. Loadout from stock-

piles is currently handled using six Fiat–Allis FR35 6.5 cu. yd. loaders.

At present there are two wash plants on–site, both employing a wet screen and a screw dewatering system. One plant is used for the washing of concrete aggregates and the other can be used to wash concrete mix, wash 3/4 in. crusher run to upgrade it or wash 3/4 in. crusher run to separate the stone and sand fractions.

SHIPPING

The Dufferin Aggregates plant uses an efficient computerized truck dispatching system. The tare weight of the incoming truck is taken by the computer, the dispatcher assigns the truck to a specific job on the schedule and gives his routing in the quarry via voice communications.

The computer calculates a dispatching schedule based on the order for the day. This schedule shows what kind of truck is to be sent, to what job, with what kind of aggregate and when the material is needed.

The weigh–out procedure is as follows: on command from the operator, the computer takes the weight of the truck, checks the weight against the truck's Registered Gross Weight (RGW) and, if the weight is within acceptable limits, prints a ticket automatically. The operator can then, through voice communication, tell the trucker at which station to pick up the ticket. The quarry has shipped approximately 27,000 tonnes of stone in a 12–hour day with this system.

REHABILITATION

The mined–out areas of the quarry are currently being returned to grass and trees. Some of the overburden removed during the stripping operation is placed within the quarry, leveled and hydro–seeded with a grass mixture. Trees from local nurseries or from within the property are planted throughout the rehabilitation areas.

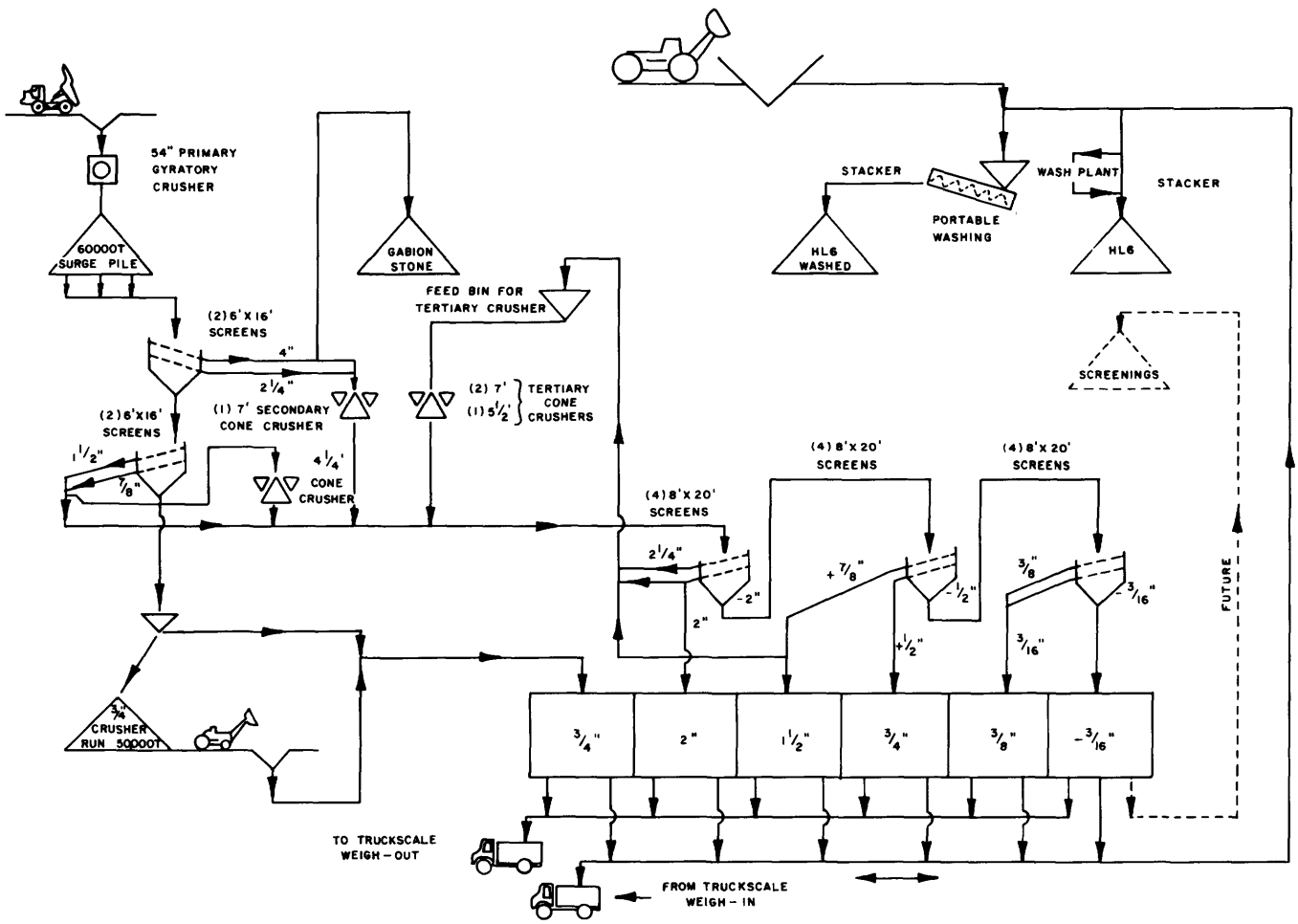


Figure CB-4-3. PROCESS FLOW SHEET FOR MILTON (DUFFERIN) QUARRY.

PRODUCTS

The following stone classifications are produced at the Dufferin Aggregates plant:

Armour Stone
4 – 6 in. Gabion Stone
3/4 in. Crusher Run
2 in. Clear
1 1/2 in. Clear
Granular A
Granular B
3/4 in. Clear Concrete Stone
3/8 in. Clear
3/16 in. Screenings
3/4 in. to 3/8 in. Blend
Concrete Aggregates
2 in. Crusher Run

REFERENCES

Hewitt, 1964a, p. 51–52
Vos, 1969, p. 42–43
Hewitt and Vos, 1972, p. 50
ARIP 47, 1982, p. 20
ARIP 46, 1983, p. 22
Rukavina, 1987

MAPS

Bond et al., 1976, ODM Map 2337

CB-5 HALTON CRUSHED STONE LTD. — HALTON QUARRY

LOCATION AND OWNERSHIP

The Halton Quarry is located 6 km west of Milton on the brow of the Niagara Escarpment in Lots 7 and 8, Concession 6, Town of Milton (Nassagaweya Township), Regional Municipality of Halton as shown on Figure CB–5–1.

In 1985 the Halton Quarry and plant was re–acquired by Halton Crushed Stone Ltd. from Indusmin Ltd., the lessees of the property from 1970 to 1985. Production at the quarry began during the summer of 1959, primarily to supply road aggregate for local construction of Highway 401.

The quarry licence covers an area of 121.5 ha.

GEOLOGY

The Halton Quarry exposes 21.47 m of section (Figure CB–5–2), from the Lower Silurian Cabot Head Formation to the Middle Silurian Amabel Formation. The quarry sump exposes 1 m of the Cabot Head Formation shales, which are olive green and appear to have dolomitic laminae. In the quarry floor and base of the vertical face are 2 m of the Reynales Formation, a shaly

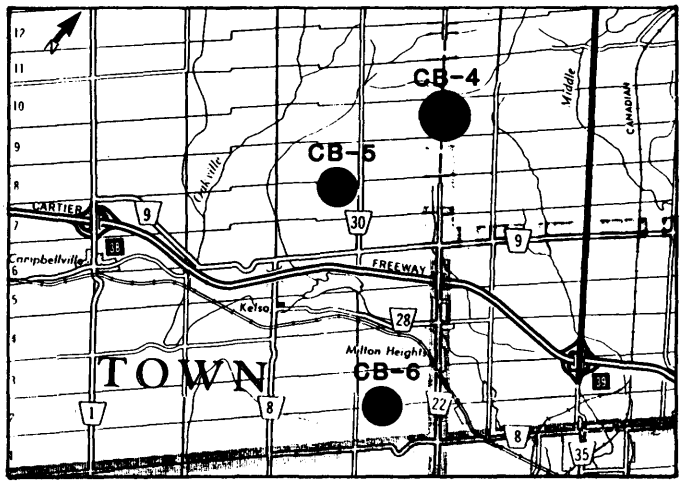


Figure CB-5-1. LOCATION MAP FOR HALTON QUARRY.

dolostone. This unit is overlain by over 20 m of massive and thin–bedded Amabel dolostone. The lower 10 m of the Amabel is banded with thin grey streaks and is fine crystalline. The overlying interval is composed of massive, lensoid beds draped with intervening thinner–bedded rocks. The Amabel Formation is richly fossiliferous, particularly in crinoidal debris. Overburden ranges from 0.25 to 4.0 m in thickness and averages 3.5 m.

CHEMICAL ANALYSES – 3/4 IN. STONE*

	Components in Percent	
	1	2
SiO_2	0.59	0.16
Al_2O_3	0.04	0.69
Fe_2O_3	0.46	0.33
CaO	31.08	30.28
MgO	20.59	21.02
S	0.04	–
CO_2	46.88	47.22
Total	99.68	99.70

* *after Hewitt and Vos, 1972, p.52.*

Geological Section

		Thickness
UNIT 4	*Amabel Formation*	*9.3m*

Dolostone: tan–brown, weathers dark brown; fine to very coarse crystalline; massive bedded, irregular and lensoid, contacts are gradational and irregular; calcite crystals in vugs; abundant crinoids, brachiopods and bryozoans; lenses pinch and swell with some zones being very fossiliferous; lower contact is gradational.

UNIT 3	*Amabel Formation*	*9.17m*

Dolostone: dark grey to brown, weathers same; very fine to fine crystalline; thin to massive bedded, gradational contacts; abundant crinoids, bryozoans, rare brachiopods; grey banding is abundant in the lower half and may be failed stylolites; lower contact is gradational.

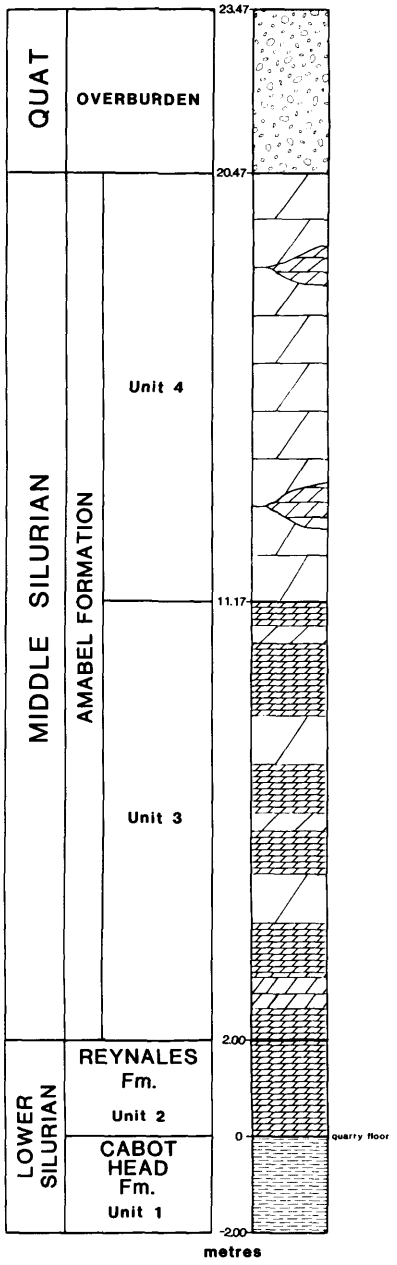


Figure CB-5-2. STRATIGRAPHIC COLUMN FOR HALTON QUARRY.

UNIT 2 Reynales Formation *2.0m*

Dolostone: grey-green, weathers same; very fine crystalline; thin bedded (about 3 cm); pyrite mineralization on bedding planes and as irregular nodules; scattered fossil trails on bedding planes; lower contact is not exposed.

UNIT 1 Cabot Head Formation *1.0m*

Shale: olive green, weathers same; very fine- grained, clayey; no bedding; apparent dolomitic laminae are present; water covered.

Total thickness *21.47m*

QUARRY OPERATION

The bedrock surface is irregular and most overburden removal requires the use of a backhoe. The overburden material is used to rehabilitate the northwestern limit of the quarry. The quarry is presently excavated over an area of approximately 30 ha and mined on a single lift of 12 m to 22 m averaging 16 m in height. Blast holes are drilled at 175 mm diameter with a CP 650 rotary drill on a 4.6 m x 4.9 m pattern to 2.7 m subgrade. Borehole liners are placed in the hole and toe loaded with aluminized AN/FO, while straight AN/FO is used for the column charge, up to a 3.65 m collar. When encountering a wet hole, a water gel cartridge (NORGEL) is loaded at the toe and borehole liners are placed in the hole and loaded with AN/FO. All holes are primed at the toe by an Austin bottom hole primer and by 1 lb. boosters (column charge) initiated by primacord detonating cord. Each hole is delayed by 25 ms connectors at surface and by 35 ms safety delay connectors down the hole (one delay period per hole). Explosives are mixed and loaded at the site by a bulk explosive truck and a powder factor of approximately 0.32 kg/tonne is achieved. Blasting is carried out once a week and all shots are monitored by seismograph and sound monitor. Secondary breakage is performed by crane and 5–ton drop ball.

A single 6 in. electric Fraser Brace impeller suction pump is used to dewater the quarry and a Gorman–Rupp 10 in. diesel pump is available as a backup during spring and fall.

Blasted stone is loaded by Cat 988B (7 yd.) and Michigan 275C (7 yd.) loaders to 4 rear dump trucks. A combination of the following trucks are used for haulage: (1) R35 Euclid, (2) 74TD Euclid, (2) Terex 3307 (40 ton) and (1) Terex 3303 (22 ton).

PROCESSING

The plant and quarry operate on a 12–month basis. Both portable and stationary crushing systems operate at the site.

Primary crushing is by Cedarapids 43 in. x 50 in. double impeller crusher (500 tph capacity), feeding a 4 ft. x 12 ft. triple deck Tyler screen. The Tyler screen produces –2 in. or 3/4 in. crusher run, 3 in. to 5 in. or 4 in. to 8 in. gabion stone to 115–tonne hoppers. A middle product of –4 in. + 2 in. or –4 in. + 3/4 in. is also produced and sent to a surge stockpile. Surge material is fed by a Jeffrey feeder to a triple–deck 7 ft. x 20 ft. Hewitt–Robins shaker screen with 2 in. top deck, 7/8 in. center deck, bottom deck consisting of two Dillon end tension sections with 1/4 in. opening and the remaining portion of the deck is covered with 1/4 in. cross slot wire cloth. The top and middle deck oversize is fed to a Hazemag APS 1320K crusher for reduction. A 2 in. clear product can be removed from this shaker prior to crusher by means of relocating a hand–operated gate and transferring the 2 in. clear to a short transfer conveyor followed

by a 30 in. x 100 ft. stacker. HL8 and screenings are also produced on this shaker.

Material from Hazemag crusher is transferred to two Hewitt–Robins 7 ft. x 20 ft. triple–deck shaker screens with 7/8 in. square opening top decks and 1/2 in. square opening center decks. Each shaker has two sections of Dillon end tension cloth with a 1/4 in. opening followed by sections of 1/4 in. cross slot wire. Oversize products from these two shakers are transferred to a holding bin which is equipped with a variable speed drive for feeding product to a 4 1/4 ft. Symons standard crusher which has been set to 7/16 in. on closed side for final reduction. HL8 and HL3 1/4 in. screenings produced in this circuit are then transferred by ground conveyors to mobile radial stackers.

A portable crushing system of 171 tph capacity is operated at the surge stockpile. Stone from the surge pile (–4 in. + 3/4 in.) is loaded by a Michigan 275C to a feed hopper. The material is then crushed by an Eljay 54 in. cone crusher and passed over a 5 ft. x 20 ft. triple deck Eljay screen, producing 3/4 in. clear, HL3 or HL8, screenings and an oversize that is sent for recrushing.

All products are stockpiled and recovered by a Michigan 275C loader for shipping by truck. Two truck scales are operated at the plant, a 50 ft. scale with 80,000 lbs. capacity for inbound traffic and a 80 ft. scale with 100,000 lb. capacity for outbound trucks.

PRODUCTS

Armour Stone
Gabion Stone
2 in. Crusher Run
3/4 in. Crusher Run
Granular "A"
2 in. Clear
3/4 in. Clear
Screenings (–5/16 in. + 200 mesh)
HL8 Concrete (–7/8 in. + 5/6 in.)
HL3 Concrete (–5/8 in. + 1/4 in.)

MOBILE EQUIPMENT

Trucks

1 – R35 Euclid
2 – 74TD Euclid 27 ton
2 – Terex 3307 40 ton
1 – Terex 3303 22 ton

Loaders

1 – Cat 988B – 7 yd.
1 – Michigan 275C – 7 yd.
1 – Michigan 175C – 5 yd.
1 – Cat 966B – 4 yd.
1 – Cat 980C – 5 yd.

REFERENCES

Hewitt, 1960, p. 120
Hewitt 1964a, p. 48–50
Hewitt and Vos, 1972, p. 52–53
ARIP 47, 1982, p. 20

MAPS

Bond et al., 1976, ODM Map 2337

CB–6 MILTON LIMESTONE — MILTON QUARRY

LOCATION AND OWNERSHIP

The Milton Limestone Quarry is located 1.5 km west of Milton on the brow of the Niagara Escarpment, in Lots 1 and 2, Concession 7, Town of Milton (Nassagaweya Township), Regional Municipality of Halton (Figure CB–6–1). The quarry has been in operation since 1958 and is a division of LAC Minerals Ltd. The quarry licence covers an area of 93.72 ha.

GEOLOGY

The quarry exposes 21.7 m of reefy, irregular massive–bedded dolostone of the Middle Silurian Amabel Formation (Figure CB–6–2).

The lowest 8 m of the Amabel Formation is stylolitic with abundant dark–grey laminations. The Reynales Formation underlies the Amabel with a thickness of 2.4 m. The top of the Reynales Formation is the quarry floor and, where exposed, has a gradational contact to the Amabel. Overburden ranges from nil to 9 m and averages about 2 m.

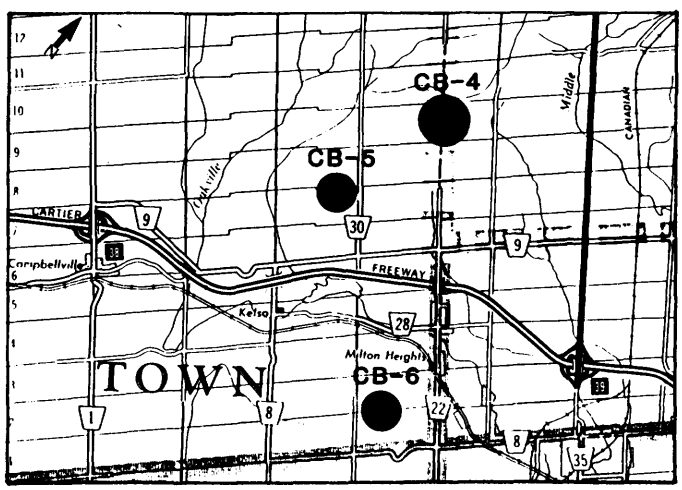


Figure CB–6–1. LOCATION MAP FOR MILTON QUARRY.

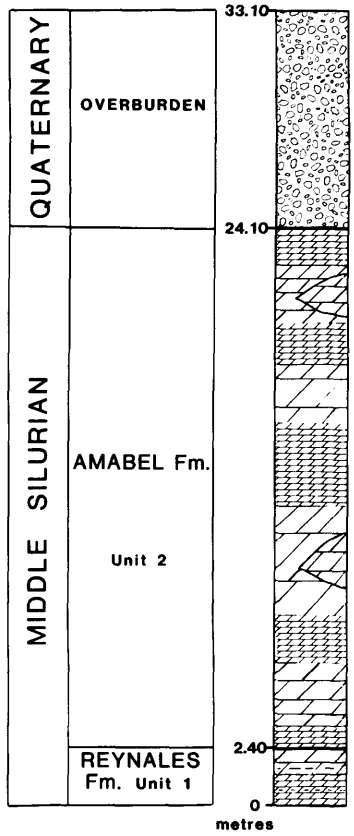


Figure CB-6-2. STRATIGRAPHIC COLUMN FOR MILTON QUARRY.

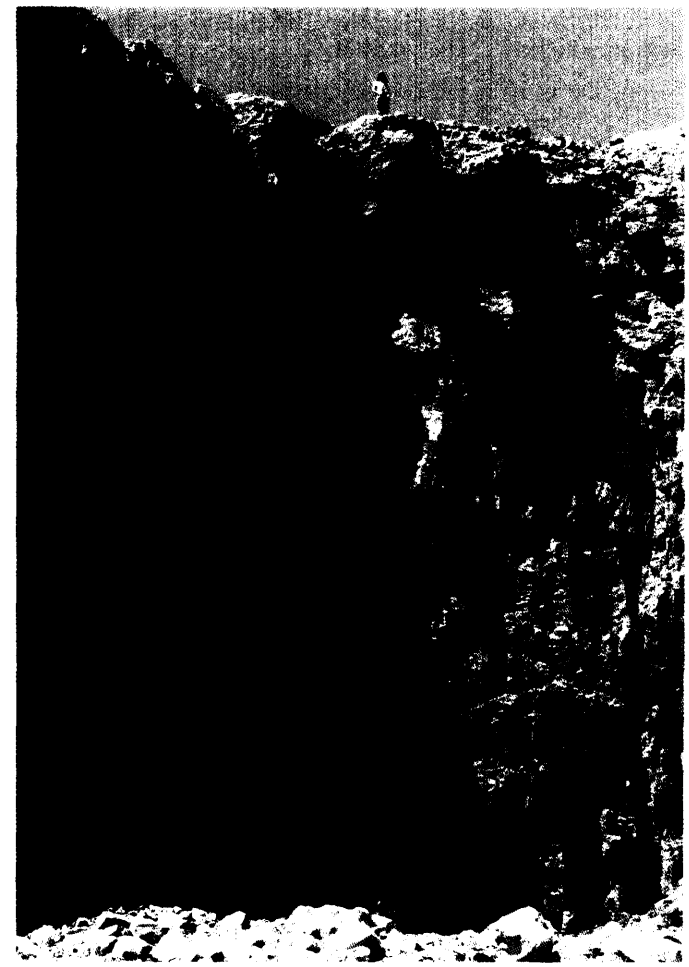


Photo CB-6-1. REEF CORE LENSES (TOP RIGHT) AND FLANKING ROCK OF THE AMABEL FORMATION; MILTON QUARRY.

Geological Section

	Thickness
UNIT 2 Amabel Formation	*21.7m*

Dolostone: light grey, weathers yellow-brown to grey; coarse crystalline; thin bedded to massive, contacts are sharp and slightly irregular; draping also occurs; crinoids and brachiopods are abundant with rare bryozoa; lower contact is the quarry floor.

UNIT 1 Reynales Formations	*2.4m*

Dolostone: medium grey, weathers light to grey-brown; fine to medium crystalline; thin to medium bedded, contacts are sharp and slightly irregular with shale partings; pyrite and calcite in vugs; fossils include abundant crinoids and rare corals; becomes coarser crystalline up section. This unit acts as relief on quarry floor.

Total thickness	*24.1m*

QUARRY OPERATION

The quarry operates all year and is currently advancing to the southwest on a single lift of about 25 m in height and approximately 300 m in length. The stripped overburden is used to rehabilitate the northeastern quarry limit. Blast hole drilling is performed by a contractor on a 4.3 m x 4.3 m pattern with 15 cm diameter holes. Blasting occurs approximately once a week and all blasts are monitored for vibration and noise levels. Holes are loaded with Magnafrac at the toe, aluminized AN/FO and/or straight AN/FO as the column charge, delivered and loaded by bulk truck. Four 1 lb. primers are used in each hole and blasting is initiated by non-electric caps. Secondary breakage is performed by crane and 3-ton drop ball. Water seepage is minimal, any quarry dewatering being handled by a 6 in. Flygt submersible pump.

PROCESSING

The process flow sheet for the Milton Quarry of Milton Limestone is illustrated on Figure CB-6-3.

Blasted stone is loaded by a Cat 988B (7 yd.) loader into two Terex 3307 (40 ton) trucks which haul approximately 1,500 m to the primary crusher. The material is

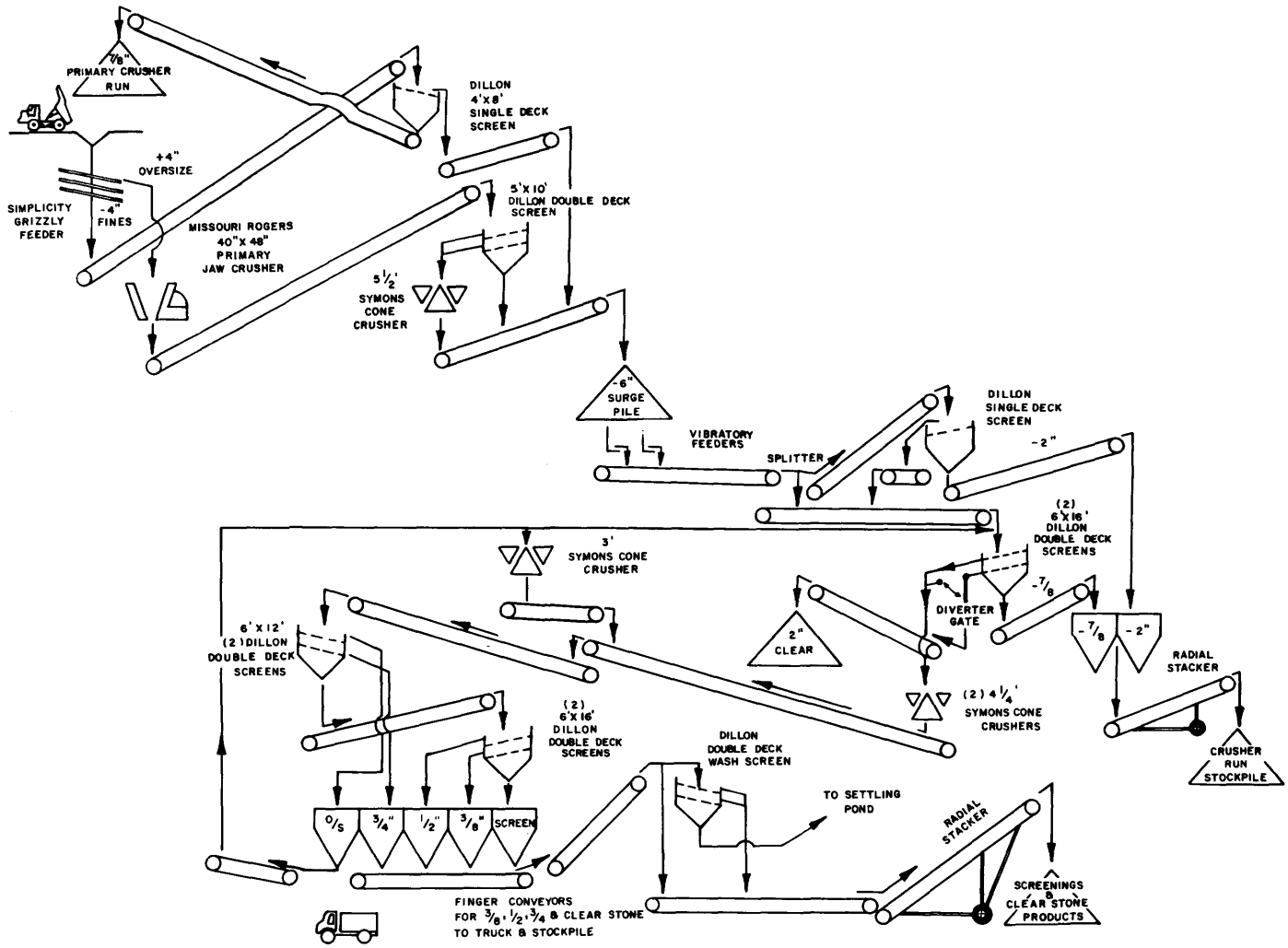


Figure CB-6-3. PROCESS FLOW SHEET FOR MILTON QUARRY.

dumped into a feed hopper and sized by grizzly feeder; +4 in. is sent to a 40 in. x 48 in. Missouri Rogers primary jaw crusher and −4 in. undersize to a 4 ft. x 8 ft. single deck Dillon screen. Oversize (+7/8 in.) from the screen goes to a −6 in. surge pile and undersize to a 7/8 in. primary crusher run pile. Material leaving the primary crusher goes to a double deck 5 ft. x 10 ft. Dillon screen. The oversize is recrushed by a 5 1/2 ft. Symons cone crusher, added to the fines from the screen and sent to the −6 in. surge pile. Crushed stone is reclaimed from the surge pile by vibratory feeders and conveyed to a splitter chute. From the splitter chute, material can be screened and conveyed to a 2 in. crusher run storage bin (and distributed by a stacker to stockpile) or sent to two double deck Dillon 6 ft. x 16 ft. screens. Oversize from the Dillon screens is sent to two 4 1/2 ft. Symons cone crushers, the middle product to a 2 in. clear stockpile and fines to a 7/8 in. crusher run storage bin (and sent by a stacker to stockpile). Material leaving the two Symons 4 1/4 ft. cones is sized by two Dillon 6 ft. x 12 ft. double deck screens producing 1 1/2 in. and 3/4 in. clear to 100 tonne storage bins, and fines. The fines product is rescreened by two double-deck Dillon 6 ft. x 16 ft. screen producing 1/2 in. clear, 3/8 in. clear and −1/4 in. screenings that are sent to 100 tonne bins. Finger conveyors are available to transfer the 3/4 in., 1/2 in. and 3/8 in. clear stone to stockpile storage. The 1 1/2 in. and 3/4 in. clear stone can be sent from the bins for tertiary crushing by a 3 ft. Symons cone or as described earlier to two double deck Dillon 6 ft. x 16 ft. screens producing oversize to two 4 1/4 ft. Symons cone crushers and undersize to storage, etc. Material in clear

Photo CB-6-2.
PROCESSING FACILITY
(LOOKING SOUTHWEST);
MILTON QUARRY.

stone storage bins may also be conveyed to a Dillon wash screen and then to a stockpile. Two Michigan 275C loaders are utilized for the loading of customer's trucks. A 35–ton Caterpillar truck is used for handling and transporting of stockpile material.

PRODUCTS

Gabion Stone
3 in. to 6 in.
8 in. to 14 in.
2 in. Crusher Run
7/8 in. Crusher Run
2 in. Clear
1 1/2 in. Clear
3/4 in. Clear
5/8 in. Clear
1/2 in. Clear
3/8 in. Clear
Screenings
HL8
HL3

REFERENCES

Hewitt, 1960, p. 119
Hewitt, 1964a, p. 47
Vos, 1969, p. 40–42
Hewitt and Vos, 1972, p. 54–55
ARIP 47, 1982
Sabina, 1986, p. 138

MAPS

Hewitt, 1969, ODM Map 2176
Bond et al., 1976, ODM Map 2337

CB–7 NELSON AGGREGATE CO. — NELSON QUARRY

LOCATION AND OWNERSHIP

The Nelson Quarry of Nelson Aggregate Co. is located on Guelph Line, 4 km north of Nelson Corners in Lots 1 and 2, Concessions 2 and 3, City of Burlington (Nelson Township), Regional Municipality of Halton as shown on Figure CB–7–1. This quarry, which is one of the largest in Ontario, began production in 1954 (Lots 1 and 2, Concession 3) and expanded in 1957 (Lots 1 and 2,

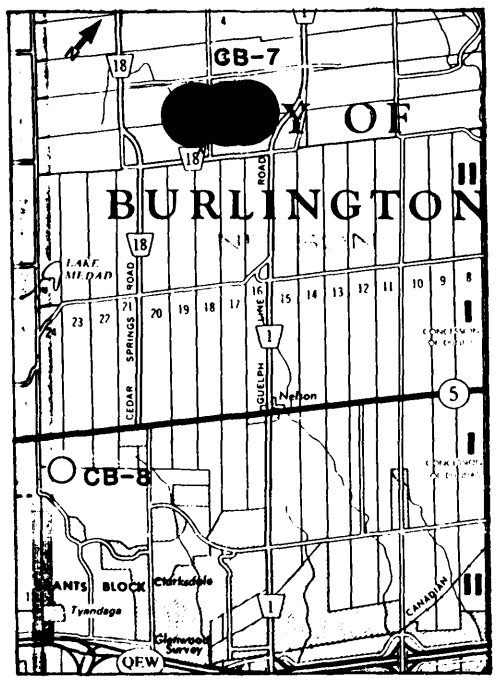


Figure CB-7-1. LOCATION MAP FOR NELSON QUARRY.

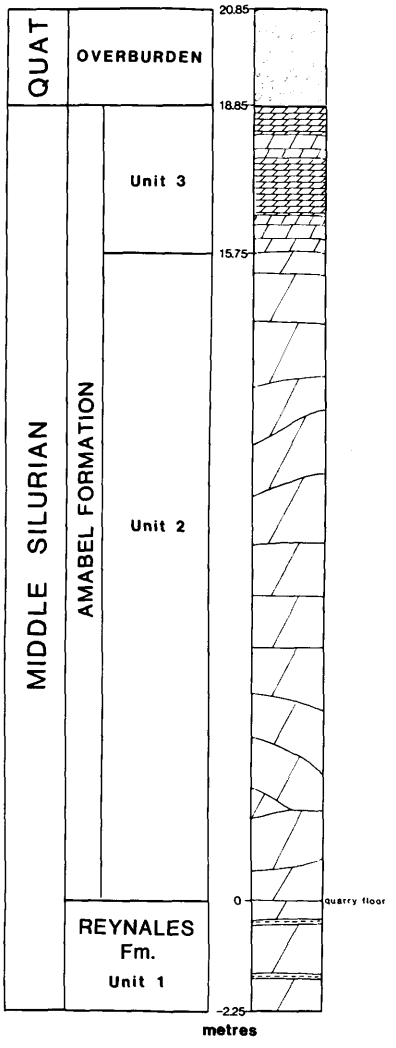


Figure CB-7-2. STRATIGRAPHIC COLUMN FOR NELSON QUARRY.

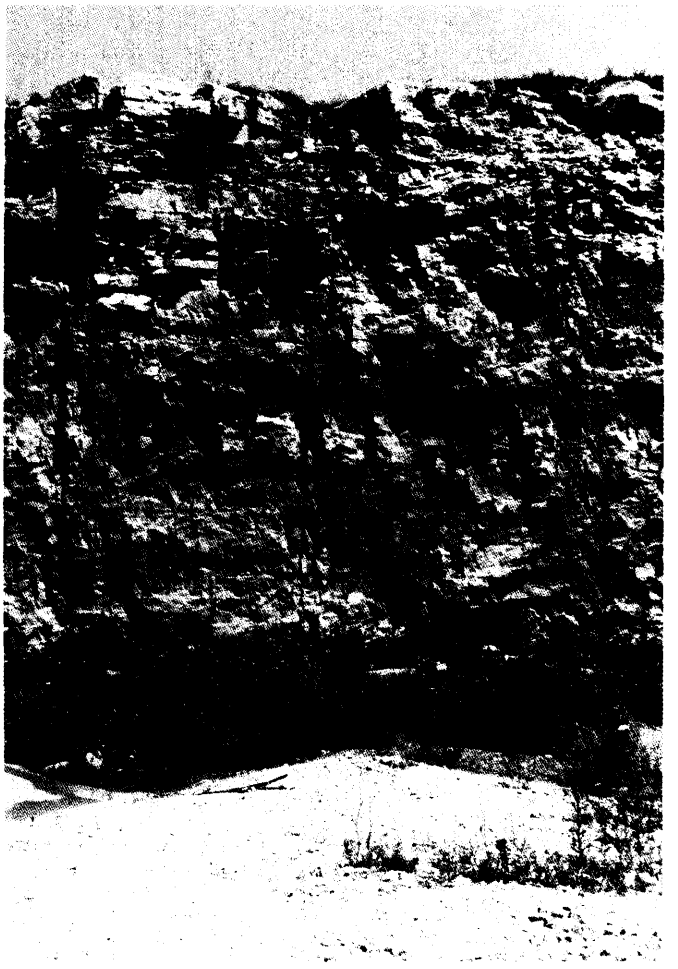


Photo CB-7-1. AMABEL AND REYNALES FORMATIONS AT THE NELSON QUARRY. THE SECTION IS ABOUT 18 m THICK.

Concession 2). The operation has a capacity in excess of 1.5 million tonnes per year in an average 10-month operating year. The quarry licence covers an area of 202.5 ha.

GEOLOGY

This active quarry exposes 18.85 m of section from the Middle Silurian Amabel and Reynales Formations (Figure CB-7-2.) The lower part of the Amabel Formation is a fine- to medium-crystalline, reefal dolostone, massive with abundant stylolitic partings. The upper part is a coarse- to very coarse-crystalline, medium-bedded, reefal dolostone. Bioherms can be quite large (60 m in length and 10 m high) with dips of flank beds up to 20°. The Reynales Formation, interbedded argillaceous dolostone and shale, is exposed in the quarry sump.

Overburden, consisting of sand, clay and glacial till, ranges from 1 m to 7 m in thickness.

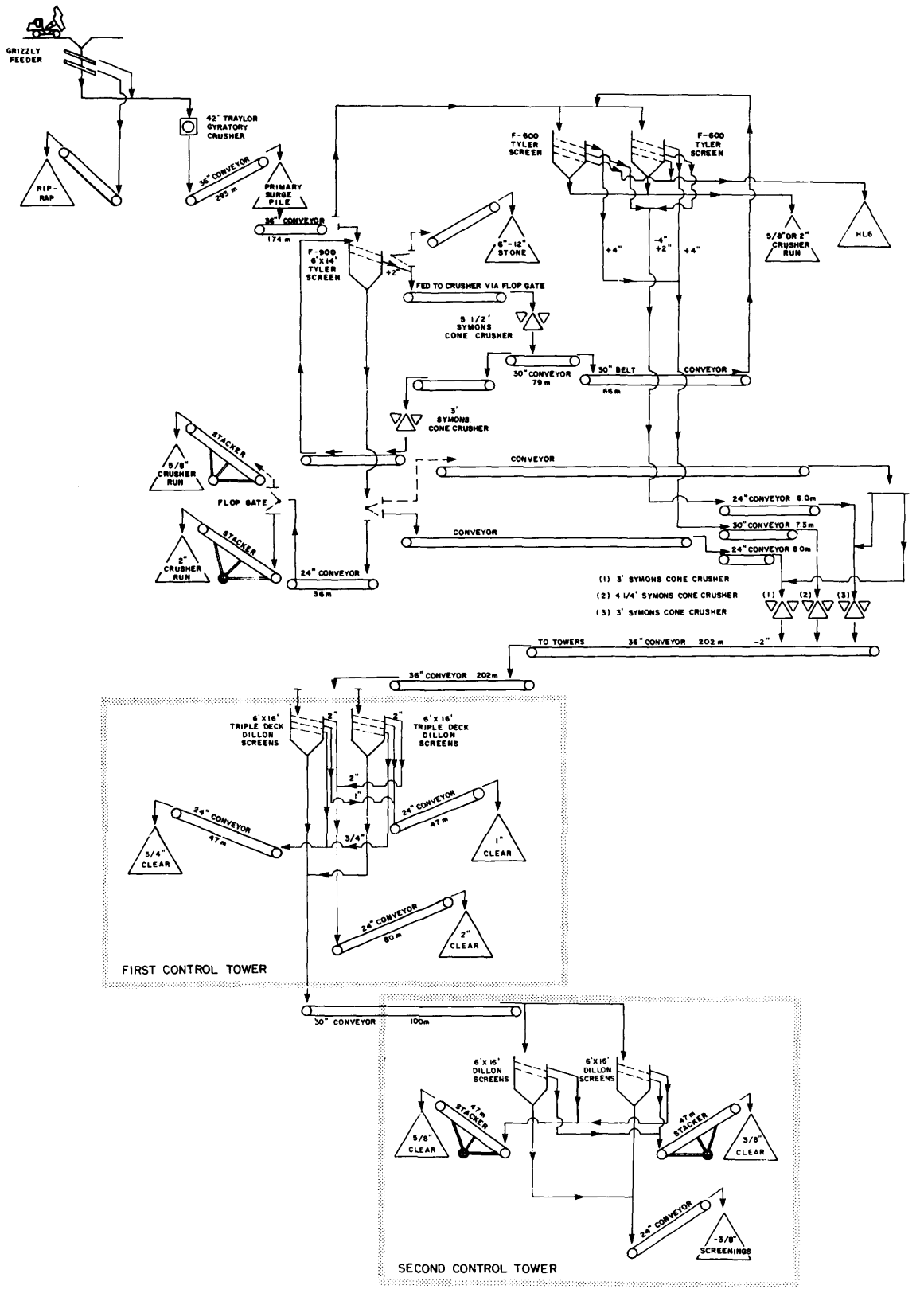


Figure CB-7-3. PROCESS FLOW SHEET FOR BURLINGTON PLANT OF NELSON AGGREGATE CO.

Geological Section

		Thickness
UNIT 3	*Amabel Formation*	*3.1m*

Dolostone: light grey, weathers buff-grey; coarse to very coarse crystalline; thin to medium bedded, contacts are sharp with leached stylolitic partings; abundant crinoidal debris; lower contact is undulatory and gradational.

UNIT 2	*Amabel Formation*	*13.5m*

Dolostone: light to medium grey, weathers buff-grey; fine to medium crystalline; massive with sharp stylolitic partings; grey banding present; reef flanks drape 15 to 25°; vuggy horizon present 2-3 m above the base of the unit; crinoids are abundant, rare corals; lower contact is quarry floor.

UNIT 1	*Reynales Formation*	*2.25m*

Dolostone with shaly partings: grey to dark grey, weathers buff; medium crystalline, massive bedding with irregular, sharp contacts and shaly partings; porous in places; pyrite in pores.

Total thickness	*18.85m*

QUARRY OPERATION

The bedrock surface is quite irregular and presents difficulties in stripping. Excavated overburden material is hauled to the old quarry boundaries and graded on a slope from the top of the quarry face to the quarry floor. Rapid growing vegetation is seeded along the slope to rehabilitate the site and prevent erosion.

A single 18 m bench is drilled on a 5.2 m x 5.2 m pattern at hole diameter of 165 mm by an Ingersoll-Rand DM25 rotary drill. Holes are toe-loaded with large diameter water gel cartridges and column-loaded with aluminized AN/FO. All blasting is initiated by non-electric blasting caps. Blasted stone is mucked by a Cat 988 loader or a P&H 1600 7 yd. electric shovel into 35- and 50-ton Euclid trucks and hauled approximately 1,500 m to stationary crushing facilities.

PROCESSING

The process flow sheet for the Nelson Aggregates Burlington Plant is illustrated on Figure CB-7-3.

The delivered quarry run material is dumped into a feed hopper and sized by a grizzly feeder. The 9 in.-18 in. riprap stone is separated and conveyed to a stockpile with the balance being sent to a Traylor 42 in. primary gyratory crusher where the material is crushed to -12 in. The crushed stone is conveyed to a primary surge pile to provide feed for the various processing circuits. The crushed stone is reclaimed from the surge pile and passed over either a single Tyler F-900 screen or two Tyler F-600 screens.

The single Tyler F-900 screen produces either feed for the secondary crushing circuit or 6 in. - 12 in. gabion stone, in addition to 2 in. crusher run and 5/8 in. crusher run material which is delivered to the stockpile area by a series of conveyors and stackers. The secondary crushing circuit utilizes a 5 1/2 ft. Symons cone crusher to provide feed material for either of the two Tyler F-600 screens or the tertiary crushing circuit which comprises a 3 ft. Symons cone crusher in series with the Tyler F-900 screen.

The two Tyler F-600 screens produce a variety of products including 5/8 in. or 2 in. crusher run material, HL6 stone and crusher feed for parallel secondary crushing circuits utilizing two 3 ft. Symons cone crushers and one 4 1/4 ft. Symons cone crusher to produce feed for two control towers.

Feed to the first control tower is passed over two parallel triple deck Dillon screens which produce 2 in., 1 in., 3/4 in. clear stones as required. The undersize, -3/4 in. material, is conveyed to the second control tower and is passed over two parallel double deck Dillon screens which produce 5/8 in. and 3/8 in. clear stone as well as -3/8 in. screenings as required.

PRODUCTS

Armour Stone
Riprap
Gabion Stone 6 in. to 12 in.
2 in. Crusher Run
3/4 in. Crusher Run
2 in. Clear
1 in. Clear
3/4 in. Clear
5/8 in. Clear
Screenings
HL6 Asphalt Stone

REFERENCES

Hewitt, 1960, p. 113-118
Hewitt, 1964a, p. 45-46
Hewitt, 1968, pp. 11, 13, 20
Vos, 1969, p. 35-36
Hewitt and Vos, 1972, p. 55
ARIP 45, 1982, p. 18
Sabina, 1986, p. 138

MAPS

Liberty, Bond and Telford, 1976, ODM Map 2336

CB-8 OLD NELSON QUARRY

LOCATION AND OWNERSHIP

The Old Nelson Quarry (previously called the Old Kerns Road Quarry and the Old Nelson Crushed Stone Quarry) is situated on the brow of the Niagara Escarpment overlooking the City of Burlington. It is 3 km northeast of Waterdown in Lot 24, Concession 1 S.D.S., City of Burlington (Nelson Township), Regional Municipality of Halton as shown on Figure CB-8-1.

GEOLOGY

This quarry is of considerable geological significance as it is the most southerly exposure of the reefal, irregular-

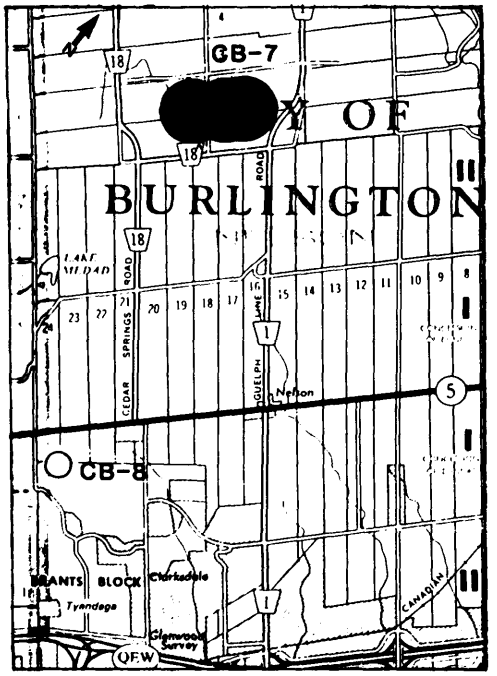


Figure CB-8-1. LOCATION MAP FOR OLD NELSON QUARRY.

bedded to massive Amabel Formation before the transition into the well-bedded Lockport Formation seen to the south in the Niagara Peninsula. The quarry exposes 15.65 m of section through the Middle Silurian Reynales, Irondequoit, Rochester and Amabel Formations (Figure CB-8-2). The units consist predominantly of shaly dolostones and dolostones. The quarry is now abandoned and is the subject of rehabilitation studies for possible use as a park. One to three metres of overburden is present.

Geological Section

Thickness

UNIT 4 Amabel Formation *12.00m*

Three distinct facies are present in this unit, but occur in no apparent order.

(Facies 1)
Dolostone: light-grey to buff-grey, weathers buff-tan; medium to coarse crystalline; massive with irregular partings; large biohermal lenses are present, approximately 2 m thick and up to 4 m wide.

(Facies 2)
Dolostone: light grey to pink, weathers tan to light grey; medium to coarse crystalline; thin to thick bedded, contacts are sharp and planar; occasional fossil fragments are present.

(Facies 1)
Dolostone: mottled cream to light grey, weathers light grey; medium to coarse crystalline; medium bedded, contacts are sharp; very porous appearance; crinoidal debris occurs as large tabular lenses.

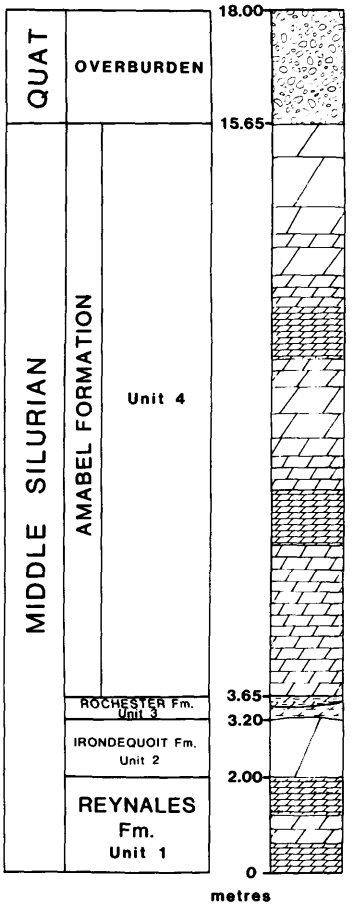


Figure CB-8-2. STRATIGRAPHIC COLUMN FOR OLD NELSON QUARRY.

UNIT 3 Rochester Formation *0.45m*

Shaly dolostone and dolomitic shale: medium grey, weathers same; very fine crystalline with shaly zones; thin bedded, with shale partings, undulatory and irregular; rare brachiopods.

UNIT 2 Irondequoit Formation *1.20m*

Dolostone: blue-grey, weathers grey to tan; fine to medium crystalline; massive bedded; vugs are abundant with calcite and gypsum (rare) mineralization; very porous; abundant fossils include crinoids and brachiopods, rare rugose and gastropods; lower contact is welded and disconformable with the Reynales Formation.

UNIT 1 Reynales Formation *2.00m*

Dolostone, with shaly partings: buff-grey, weathers tan to light grey; fine crystalline; thin to medium bedded, contacts have shaly partings; scattered pyrite present in brachiopod molds and nodules; mud clasts with glauconite in lower 0.5 m and on quarry floor; pentamerids are very abundant, rare rugose corals.

Total thickness *15.65m*

REFERENCES

Hewitt, 1960, p. 113
Hewitt, 1968, p. 11

Vos, 1969, p. 35
ARIP 45, 1982, p. 18
Telford and Johnson, 1984, p. 10–11

MAPS

Caley, 1941c, GSC Map 584A
Liberty, Bond and Telford, 1976, ODM Map 2336

CB–9 FLAMBORO QUARRIES LTD.

LOCATION AND OWNERSHIP

The Flamboro Quarry is located in Lot 6, Concession 4, Town of Flamborough (West Flamborough portion), Regional Municipality of Hamilton–Wentworth as shown on Figure CB–9–1. Crushed stone is transported by truck, supplying local road construction projects. The quarry licence covers an area of 41.30 ha.

GEOLOGY

The Flamboro Quarry exposes 4.3 m of the Middle Silurian Lockport Formation (Eramosa Member) and 4.46 m of the Guelph Formation (Figure CB–9–2). The Eramosa Member is a brown, fine–crystalline dolostone which releases a strong petroliferous odor when freshly broken. The upper contact is gradational to the Guelph Formation, a grey–buff, fine– to medium–crystalline, vuggy dolostone. Bedding becomes slightly thicker in the Guelph Formation. Overburden is light, ranging from 0 to 30 cm in thickness.

Geological Section

		Thickness
UNIT 2	*Guelph Formation*	*4.46m*
	Dolostone: grey to buff, weathers brown–buff; fine to medium crystalline; thin to medium bedded, irregular and undulatory contacts, some with stylolitic partings; sucrosic; porous zones; bituminous stylolitic partings; gradational lower contact.	
UNIT 1	*Lockport Formation, Eramosa Member*	*4.30m*
	Dolostone: dark to light brown, weathers medium brown; fine to medium crystalline; thin to medium bedded, with stylolitic partings, sharp contacts; calcite crystals in fossils and vugs; coral and brachiopod fossils present.	
Total thickness		*8.76m*

QUARRY OPERATION

The quarry is worked on a single 7 m lift. Blast–hole drilling is contracted out with 16.5 cm diameter holes used in a 4 m x 5.5 m pattern. The holes are loaded with 1 lb. primers, primacord and AN/FO, and the thin–bedded strata allows good blasting fragmentation with no oversize stone produced. The broken rock is fed to a portable crushing system (jaw crusher, cone crusher and screens), approximately 100 m from the face, by Cat 988 loaders.

REFERENCES

Goudge, 1938, p. 299

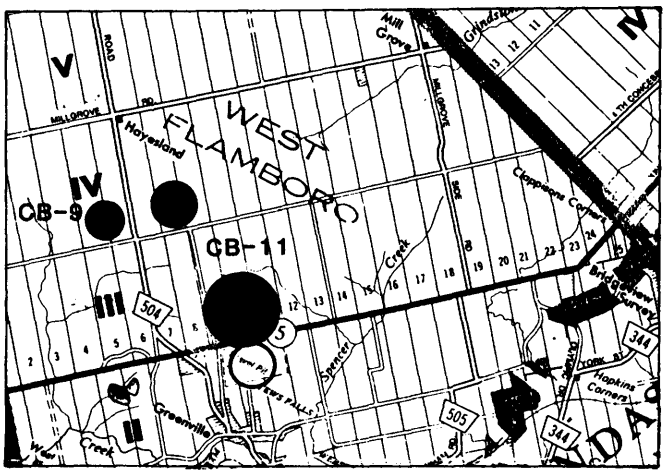


Figure CB–9–1. LOCATION MAP FOR FLAMBORO QUARRY.

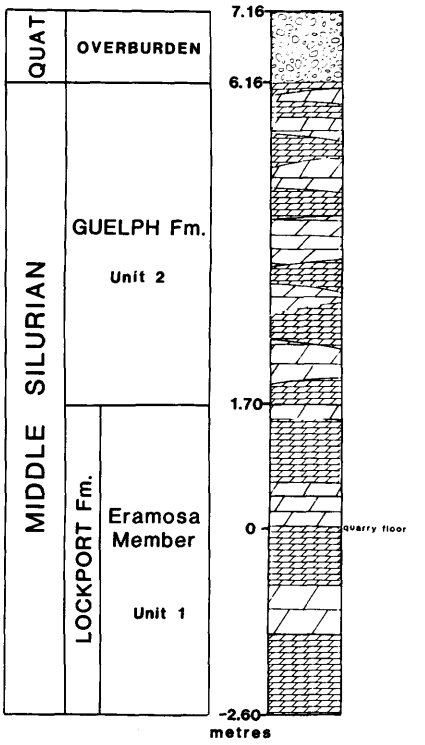


Figure CB–9–2. STRATIGRAPHIC COLUMN FOR FLAMBORO QUARRY.

Hewitt, 1960, p. 111
Hewitt, 1964a, p. 45
Hewitt and Vos, 1972, p. 50
ARIP 50, 1984, p. 37

MAPS

Telford, 1979, OGS Map P.1983

CB-10 CLAPPISON'S CORNERS QUARRY

LOCATION AND OWNERSHIP

This abandoned quarry is located on the southeast corner of Clappison's Corners in Lot 12, Concession 3, Town of Flamborough (East Flamborough portion), Regional Municipality of Hamilton-Wentworth (Figure CB-10-1).

GEOLOGY

The quarry exposes dolostones and shales of the Reynales, Irondequoit and Rochester Formations, capped by the Gasport and Goat Island Members of the Lockport Formation (Figure CB-10-2.) The Reynales Formation consists of grey-brown, fine- to medium-crystalline, interbedded dolostones and shales. The Irondequoit Formation is a crinoidal, dolomitic limestone, brown-buff in colour and fairly massive. The Rochester Formation is an argillaceous dolostone with interbedded shales. The Gasport Member of the Lockport Formation is a brown to buff, medium- to coarse-crystalline, thin-bedded and fossiliferous dolostone. This unit is capped by the Goat Island Member dolostones which are grey to buff, coarse crystalline and fossiliferous.

Figure CB-10-1. LOCATION MAP FOR CLAPPISON'S CORNERS QUARRY.

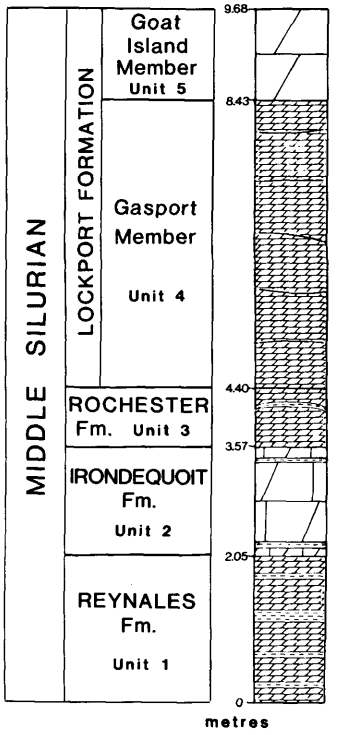


Figure CB-10-2. STRATIGRAPHIC COLUMN FOR CLAPPISON'S CORNERS QUARRY.

Geological Section

Thickness

UNIT 5 Lockport Formation, Goat Island Member *1.25m*

Dolostone: light grey, weathers buff; coarse crystalline; massive bedded, sharp contacts; marcasite in pores; zones of fossil debris (crinoid and brachiopod); stylolites present; sharp lower unit contact.

UNIT 4 Lockport Formation, Gasport Member *4.03m*

Dolostone: light grey-brown, weathers light buff; medium to coarse crystalline; thin bedded (3 to 8 cm), undulatory contacts; fossiliferous (crinoid and brachiopod); weathers blocky; sharp lower contact.

UNIT 3 Rochester Formation *0.83m*

Interbedded shales and dolostones: light grey dolostones and grey shales which weather dark grey; dolostones are fine crystalline, very thin bedded (2 to 3 cm), thickening towards the top (5 cm), contacts are undulatory and irregular; lamination present; 1 cm thick sulphide seam present 25 cm below the top; sharp lower contact.

UNIT 2 Irondequoit Formation *1.52m*

Dolomitic Limestone: light brown-grey, weathers brown-buff; medium to coarse crystalline; mainly massive with some thinner beds (0.05-1.0m), contacts are sharp with shaly partings; middle portion of the unit is barren of shaly beds; calcite, pyrite, and marcasite occur in small pores and on shaly partings; crinoidal debris present; lower contact is sharp.

Photo CB-10-1. MIDDLE SILURIAN FORMATIONS AT CLAPPISON'S CORNERS QUARRY.

UNIT 1 Reynales Formation *2.05m*

Interbedded dolostones and shales: medium grey dolostones, weathers brown-grey, buff-brown to grey shales; dolostones are fine to medium crystalline; thin-bedded with shaly contacts, beds are laterally extensive; fossil debris present on shaly partings.

Total thickness *9.68m*

REFERENCES

Goudge, 1938, p. 302–303
Hewitt, 1960, p. 112–113
Hewitt, 1964a, p. 45
Hewitt, 1968, pp. 11–12, 22
Vos, 1969, p. 35
Hewitt and Vos, 1972, p. 47
ARIP 50, 1984, pp. 21, 37
Sabina, 1986, p. 140–142

MAPS

Liberty, Bond and Telford, 1976, ODM Map 2336

CB-11 STEETLEY LIME & AGGREGATES DIVISION — DUNDAS QUARRY

LOCATION AND OWNERSHIP

Steetley Lime & Aggregates Division of Steetley Industries Limited operates one of the largest stone quarries in Canada in terms of its size and product range. The Lime and Aggregates Division serves the construction, steel, glass, agricultural and filler markets with a wide range of products.

The Dundas Quarry of Steetley Lime & Aggregates is located northwest of the City of Hamilton and north of the Town of Dundas as shown on Figure CB-11- 1. The plant and quarry workings are situated in Lots 10 and 11, Concession 2, Lots 9 to 12, Concession 3, and Lots 7 to 10, Concession 4, Town of Flamborough (West Flamborough portion), Regional Municipality of Hamilton-

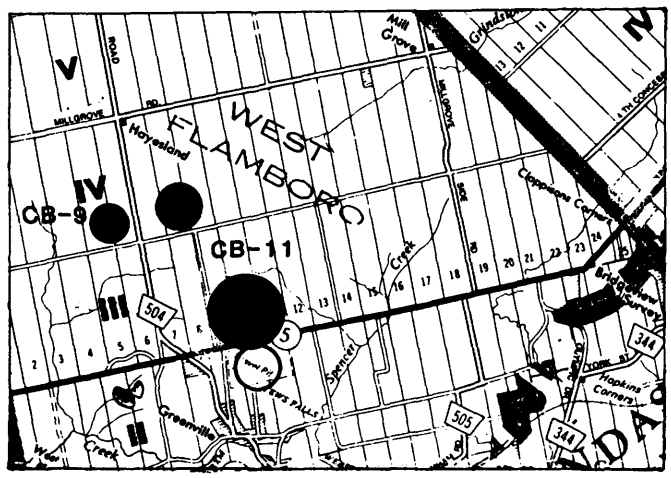


Figure CB-11-1. LOCATION MAP FOR DUNDAS QUARRY.

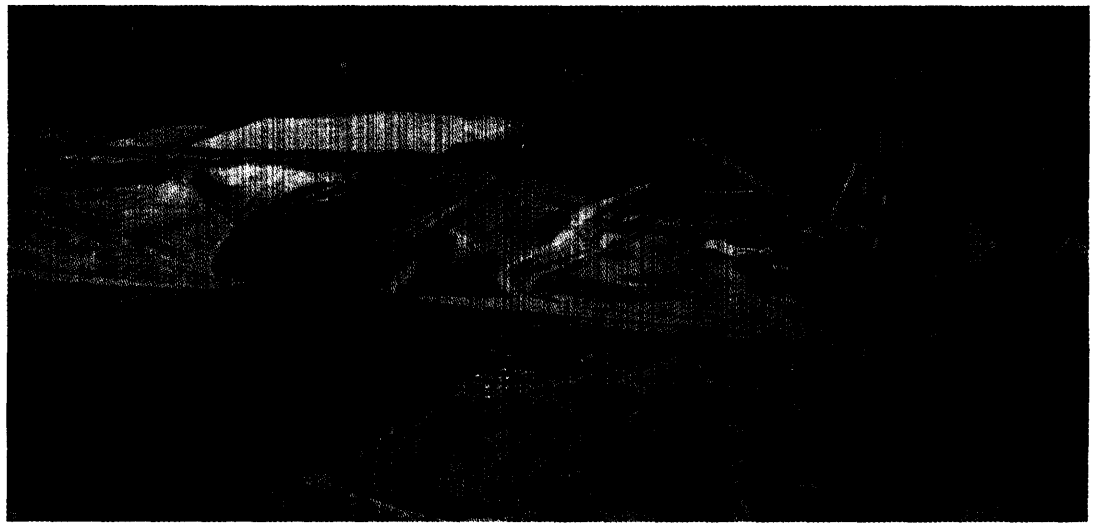


Photo CB-11-1. AERIAL VIEW OF DUNDAS OPERATIONS OF STEETLEY LIME AND AGGREGATES. AGGREGATE OPERATION IS IN FOREGROUND, DOLOMITIC LIME PLANT IN BACKGROUND. EXTRACTION FROM QUARRY AT LEFT IS NOW COMPLETED.

Wentworth. This area lies on both sides of Highway 5. Extraction has ceased in the quarry to the south of Highway 5, now the site of a modern aggregate plant, stone pulverizing plant, crushing plant and rotary kilns of Steetley Lime. Included on this site, but not operated by Steetley is a ready-mix concrete plant. Extraction is now taking place in the new quarry on Concession 4 north of the existing quarry. The total licenced area is 415 ha.

GEOLOGY

The quarry north of Highway 5, in Lots 9 and 12, Concession 3, has two benches with a total rock thickness of 18 to 21 m, overlain by up to 15 m of silty till and lacustrine fine sands. The upper lift, of approximately 14 to 15 m in height, has produced stone used for aggregate, metallurgical stone, and dolomitic lime. The quarry face consists of 6 to 7 m of Guelph Formation rock which is a light grey, very fine-crystalline, medium-bedded dolostone, underlain by 6 to 8 m of the upper part of the Eramosa Member of the Lockport Formation. This rock is a medium light brown, very fine-crystalline, medium- to thick-bedded dolostone with some black shaly partings in the lower part of the section, and appears to be a transitional unit between the Guelph Formation and the Eramosa Member. This upper lift has been reported to have less than 0.5% silica and less than 0.5% alumina plus iron oxide, and is a high purity dolostone (Hewitt, 1960).

The 6 m lower lift is part of the Eramosa Member of the Lockport Formation. Characteristic of this member is the medium to dark brown or black, very fine-crystalline, thin-bedded dolostone. Laminations and petroliferous bands are common. Vugs occur in the lower part of the face and some may be filled with gypsum, calcite or chert. There is a higher concentration of silica and alumina in the Eramosa Member rock of this lift, evident in the visible increase in chert and shaly material.

Geological Section

		Thickness
UNIT 3	*Guelph Formation*	*7.0m*
	Dolostone: brown-grey, weathers light grey; very fine crystalline; medium bedded.	
UNIT 2	*Lockport Formation, Eramosa Member*	*7.0m*
	Dolostone: medium brown, weathers light brown; very fine crystalline; medium to thick bedded; abundant shaly partings present in lower part; unit appears to be transitional between the Guelph and Eramosa.	
UNIT 1	*Lockport Formation, Eramosa Member*	*6.0m*
	Dolostone: medium brown, weathers dark brown to black; very fine crystalline; thin bedded, laminations and bituminous banding is common; vugs are present in the lower part and filled with gypsum, calcite or chert.	
Total thickness		*20.0m*

QUARRY OPERATION

The following description is modified from Scott and Yundt, 1983. The dolostone quarried at Steetley is used for a variety of purposes, ranging from armour stone to dolomitic lime. Stone is quarried by drilling fourteen 60 cm holes on a 5.2 m x 6.1 m pattern with an Ingersoll-Rand DM45 drill and blasting with AN/FO and aluminized slurry. The blast rubble is loaded by a LeTourneau L800 (15 yd.) into three 75 tonne and four 55 tonne haulers and delivered to the processing plant.

PROCESSING

The quarry run material is dumped into a 52 in. primary crusher in series with two 20 in. secondary gyratory crushers, capable of producing 1,000 tonnes per hour of −6 in. stone. Following primary reduction, the stone is crushed to 2 1/2 in. with two short head cone crushers and two 5 1/2 ft. standard cone crushers. Screening is by double−deck F800 Tyler screens as follows: two 6 ft. x 14 ft. screens with 2 1/2 in. and 1 1/2 in. openings; followed by two 7 ft. x 16 ft. screens with 7/8 in. and 3/4 in. openings; followed by two 6 1/2 ft. x 19 1/2 ft. screens with 1/2 in. and 5/8 in. openings; followed by two 6 ft. x 16 ft. screens with 1/4 in. and 1/8 in. openings. The secondary plant is designed to produce 1,000 tonnes per hour of a full range of stone sizes. The products are conveyed to surge piles or bins. Blending of sizes can occur to meet virtually any specification.

AGGREGATE AND DRIED STONE PRODUCTS

The company offers more than 120 blends of products from various combinations of the 46 stockpiles. Numerous products exclusive of blended materials are produced, including the following from largest to smallest:

- armour stone, in 3 to 5 tonne, 5 to 6 tonne, and 6 to 9 tonne sizes, which is used for shore protection and has been shipped as far as Tobermory on Lake Huron.

- riprap material produced in the 4 in. to 12 in. size used in shore protection, and in the past 15 years over 3.6 million tonnes from this site have been used in the Hamilton Harbour area.

- metallurgical grade dolostone (2 in. x 1 in.) is used for blast furnace flux, as well as kiln feed to produce a range of dolomitic lime products for use in the steel and glass industries.

- concrete and asphalt aggregate is another major product, in sizes of −3/4 in. concrete aggregate, HL6 stone, HL5 wash stone, HL3 (−1/2 in.) stone, 1/4 in. chips for cold mix and surface treating, and manufactured sand.

Near the large aggregate plant is the dried fines pulverizing plant. Screenings from the aggregate plant are processed to produce materials destined for the agricultural, glass and filler markets.

- fertilizer grits, −1/8 in. + 1/16 in. and used as a fertilizer filler.

- a fine sand, −1/16 in. + 75 micron used in the glass industry and for cow bedding.

- agricultural limestone (agricultural index 75)

- fillers (−75 micron) for roofing shingles and sound deadeners.

In addition to the crushed and pulverized dolostone products there are several steel slag products produced at the nearby Old Brow Quarry site located a few kilometres away. The steel slag is processed as a skid−resistant aggregate replacing trap rock in many road surface applications. Three products are made: HL1; dense friction coarse (DFC) used in making asphalt pavement; and open friction coarse (OFC) which is used in asphaltic concrete to create a pavement that produces a lower decibel level and reduces hydroplaning.

LIME − KILN OPERATIONS

The lime kilns are located at the eastern end of the processing plant area. There are three rotary kilns producing dolomitic lime and dead−burned dolomite at this site with the following specifications:

1. Kiln number 1 is a 350 ft. long F.L. Smidth kiln with a diameter of 9 ft. at the feed end and 10 ft. at the firing end. The clinker discharges to a Niems cooler. The kiln is fired by solid or oil fuels only.

2. Kiln number 2 is a 300 ft. long F.L. Smidth kiln of 10 ft. diameter for the full length, the clinker discharging to a Fuller grate cooler. It is fired by a solid or oil fuel, and can burn some gas.

3. Kiln number 3 is a 385 ft. long Fuller kiln of 11 1/2 ft. diameter for the full length, the clinker discharging to a Niems cooler. This kiln is fired by solid, oil or gas fuels.

The total production capacity from the three kilns is 350,000 tonnes per year requiring approximately twice as much feed. Two sizes of stone (−2 1/2 in. + 1 1/2 in., and −1 1/2 in. + 3/4 in.) are used as feed. Following burning, the clinker may be crushed and/or screened depending on the customer specifications. Product storage totals approximately 7,000 tonnes.

KILN PRODUCTS

The larger feed material is used to make Dolime (soft burned dolomite) at a kiln temperature of 1,538°C. Dolime is used by the steel companies for slag conditioning in Basic Oxygen Furnaces and when in contact with molten steel the Dolime goes into solution, tying up the silica, which would destroy the furnace lining, and the sulphur which, if not removed, would result in a low quality steel.

The smaller size feed material is used to manufacture dead burned dolomite, called Dolomax, at kiln temperatures of 1,649°C to 1,760°C. Dolomax is coated with iron oxide (mill scale) and is used to fettle Open Hearths and Electric Furnaces.

Dolopel is a double burned, special hard, high−purity dolomite grain for the production of resin bonded and

fired refractory bricks. Another special product, Dolomax "G", is used as a refractory raw material in gun mixes to protect the linings of steelmaking vessels.

A new product called Ferrodolime is a soft burned dolime, coated with iron oxide in the kiln, and is used as a slag conditioner in the Basic Oxygen Furnaces and Electric Furnaces. The iron oxide coating creates a dust-free product that goes into solution more readily.

REFERENCES

Goudge, 1938, p. 300–302
Caley, 1940, p. 63
Hewitt, 1960, p. 106–110
Hewitt, 1964a, p. 44
Hewitt, 1968, pp. 12–13, 14, 22
Hewitt and Vos, 1972, p. 47–148
Segall and Dunn, 1972, p. 21
Winder and Sanford, 1972, p. 61–62
Scott and Yundt, 1983, p. 27–28
ARIP 50, 1984, pp. 19–20, 37
Sado et al., 1985, p. 24–27
Sabina, 1986, p. 143

MAPS

Caley, 1941c, GSC Map 584A
Liberty, Bond and Telford, 1976, ODM Map 2336

CB-12 TARO AGGREGATES INC. — STONEY CREEK QUARRIES

LOCATION AND OWNERSHIP

Taro Aggregates Inc. owns a property in Lots 25–28, Concession 6, City of Stoney Creek (Saltfleet Township), Regional Municipality of Hamilton–Wentworth (Figure CB–12–1). The property is located at the top of the Niagara Escarpment, on the southern edge of Stoney Creek, west of Highway 20 and contains two operations known as the east and west quarries. The west quarry, in Lots 27 and 28, has been in operation since the turn of the century, and only ceased operations in December, 1986. The quarry was owned and operated by A. Cope and Sons Ltd., a family–owned construction company, until 1971 when Taro Aggregates Inc. and partners purchased the company. In 1978, Taro acquired a 100% interest and divested itself of the construction division.

After the completion of mining operations at the west quarry at the end of 1986 a 25–hectare parcel (section of west quarry) was donated to the City of Stoney Creek. Operations continue on a new licence on the south half of Lots 25 and 26 for the east quarry. The property comprises several parcels which total 166 ha.

GEOLOGY

The two quarries display approximately 19 m of the Eramosa Member and the Vinemount shale beds of the Lockport Formation (Figure CB–12–2). The Vinemount shale beds are a grey, shaly dolostone, fine crystalline and medium–bedded. Chert and gypsum nodules are present and the unit has a distinct petroliferous odor. It is overlain by a grey–brown, fine– to medium–crystalline, thin–bedded dolostone of the Eramosa Member. Some shaly partings are present which also release a petroliferous odor when freshly broken.

Geological Section

		Thickness
UNIT 2	*Lockport Formation, Eramosa Member*	*13.10m*

Dolostone: brown-grey, weathers grey; fine to medium crystalline; thin to medium bedded, sharp contacts with bituminous and shaly partings; calcite and gypsum nodules present; crinoids and brachiopods common in shaly partings; vuggy; porous; has a petroliferous odor; slump features present; blocky fracture pattern; transitional lower contact.

UNIT 1	*Lockport Formation, Vinemount shale beds*	*6.28m*

Shaly dolostone: light grey, weathers dark grey; fine crystalline; medium bedded, sharp contacts with fine, undulatory laminae; shale/dolostone ratio 75/25; gypsum and calcite nodules present, sphalerite occurs along shaly partings; trace fossils present with silt infill; petroliferous odor when freshly broken; subconchoidal fracture; shale beds possess parallel lamination.

Total thickness	*19.38m*

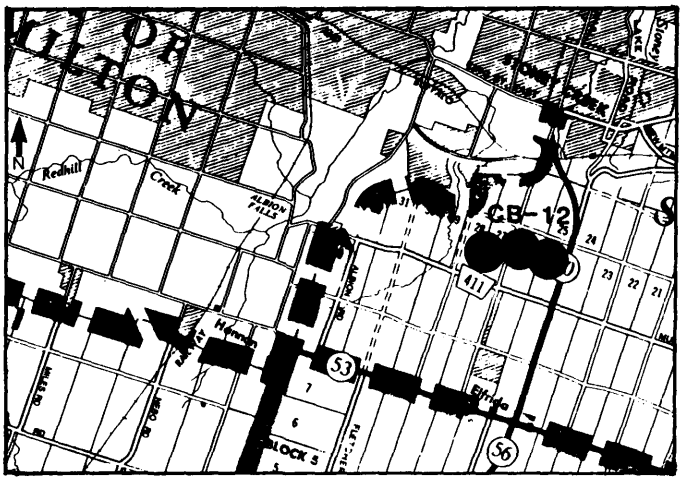


Figure CB-12-1. LOCATION MAP FOR STONEY CREEK QUARRIES.

CHEMICAL ANALYSES – LOCKPORT FORMATION, ERAMOSA MEMBER*

	Components in Percent						
Sample No.	1	2	3	4	5	6	7
Depth from surface metres	0.0–1.5	1.5–3.1	3.1–4.6	4.6–6.1	6.1–7.6	7.6–9.1	9.1–10.7
SiO_2	1.97	1.07	1.26	1.06	1.64	1.86	4.12
Al_2O_3	2.02	0.91	1.34	0.86	0.50	1.19	1.87
Fe_2O_3	0.58	0.38	0.48	0.45	0.48	0.53	0.82
MgO	20.7	20.7	21.7	21.5	21.3	21.3	20.7
CaO	28.7	28.7	27.9	27.6	27.9	27.9	26.6
CO_2	44.4	45.6	44.8	45.7	44.4	43.0	43.4
S	0.03	0.03	0.12	0.05	0.14	0.26	0.37
Total	98.4	97.4	97.6	97.2	96.4	96.0	97.9

**After Hewitt and Vos, 1972, p. 49.*

Photo CB-12-1. VINEMOUNT SHALE AND ERAMOSA MEMBER AT STONEY CREEK QUARRIES.

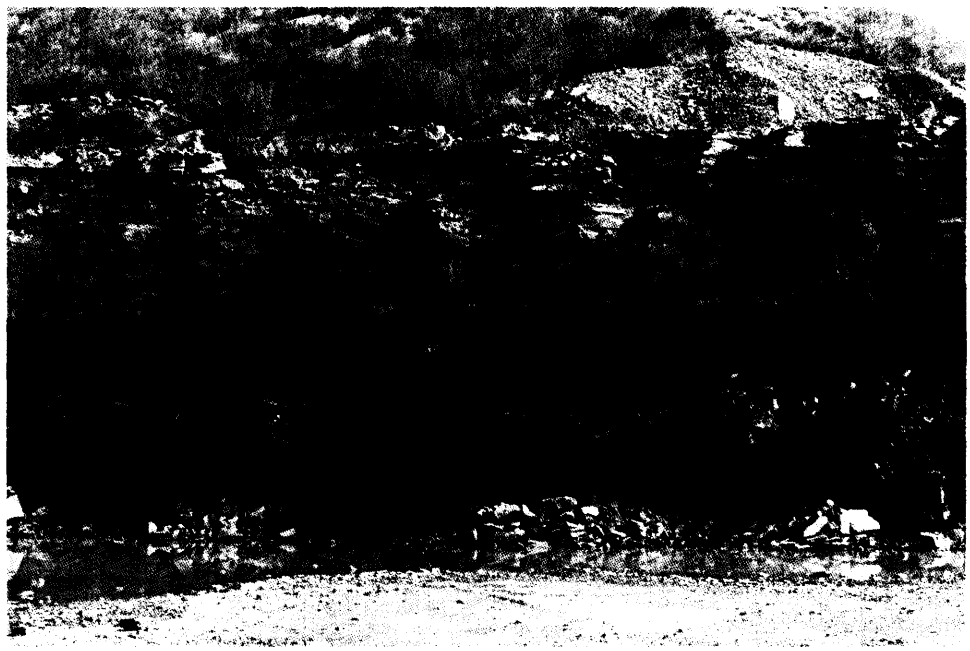


Photo CB-12-2. STONEY CREEK (WEST) QUARRY (LOOKING SOUTHWEST).

QUARRY OPERATION

The quarry operations in place at the time of the field work in 1986 are described in this report. Blasting design techniques focus on minimizing blast vibration and a large 9 m berm separates the quarry from local housing. A single 8.5 m lift is drilled on a 2.4 m x 2.7 m pattern with 7.6 cm diameter holes by two Ingersoll–Rand VL–671 air track drills (equipped with dust suppression systems) and a 1400 cfm compressor. All blast holes are stemmed by 1.2 m with stone chips and initiated with Nonel delay caps at the bottom of the holes, kicking out the bottom of the shot and allowing the upper section to break downward and horizontally away from the face. Each hole has a 42 ms delay, resulting in 40 lbs. of explosive delayed per hole. The quarry floor is very smooth due to the blasting allowance of a thin buffer of dolostone above the underlying shale. A maximum 15 cm subgrade is drilled.

Blasted stone is loaded by two Cat 988B 7 1/2 yd. A Poclain marble rock breaker is used for secondary breakage.

PROCESSING

The process flow sheet for Stoney Creek Quarries is shown on Figure CB–12–3.

The crushing and screening plant is located in the east quarry. A 43 in. x 53 in. Cedarapids twin impeller crusher breaks the stone to –6 in. and this is carried approximately 250 m by a 36 in. conveyor to a surge bin. Stone from the surge bin is fed to a Cedarapids 5 ft. x 16 ft. triple deck screen that produces Granular "A", 2 in. clear and –6 in. + 2 in. oversize that is recrushed in an Eljay 54 in. cone. The Eljay crusher feeds a 5 ft. x 16 ft. triple–deck Cedarapids horizontal screen. The –9/16 in. fines are sent to a 6 ft. x 16 ft. Dillon triple–deck screen and separated into –9/16 in. + 3/8 in. (1/2 in. chips), –3/8 in. + 1/4 in. (HL3 asphalt stone) and screenings. If desired, a 4 ft. roller crusher and Assinck 4 ft. x 12 ft. portable screen are available to recrush the 1/2 in. chips.

Dust sources in the plant are as strictly controlled as in the drilling operations. Water is applied to all belts, though not so much as to create a build–up that would clog the screens. Taro Aggregates supplies primarily 3/4 in. stone for residential construction (weeping tile, basement foundation, driveways, etc.) within a 12 km radius of the plant.

REFERENCES

Hewitt, 1960, p. 103–105
Hewitt, 1964a, p. 44
Vos, 1969, p. 32–33
Hewitt and Vos, 1972, p. 49–50
ARIP 50, 1984, p. 37
Sabina, 1986, p. 143–144

MAPS

Caley, 1941c, GSC Map 584A
Liberty, Feenstra and Telford, 1976a, ODM Map 2343

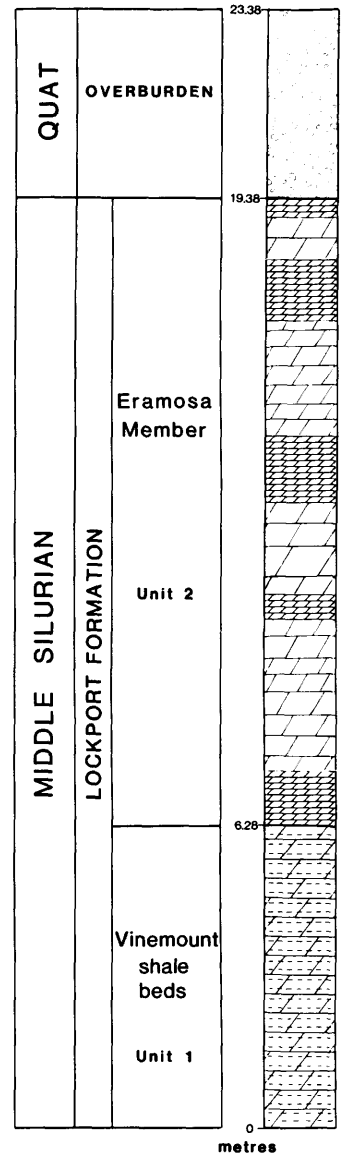


Figure CB–12–2. STRATIGRAPHIC COLUMN FOR STONEY CREEK QUARRIES.

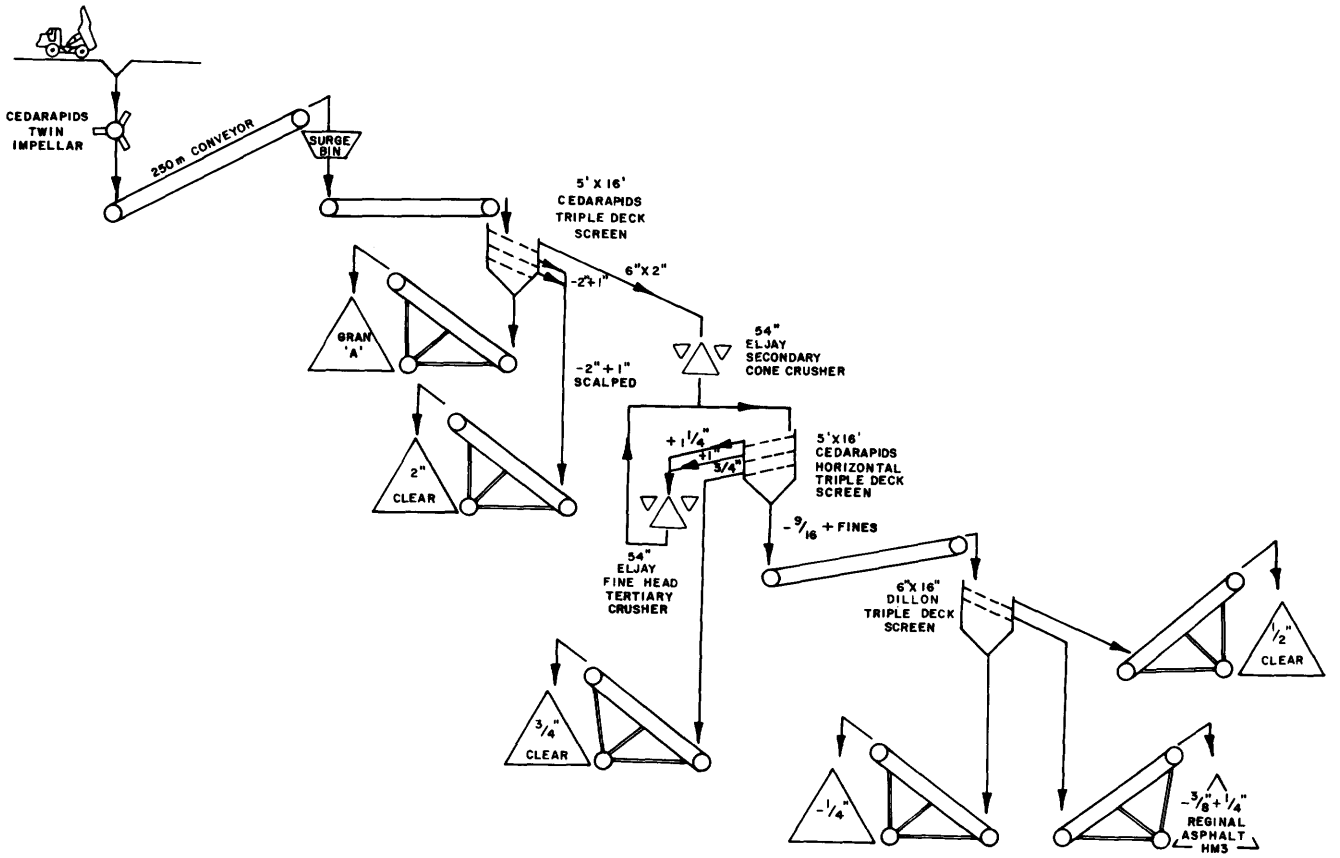


Figure CB-12-3. PROCESS FLOW SHEET FOR STONEY CREEK QUARRIES.

CB-13 WATERFORD SAND AND GRAVEL LTD. — VINEMOUNT QUARRY

LOCATION AND OWNERSHIP

This quarry is located 4 km south of Winona in Lot 5, Concession 5, City of Stoney Creek (Saltfleet Township), Regional Municipality of Hamilton-Wentworth (Figure CB-13-1). At the time of the field visit in 1986, the quarry was being dewatered. Quarrying operations and production of crushed stone were planned for 1987. The licenced area of the quarry is 20 ha.

GEOLOGY

The quarry exposes a total of 19.47 m of the Goat Island Member, Vinemount shale beds and Eramosa Member of the Lockport Formation (Figure CB-13-2). The lower part of the Goat Island Member is a brown-grey, medium-crystalline, fine-to medium-bedded dolostone with stylolitic and bituminous partings. This unit contains 2.4 m of the informally named Ancaster Chert Beds. Calcite and gypsum mineralization is prevalent throughout.

The Goat Island Member is overlain by a black-grey shaly dolostone informally termed the Vinemount shale beds. Trace fossils are very common in the Vinemount shale beds, along with abundant brachiopods and crinoidal debris and gypsum and calcite nodules. The Vinemount shales are in turn overlain by the Eramosa Member (4.16 m) which consists of light to medium brown, fine- to medium-crystalline, thin-bedded dolostone. Shaly partings persist in the upper 2 m with zones of abundant crinoidal debris.

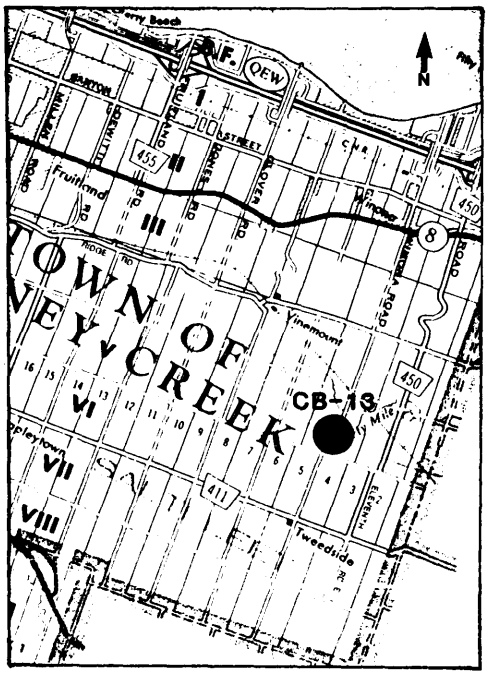


Figure CB-13-1. LOCATION MAP FOR VINEMOUNT QUARRY.

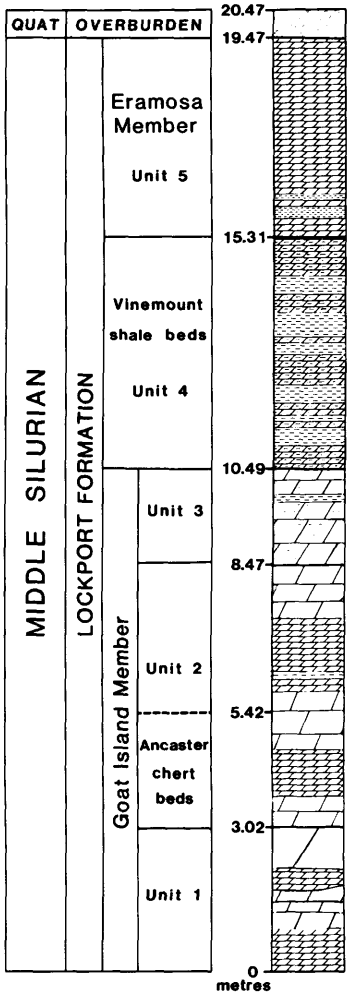


Figure CB-13-2. STRATIGRAPHIC COLUMN FOR VINEMOUNT QUARRY.

Geological Section

Thickness

UNIT 5 Lockport Formation, Eramosa Member *4.16m*

Dolostone: dark to light brown, weathers buff-grey; fine to medium crystalline; thin bedded, sharp - irregular contacts with shaly partings in the lower 2 m; rich crinoidal zones; vuggy; laminations present; lower contact is sharp.

UNIT 4 Lockport Formation, Vinemount shale beds *4.82m*

Interbedded argillaceous dolostones and shales: light buff to dark brown, weathers buff; fine to medium crystalline; thin bedded, laminated with sharp contacts; very shaly in places; sedimentary features present include flame structures and graded beds; gypsum and calcite nodules throughout; fossils present include brachiopods, crinoids and trace fossils; sharp lower contact.

UNIT 3 Lockport Formation, Goat Island Member *2.02m*

Argillaceous dolostone: light grey to dark brown, weathers grey-black; fine crystalline; medium bedded, sharp irregular contacts; interbedded shaly zones with abundant trace fossils; sucrosic; buff coloured chert beds and nodules present in upper 1 m (very irregular); gypsum and calcite scattered throughout; lower contact is sharp.

UNIT 2 Lockport Formation, Goat Island Member *5.45m*

Dolostone: medium to grey-brown, weathers grey-brown; very fine to medium crystalline; thin to medium bedded (3 to 40 cm), contacts are shaly or stylolitic; has a bituminous odor; some shaly partings present; lower 2.4 m of unit has extensive chert lenses (2 to 3 cm thick) and is referred to as the Ancaster Chert Beds; gypsum and calcite nodules occur in vugs; lower contact is sharp.

UNIT 1 Lockport Formation, Goat Island Member *3.02m*

Dolostone: medium grey, weathers light buff; medium crystalline; thin to medium bedded, contacts are irregular, shaly and sometimes bituminous; upper beds are massive with undulatory and irregular contacts; banding is common; large white gypsum nodules (2x15cm) occur in vugs; calcite mineralization is also present in vugs, some surround gypsum crystals.

Total thickness *19.47m*

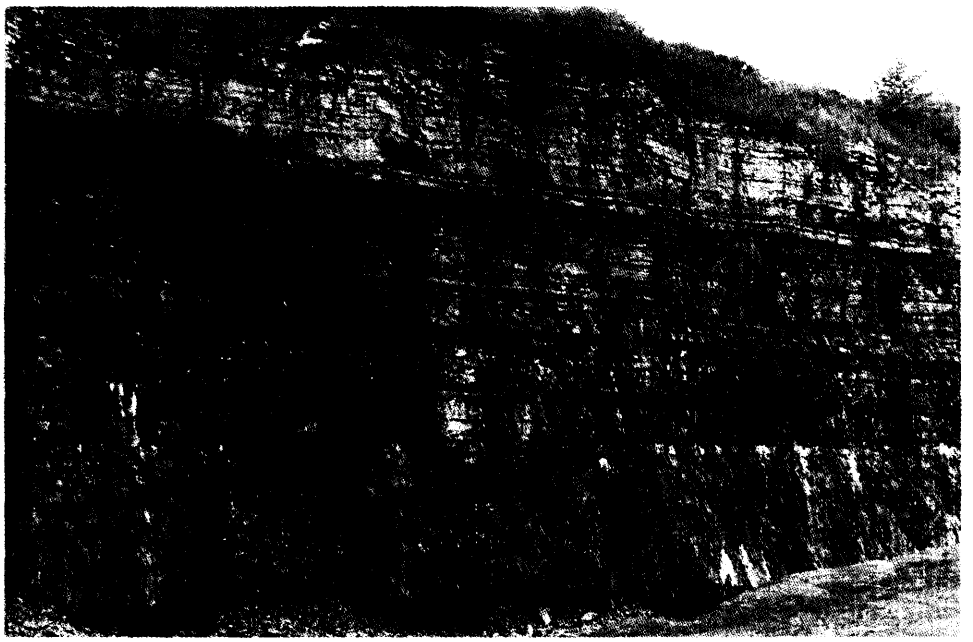


Photo CB-13-1. UNITS OF THE LOCKPORT FORMATION AT THE VINEMOUNT QUARRY.

REFERENCES

Goudge, 1938, p. 307–308
Hewitt, 1960, p. 100–103
Hewitt, 1964a, p. 44
Vos, 1969, p. 21
Hewitt and Vos, 1972, p. 47
ARIP 50 1984, pp. 19. 37
Sabina, 1986, p. 144

MAPS

Caley, 1941c, GSC Map 584A
Liberty, Feenstra and Telford, 1976a, ODM Map 2343

CB-14 ARRISCRAFT CORPORATION

LOCATION AND OWNERSHIP

Arriscraft Corporation has its plant and head office located on Speedsville Road, immediately north of Highway 401 in Cambridge, Ontario. The plant produces dressed stone with the trade name "Adair Marble" made from blocks of Amabel Formation dolostone which is quarried near Wiarton (site O–1 in Owen Sound District) and trucked to Cambridge. The company also manufactures an artificial calcium silicate building stone and brick. While markets for Adair Marble were strong in 1986, the natural stone division accounted for only about one–quarter of the company's revenues.

The company's production began in 1949 based on artificially coloured concrete stone. In 1956 the company's founder, E.G. Ratcliffe, developed a line of calcium silicate based building stone products. These have been marketed under such trade names as Citadel, Garrison, Ramparts Building Stone, Renaissance Masonry Units, Angelstone and Pioneer Brick.

MANUFACTURED STONE

Manufactured stone products are made from natural sands, lime and colouring pigments. Glacial sand from the plant property is the major constituent, augmented by Nepean Formation sandstone from a quarry near Elgin in eastern Ontario when improved whiteness is desired. About 20% of quicklime is added to the sands and the mixture is held in two reactor bins at about 140°C. Various mineral pigments (mostly iron oxides) are introduced to the batch via two rod mills. A variety of product shapes are made in two Chisholm, Boyd and White presses and are cured for 8 hours in two autoclaves under a steam pressure atmosphere of 69 Mpa (10,000 p.s.i.). Special face texturing is applied by hand and through various splitting and finishing techniques. The result is a range of attractive manufactured sandstones in a variety of earth tone colours. Products include rock–face ashlar, random fieldstone, rectangular building stones and antique bricks for interior and exterior uses.

NATURAL STONE

Natural stone is dressed in an adjoining plant. Mill blocks of thick–bedded Lockport Formation (Wiarton–Colpay Bay Member) dolostone are delivered by flat–bed truck from the Adair Marble Quarry (0–1) 200 km to the north (near Wiarton). They are off–loaded by forklift and placed in inventory for 2 or 3 months for seasoning. The process of eliminating "quarry sap" is not well understood, but it is believed to be related to moisture in rock pores which otherwise can cause spalling and other undesirable fracturing. Mill blocks are first trimmed by one of three large diameter (2 m) diamond–tipped circular saws. Sized blocks are then slabbed by a modified gang saw or multiple saw equipped with as many as 16 blades. Slabs of 1 1/4 in. and 2 1/4 in. are common thicknesses. Sawn faces may be textured by honing, sandblasting, bush hammering, flame finishing or conventional polishing. Final sizing is done with circular diamond saws. In 1986 the plant produced 15,000 pieces for the new Canadian embassy in Washington, D.C., involving 3,000 different sizes.

Quarrying of natural stone began in 1968 with the acquisition of the R.G. Ebel quarry (0–6) at Hope Bay. In 1979 the present Adair quarry (0–1) was opened in the same vicinity. Early production was mainly hearth slabs and sills, and it wasn't until 1980 that substantial production of building stone slabs was initiated. Products now include sills, coping, coursing stone, paving stone, slabbing and thin wall overlays. The company markets and distributes its products throughout North America by a dealer network of nearly 300.

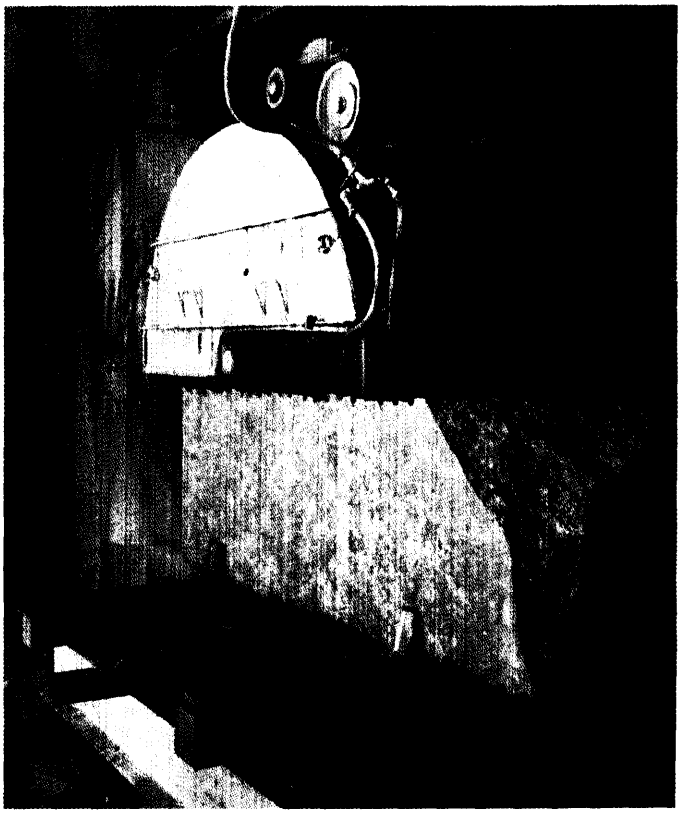


Photo CB-14-1. TRIMMING MILLBLOCKS WITH A LARGE DIAMOND SAW AT THE CAMBRIDGE PLANT OF ARRISCRAFT CORPORATION.

Niagara District

INTRODUCTION

The Niagara District is situated in the Central Region of southern Ontario and includes all or portions of the Regional Municipalities of Niagara and Haldimand–Norfolk as shown in Figure NI–0–1.

Seventeen quarry properties are currently licensed in the Niagara District; 11 are active at the present time. The balance of the properties represent past producing quarries or those properties designated for future production. The quarries are located either along the Niagara Escarpment which trends east–west across the northern half of the district or along the discontinuous east–west trending Onondaga Escarpment which occupies the southern half of the district.

All of the quarries currently in production and those past producing quarries of geological significance were visited during the study and include the following:

NI–1 *Nelson Aggregate Co. – Lincoln Quarry (active)*

NI–2 *Vineland Quarries and Crushed Stone – Vineland Quarry (active)*

NI–3 *Walker Brothers Quarries Ltd. – Thorold Quarry (active)*

NI–4 *Steetley Industries Ltd. – Queenston Quarry (active)*

NI–5 *Standard Aggregates Incorporated – Hagersville Quarry (active)*

NI–6 *Nelson Aggregate Co. – West Oneida Quarry (intermittent)*

NI–7 *Nelson Aggregate Co. – Oneida Quarry (intermittent)*

NI–8 *Cayuga Materials and Construction – Cayuga Quarry (active)*

NI–9 *Sweets Corners Quarries (abandoned)*

NI–10 *Dunnville Rock Products Ltd. Quarry (active)*

NI–11 *Hard Rock Paving Co. Ltd. – R. E. Law Quarry (active)*

NI–12 *Port Colborne Quarries Ltd. – Port Colborne Quarry (active)*

NI–13 *Bertie Bay Quarry (abandoned)*

NI–14 *Ridgemount Quarries Ltd. – Pit 1 (intermittent)*

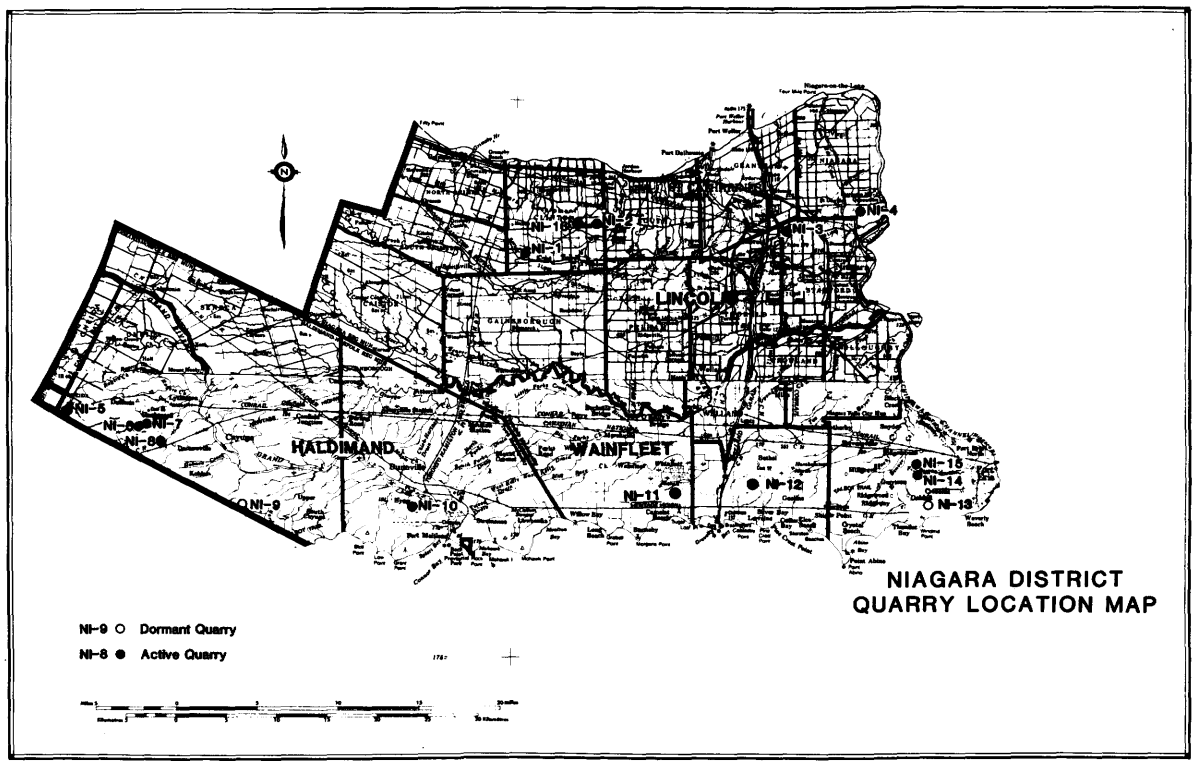


Figure NI–0–1. NIAGARA DISTRICT QUARRY LOCATION MAP.

NI-15 *Ridgemount Quarries Ltd. - Pits 2 and 3 (active)*
NI-16 *Clinton Quarry Ltd. (active)*

REGIONAL GEOLOGY

The regional geology of the Niagara District, for the purpose of this report, will be discussed by quarry distribution which conveniently divides the district into two distinct regions designated as the northern region and the southern region by an east–west line through the City of Welland.

The geomorphology of the northern region of Niagara District is dominated by three main features: the Niagara Escarpment, which trends east–west across the area; Lake Ontario to the north; and the deeply incised Niagara River along the eastern margin of the area. The Escarpment exposes resistant Silurian dolostones and dolomitic limestones, which overlie easily eroded Ordovician shales.

The Upper Ordovician Queenston Formation, represented by olive–green to red, hematitic shales, is the oldest unit in the northern portion of Niagara District. It forms much of the bedrock for the area north of the Escarpment, and has been quarried in places as a clay source. The Queenston Formation is disconformably overlain by the Lower Silurian Cataract Group, represented by the Whirlpool, Cabot Head, and Grimsby Formations (a succession of sandstones, limestones, dolostones, and sandstones with interbedded shales). These units are overlain by the Middle Silurian Clinton Group, a succession of sandstones, limestones, and dolostones with shaly partings, that are represented by the Thorold, Neahga (found only in the eastern margin of the district), Reynales, Irondequoit, Rochester, and the Decew Formations.

The Middle Silurian Lockport Formation overlies the Clinton Group rocks and includes (in ascending stratigraphic order) the following members: the Gasport Member, which consists of medium– to massive–bedded, fossiliferous dolostones and limestones; the Goat Island Member, a thin– to medium–bedded, microcrystalline to very fine–crystalline, cherty dolostone; and the Eramosa Member, a dark, bituminous and fine–crystalline dolostone which is not well exposed in the area. The Vinemount shale beds are found in the northwestern edge of the district near the base of the Eramosa Member.

The overlying Middle Silurian Guelph Formation and the Upper Silurian Salina Formation are present in the subsurface but are not well exposed in this area.

Quarry operations in the northern half of the Niagara Peninsula (see Figure NI–0–2) have concentrated primarily on the Lockport Formation (mainly the Gasport Member). Some abandoned quarries in Clinton Township and three operating quarries (Vineland NI–2, Thorold NI–3, and Queenston Quarries NI–4), have quarried the Decew Formation along with the overlying Gasport Member. The Lincoln Quarry (NI–1), south of Beamsville, is the only operating quarry in the district which utilizes both the Eramosa and Goat Island Members of the Lockport Formation.

All quarries in the northern part of the Niagara District are located along an east–west line parallel to and south of the crest of the Escarpment. The Lockport Formation outcrops in this area that are best suited for quarrying purposes, now lie within Niagara Escarpment Plan Zones which prohibit extraction. Stone from the Lockport Formation is used as aggregate for road construction and concrete, and as a source of building stone.

The southern region of the Niagara District includes all parts of the district south of a line trending east–west through the City of Welland. Geomorphically this is an area of low relief which is dominated by the south and southeastern trending patterns of the Grand River and the discontinuous Onondaga Escarpment. Outcrop exposures are rare because of glacial and lacustrine cover. Limited exposures are located along the Lake Erie shoreline, the Onondaga Escarpment (especially between Clanbrassil and Kohler), and in quarry excavations.

The oldest unit occurring in this area is the Upper Silurian Salina Formation, which consists of argillaceous dolostones with shaly and gypsum partings. The only definite exposure of this unit in the area is found in a roadcut, south of Welland and adjacent to the Welland Canal. Overlying it is the Upper Silurian Bertie Formation which is exposed on the Onondaga Escarpment. This unit, represented by five members (in ascending stratigraphic order; the Oatka, Falkirk, Scajaquanda, Williamsville, and Akron), has lithologies ranging from shaly dolostones to calcareous dolostones and is quarried for various products. The member names are the same as those used in New York State. Individual members are best seen in the eastern portion of the area. The entire Bertie Formation is best seen in the operating Ridgemount Quarries Ltd. Pits 2 and 3 (NI–15).

The top of the Upper Silurian Bertie Formation is a major erosional disconformity (Silurian/Devonian) and it is overlain by the Lower Devonian Bois Blanc Formation. The only known exposures of the Oriskany Formation (an Appalachian Basin unit) in Ontario occur in the extreme southwest corner of the district (near Clanbrassil). In outcrop the Oriskany Formation is a massive, grey to white, medium–grained, friable, fossiliferous, quartz sandstone, but in the subsurface it is difficult to distinguish from the discontinuous Springvale Sandstone Member of the Bois Blanc Formation. In the Cayuga area where the Springvale Sandstone Member is absent, the upper contact of the Oriskany Formation with the Bois Blanc Formation is sharp. The large operating Cayuga Quarry (NI–8), and the smaller quarries NI–6

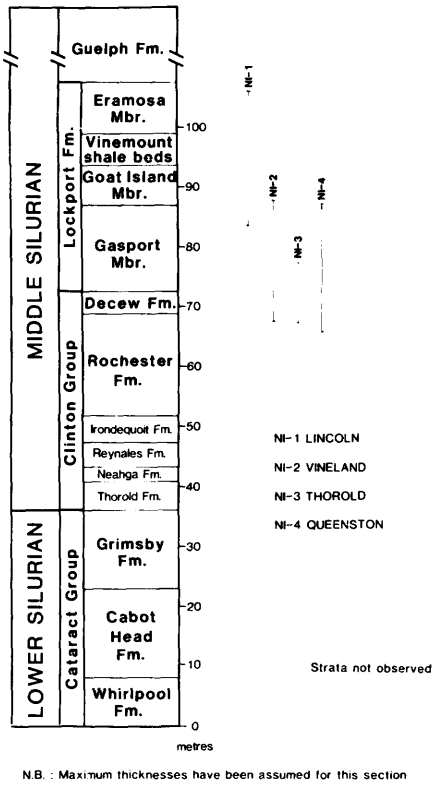


Figure NI-0-2. STRATIGRAPHIC COLUMN SHOWING PRINCIPAL QUARRIES IN NORTHERN NIAGARA DISTRICT.

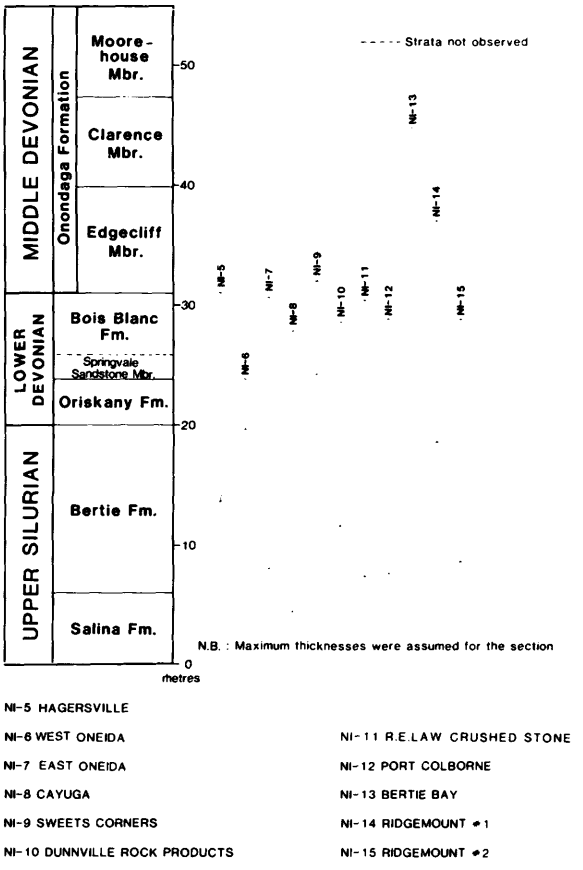


Figure NI-0-3. STRATIGRAPHIC COLUMN SHOWING PRINCIPAL QUARRIES IN SOUTHERN NIAGARA DISTRICT.

and NI-7 offer the best exposures of the succession of Bertie, Oriskany and Bois Blanc Formations.

Where present, the Springvale Sandstone Member occupies the basal portion of the Bois Blanc Formation and occurs mainly in the southwestern portion of the district. It consists of a medium- to coarse-grained, green to grey, calcareous, quartz sandstone with interbeds of green glauconitic sandstone, limestone, dolostone and brown chert. The maximum recorded thickness for this member is 2.6 m in the Hagersville quarry (NI-5), although usually it is only observed infilling cracks and joints within the top 2 m of the Bertie Formation. The Springvale Sandstone Member is very irregularly developed and its geographic extent can not be easily delineated.

The Bois Blanc Formation is a cherty limestone with shaly partings which can exhibit a very diverse texture and composition. Locally, it can be quite fossiliferous, and is best exposed in a small abandoned quarry (NI-9), north of Sweets Corners, where a total of 5.4 m of the unit is present. This formation is disconformably overlain by the Middle Devonian Onondaga Formation.

The Onondaga Formation can be subdivided into three members (New York State terminology): the Edgecliff, Clarence, and Moorehouse Members (in ascending order). These three members are restricted to the southern portion of the district. The Edgecliff Member is predominantly a cherty, fossiliferous, bioclastic limestone with shaly partings, and in some areas it can become quite reefal with biohermal and biostromal development. This member is best exposed in the inactive Ridgemount Quarries Ltd. Pit 1 (NI-14) where the upper contact is gradational to the Clarence Member, a massive-bedded, dark grey-brown, fine-crystalline, poorly fossiliferous, very cherty limestone. The distribution of the Clarence Member is controlled by the occurrence of biohermal mounds in the Edgecliff Member. An abandoned quarry, NI-13, near Windmill Point Station, exposes the best stratigraphic sequence of the Clarence Member. The upper contact is gradational to the Moorehouse Member, a brown, fossiliferous, variably

cherty limestone. The Moorehouse Member is only seen in outcrop along the Lake Erie shoreline around Cassaday, Pine Crest Point, and Point Abino.

Of the abandoned and operating quarries in the southern portion of the Niagara District (*see* Appendix IV, Volume I), the distribution of eleven of the more significant quarries in the area is illustrated in Figure NI-0-3. The major quarrying operations in the Niagara District have concentrated on the Bertie and Bois Blanc Formations, with minor operations in the Onondaga Formation (Edgecliff and Clarence Members). The six operating quarries in the region utilize the stone for asphalt aggregate and road construction, concrete, and agricultural lime. The Oriskany Formation has been used to produce silica sand.

LIMESTONE INDUSTRIES

The principal limestone industry in the Niagara District is construction aggregate. Stone production in 1985 and 1986 for the district was approximately 4,170,000 tonnes and 5,168,000 tonnes respectively. The material was used primarily in the construction industry as road and concrete/asphalt aggregate.

Production from quarries within the Regional Municipality of Niagara was 3,115,000 tonnes in 1985 and 4,071,000 tonnes in 1986. Production from the portion of the Regional Municipality of Haldimand-Norfolk which falls within Niagara District amounted to 1,052,000 tonnes in 1985 and 1,097,000 tonnes in 1986.

NI-1 NELSON AGGREGATE CO. — LINCOLN QUARRY

LOCATION AND OWNERSHIP

This active quarry, located 6 km south of Beamsville in Lot 20, Concession 9, Town of Lincoln (Clinton Township), Regional Municipality of Niagara, is operated by Nelson Aggregate Co. (Figure NI-1-1). The quarry was opened in 1969 by Aiken and MacLachlan of St. Catharines at a capacity of 900 tonnes per day, a rate that had increased by 1986 to 500,000 tonnes annually over an 8-month operating period. The quarry licence covers an area of 44.53 ha.

GEOLOGY

The Lincoln Quarry exposes a total of 19.16 m of section from the Lockport Formation (Figure NI-1-2). This includes rocks of the Eramosa and Goat Island Members. The Eramosa Member exposure consists of 8.3 m of a brown, fine-crystalline, medium-bedded, bituminous dolostone. This unit is characterized by very large vugs (up to 1.5 m in diameter) rimmed with calcite crystals. The Goat Island Member is a fine- to medium-crystalline, thin- to massive-bedded, brown dolostone. It is bituminous and richly fossiliferous with abundant stylolites. Mineralization present in the Goat Island Member includes gypsum, sphalerite, calcite, dolomite and chert. Arenaceous zones with sedimentary features are present towards the top of the unit. Overburden is thin, ranging from 15 cm to 90 cm, and is easily removed. The material is currently used to rehabilitate the top bench along the eastern quarry limit.

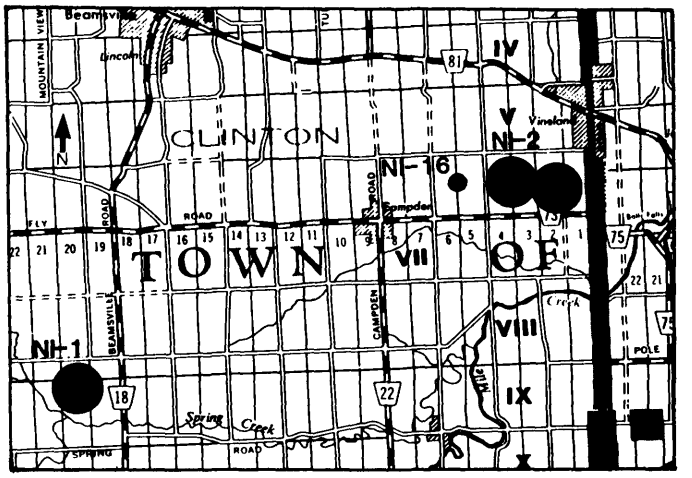


Figure NI-1-1. LOCATION MAP FOR LINCOLN QUARRY.

Geological Section

Thickness

UNIT 5 Lockport Formation, Eramosa Member — *8.30m*

Dolostone: brown, weathers brown; fine crystalline; medium bedded (8 to 30 cm), contacts are sharp, slightly undulatory and irregular; calcite crystals rim large vugs (up to 1.5 m in diameter), selenite in pores and vugs; bituminous odor; porous; bryozoa are abundant; stylolitic and bituminous partings present; lower contact is floor of lift #1.

UNIT 4 Lockport Formation, Goat Island Member — *3.83m*

Dolostone: dark grey, weathers grey; sub- to fine and medium crystalline; thin to medium bedded (4 to 15 cm), contacts are sharp and planar; gypsum occurs along fractures, calcite in vugs and pores, dolomite in contorted vugs - some in fractures, red/yellow sphalerite occurs as small nodules; crinoids and brachiopods are abundant as fragments, corals are rare; shaly and silty partings at base with shale rip-ups within the dolostone; the character of the rock changes gradually in the upper 1.40 m to a finer crystalline rock with abundant bituminous stylolites; rock has a lithographic texture; lower contact is sharp, with a 3 cm thick shaly parting.

UNIT 3 Lockport Formation, Goat Island Member — *2.83m*

Dolostone: dark brown, weathers light brown; fine crystalline; massive bedded; stylolitic; calcite in pores, gypsum in fractures and scattered sphalerite mineralization; large stromatoporoids present, abundant algal material in upper part; the upper third of the unit is highly fractured and mineralized; lower contact is sharp.

UNIT 2 Lockport Formation, Goat Island Member 1.70m

Dolostone: dark brown, weathers black-brown; very fine to fine crystalline; thin to medium bedded (4 to 15 cm), sharp contacts with bituminous partings and stylolites; chert, calcite, gypsum and abundant tabulate corals (which can occur in lateral sheets), rare solitary corals, abundant bioturbation (*Chondrites*); bituminous partings present; chert occurs as beds (3 cm thick), black in colour and rimmed with bituminous material; base of unit is quarry floor.

UNIT 1 Lockport Formation, Gasport Member (in sump) 2.5m

Dolostone: light brown-buff, weathers tan; fine crystalline; medium to thick bedded, contacts are sharp with black, bituminous partings, some are stylolitic; sphalerite occurs in fractures and on laminae; gypsum, calcite, dolomite and chert (black and tan) mineralization are also present; stromatoporoids and tabulate corals are present; darker laminae occur with bituminous partings.

Total thickness 19.16m

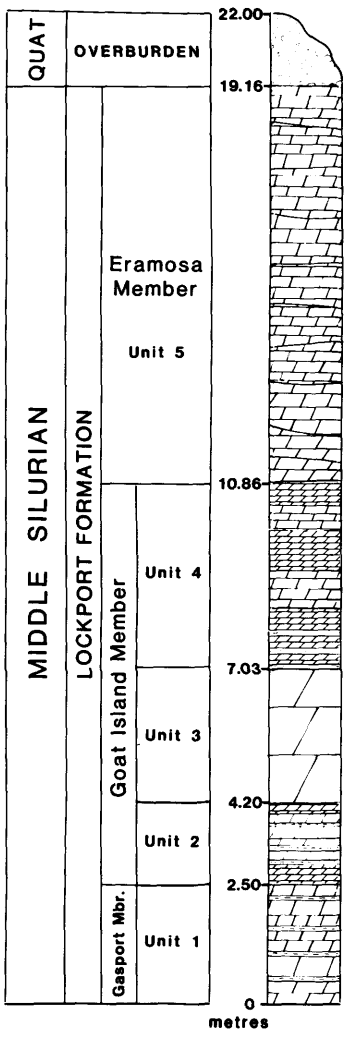


Figure NI-1-2. STRATIGRAPHIC COLUMN FOR LINCOLN QUARRY.

CHEMICAL ANALYSES - 3/4 IN. CONCRETE STONE*

Components in Percent

SiO_2	1.40	CaO	29.5
Al_2O_3	0.96	L.O.I.	46.4
Fe_2O_3	0.52	Total	99.28
MgO	20.5	CO_2	45.0

* *After Hewitt and Vos, 1972, p. 54.*

QUARRY OPERATION

Three bench faces are currently exposed to depths of 9 m, 8 m and 4 m, with the future development of a 4th lift projected. Containing low silica (less than 0.5%), the first bench is a high quality stone suitable for metallurgical applications. The second bench has a higher silica content (about 6%) and is used for aggregates.

Blast holes are drilled at 7.6 cm diameter with a Gardner-Denver 3100 air-track on 3.0 m x 3.7 m and 2.4 m x 2.7 m patterns respectively for the first bench and lower two benches. The holes are toe primed with water gel cartridges, loaded with bulk AN/FO and initated with electric caps. Blasting of the lower benches produces some armour stone-sized material that, lacking a ready market, is sorted by a grappler and broken down by a Liebherr backhoe equipped with a hydraulic hammer.

The quarry is dewatered by two 6 in. Flygt electric pumps which supply the twin washing screens. Return water from the screens passes through a series of settling ponds in the quarry before recycling by the Flygt pumps.

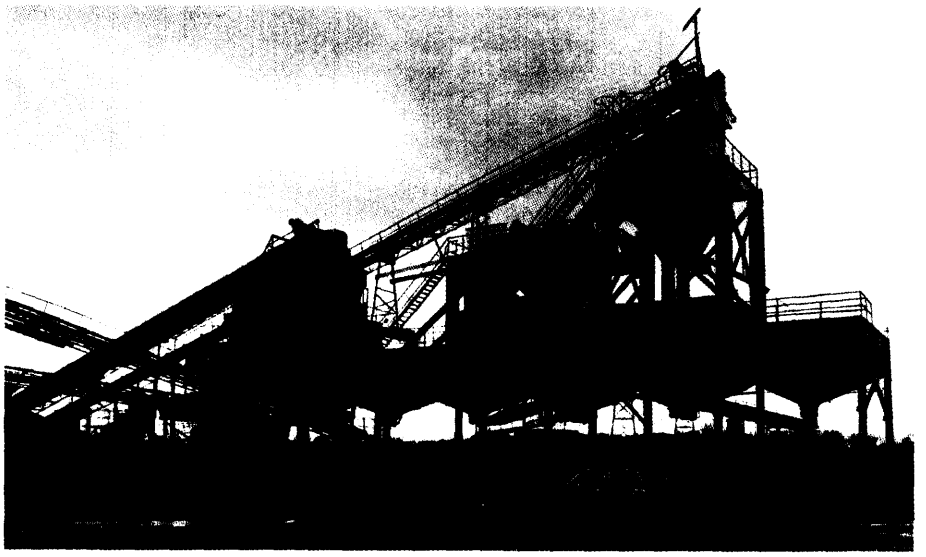
PROCESSING

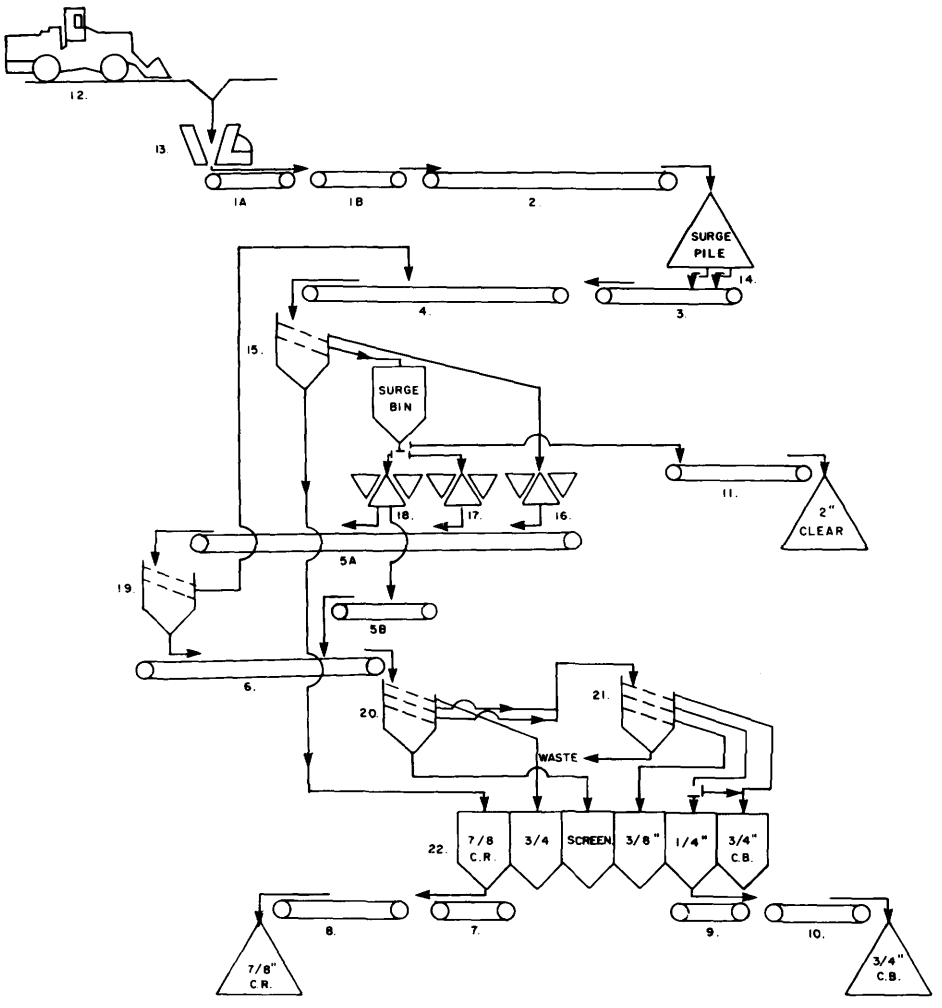
The process flow sheet is shown on Figure NI-1-3. Blasted stone is loaded by one 475 Michigan 12 yd. loader and transported an average 125 m to a portable Cedarapids single impeller primary crusher. The stone is crushed to -7 in. and transported a distance of 500 m by three 36 in. belt conveyors for secondary crushing by 4 ft. and 4 1/4 ft. Symons standard cone crushers. Screening equipment includes two double-deck 5 ft. x 14 ft. Tyrock screens, one single deck 5 ft. x 12 ft. Dillon, two triple-deck 4 ft. x 14 ft. Dillon screens and two triple-deck Cedarapids wash screens. Six bulk bins with approximately 70-tonne storage capacity hold the finer products for truck loadout. Recovery of stockpiled 7/8 in. crusher run and 3/4 in. concrete stone material is by 6.5 yd. 275-B Michigan loader. All products are shipped by truck and are weighed by a 50 ft. truck scale (62.5 tons).

PRODUCTS

2 in. Clear
3/4 in. Clear
1/2 in. Clear
3/8 in. Clear
1/4 in. Clear
Screenings

Photo NI-1-1.
PROCESSING PLANT AT LINCOLN QUARRY SHOWING SYMONS CONE CRUSHER (LEFT), SCREENS AND BULK LOAD-OUT BINS.





CONVEYOR LIST

1A - 36" x 504'	6 - 30" x 195'
1B - 36" x 450'	7 - 24" x 90'
2 - 36" x 650'	8 - 24" x 60'
3 - 36" x 80'	9 - 24" x 200'
4 - 36" x 130'	10 - 24" x 150'
5A - 30" x 120'	11 - 30" x 80'
5B - 30" x 90'	

EQUIPMENT LIST

12 - Front End Loader
13 - Cedarapids 43"x 40" Primary Crusher
14 - Mod F55 Syntron Feeder
15 - 2 5' x 12' Tyrock Double Deck Screens
16 - 4¼' Symons Std. Cone Crusher
17 - 4' Symons Std. Cone Crusher
18 - Barmac Rotopactor Crusher
19 - 1 5'x16' Dillon Single Deck Screen
20 - 2 4'x14' Dillon Triple Deck Screen
21 - 2 4'x14' Cedarapids Triple Deck Screen
22 - Truck Loading Bins

Figure NI-1-3. PROCESS FLOW SHEET FOR LINCOLN QUARRY.

7/8 in. Crusher Run
Asphalt Stone
Agricultural Lime

REFERENCES

Hewitt and Vos, 1972, p.54
ARIP 104, 1985, p.20 (Q1)

MAPS

Liberty, Feenstra and Telford, 1976b, ODM Map 2344

NI-2 VINELAND QUARRIES AND CRUSHED STONE LTD. — VINELAND QUARRY

LOCATION AND OWNERSHIP

This active quarry is located near the edge of the Niagara Escarpment south of Vineland in Lots 1, 2, 3 and 4, Concessions 6 and 7, Town of Lincoln (Clinton Township), Regional Municipality of Niagara (Figure NI-2-1). Vineland Quarries and Crushed Stone Ltd. is owned by Walker Industries Holdings Ltd., the present operator. The quarry licence covers an area of 165.1 ha. Part of Vineland Quarry's annual production is derived from blasted stone supplied from the adjacent Clinton Quarry (NI-16). The Vineland crushing facilities are forecast to become increasingly dependent on the Clinton Quarry (also owned by Walker Industries), for a supply of feed stone.

GEOLOGY

The Vineland Quarry exposes a total of 8.95m of section which consists of Middle Silurian rocks from the Rochester and Decew Formations, and from the Goat Island and Gasport Members of the Lockport Formation (Figure NI-2-2). The basal Rochester Formation consists of 0.30 m of shaly dolostone which is overlain by the Decew Formation, 1.22 m of a fine-crystalline, massive-and irregular- bedded dolostone. The Lockport Formation exposure consists 7.43 m of a medium- to coarse-crystalline, fossiliferous dolostone (Gasport Member) and a subcrystalline, massive dolostone representing the Goat Island Member. The quarry is large and the working face is being extended westward.

Geological Section

		Thickness
UNIT 5	*Lockport Formation, Goat Island Member*	*1.70m*

Dolostone: pinkish-brown, weathers buff; fine crystalline; massive bedded with irregular contacts; stylolitic and sucrosic; weathers vuggy and pocked; this unit is only found on the east side of the quarry; lower contact is sharp and undulatory.

UNIT 4	*Lockport Formation, Gasport Member*	*2.40m*

Dolostone: light brown to cream, weathers buff; medium crystalline; massive bedded with irregular contacts; very porous and stylolitic; quite fossiliferous with abundant crinoids; sharp lower contact.

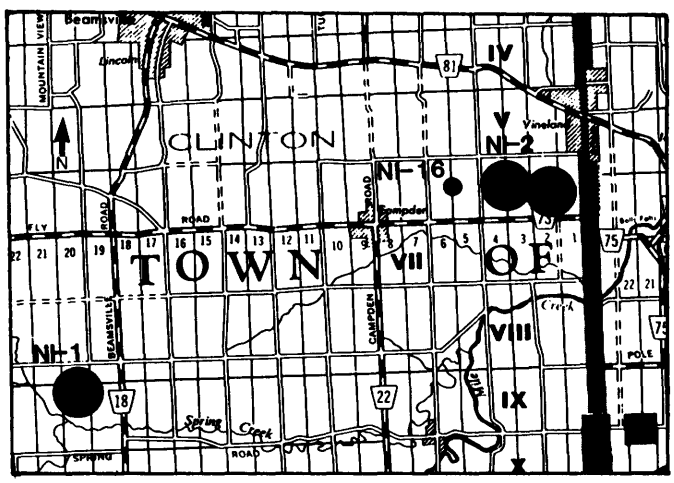


Figure NI-2-1. LOCATION MAP FOR VINELAND QUARRY.

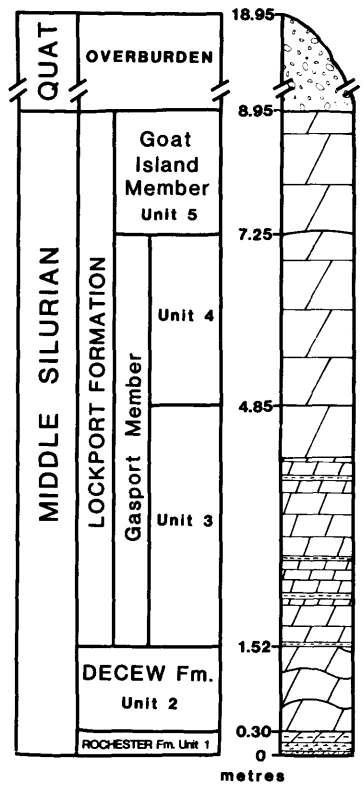


Figure NI-2-2. STRATIGRAPHIC COLUMN FOR VINELAND QUARRY.

Photo NI-2-1.
QUARRY SECTION SHOWING GASPORT MEMBER OF THE LOCKPORT FORMATION OVERLYING THE DECEW FORMATION; VINELAND QUARRY.

UNIT 3 Lockport Formation, Gasport Member *3.33m*

Dolostone: dark grey-brown, weathers buff-grey; medium to coarse crystalline; medium to thick bedded, contacts are sharp and irregular, some beds are laminated; lower 48 cm is a crinoidal dolostone with shaly interbeds; upper 2.85 m is more massive, coarse crystalline and not as shaly; dolomite mineralization replaces fossil debris, gypsum occurs as nodules, and calcite is present in vugs; very fossiliferous throughout (bryozoa, brachiopods and crinoids); some rip-up clasts present at the base; rare bituminous partings; lower contact is sharp.

UNIT 2 Decew Formation *1.22m*

Dolostone: dark grey-brown, weathers light grey-brown; fine crystalline; thick bedded with contorted contacts; mottled appearance with contorted laminae; calcite crystals rim vugs, as does gypsum; some slumping features present; sharp lower contact.

UNIT 1 Rochester Formation *0.30m*

Interbedded shaly dolostone and dolomitic shales: black-grey, weathers black; very fine to fine crystalline; thin to medium bedded (5 to 25 cm), contacts are sharp and laminated; gypsum filled vugs are abundant; some sedimentary features; rare gastropods present, abundant burrows (*Chondrites*) on bedding planes.

Total thickness *8.95m*

QUARRY OPERATION

The quarry is worked on two lifts totalling 9 m. Blasthole drilling is carried out with a Gardner–Denver 123 drill, on a 2.7 m x 2.7 m pattern with 7.6 cm diameter holes. The blasting conditions are dry and prilled ammonium nitrate is used as a bulk explosive. The blasted stone is transferred by a Caterpillar 992B loader to three 50–ton Euclid trucks for haulage to the primary crusher.

PROCESSING

The process flow sheet is shown on Figure NI–2–3. The primary crusher, a Jeffrey 536 impact unit, reduces the stone to –8 in. which is then fed by a 48 in. conveyor to a 6 ft. x 16 ft. double–deck screen. The screen produces Granular "A" and +4 in. –6 in. rubble rock, both of which are stockpiled by conveyor, and –8 in. material that is carried to a surge pile by a 42 in. conveyor. The surge pile material is recovered by a vibrating feeder onto a 36 in. tunnel conveyer that feeds a second 6 ft. x 16 ft. double–deck screen. This screen produces +1 1/2 in. oversize that is sent to a Symons 5 1/2 ft. cone crusher, –1 1/2 in. and +7/8 in. material sent to either a Penn or Jeffrey impact crusher, and –1/2 in. fines that are added to the output of the Symons cone crusher and fed to another 6 ft. x 16 ft. double–deck screen. This screen produces 3/4 in. clear, –5/8 in. granular stone and screenings. Stone crushed by the two impactors is screened by two parallel 7 ft. x 20 ft. double–deck screens that return +3/4 in. oversize for recrushing and feed the –3/4 in material to an 8 ft. x 22 ft. double–deck screen. This screen produces –3/4 in. +1/2 in. concrete stone and –1/2 in. material that is split by a 5 ft. x 12 ft. screen into –1/2 in. +3/16 in. chips and –1/4 in. screenings.

PRODUCTS

Vineland Quarries and Crushed Stone Ltd. has the capability to produce different grades of concrete, asphalt

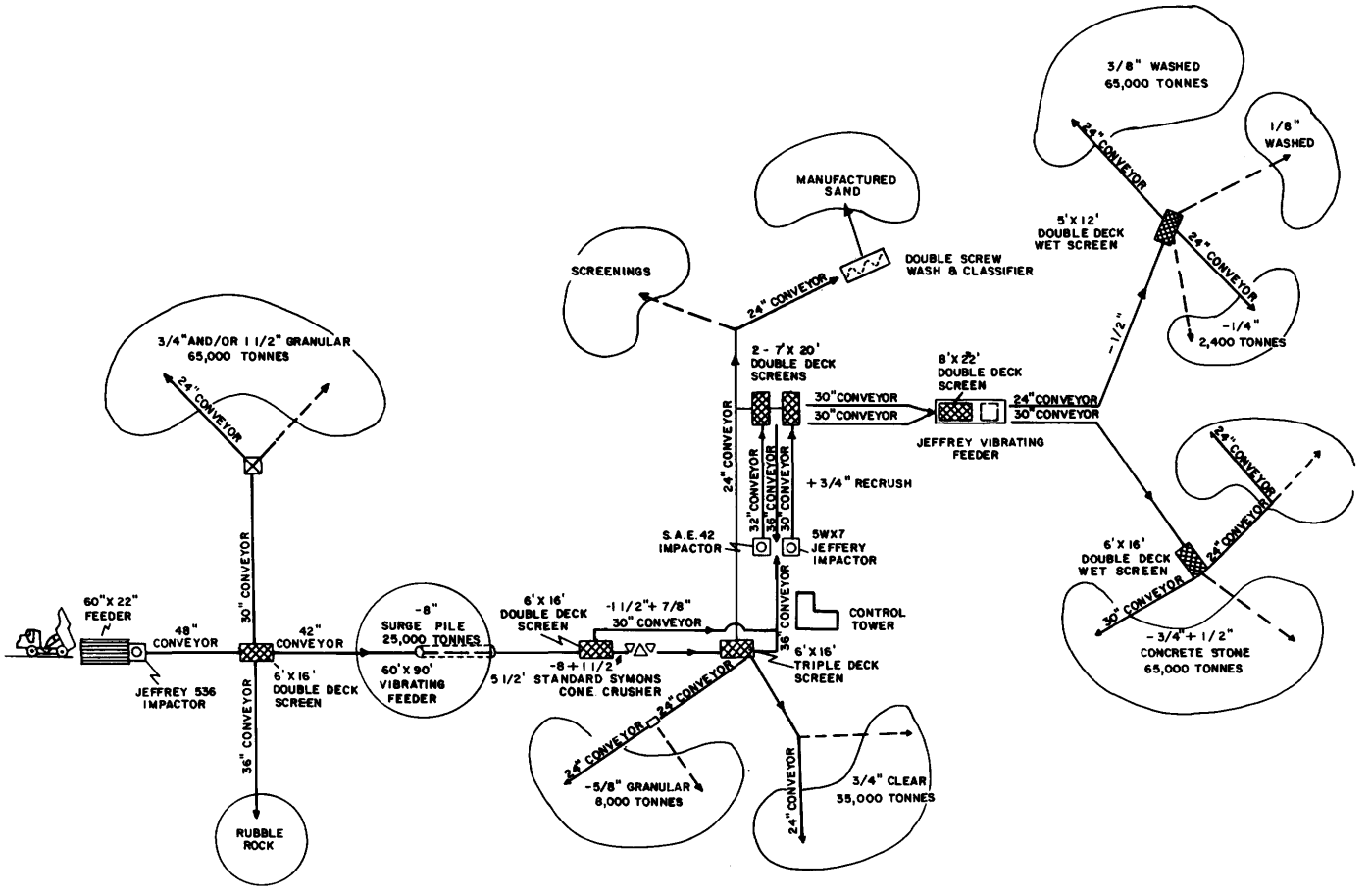


Figure NI-2-3. PROCESS FLOW SHEET FOR VINELAND QUARRY.

and crusher run stone by varying the screen sizes including but not restricted to, the following:

Rubble Rock
1 1/2 in. Granular
3/4 in. Granular
-5/8 in. Granular
3/4 in. Clear
Screenings
Manufactured Sand
3/8 in. Washed
1/8 in. Washed
-1/4 in. Washed
-3/4 in. + 1/2 in.
Concrete Stone

REFERENCES

Hewitt, 1960, p.98–99
Hewitt and Vos, 1972, p.55–56
ARIP 104, 1985, p.20

MAPS

Liberty, Feenstra and Telford, 1976b, ODM Map 2344

NI-3 WALKER BROTHERS QUARRIES LTD. — THOROLD QUARRY

LOCATION AND OWNERSHIP

The Walker Brothers Quarry is owned and operated by Walker Industries Holdings Limited and is located on the brow of the Niagara Escarpment, 2 km east of Thorold in Lots 11, 30, 31, 49, 50 and 66, City of Niagara Falls (Stamford Township) and Lots 43, 44 and 45 in the City of Thorold, Regional Municipality of Niagara (Figure NI-3-1). The quarry licence covers an area of 171.9 ha.

Walker Brothers celebrated their one hundredth anniversary in 1987. Early operations were confined to stone cutting, followed in 1893 by a shift to stone crushing. Walker Brothers have provided cut stone for such structures as the Chatham Armory, the Toronto Armory and the Welland Canal. In the early years of the twentieth century many pulp and paper producers relied on

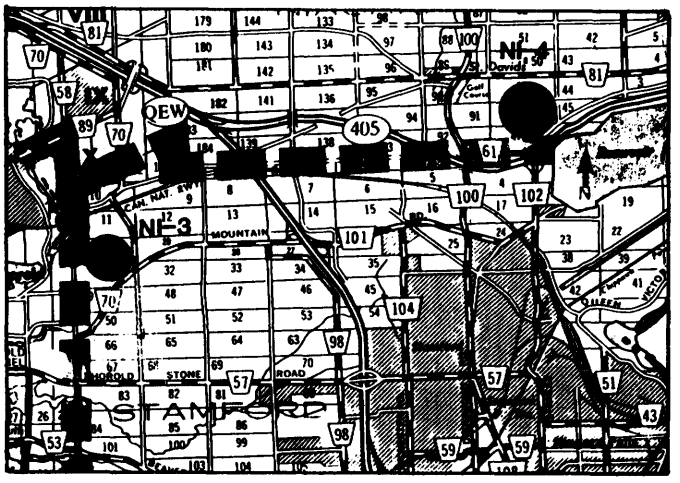


Figure NI-3-1. LOCATION MAP FOR THOROLD QUARRY.

crushed stone from the Thorold Quarry to facilitate their chemical processes. The first fully mechanized crushed stone plant, with a 250 ton per hour capacity, was built at the Thorold Quarry in 1947. Concrete aggregate was supplied for the construction of the Queen Elizabeth Way and the Skylon Tower in Niagara Falls.

GEOLOGY

The Thorold Quarry exposes 9.78 m of section: 0.88 m from the Rochester Formation, 3.0 m from the Decew Formation, and 5.9 m from the Gasport Member of the Lockport Formation (Figure NI-3-2). The Rochester Formation is typically an interbedded dolomitic shale and shaly dolostone, whereas the Decew is a fine-crystalline, irregular-bedded, fossiliferous dolostone. The Gasport Member is a massive-bedded fossiliferous dolostone. The thickness of the Decew Formation is variable and ranges from 0.0 to 3.0 m along the quarry face.

Geological Section

Thickness

UNIT 3 Lockport Formation, Gasport Member *5.9m*

Dolostone: pink-grey, weathers tan-buff; fine to coarse crystalline (fines upwards); medium to thick bedded, contacts are sharp but very irregular, unit becomes medium bedded at the top; some beds appear biohermal at the top of the unit; stylolites present; dolomite, sphalerite, and calcite mineralization present; a 10 to 15 cm bed at the base is a fine crystalline, green-grey, shaly, glauconitic dolostone, its upper contact to the Gasport is sharp; lower contact with the Decew is sharp and undulatory.

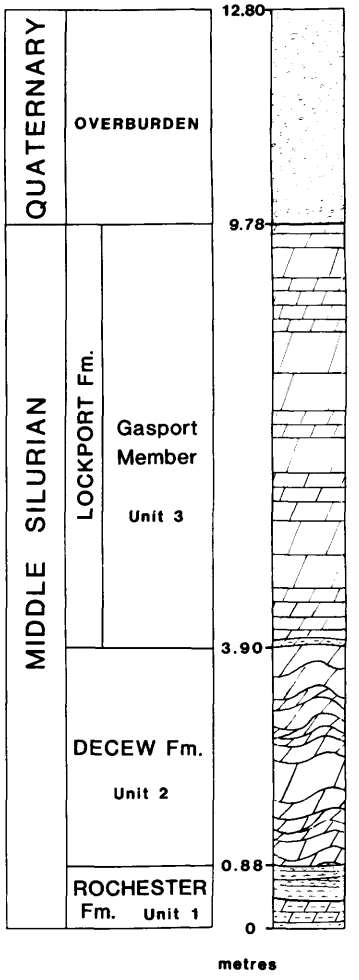


Figure NI-3-2. STRATIGRAPHIC COLUMN FOR THOROLD QUARRY.

UNIT 2 Decew Formation *3.0m*

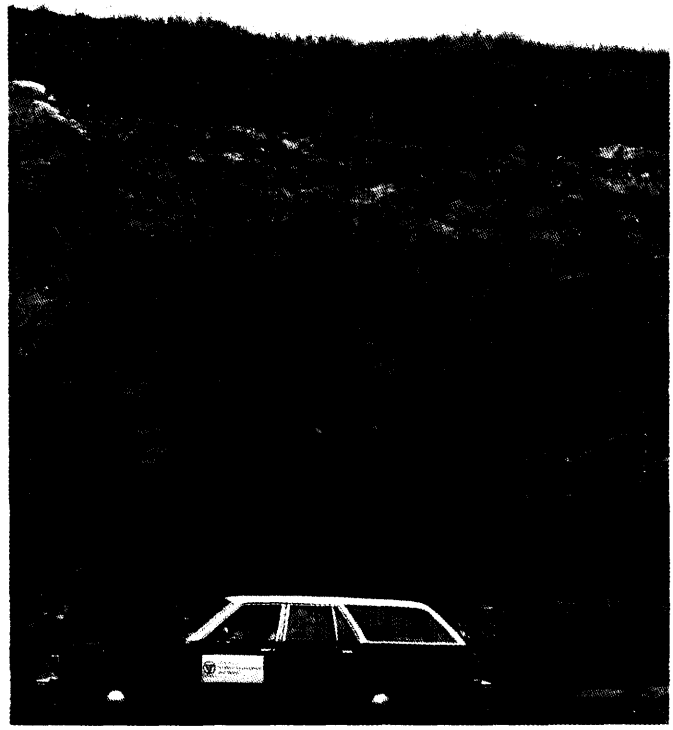
Dolostone: medium to dark grey, weathers dark tan to rust; fine crystalline; very irregularly bedded, beds pinch and swell, and are contorted with a hummocky appearance; lower 0.5 m is sucrosic, vuggy and porous, and displays some soft sediment deformation with debris; lower contact is sharp with bituminous and clayey partings, scouring occurs into the underlying units; lower contact is sharp.

UNIT 1 Rochester Formation *0.88m*

Interbedded dolomitic shale and shaly dolostone: black to dark grey, weathers black; sub- to fine crystalline; thin to medium bedded (3 to 30 cm), contacts are sharp and slightly undulatory, beds are quite laminated; rare gypsum occurs in vugs; scattered clay seams and bituminous partings.

Total thickness *9.78m*

Photo NI-3-1. TYPICAL SECTION AT THOROLD QUARRY.



Lockport Formation
Gasport Member
Unit 3

Decew Formation
Unit 2

Rochester Formation
Unit 1

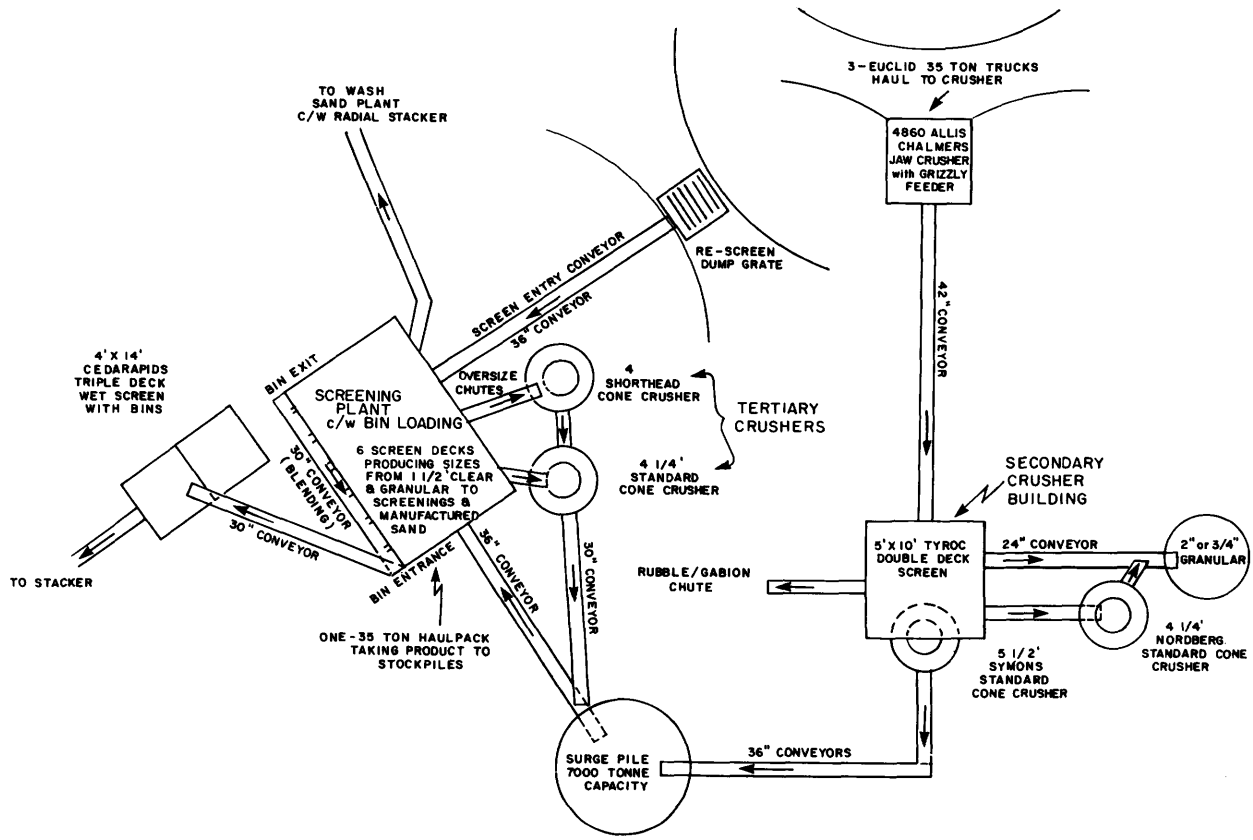


Figure NI-3-3. PROCESS FLOW SHEET FOR THOROLD QUARRY.

QUARRY OPERATION

A single 8.9 m lift is drilled by a Gardner–Denver Hydratrac on a 2.75 x 2.75 m pattern with 7.6 cm diameter holes. The blasting agents are Powermex 300 and prilled ammonium nitrate, initiated with electric caps. A Cat 988B loader transfers the blasted stone from the face into 3 Euclid R35 trucks for haulage to the primary crusher.

PROCESSING

The process flow sheet is shown on Figure NI–3–3. The blasted stone is dumped onto a grizzly that feeds an Allis–Chalmers 4860 jaw crusher. The crushed stone is conveyed to a 5 1/2 ft. Symons standard cone in the Secondary Crusher Building, producing 2 in. to 3/4 in. granular stone or feeding a surge pile. Stone from the surge pile is conveyed to the screening plant where stone sizes from 1 1/2 in. clear and 1 1/2 in. granular to screenings and manufactured sand are produced. Oversize from different screens is recrushed in either a 4 ft. shorthead cone or a 4 1/4 ft. standard cone and returned to the surge pile. The screening plant products can be blended as required or sent to twin washing screens.

PRODUCTS

The Walker Brothers Thorold Quarry produces a variety of products ranging from Gabion stone, to 1 1/2 in. clear and granular, to screenings and manufactured sand.

REFERENCES

Goudge, 1938, p.278–279

Hewitt, 1960, p.95–95

Hewitt, 1964a, p.43

Hewitt and Vos, 1972, p.56

MAPS

Caley, 1941c, GSC Map 584A

Liberty, Feenstra and Telford, 1976b, ODM Map 2344

NI–4 STEETLEY INDUSTRIES LTD. — QUEENSTON QUARRY

LOCATION AND OWNERSHIP

This large operating quarry in Lots 44, 45, 47, 48 and 49, Town of Niagara–on–the–Lake (Niagara Township), Regional Municipality of Niagara, is 3 km west of the town of Queenston (Figure NI–4–1). The licensed area of the quarry is 157.48 ha.

Extraction from the Queenston Quarry site began in 1837 with the development of a small building stone quarry. Material from this quarry was used for construction of the Grand Trunk Railway and later in 1874 for the locks of the Welland Canal. By 1892 seven small quarries occupied the site of the present large quarry. Also by this time, material from these quarries was being utilized in the manufacturing of cement.

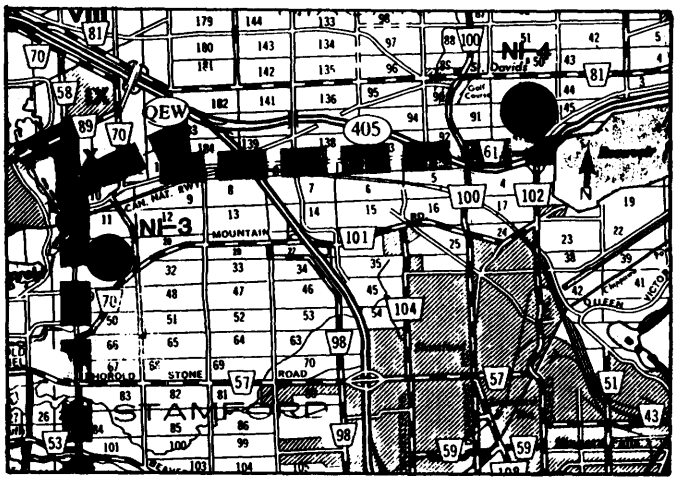


Figure NI–4–1. LOCATION MAP FOR QUEENSTON QUARRY.

The distinctive "blue" dolostone quarried from the Gasport Member of the Lockport Formation at this site was extensively used for monument bases and shafts and for the construction of post offices in Cornwall, Niagara Falls and St. Catharines.

GEOLOGY

The quarry exposes 9.7 m of Middle Silurian strata (Figure NI–4–2). At the base of the quarry, 2.4 m of the Rochester Formation is exposed and consists of interbedded shaly dolostones and dolomitic shales. The Rochester is sharply overlain by the Decew Formation (1.5 m) which is a medium to thickly bedded, undulatory and contorted dolostone. Above the Decew Formation, 0.65 m of a conglomeratic, shaly dolostone occurs, which is transitional between the Decew and the Gasport Member of the Lockport Formation. This lithology is distinctively green, glauconitic, very fossiliferous, and both the upper and lower contacts are erosional.

The Gasport Member (Lockport Formation) caps the transitional zone, and is typically a massive bedded, crinoidal dolostone (4.37 m thick). It is overlain by 0.75 m of the Goat Island Member from the Lockport Formation and consists of thin– to medium–bedded, fine–crystalline dolostone. Overburden cover is approximately 4 m.

Geological Section

Thickness

UNIT 5 Lockport Formation, Goat Island Member *0.75m*

Dolostone: dark grey, weathers tan; fine crystalline; thin to medium bedded, contacts are sharp, slightly undulatory, but laterally continuous; sucrosic; chert and dolomite mineralization present in vugs; crinoidal debris abundant in lower 2 to 3 m; sharp lower contact.

UNIT 4 Lockport Formation, Gasport Member *4.37m*

Crinoidal dolostone: blue to green-grey, weathers grey-rust to brown; fine to medium crystalline; massively bedded (average 2 m), contacts are sharp and stylolitic (up to 5 cm thick) with undulatory partings; draping of beds are present; one meter above the base, a 1 cm thick glauconitic shale bed exists which is laterally discontinuous; scattered irregular shale beds are present; dolomite, calcite and sphalerite mineralization present in vugs; some bituminous residue and iron staining also present; very fossiliferous with abundant crinoids and coralgal debris and material, rare brachiopods; upper 2 m of the unit possesses abundant coralgal debris and vugs; lower contact is sharp.

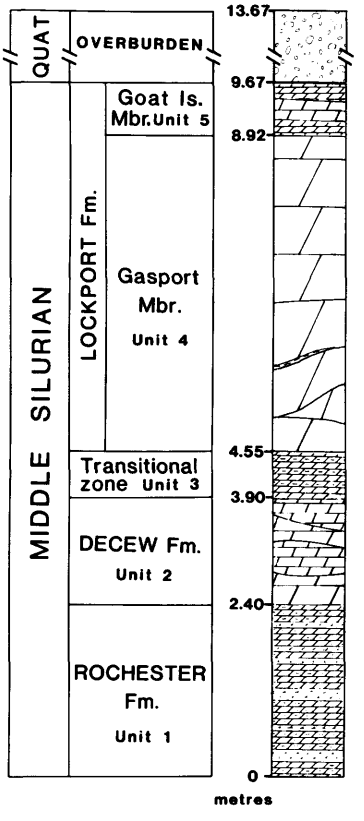


Figure NI-4-2. STRATIGRAPHIC COLUMN FOR QUEENSTON QUARRY.

UNIT 3 Transitional Zone: Lockport Formation (Gasport Member) and Decew Formation *0.65m*

Conglomeratic and shaly dolostone: dark grey to green, weathers same; coarsely crystalline; thinly bedded, becomes medium bedded at top of unit; very fossiliferous (abundant crinoids); abundant rip-up clasts from the underlying shaly dolostone, clasts are up to 5 cm long, angular and oriented parallel to bedding; shaly dolostone is 25 to 35 cm thick and occurs at the base of the unit; top contact is sharp and erosional; finely crystalline; thinly bedded and laminated; glauconitic; occurs in hollows of the underlying Decew Formation; abundant insoluble residue seams (approximately 1 mm thick); sharp lower contact.

UNIT 2 Decew Formation *1.50m*

Dolostone: dark grey, weathers grey to tan; sub- to fine-crystalline; medium to thick bedded (10-60 cm); contacts are sharp and very undulatory; beds pinch and swell with contorted laminae; some crenaceous zones are present; some bituminous dark grey partings present (up to 4 cm thick); sphalerite mineralization occurs in pores; crinoids abundant as fossil debris; sharp, scoured lower contact.

UNIT 1 Rochester Formation *2.40m*

Interbedded shaly dolostones and dolomitic shales: grey to black, weathers black; sub- to fine-crystalline; thin bedded and laminated, contacts are irregular; possesses a bituminous odour.

Total thickness *9.67m*

QUARRY OPERATION

The following description of the Queenston Quarry operation was prepared from information provided by Steetley Industries Ltd. The quarry site was not visited at the owner's request.

The current reserves and quarry area comprise approximately 100 ha. The overburden thickness on the property is moderately variable ranging from 5.5 to 7.5 m which results in a 1:1 stripping ratio. The quarry is being developed on two benches with the production coming from one 7.5 m and one 3.5 m working face. Surface run off and ground water seepage is controlled at one internal and one external pumping station by one 4 in. and one 6 in. submersible pump, respectively.

The stone is quarried by drilling and blasting. An Ingersoll–Rand airtrac is used to drill 7 cm diameter holes in a 2 m x 2 m blasting pattern. A CIL high explosive with ammonium nitrate is used as the blasting agent. Secondary breaking at the face is accomplished with a drop ball.

At the quarry face, the broken rock is loaded by a VME 320 8 yd. front end loader into a 22-tonne Terex truck and delivered to the processing plant a maximum haul distance of 215 m.

PROCESSING

The quarry run material is dumped into a Pioneer 35 in. x 46 in. primary jaw crusher. The throughput is further reduced by two 4 1/4 in. secondary cone crushers and conveyed to a screening tower where three Tyrock dou-

Lockport Formation
Goat Island Member
Unit 5

Gasport Member
Unit 4

Photo NI-4-1. TYPICAL SECTION AT QUEENSTON QUARRY.

ble–deck screens produce a variety of sized products as required. The screened material is conveyed to 8 sized stockpiles.

PRODUCTS

The product sizes were not disclosed by Queenston Quarries but would probably include a wide range of products from Gabion stone to 1 1/2 in. clear and granular, to screenings and manufactured sand.

REFERENCES

Blair, 1965, p.49–50
Goudge, 1938, p.251–254
Hewitt, 1960, p.91–94
Hewitt, 1964b, p.2–7
Hewitt, 1964a, p.43
Hewitt and Vos, 1972, p.55

MAPS

Caley, 1941c, GSC Map 584A
Liberty, Feenstra and Telford, 1976b, ODM Map 2344

NI-5 STANDARD AGGREGATES INCORPORATED — HAGERSVILLE QUARRY

LOCATION AND OWNERSHIP

The Hagersville Quarry is located on the northeastern outskirts of the town of Hagersville in Lots 28 and 29, Range east of Plank Rd., Town of Haldimand (Oneida Township), Regional Municipality of Haldimand–Norfolk (Figure NI–5–1). This quarry began operation in the 1920s and is owned and operated by Standard Aggregates Inc. (Division of Standard Industries). At present, extraction is from the quarry south of the railway line and the plant equipment (crusher, etc.) is located in the depleted portion of the quarry north of the railway. The

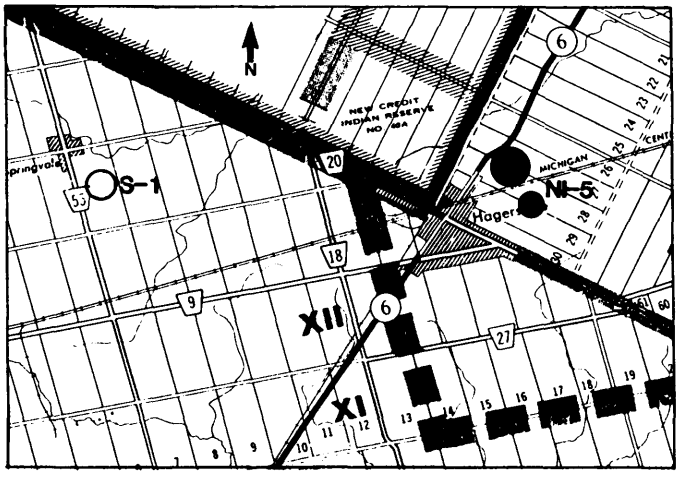


Figure NI-5-1. LOCATION MAP FOR HAGERSVILLE QUARRY.

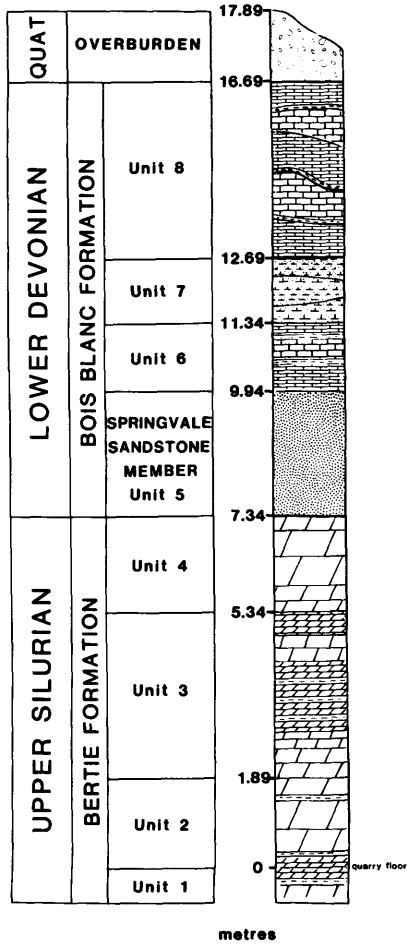


Figure NI-5-2. STRATIGRAPHIC COLUMN FOR HAGERSVILLE QUARRY.

quarry operates under two licences for 42.10 ha and 43.34 ha.

GEOLOGY

In the Hagersville Quarry, a total of 16.39 m of Upper Silurian Bertie Formation and Lower Devonian Bois Blanc Formation is exposed (Figure NI-5-2). The Bertie Formation exposure is 7.34 m of various lithologies including dolostones, bituminous dolostones and shaly dolostones. Some are very brecciated and laminated in places. The top contact with the Bois Blanc is sharp and contains fractures infilled with glauconitic sandstone and represents a major unconformity. The base of the Bois Blanc Formation contains 2.6 m of this sandstone, assigned to the Springvale Sandstone Member. Overlying this unit are typical cherty, fossiliferous limestones from the Bois Blanc Formation. There is some paleontological evidence to suggest the upper 2.3 m of the quarry is Onondaga Formation (Edgecliff Member) although a lithological contact is not evident. The overburden cover is 1.0 to 1.5 m thick.

Geological Section

Thickness

UNIT 8 Bois Blanc Formation *3.70m*

Cherty, fossiliferous limestone: cream-grey, weathers tan; fine crystalline; thin to medium bedded with sharp, thin shaly contacts; beds pinch and swell and are contorted; calcarenite beds occur at the base; grey to dark grey chert replaces fossils; minor pyrite mineralization present; very fossiliferous with abundant rugose corals, colonial corals and bryozoans; very bioclastic zones occur throughout; lower contact is sharp.

UNIT 7 Bois Blanc Formation *1.35m*

Calcarenite: cream-grey, weathers same; fine to medium grained; thin bedded (5 to 10 cm), contacts are sharp and undulatory; grey chert appears in upper horizons; becomes finer grained at the top; lower contact is sharp.

UNIT 6 Bois Blanc Formation *1.40m*

Cherty limestone: buff-brown, weathers buff-grey; very fine crystalline; fine to medium bedded (less than 15 cm), contacts are sharp with fine black shaly partings; blue-grey chert occurs as lenses and contorted beds; abundant bryozoans; abundant pyrite in shaly partings; lower contact is sharp.

UNIT 5 Bois Blanc Formation, Springvale Sandstone Member *2.60m*

Glauconitic sandstone: green, weathers grey-green; fine to medium grained; one massive bed; lower contact is sharp and disconformable.

UNIT 4 Bertie Formation *2.00m*

Dolostone: light grey to tan, weathers light buff to tan; sub- to fine-crystalline; medium to thick bedded, contacts are irregular and beds are not laterally extensive; glauconitic sand occurs as clasts and lenses in upper part of unit; chert appears as nodules, lenses, and discontinuous beds; lower contact is sharp.

UNIT 3 Bertie Formation *3.45m*

Bituminous dolostone: dark brown to medium grey, weathers dark brown; fine crystalline; thin to medium bedded, contacts are sharp with bituminous partings; banded and laminated; three grey-black shale interbeds present; bituminous material occurs in fractures; lower contact is sharp.

UNIT 2 Bertie Formation *1.89m*

Dolostone, with some bituminous shale: grey to dark brown, weathers same; very fine to medium crystalline; mainly thick bedded with some thinner beds, contacts are indistinct and have bituminous and stylolitic partings; dolostones display "birdseye" structures; overall unit is very laminated and mottled; some brecciation present with rip-up clasts; more calcarenaceous in places; rare pyrite and chalcopyrite mineralization; mud cracks present on shale partings; sharp lower contact.

UNIT 1 Bertie Formation *quarry floor*

Interbedded dolostones and shales: blue-grey shale and grey-brown dolostone, weathers same; fine crystalline; thin to medium bedded with sharp contacts; shales are very friable; pyrite present on shale beds; some bioturbation on bedding planes.

Total thickness *16.39m*

Photo NI-5-1. TYPICAL SECTION OF BOIS BLANC FORMATION AT HAGERSVILLE QUARRY.

QUARRY OPERATION

Operating eight months per year, the nominal annual capacity of the Hagersville Quarry is 350,000 tonnes. The quarry has been mined on two lifts of 9 m and 7.4 m over an area of approximately 17 ha. The upper lift is a cherty formation used for road aggregate, while the lower lift is essentially a good quality dolostone used for concrete and asphalt stone. A rehabilitation program at the southwest corner of the quarry was completed during the summer of 1986; a 3 ha site was developed as a public park and recreation facility and donated to the town of Hagersville.

Spring run-off is the main source of quarry water, and is removed by three 6 in. Flygt electric submersible pumps. Blast holes 76 mm in diameter are drilled by a JOY VCR-260 air track on a 2.75 m x 3.05 m pattern. Holes are column loaded with AN/FO, toe primed with watergel slurry cartridges and initiated with electric caps. Blasted stone is loaded by a single Cat 988 7 yd. loader into haulage trucks (three Euclids, two 20 ton and a single 35 ton, one of which serves as a spare). The average haulage distances from the face to the crusher are 175 m and 325 m for the upper and lower benches respectively.

PROCESSING

The process flow sheet is shown on Figure NI-5-3. Primary crushing of the blasted stone is by a 36 in. x 48 in. Cedarapids jaw crusher. The crushed material is then carried on a 30 in. conveyor for approximately 600 m to a 150 ft. radial stacker and surge pile. From the surge pile the stone is processed through a series of secondary crushers and vibratory screens. Secondary crushing is performed by 4 1/4 ft., 4 ft. and 3 ft. Symons cone crushers that feed 6 ft. x 16 ft. and 6 ft. x 14 ft. double-deck Dillon screens, as well as 8 ft. x 20 ft. and 5 ft. x 14 ft. triple-deck Tyler screens. The stone products are used for road and concrete aggregate.

The stone products are stockpiled then rehandled for shipping by a Clark 175 front-end loader. At present all shipping is by truck; rail facilities still exist at the site but are not currently used.

PRODUCTS

Gabion Stone
6 in. Crusher Run
3 in. Crusher Run
2 in. Crusher Run
3/4 in. Crusher Run
2 in. Clear
3/4 in. Clear
3/8 in. Clear
1/4 in. Clear
Screenings
3/4 in. Concrete Stone
Agricultural Lime

REFERENCES

Best, 1953, p.35-36
Caley, 1941a, pp.44,47,48,51,64
Goudge, 1938, p.233
Hewitt, 1960, p.140-142
Hewitt, 1964a, p.63
Hewitt and Vos, 1972, p.61
Kobluk and Brookfield, 1982, p.24-27

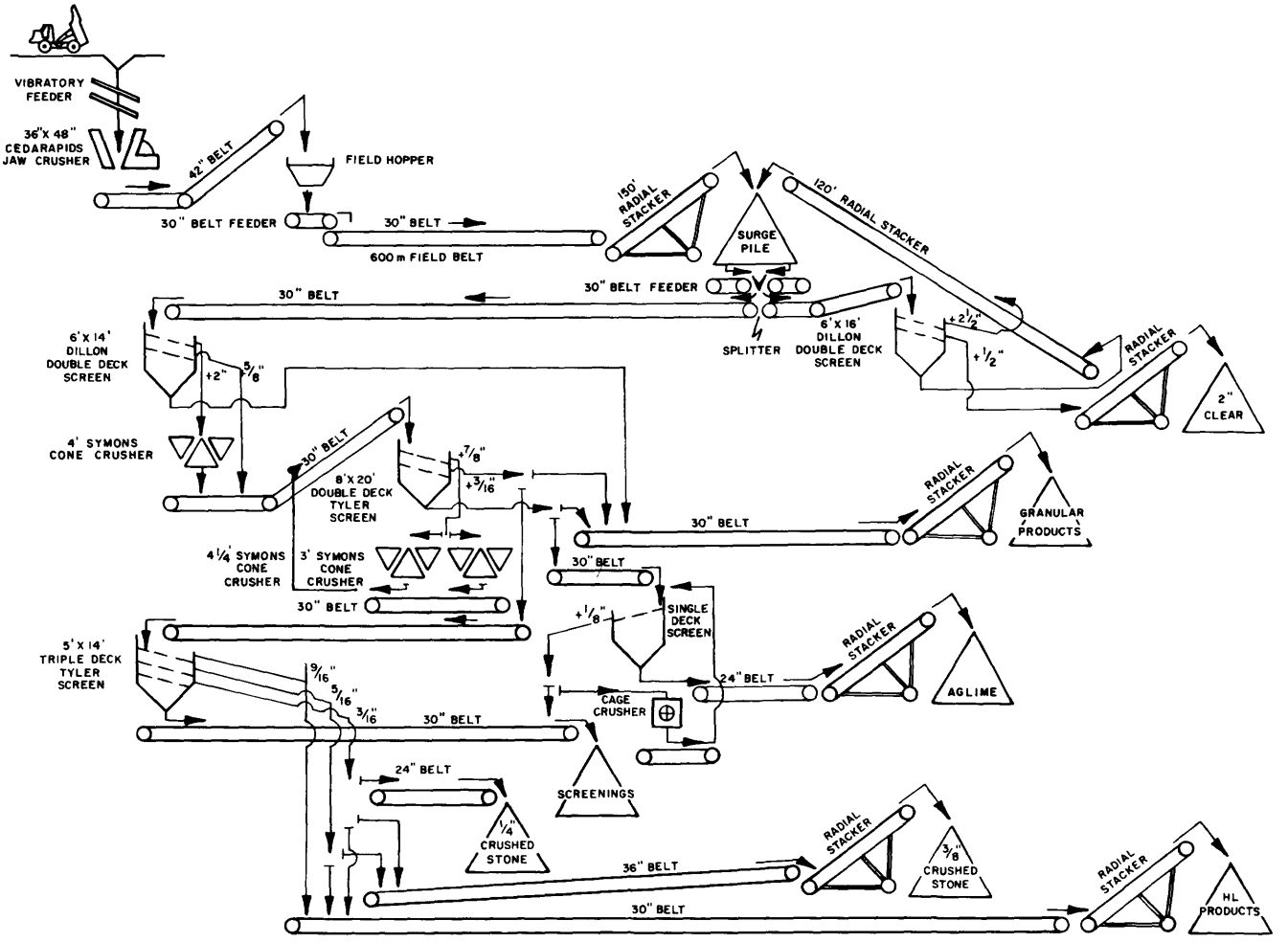
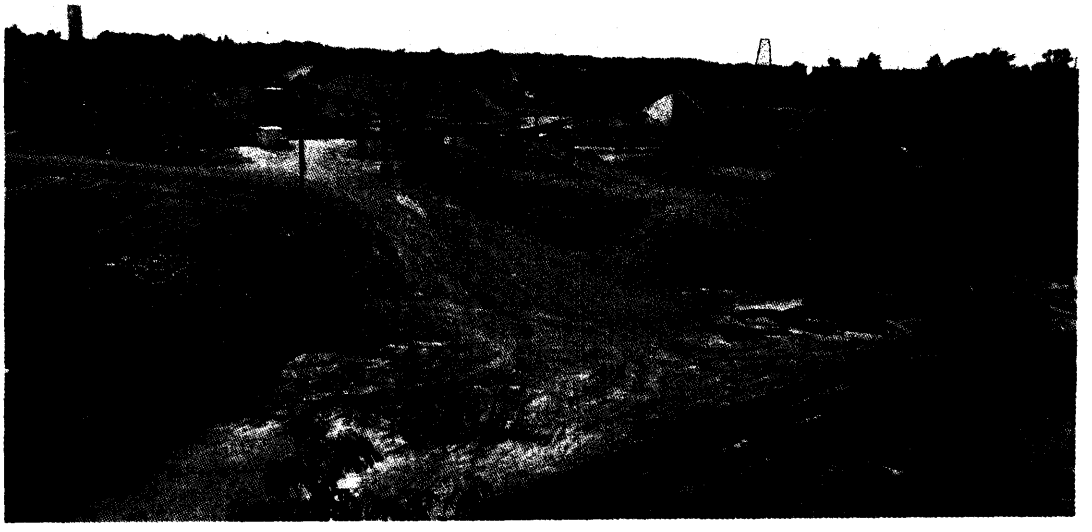


Figure NI-5-3. PROCESS FLOW SHEET FOR HAGERSVILLE QUARRY.

Photo NI-5-2. PROCESSING PLANT FIELD CONVEYOR, SURGE PILE (FOREGROUND) AT HAGERSVILLE QUARRY. SECONDARY CRUSHING AND SCREENING PLANT IN THE BACKGROUND.



Oliver, 1976, p.144
Uyeno et al., 1982, p.43
ARIP 64, 1985, p.18

MAPS

Caley, 1941b, GSC Map 619A
Telford and Hamblin, 1980, OGS Map P.2234

NI-6 NELSON AGGREGATE CO. — WEST ONEIDA QUARRY

LOCATION AND OWNERSHIP

This small inactive quarry is located 1.5 km south of Clanbrassil in Lot 49, Concession 1N, Town of Haldimand (Oneida Township), Regional Municipality of Haldimand–Norfolk (Figure NI-6-1). This quarry constitutes part of a 208.35 ha licence issued to Nelson Aggregate Co. This licensed area also includes the East Oneida Quarry (NI-7).

GEOLOGY

The quarry exposes 4.05 m of Upper Silurian and Lower Devonian strata, namely 0.5 m of dolostones of the Bertie Formation, overlain by 3.55 m of the Oriskany Formation, a calcareous sandstone. The sandstone is unique in that it contains large orthoquartzite boulders which occupy the base of the unit as a conglomerate.

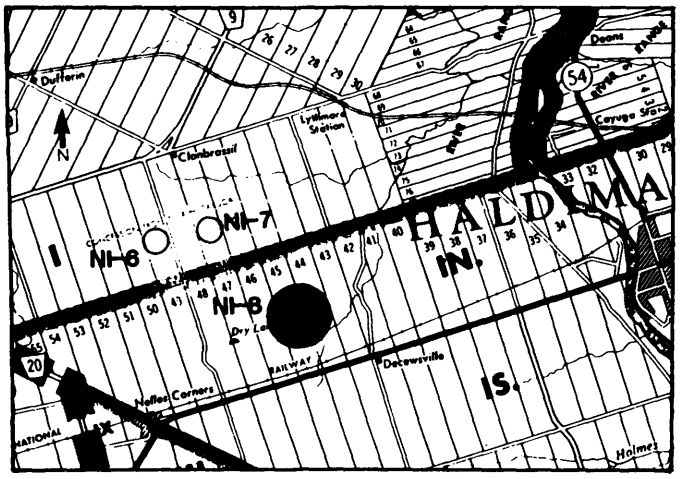


Figure NI-6-1. LOCATION MAP FOR WEST ONEIDA QUARRY.

Geological Section

		Thickness
UNIT 2	*Oriskany Formation*	*3.55m*

Calcareous sandstone: white to cream, weathers grey-white; medium to coarse grained; thin to medium bedded, contacts are irregular and undulatory; large orthoquartzite boulders occur at the base of the unit, therefore very conglomeratic; sharp lower contact with the Bertie is unconformable.

UNIT1	*Bertie Formation*	*0.50m*

Dolostone: mottled grey brown, weathers same; very fine crystalline; thin to medium bedded with irregular contacts; upper contact is jointed and fractured, infilled with sand.

Total thickness *4.05m*

REFERENCES

Best, 1953, p.23, 24–25, 28–30
Telford and Johnson, 1984

MAPS

Caley, 1941c, GSC Map 584A
Telford and Tarrant, 1975a, ODM Map P.988

NI-7 NELSON AGGREGATE CO. — EAST ONEIDA QUARRY

LOCATION AND OWNERSHIP

The quarry is located 1.5 km south of Clanbrassil in Lot 47, Concession 1N, Town of Haldimand (Oneida Township), Regional Municipality of Haldimand–Norfolk (Figure NI-7-1). Extraction from the East Oneida and West Oneida quarries (NI-6) was suspended in 1983.

GEOLOGY

This intermittently active quarry exposes 18.8 m of Upper Silurian to Lower Devonian strata (Figure NI-7-2). This section includes 12.2 m of the Bertie Formation, 2.2 m of the Oriskany Formation, and 4.4 m of the Bois Blanc Formation. The Bertie Formation consists predominantly of dolostones and dolomitic shales, and its upper contact with the overlying Oriskany Formation is sharp and unconformable. The Oriskany is a pure calcareous sandstone, medium grained with large orthoquartzite boulders at the base. The Bois Blanc Formation is a cherty and sandy limestone.

Geological Section

		Thickness
UNIT 6	*Bois Blanc Formation*	*4.4m*

Sandy limestone: light brown, weathers grey; fine crystalline; thin to medium bedded; base of unit contains reworked sandstones (medium grained) and chert fragments; grey chert nodules and lenses occur throughout; lower contact is sharp.

UNIT 5	*Oriskany Formation*	*2.2m*

Calcareous sandstone: white to cream; weathers same; medium grained; thick to massive bedded, contacts are sharp and undulatory; conglomeratic at base with orthoquartzite boulders; some iron staining; rare corals, brachiopods, and bryozoa; sharp, unconformable contact.

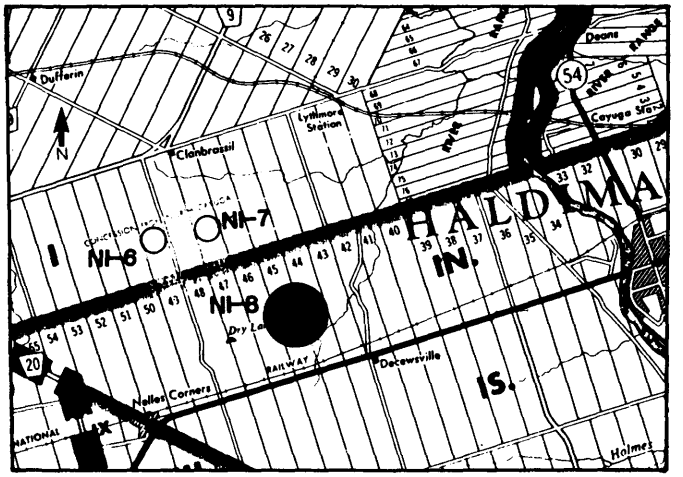


Figure NI-7-1. LOCATION MAP FOR EAST ONEIDA QUARRY.

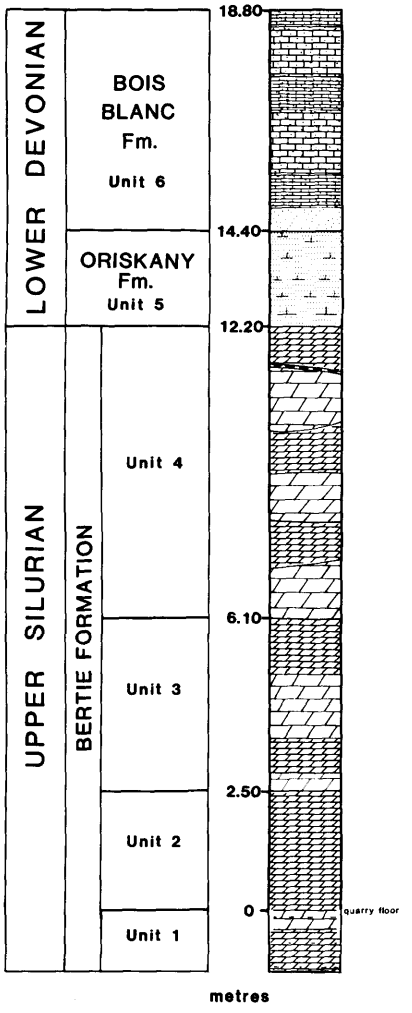


Figure NI-7-2. STRATIGRAPHIC COLUMN FOR EAST ONEIDA QUARRY.

UNIT 4 Bertie Formation *6.1m*

Dolostone: buff-brown, weathers same; sub- to very fine-crystalline; thin to medium bedded, contacts are undulatory; top is very jointed and fractured, infilled with quartz sand; some shale seams at top; also some brecciation; has a mottled appearance; some beds are contorted; lower contact is gradational.

UNIT 3 Bertie Formation *3.6m*

Dolostone: buff grey to brown, weathers same; very fine crystalline; medium to thick bedded; has a mottled appearance; sharp lower contact.

UNIT 2 Bertie Formation *2.5m*

Dolomitic shale: grey-brown, weathers blue-grey to brown; thin bedded and fissile; lower contact is covered.

UNIT 1 Bertie Formation *quarry floor*

Bituminous dolostone: dark brown, weathers same; fine to medium crystalline; thin to medium bedded; very abundant bituminous partings and with a strong odor; located below quarry floor.

Total thickness *18.8m*

REFERENCES

Caley, 1940, p.83–84
Fahselt et al., 1979
Goudge, 1938, p.234
Uyeno et al., 1982, p.43
Winder and Sanford, 1972, p.66
ARIP 64, 1985, p.10

MAPS

Caley, 1941c, GSC Map 584A
Telford and Tarrant, 1975a, ODM Map P.988

NI-8 CAYUGA MATERIALS AND CONSTRUCTION CO. — CAYUGA QUARRY

LOCATION AND OWNERSHIP

The Cayuga Quarry of Cayuga Materials and Construction Co. is located 5.5 km west of the village of Cayuga on the north side of Highway No. 3, in Lots 44, 45, 46 and 47, Concession 1N, Town of Haldimand (North Cayuga Township), Regional Municipality of Haldimand–Norfolk (Figure NI–8–1). The quarry and processing plant have been in operation since 1957. The quarry licence covers an area of 176.2 ha.

GEOLOGY

In the Cayuga Quarry, a total of 19.8 m of section is exposed and consists of the Upper Silurian Bertie Formation through to the Lower Devonian Oriskany and Bois Blanc Formations (Figure NI–8–2). The Bertie Formation exhibits 15.4 m of section with lithologies ranging from dolomitic shales to dolostones to shaly dolostones. Overlying the Bertie Formation is 2.9 m of the Oriskany Formation, a calcareous sandstone, overlain by 1.5 m of the Bois Blanc Formation, a cherty limestone. The Oris-

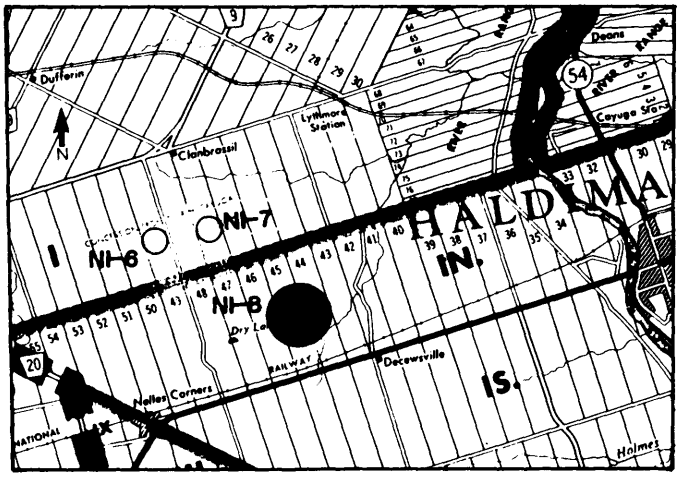


Figure NI-8-1. LOCATION MAP FOR CAYUGA QUARRY.

kany Formation is the prominent feature in this quarry. The formation weathers quickly to sand when the overlying Bois Blanc Formation is removed. Faulting occurs along the west face. Overburden is thin around the quarry.

Geological Section

		Thickness
UNIT 6	*Bois Blanc Formation*	*1.5m*

Cherty limestone: light brown, weathers grey; fine to medium crystalline; thin to medium bedded (less than 10 cm), contacts are sharp, undulatory and irregular; rare shaly partings with glauconitic staining; scattered quartz lenses and clasts (coarse grained); scattered stylolitic and bituminous partings; chert is white to light grey, usually bounded by stylolites; abundant iron staining, pyrite mineralization occurs as clasts and in pores; rare colonial and solitary corals, brachiopods, and abundant bivalves; lower contact is sharp to transitional.

UNIT 5	*Oriskany Formation*	*2.9m*

Calcareous sandstone: light cream to white, weathers buff; medium to coarse grained; thick bedded, contacts are sharp and irregular; lower 30 cm is conglomeratic with clasts of calcareous glauconitic shale, dolostones and mudstones, clasts are oval in shape and some possess lamination; abundant hematitic staining and nodules; few scattered brachiopods, becomes more fossil-rich in the upper part; sharp lower contact - a major unconformity.

Photo NI-8-1. TYPICAL SECTION AT CAYUGA QUARRY.

UNIT 4 Bertie Formation *9.3m*

Dolostone: medium to light brown, weathers light to dark brown to buff; sub- to fine-crystalline; medium to thick bedded (0.40 to 1.50 m), contacts are sharp and undulatory; three variations of dolostones interbedded with each other: a light brown, a dark brown, and a mottled dolostone, each occurring in varying proportions; some beds are laminated, rare shale interbeds; pyrite mineralization abundant in lower 1 m and occurs in large pores, calcite occurs in pores and fractures; abundant fossil debris in scattered zones, abundant vertical burrows in some beds; sharp lower contact.

UNIT 3 Bertie Formation *3.1m*

Interbedded shaly dolostones and dolomitic shales: grey to brown, weathers blue-grey to brown; fine crystalline; thin to medium bedded (5 to 40 cm), contacts are sharp, planar, and laterally extensive; laminated; fractured and brecciated zones present, infilled with quartz sandstone (coarse grained); chert present; lower contact is sharp, a single clay seam.

UNIT 2 Bertie Formation *3.0m*

Dolostone: brown, weathers same; fine to medium crystalline; thin to medium bedded (2 to 30 cm), contacts are sharp, irregular and undulatory; calcite present along fracture faces, marcasite in pores; very abundant bituminous partings with a strong petroliferous odor; laminated, stylolitic; at base, deformed beds occur and is very porous; chert nodules present at top of unit; lower contact is sharp.

UNIT 1 Bertie Formation *quarry floor*

Interbedded dolomitic shales and shaly dolostones: blue-grey, weathers grey; fine crystalline; thin bedded and platy.

Total thickness *19.8m*

QUARRY OPERATION

Annual production takes place over an average 8–month period. Four blasting faces are exposed conforming to Units 5 and 6; Unit 4; the top 1.8 m of Unit 3; and the less shaly lower part of Unit 3 plus the dolostones of Unit 2. The sandstone and cherty limestone of the top lift is used for armour stone. All drilling is performed by Joy and Sullair airtrack drills, with 76 mm diameter holes on 1.8 m x 1.8 m and 2.1 m x 2.3 m patterns. Holes are loaded with AN/FO and initiated by electric caps. Water seepage in the quarry is not significant, but heavy rainfall can make it necessary to blow the holes clear before the explosives are loaded.

PROCESSING

Blasted stone is transferred by a Cat 988 loader to 35–ton Euclid trucks or transported directly to one of two portable crushing systems. A jaw and cone crusher system produces 3/4 in. and 1/2 in. crusher run stone, and a single jaw crusher feeds –6 in. material onto a 36 in. conveyor. The crushed stone is conveyed 1000 m to the secondary crushing and screening plant. After processing, the stone is stored in stockpiles or 60–ton bulk bins, the latter also being used to blend specific concrete and asphalt stone products. Stockpile material is reclaimed and loaded into trucks or railway cars by front–end loaders. Both rail and truck scales exist at the plant.

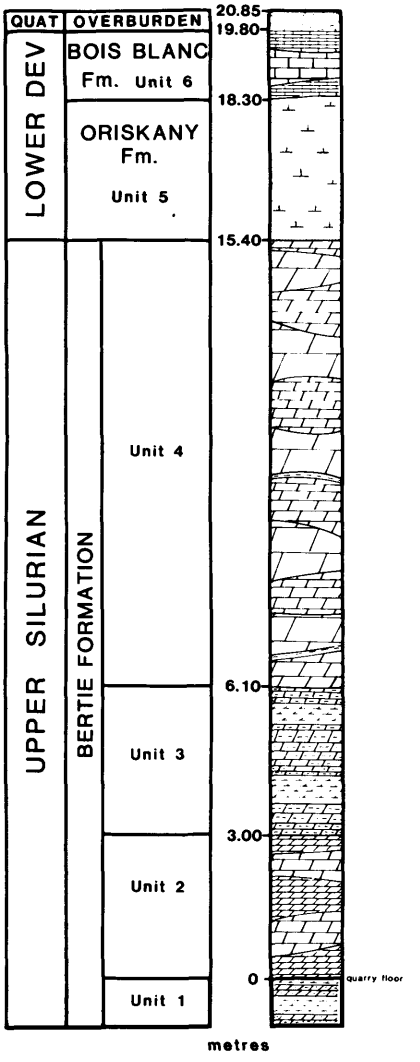


Figure NI-8-2. STRATIGRAPHIC COLUMN FOR CAYUGA QUARRY.

PRODUCTS

Armour Stone
Quarry Run Stone
36 in. Riprap
24 in. Riprap
18 in. Riprap
12 in. Riprap
8 in. Riprap
Gabion Stone
1 1/2 in. Crusher Run
3/4 in. Crusher Run
1/2 in. Crusher Run

3/8 in. Clear
1/4 in. Clear
Screenings
21A Concrete Stone
HL3 Stone
HL4 Stone
HL5 Stone
"B" Ballast (3/4 in.)
"A" Ballast (1 1/2 in.)
Agricultural Limestone

REFERENCES

Best, 1953, p.25, 70
Caley, 1940, p.81
Goudge, 1938, p.234–235
Hewitt, 1960, p.138–140
Hewitt and Vos, 1972, p.58–59
Oliver, 1976, p.133
Uyeno et al., 1982, p.43
ARIP 64, 1985, p.18

MAPS

Caley, 1941c, GSC Map 584A
Telford and Tarrant, 1975a, ODM Map P.988

NI-9 SWEETS CORNERS QUARRIES

LOCATION AND OWNERSHIP

Two abandoned quarries are located 5 km northwest of Sweets Corners in Lot 31, Concession 4, Town of Haldimand (South Cayuga Township), Regional Municipality of Haldimand–Norfolk (Figure NI-9-1). The land containing these two quarries has recently been sold to private interests, and the larger water-filled quarry may become a recreational site.

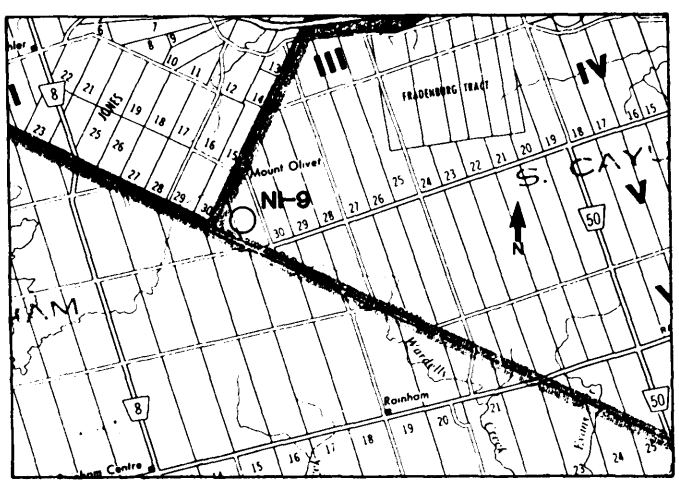


Figure NI-9-1. LOCATION MAP FOR SWEETS CORNERS QUARRIES.

GEOLOGY

The larger quarry exposes 1.3 m of the Edgecliff Member from the Onondaga Formation and is water filled; the other one is smaller and exposes 6.9 m from both the Bois Blanc and the Onondaga Formations. The Bois Blanc Formation is typically a cherty fossiliferous limestone, as is the Edgecliff Member, but displays more biohermal features.

Geological Section

		Thickness
UNIT 2	*Onondaga Formation, Edgecliff Member*	*1.5m*

Cherty limestone: brown, weathers buff-brown to grey; sub-to fine-crystalline; medium bedded, contacts are undulatory and irregular; some zones are very reefal and biohermal; chert is blue-grey in colour (approximately 15%); rare shale seams; very fossiliferous with bryozoa, solitary corals, colonial corals and crinoids, some have been replaced with blue-grey silica; scattered calcite crystals; lower contact is sharp and disconformable.

UNIT 1	*Bois Blanc Formation*	*5.4m*

Cherty limestone: light grey, weathers dark grey; sub- to fine-crystalline; thin to medium bedded, contacts are irregular; top of unit appears to be reworked and contains large solitary corals; some shaly seams; chert is light grey to buff and comprises 50% of the unit; fossiliferous with solitary corals and colonial corals.

Total thickness	*6.9m*

REFERENCES

Best, 1953, p.68–69
Oliver, 1976, p.144
ARIP 64, 1985, p.18

MAPS

Telford and Tarrant, 1975a, ODM Map P.988

NI-10 DUNNVILLE ROCK PRODUCTS LTD. QUARRY

LOCATION AND OWNERSHIP

The property of Dunnville Rock Products Ltd. is located 1 km south of the town of Byng, in Pt. Lots 3, 6, 7 and 8, Earl Tract, Town of Dunnville (Dunn Township), Regional Municipality of Haldimand–Norfolk (Figure NI-10-1). The licensed area totals 66.8 ha. The quarry was first opened in the early 1900s and was owned and operated by Haldimand County. In 1942 the property was purchased by P. L. Jackson and became known as Dunnville Rock Products. In 1963 the organization changed and became a private limited company under the present name Dunnville Rock Products Ltd. The company presently has ownership ties with Waterford

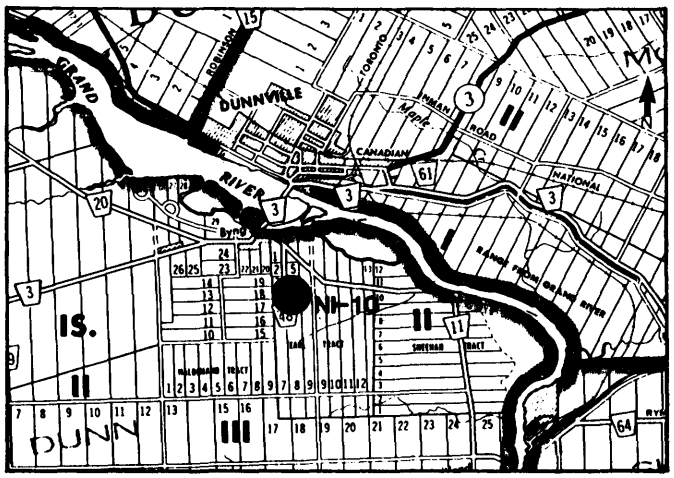


Figure NI-10-1. LOCATION MAP FOR DUNNVILLE ROCK PRODUCTS QUARRY.

Sand and Gravel Ltd. and Waterford Crushing and Screening.

GEOLOGY

In the Dunnville Rock Products Quarry, a total of 11.7 m is exposed of the Upper Silurian Bertie Formation and the Lower Devonian Bois Blanc Formation (Figure NI–10–2). The Bertie Formation consists of the lower 8.45 m. Contact with the overlying Bois Blanc Formation is sharp and uncomfortable. The base of the Bois Blanc contains the Springvale Sandstone Member (0.95 m), a calcareous sandstone, with the rest of the formation is a cherty limestone with abundant fossil debris (2.3 m). Overburden is consistently about 3 m thick and its removal exposes a smooth rock surface. Folding and faulting are visible on the south and southwest faces at the quarry.

Geological Section

Thickness

UNIT 5 Bois Blanc Formation *2.30m*

Cherty limestone: cream to green, weathers white to light grey; very fine crystalline; medium bedded with sharp undulatory contacts; blue chert occurs as nodules and lenses, calcite crystals infill pores and fractures; greenish coloured shale partings occur throughout; abundant fossil debris (including brachiopods, rugose, colonial corals, and nautiloids); lower contact is sharp.

UNIT 4
Bois Blanc Formation, Springvale Sandstone Member *0.95m*

Calcareous sandstone: blue-white to grey, weathers buff; fine to medium grained; thin bedded and very irregular; blue-grey chert occurs as nodules and lenses and infills fractures (brick-like features); top of unit contains large nodules of welded orthoquartzites rimmed with a limestone coating; becomes glauconitic towards the top with shaly partings; lower contact is sharp.

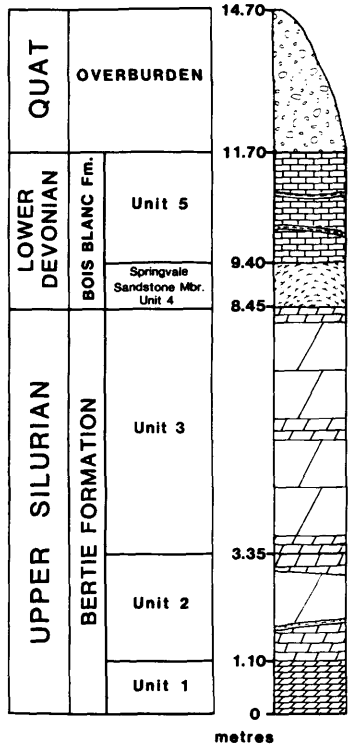


Figure NI-10-2. STRATIGRAPHIC COLUMN FOR DUNNVILLE ROCK PRODUCTS QUARRY.

UNIT 3 Bertie Formation *5.10m*

Mottled and laminated dolostones: grey to cream, weathers buff; sub- to fine-crystalline; medium to massive bedded, some contacts are sharp, others have bituminous laminae; rip-up clasts present; becomes arenaceous in places and lighter in colour towards the top; sharp lower contact.

UNIT 2 Bertie Formation *2.25m*

Mottled dolostone: brown-grey, weathers same; sub- to fine-crystalline; medium to massive bedded, contacts are sharp, undulatory and laterally continuous; rare sphalerite mineralization; bituminous residues present on partings; bandings and laminations present towards the base with rare shaly partings; lower contact is covered.

UNIT 1 Bertie Formation *1.10m*

Dolostone: dark grey, weathers same; very fine crystalline; thin bedded with a shaly appearance (calcilutite); pyrite and calcite mineralization in pores.

Total thickness *11.70m*

QUARRY OPERATION

Overburden material is currently hauled approximately 200 m to the eastern quarry limit for rehabilitation of the old face. The quarry is presently advancing to the south on a single lift of 10 m. Dewatering has been a serious problem in the past; pumps were installed in 1967–68 and in 1970 the lower lift of approximately 5 m was opened. Past difficulties in dewatering of the lower lift

Photo NI-10-1.
TYPICAL WORKING FACE AT DUNNVILLE ROCK PRODUCTS QUARRY (LOOKING SOUTH-WEST).

will soon be remedied with the completion in the north-east corner of the quarry of a 15 m wide, 5 m high berm, composed of overburden material that will create a pond with an approximate holding capacity of 15,000,000 litres.

Drilling is performed with a Gardner–Denver 3100 airtrack on a 1.5 m x 3.0 m pattern with a hole diameter of 7.6 cm.

Holes are toe loaded and primed with Cilgel 70% stick powder, column loaded with Amex II and initiated with electric delay caps. The blasted stone is loaded by either John Deere 844 (6 yd.), or Massey Ferguson 66 (4.5 yd.) loaders into three Euclid 22–ton trucks.

PROCESSING

The stationary crushing plant has a capacity of about 300 tonnes/hr. Proposed changes should more than double current production. The blasted stone is hauled 1,000 m from the face to the feed hopper at the stationary plant, where a Jeffrey Vibratory feeder scalps –3 in. material to a conveyor, the +3 in. oversize going to a 20 in. Traylor gyratory crusher. The stone is crushed to –6 in. and joins the scalped undersize on a 40 in. belt conveyor (150 ft.) leading to a 5 ft. x 12 ft. Allis–Chalmers triple–deck screen. The screening products are –6 in. + 1 1/2 in., –1 1/2 in. + 7/8 in. and Granular "A". The –6 in. + 1 1/2 in. material goes to a surge bin and can be passed by a Jeffrey Feeder to a Pulvamatic secondary crusher. The Granular "A" material is stockpiled by a 120 ft. Nordberg stacker. The –1 1/2 in. + 7/8 in. stone goes to a bin as a finished product or can be sent for secondary crushing by a new Hazemag APK unit. The secondary crushing products are conveyed to three 4 ft. x 10 ft. double–deck Tyler screens that produce 1/4 in. washed, 3/8 in. washed, 1/2 in. clear and 3/4 in. clear and 3/4 in. concrete stone (a blend of 3/8, 1/2 and 3/4 in. sizes). The products are stored in 8 bins each with an approximate capacity of 125 tonnes. During the second half of 1986, a large portable H.R.E. crusher was acquired for primary crushing in the pit. The crusher is capable of producing 400 tonnes per hour of –8 in. material which is hauled by 22–ton Euclid trucks to the stationary crushing/screening plant facilities. This new system has increased production to approximately 2,700 tonnes per 8.5 hr. day. Future plans are to incorporate a belt conveyor system (800 m) from the new portable primary crusher to the stationary plant.

PRODUCTS

Armour Rock
Gabion Stone
Rubble Rock
–6 in. Crusher Run
Granular "A" and "B"
1 1/2 in. Clear
1 1/2 in. Clear
3/4 in. Clear
1/2 in. Clear
3/8 in. Washed
1/4 in. washed
Washed Masonry Sand
Washed Concrete Sand
3/4 in. Concrete Stone
Screenings

REFERENCES

Best, 1953, p.37, 60
Caley, 1940, p.79, 80–81
Hewitt, 1960, p.136–138
Hewitt and Vos, 1972, p.60–61
ARIP 67, 1984, p.18

MAPS

Caley, 1941c, GSC Map 584A
Telford and Tarrant, 1975a, ODM Map P.988

NI-11 HARD ROCK PAVING CO. LTD. — R.E. LAW QUARRY

LOCATION AND OWNERSHIP

The quarry of Hard Rock Paving Co. Ltd. occupies parts of Lots 3, 4 and 5, Concession 2, Wainfleet Township, Regional Municipality of Niagara, about 3 km west of Port Colborne (Figure NI-11-1). The present working area is located in the northern part of Lot 4, though a mining limit will soon be reached due to the dip of the bedding. Future quarry development will occur in the east half of Lot 5, Concession 2 and progress south towards the existing plant facilities in the east half of Lot 5, Concession 2. The quarry licence covers an area of 135.4 ha.

R.E. Law Crushed Stone began operations in 1937 when Roy E. Law moved his quarry operations from Windmill Point in Fort Erie to a location 3 km west of Port Colborne on Highway 3. Later that year the company was incorporated as R. E. Law Crushed Stone Ltd. In 1978 Hard Rock Paving Co. Ltd. purchased R. E. Law Crushed Stone Ltd.

GEOLOGY

A total of 17.93 m is exposed through the Upper Silurian Bertie Formation into the Lower Devonian Bois Blanc Formation (Figure NI-11-2). There are 12.58 m of the Bertie Formation, represented by the following members: Falkirk, Scajaquanda, Williamsville and Akron, overlain by 5.35 m of the Bois Blanc Formation with the basal 0.55 cm representing the Springvale Sandstone Member. The dominant lithology for the Bertie Formation is a dolostone which can range from shaly to calcareous. The Bois Blanc Formation is a fine-crystalline, cherty, fossiliferous limestone. The contact between the two formations is sharp and represents a major unconformity. Due to the regional southwest dip the Bois Blanc Formation has its thickest exposure in the southwest corner of the quarry, thinning to the north and east. Overburden consists of 0.3 to 1 m of clay.

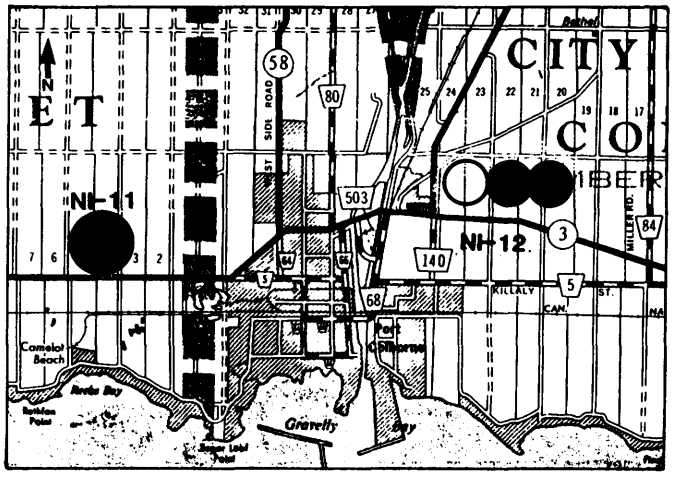


Figure NI-11-1. LOCATION MAP FOR R.E. LAW QUARRY.

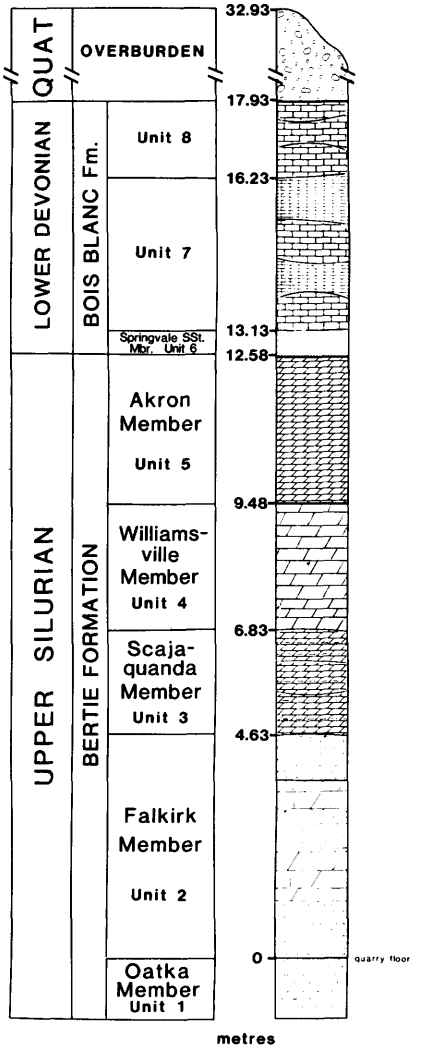


Figure NI-11-2. STRATIGRAPHIC COLUMN FOR R.E. LAW QUARRY.

Photo NI-11-1. TYPICAL SECTION OF BOIS BLANC FORMATION OVERLYING THE BERTIE FORMATION AT R.E. LAW QUARRY.

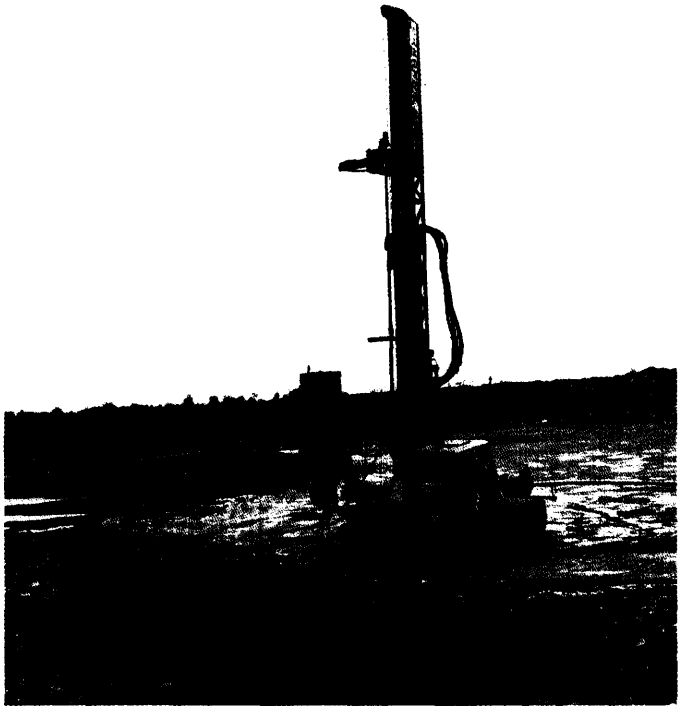


Photo NI-11-2. GARDNER-DENVER AIRTRACK DRILL ON 2ND LIFT OF R.E. LAW QUARRY (LOOKING SOUTH).

Geological Section

		Thickness
UNIT 8	*Bois Blanc Formation*	*1.70m*

Cherty limestone: buff-brown, weathers buff; fine crystalline; medium bedded with sharp, undulatory contacts; shaly zones present; chert occurs as nodules and irregular, lenticular beds; abundant fossils include rugose and colonial corals; lower contact is sharp.

UNIT 7	*Bois Blanc Formation*	*3.10m*

Cherty limestone: buff-cream, weathers buff; fine crystalline; thin to medium bedded (3 to 7 cm), contacts are sharp and undulatory; unit becomes dark grey and coarser crystalline toward the upper part; scattered pyrite and calcite mineralization occurs in small vugs and pores; abundant fossils include bryozoa, brachiopods, nautiloids, rugose corals and rare crinoids; lower contact is irregular with some parts transitional and some sharp.

UNIT 6		
Bois Blanc Formation, Springvale Sandstone Member		*0.55m*

Sandstone: green, buff to grey, weathers same; fine to medium grained; thin to medium bedded, contacts are very irregular and mottled; glauconitic with cherty and dolomitic zones; chert occurs as nodules and lenses (green to cream to black in colour); quartz grains are well rounded and clean; some zones of the unit are dolomitic and slightly calcareous; this unit is very irregular and in places fills in cracks and joints in the underlying unit; lower contact is sharp.

UNIT 5	*Bertie Formation, Akron Member*	*3.10m*

Dolostone: light grey, weathers brown; sub- to fine-crystalline; thin bedded (1 to 4 cm), contacts are poorly defined and irregular; slightly mottled with a conchoidal fracture; rare shaly laminations and bituminous partings; lower contact is transitional.

UNIT 4	*Bertie Formation, Williamsville Member*	*2.65m*

Dolostone: light grey, weathers buff; sub- to fine-crystalline; medium bedded (up to 40 cm), contacts are sharp; sucrosic appearance; fine parallel laminations occur within some of the sandier zones and display scouring features; west face contains fractures infilled with glauconitic sandstone and chert; calcite mineralization present along vertical fracture faces; lower contact is sharp and undulatory.

UNIT 3	*Bertie Formation, Scajaquanda Member*	*2.20m*

Dolostone: dark grey, weathers blue-grey; sub- to fine-crystalline; thin bedded (2 to 15 cm), contacts are sharp and undulatory; shaly partings are abundant; sedimentary features are present including slumping and compaction; bituminous odor; unit thickness is variable throughout the quarry; rare chert nodules; lower contact is sharp.

UNIT 2	*Bertie Formation, Falkirk Member*	*4.63m*

Calcareous dolostone: brown, weathers same; fine crystalline; thin to medium bedded (3 to 20 cm), contacts are welded, some have bituminous partings; abundant dark laminae and banding; partly stylolitic; porous; pyrite mineralization occurs along laminations; iron staining present in vugs, rare calcite and dolomite crystals in small pores and vugs; rare bryozoa; upper 20 cm of the unit is brecciated and contorted; lower contact is covered.

UNIT 1	*Bertie Formation, Oatka Member*	*quarry floor*

Dolomitic shale: dark grey, weathers blue-grey; very fissile and platy, occurs at quarry floor.

Total thickness	*17.93m*

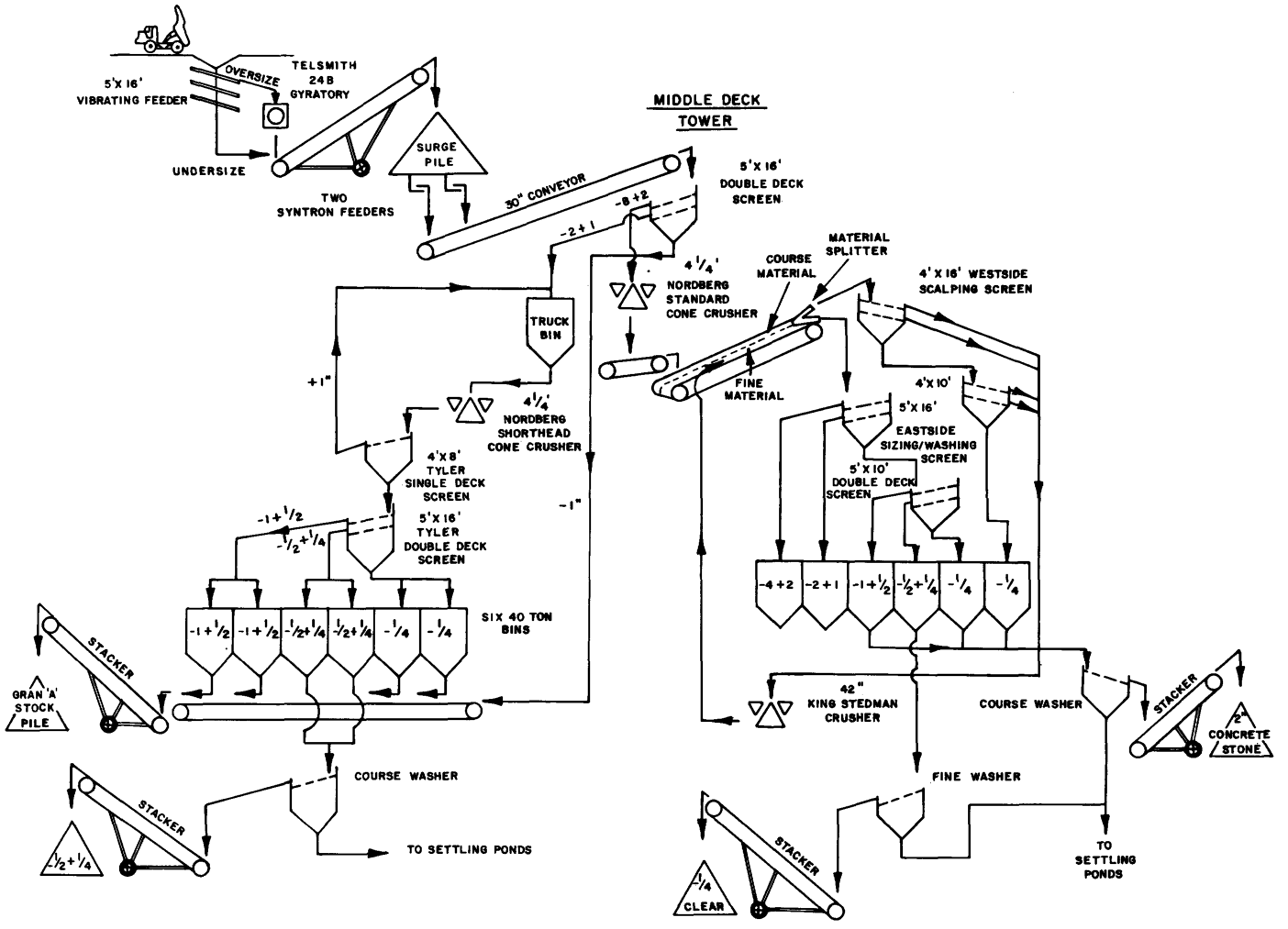


Figure NI-11-3. PROCESS FLOW SHEET FOR R.E. LAW QUARRY.

Quarry Operation

The thin clay overburden covers 2.0 to 2.5 m of fractured cherty cap rock that constitutes the top lift of the quarry. The cap rock used to be removed by drilling and blasting but is now broken and removed with a bulldozer and ripper and used locally for fill and to backfill depleted quarry faces.

The second lift consists of Bertie Formation, Akron Member dolostone which thickens southwestwards from 5 to 7 m. This lift is drilled on a 2.4 x 3.7 m pattern with 10 cm diameter holes. The third (bottom) lift extracts the Bertie Formation dolostones and varies in height from 7 to 12 m. Drilling is on a 2.4 x 2.4 m pattern with 10 cm diameter holes, carried out with a Gardner–Denver HDOF carrier, PRH80 hammer and a 1600 cfm Ingersoll–Rand compressor.

Wet holes are blown out with compressed air; all holes are toe loaded with 75 mm x 400 mm Powerfrac 75% stick powder and column loaded with AN/FO. The blast holes are primed with 50 mm x 400 mm Cilgel 70% and initiated by electric delay caps, and 1,500 to 2,000 tonnes of stone are blasted each day in approximately 30 holes.

Processing

The process flow sheet is shown on Figure NI–11–3. The Law quarry has an average nine–month operating year. The crushing facilities have a rated capacity of 2,600 tonnes per day. Blasted stone is loaded by a 7–yd. Terex 7271B onto two R25 Euclid trucks 1300 m to the primary feed hopper. A 5 ft. x 16 ft. Simplicity vibratory feeder is used to scalp the fine feed material, with the oversize going to the primary Telsmith 24B gyratory crusher. The crushed stone then joins the scalped feeder

Photo NI-11-3.
PROCESSING PLANT SHOWING PRIMARY CRUSHER, SURGE PILE AND SCREENING TOWERS AT R.E. LAW QUARRY.

fines and is stockpiled as a −8 in. surge pile. The surge pile is recovered by two Syntron feeders to a 30 in. tunnel conveyor and transferred to the middle screening tower. The stone is separated by a 5 ft. x 16 ft. double-deck Tyler screen which produces a −8 in. + 2 in. material for secondary crushing (Nordberg 4.5 ft. standard cone), −2 in. + 1 in. for secondary crushing (Nordberg 4.5 ft. shorthead cone) and −1 in. for the Granular "A" stockpile. Crushed stone leaving the Nordberg shorthead is screened by 4 ft. x 8 ft. single-deck Tyler screen which removes +1 in. oversize for recrushing and a 5 ft. x 16 ft. double-deck Tyler screen which produces −1/4 in., −1/2 in. + 1/4 in. and −l in. + 1/2 in. stone. These three products are each stored in two 40-ton bins and can be loaded onto trucks for stockpiling, sent to the washing facilities, or added to the −1 in. material (from the middle screening tower), and conveyed to the Granular "A" stockpile. The Nordberg standard cone crusher produces −4 in. material that is conveyed to the top screening tower. From the conveyor belt the −4 in. stone can be sent to either the eastside sizing and washing screens for direct product sizing, or to the westside scalping screens (double-deck Tyler 4 ft. x 16 ft. and 4 ft. x 10 ft.), and recrushing in a King Stedman 42 in. crusher. Recrushed material is returned to one side of the conveyor belt and sent through the 5 ft. x 16 ft. and 5 ft. x 10 ft. double-deck screens of the eastside sizing and washing circuit. Minus 4 in. + 2 in., −2 in. + 1 in., −1 in. + 1/2 in., −1/2 in. + 1/4 in. material and −1/4 in. fines are produced and stored in 50-ton bins. Products in the bins may be removed and sent for washing at the fine or coarse washer.

A 250 tons per hour asphalt plant is also located at the quarry.

PRODUCTS

Armour Stone
Riprap
Quarry Rubble
−4 in. Crusher Run
Granular "A" and "B"
2 in. Clear
3/4 in. Clear
3/8 in. Clear
21A Concrete Stone
HL6 and HL3

REFERENCES

Best, 1953, p.53–55
Caley, 1940, p.88, 102
Hewitt, 1960, p.134–136
Hewitt, 1964a, p.63
Hewitt and Vos, 1972, p.61–62
Kobluk and Brookfield, 1982, p.27–29
Oliver, 1976, p.143–144
Uyeno et al., 1982, p.43
ARIP 115, 1985, p.17

MAPS

Caley, 1941c, GSC Map 584A
Telford and Tarrant, 1975b, ODM Map P.989

NI-12 PORT COLBORNE QUARRIES LTD. — PORT COLBORNE QUARRY

LOCATION AND OWNERSHIP

This operating quarry is located 2 km northeast of Port Colborne on Chippewa Road in Lots 19 to 22, Con. 2, City of Port Colborne (Humberstone Township), Regional Municipality of Niagara (Figure NI-12-1). Two quarries are located here; one depleted and the other extending eastward. The licensed area of the quarry is 142.1 ha.

GEOLOGY

A total of 15.27 m of section is exposed with 12.23 m of the Upper Silurian Bertie Formation and 3.04 m of the Lower Devonian Bois Blanc Formation present (Figure NI-12-2). The Bertie Formation here consists of the

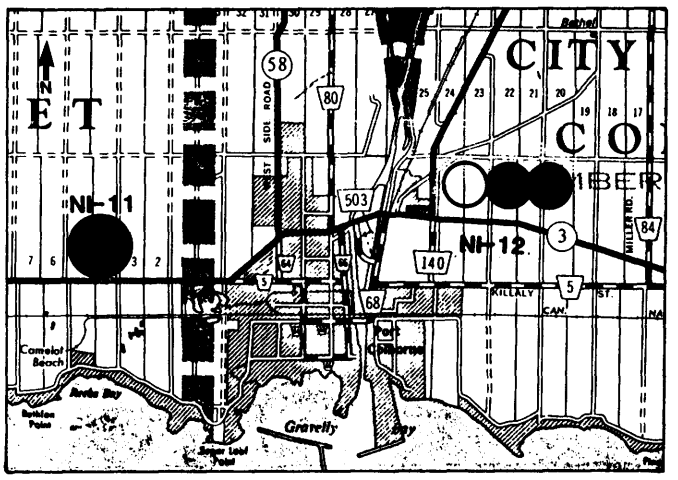


Figure NI-12-1. LOCATION MAP FOR PORT COLBORNE QUARRY.

Akron, Williamsville, Scajaquanda, Falkirk and Oatka Members with lithologies ranging from dolomitic shales to shaly and calcareous dolostones to dolostones. The Bois Blanc Formation is a cherty limestone with some shaly zones. The quarry operates in three lifts and has 1 to 3 m of overburden.

Geological Section

Thickness

UNIT 6 Bois Blanc Formation *3.04m*

Cherty limestone: light grey-cream, weathers mottled; fine crystalline; thin to medium bedded, contacts are sharp, undulatory, some have shaly partings; white to grey chert, occurs as nodules and lenticular beds; very fossil rich with abundant bryozoa, rugose, crinoids, brachiopods and fragments, many are replaced by silica; the base of this unit is a shaly sandstone bed (probably the Springvale Sandstone Member); lower contact is sharp.

UNIT 5 Bertie Formation, Akron Member *2.57m*

Dolostone: grey-brown, weathers buff; fine crystalline; medium to thick bedded, contacts are sharp and undulatory; calcite and chert mineralization occurs in fractures, pyrite occurs along bedding planes; sucrosic and very mottled; glauconitic sand infills voids and cracks along the upper contact; lower contact is transitional.

UNIT 4 Bertie Formation, Williamsville Member *2.84m*

Calcareous dolostone: light to medium grey, weathers buff; fine crystalline; very thin to medium bedded, contacts are sharp, but irregular and undulatory, mottled appearance; chert occurs in scattered layers; lower contact is sharp.

UNIT 3 Bertie Formation, Scajaquanda Member *1.91m*

Calcareous dolostone: grey-green, weathers blue-grey to green; fine crystalline; thin bedded with laminations, contacts are sharp and irregular; some sandy layers occur with minor sedimentary structures such as slump features and draping; rare pyrite mineralization occurs along bedding planes; fossil debris is rare; lower contact is sharp.

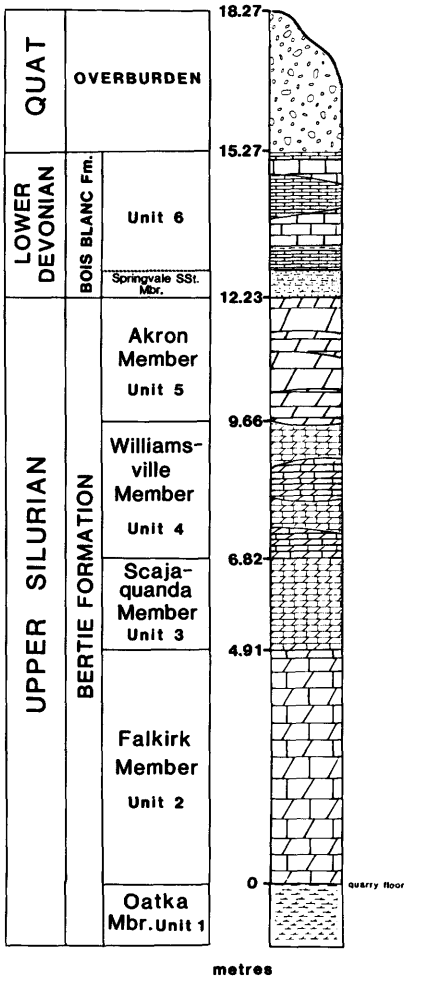


Figure NI-12-2. STRATIGRAPHIC COLUMN FOR PORT COLBORNE QUARRY.

UNIT 2 Bertie Formation, Falkirk Member *4.91m*

Calcareous dolostone: dark brown, weathers same; medium crystalline; medium bedded (3 to 40 cm), contacts are welded and some are bituminous; laminations are present; sucrosic and porous; stylolitic; shaly beds present; calcite occurs in fractures, gypsum and selenite crystals in vugs; lower contact is sharp.

UNIT 1 Bertie Formation, Oatka Member *quarry floor*

Dolomitic shale: dark grey, weathers green-grey; shaly; very thin bedded, slaty; some sulphide mineralization present.

Total thickness *15.27m*

QUARRY OPERATION

The quarry has a production capacity of 7,200–11,000 tonnes/day based on an 8-hour day. Production could be increased to 15,000 tonnes per 8-hour shift with little difficulty. The quarry operates only during the shipping season from mid-March to the end of December. A third property of approximately 70 ha lies to the east of

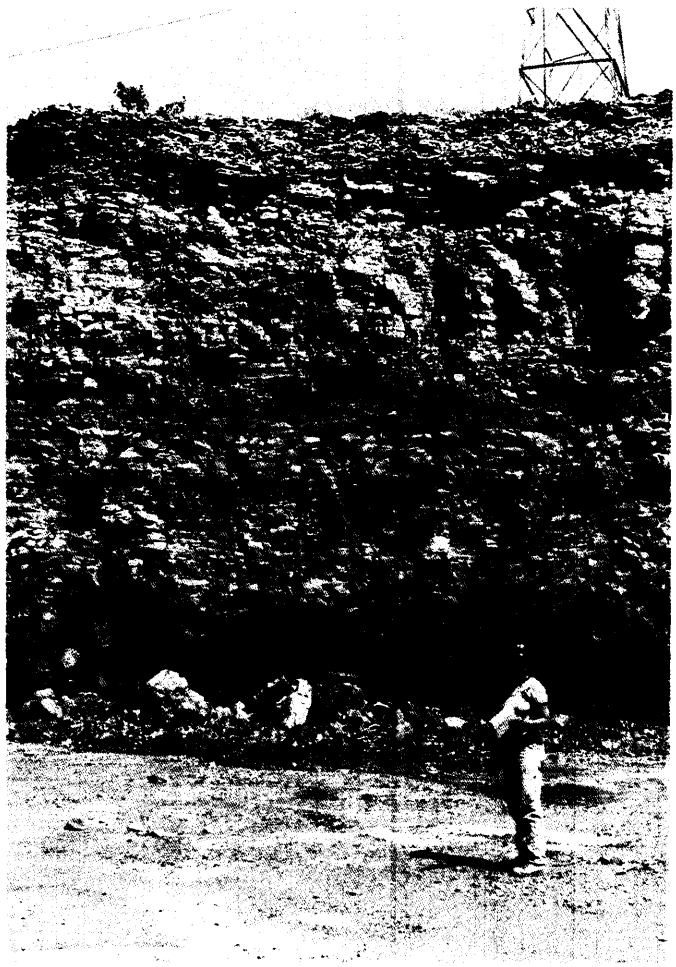


Photo NI-12-1. TYPICAL SECTION AT PORT COLBORNE QUARRY.

the existing quarry. This area will be accessed by means of a tunnel under a township road. Nearby urban growth is placing constraints on the operation of the quarry in terms of blasting and haulage activities.

Overburden is removed by a Caterpillar D–9 bulldozer and piled into berms for screening and noise reduction, or reserved for pit rehabilitation. Stripping is complete on the south side of the quarry and a berm is being constructed.

Drilling is conducted by quarry staff using rotary drills, either a Joy Mustang 1700 series or a Gardner–Denver 2000 series drill is used. Both drill 10 cm holes on a 3 m x 3 m pattern. Drilling is to full bench height. AN/FO premix is used for blasting, either Powerfrac 75 or Powermix 300, with a 2 m collar. Blasting is conducted sequentially. There is a minimum of two, and a maximum of four, blasts per day, in the morning and afternoon. The rock shatters freely and no secondary breaking is required.

The lower member of Unit 6, which is comprised of a shaly sandstone 60 cm to 120 cm thick is ripped using a D–9 Caterpillar bulldozer. The material may be used for berm construction, or stored for pit rehabilitation.

PROCESSING

The process flow sheet is shown on Figure NI–12–3. Blasted material is loaded into trucks using 3 Clark 475 and 2 Cat 992 17 yd. front end loaders. Rock is loaded into two 85–ton Euclid and 3 50–ton Euclid trucks and transported approximately 300 m to 450 m to the primary crusher.

The primary crusher is located adjacent to the old quarry. It is a Cedarapids dual impact model 5460 unit which reduces the rock to 8 in. to 6 in. After initial screening the stone passes to a Hewitt–Robins 48 in. single impact crusher where material is reduced to 4 in. to dust size in closed circuit. Secondary crushed material is stored in a 60,000 tonne surge pile on the floor of the old quarry.

Material is reclaimed from the surge pile by means of underground conveyor and sent to a screening plant. Plus 2 in. material is conveyed to storage on the floor of the old quarry. The balance of the material is passed to either a 4.25 in. or 5.5 in. Cedarapids cone crusher to produce +3/8 in, –1 in. material. This material is washed in a tub washer and dried in a drum dryer and is the main export product. After washing and drying the stone is conveyed to either overhead storage bins for truck loading, or moved by conveyor to storage piles.

Wash water is passed to settling ponds in the old quarry for clarification. Make–up water is provided by pit runoff. Both the working pit and the old quarry are dry. Pumping is provided by an 8 in. Gorman–Rupp centrifugal pump.

Material for export is hauled by independent contractor to storage and dock facilities at Wharf 12 on the east side of the Welland Canal at Port Colborne. The total storage and dock area is 13 acres. Stone is dumped and then piled by a D–9 Cat bulldozer. Shiploading is by means of a gravity fed 48 in. underground conveyor feeding a 2,000–2,200 tonne/hr. luffing loader. The total length of the dock is 1,800 ft. The main product sizes exported are 3/8 in., 3/4 in., 1 in., 2 in., and 4 in.

PRODUCTS

4 in. Clear
2 in. Clear
1 in. Clear
3/4 in. Clear
5/8 in. Clear
3/8 in. Clear

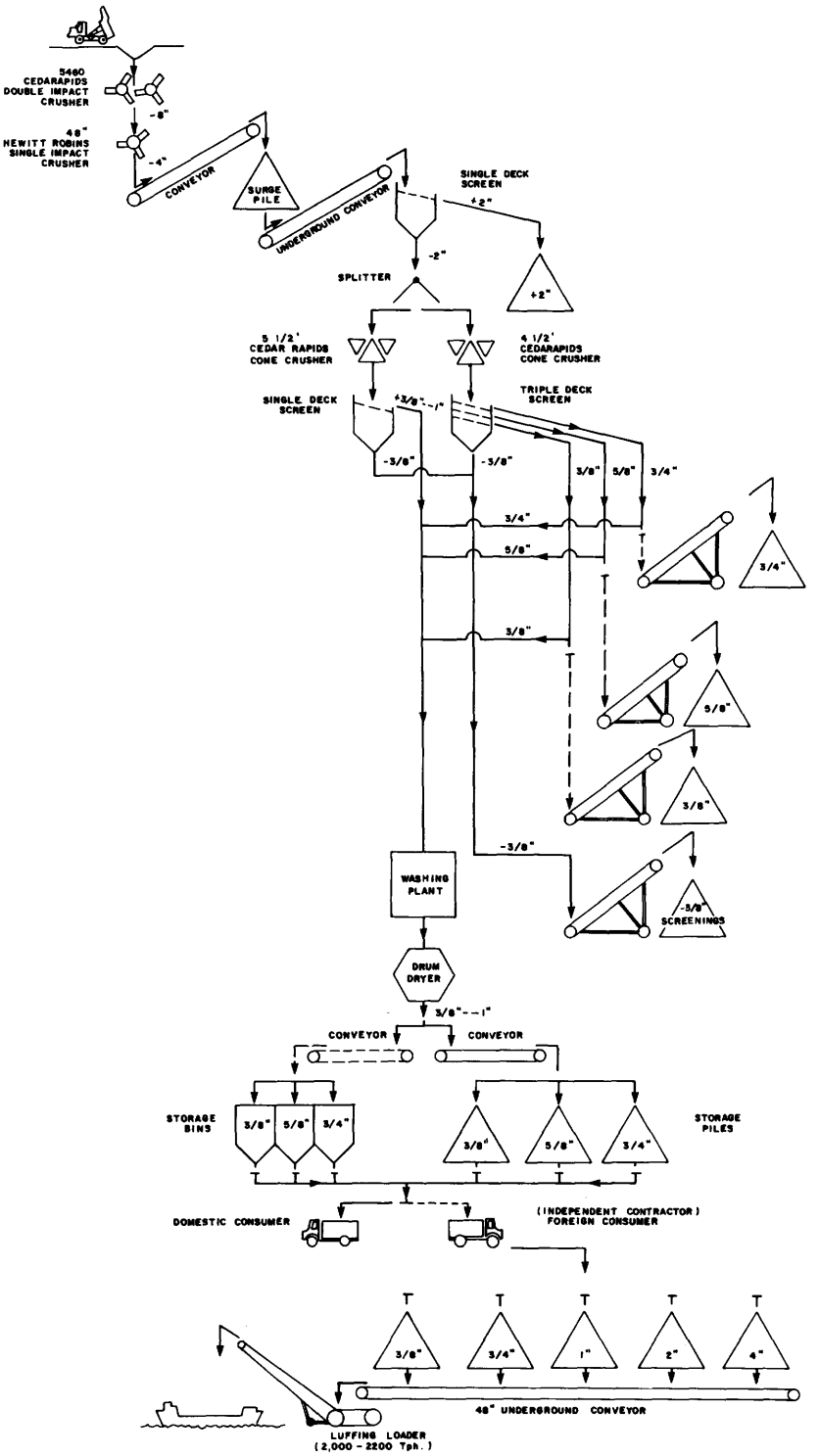


Figure NI-12-3. PROCESS FLOW SHEET FOR PORT COLBORNE QUARRY.

REFERENCES

Hewitt, 1960, p. 130–132
Hewitt, 1964a, p. 61–62
Hewitt and Vos, 1972, p. 62
ARIP 117, 1985, p. 22

MAPS

Owen, 1972, GSC Map 8–1971
Telford and Tarrant, 1975b, ODM Map P.989

NI–13 BERTIE BAY QUARRY

LOCATION AND OWNERSHIP

Two abandoned quarries are located 3 km west of Bertie Bay on Lake Erie in Lot 12, Concession 2, Town of Fort Erie (Bertie Township), Regional Municipality of Niagara (Figure NI–13–1).

GEOLOGY

The smaller quarry of the two exposes 4.2 m of the Clarence Member from the Onondaga Formation, a fine– to medium–crystalline and sucrosic cherty limestone that displays silicified crinoids and rugose corals.

Geological Section

		Thickness
UNIT 1	*Onondaga Formation, Clarence Member*	*4.20m*
	Cherty limestone: brown–grey, weathers light brown; fine to medium crystalline; fine to medium bedded, contacts are undulatory; sucrosic; abundant silicified crinoids and rugose corals are present.	
Total thickness		*4.20m*

REFERENCES

Best, 1953, p.48–49
Goudge, 1938, p.286
Oliver, 1976, p.143–144
ARIP 117, 1985, p.23

MAPS

Caley, 1941c, GSC Map 584A
Telford and Tarrant, 1975b, ODM Map P.989

NI–14 RIDGEMOUNT QUARRIES LTD. — PIT 1

LOCATION AND OWNERSHIP

This large quarry is located 2.5 m south of Ridgemount and just south of the large operating quarry (NI–15), in Lots 3 and 4, Concession 8 NR, Town of Fort Erie (Bertie Township), Regional Municipality of Niagara (Figure NI–14–1). The quarry licence covers an area of 82.19 ha. It is owned by Walker Industries Holdings Limited.

GEOLOGY

The quarry exposes 10.69 m of section ranging from the Upper Silurian Bertie Formation through to the Middle Devonian Onondaga Formation, Edgecliff Member (Figure NI–14–2). The Bertie Formation is represented by 1.35 m of the Akron Member, a subcrystalline to fine–crystalline dolostone with some green to cream–coloured chert. Towards the top, abundant glauconite clasts occur which are surrounded by a coarse quartz sand. The Bertie is sharply overlain by the Bois Blanc Formation on an erosional contact. The Bois Blanc Formation is a cherty, dolomitic limestone with shaly partings. In places it can be very fossiliferous with coquinas of brachiopods and coral debris. Chert occurs as thin beds or nodules.

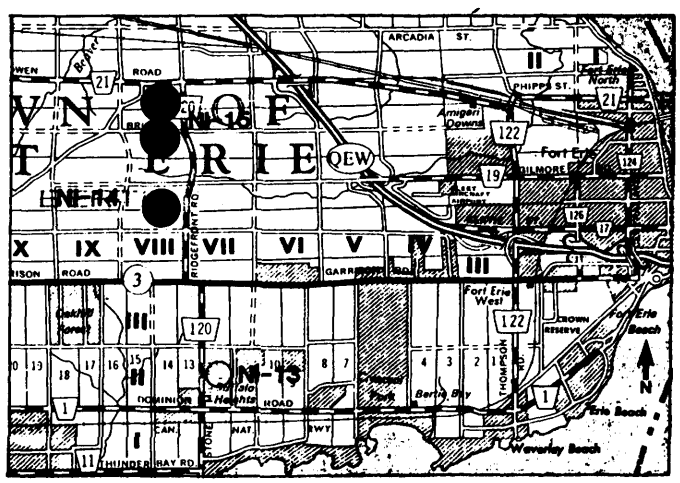


Figure NI–13–1. LOCATION MAP FOR BERTIE BAY QUARRY.

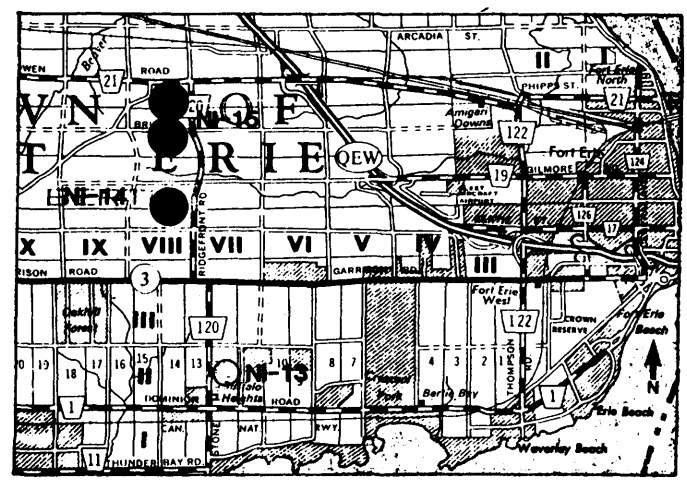


Figure NI–14–1. LOCATION MAP FOR PIT 1 OF RIDGEMOUNT QUARRIES LTD.

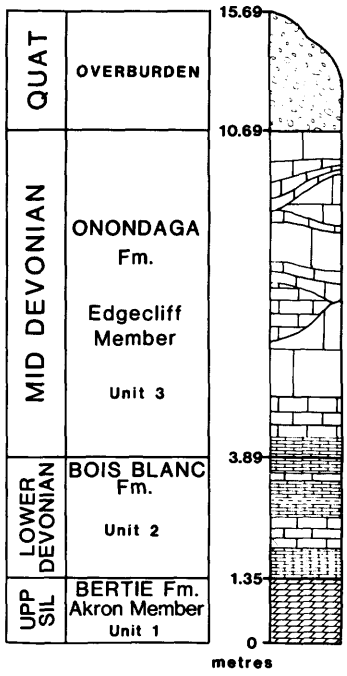


Figure NI-14-2. STRATIGRAPHIC COLUMN FOR PIT 1 OF RIDGEMOUNT QUARRIES LTD.

The Bois Blanc Formation is disconformably overlain by 6.8 m of the Edgecliff Member of the Onondaga Formation. This consists mainly of biohermal and reefal limestones. The biohermal limestones commonly surround or overlie the reefal limestones. The Bois Blanc is typically medium bedded, very fossiliferous and bioclastic, with abundant black chert nodules while the Onondaga is massive, light grey, porous, coarse crystalline, and consists mainly of colonial rugose corals. Currently this quarry is undergoing rehabilitation.

Geological Section

Thickness

UNIT 3 Onondaga Formation, Edgecliff Member *6.8m*

Reefal and biohermal limestones: cream to brown, weathers buff-grey; fine to medium crystalline, reefy zones can be coarse crystalline; medium to massive bedded, contacts between reefal and biostromal zones are sharp and usually shaly; irregular-shaped black chert nodules occur; very fossiliferous with solitary rugose corals, colonial corals, crinoids, brachiopods, and bryozoans; porous; lower contact is sharp with a 15 cm thick calcarenite (fine to medium grained, brown to green-grey, thin bedded).

Photo NI-14-1. TYPICAL QUARRY SECTION AT PIT 1 OF RIDGEMOUNT QUARRIES LTD.

UNIT 2 Bois Blanc Formation *2.54m*

Cherty dolomitic limestone: light grey to cream, weathers brown to buff-grey; fine crystalline; thin to medium bedded, contacts are not distinct, contorted, and may be shaly and bituminous; blue-grey to black chert occurs as nodules or lenses; scattered shaly partings occur with some brachiopods; abundant fossils occur in the limestones and include bryozoa, solitary corals and brachiopods; rare dolomite crystals and iron staining are present; the base may possess sandy lenses; lower contact is sharp.

UNIT 1 Bertie Formation, Akron Member *1.35m*

Dolostone: cream to light grey, weathers grey to light brown; sub- to fine-crystalline; thin bedded (less than 8 cm), appears laminated in places, contacts are not distinct and some are glauconitic; very mottled appearance; some scattered green chert lenses; abundant pelletoid-like material infilled with calcite, some fossil debris; abundant glauconite sand clasts occur towards the top, and in some places some minor brecciation has taken place.

Total thickness *10.69m*

REFERENCES

Best, 1953, p.49–51
Cassa and Kissling, 1982, p.87–91
Goudge, 1938, p.286
Hewitt, 1960, p.130
Hewitt, 1964a, p.61
Hewitt and Vos, 1972, p.62–63
Oliver, 1976, p.143
Telford and Johnson, 1984, p.18–19
Telford and Johnson, 1985, p.10
Uyeno et al., 1982, p.43
Winder and Sanford, 1972, p.65
ARIP 117, 1985, p.22

MAPS

Caley, 1941c, GSC Map 584A
Telford and Tarrant, 1975b, ODM Map P.989

NI-15 RIDGEMOUNT QUARRIES LTD. — PITS 2 AND 3

LOCATION AND OWNERSHIP

This Ridgemount Quarry location was purchased from Campbell Brothers Quarry Ltd. and has since been amalgamated with Ridgemount Quarries Ltd. as pits 2 and 3. They are owned and operated by Walker Industries Holdings Limited. This operating quarry is located 4 km southeast of Stevensville in Lots 5–8, Concession 8 NR, Town of Fort Erie (Bertie Township), Regional Municipality of Niagara (Figure NI–15–1). The quarry is licensed for 78.14 ha.

The projected Ridgemount #3 quarry, located in Lots 7 and 8, Concession 7 NR, Town of Fort Erie (Bertie Township), is slated for future production by Walker Industries. This property has a quarry licence covering 44.53 ha.

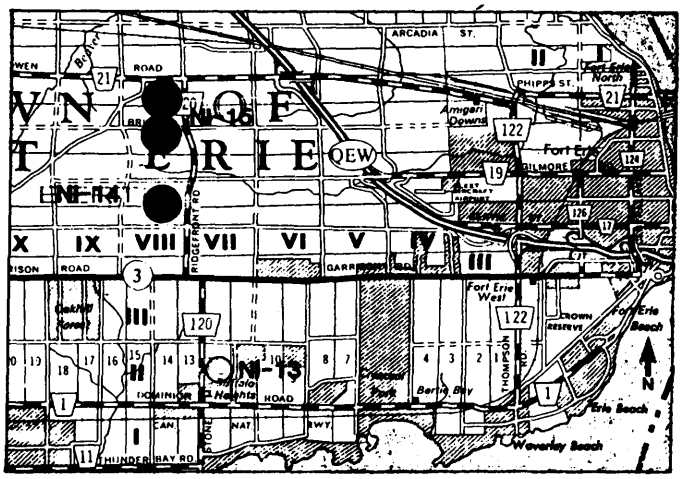


Figure NI-15-1. LOCATION MAP FOR PITS 2 AND 3 OF RIDGEMOUNT QUARRIES LTD.

GEOLOGY

Pit #2, also known as the Campbell Quarry, exposes 14.25 m of section and includes the Upper Silurian Bertie Formation (11.35 m) and the Lower Devonian Bois Blanc Formation (2.90 m) (Figure NI–15–2). Five members of the Bertie Formation are seen here: the Oatka, Falkirk, Scajaquanda, Williamsville and Akron, with the dominant lithologies consisting of dolostones and shaly dolostones. The Williamsville Member is of interest to fossil collectors for the abundance of eurypterids. The contact of the Bertie and Bois Blanc Formations is sharp and represents a major unconformity. The Bois Blanc Formation is a cherty, fossiliferous limestone with dolomitic zones. Overburden is moderate, from 1.5 to 2 m in thickness.

The quarry operators have plans to extend the quarry southward to join the Ridgemount Quarry Pit 1 (NI–14).

Geological Section

Thickness

UNIT 6 Bois Blanc Formation *2.90m*

Cherty limestone: light grey, weathers mottled buff to grey; fine crystalline; thin to medium bedded, contacts are irregular with shaly and bituminous partings; some zones are dolomitic; chert nodules are dark grey to black, some are white and occur as lenses in lower 40 cm; very fossiliferous with silicified brachiopods, bryozoans, crinoids, and large burrows (Chondrites); bedding partly contorted; lower contact is sharp and represents a major unconformity.

UNIT 5 Bertie Formation, Akron Member *1.72m*

Dolostone: cream-grey, weathers cream-brown; fine crystalline; thin bedded with sharp, undulatory contacts; has a mottled appearance; lower contact is sharp.

UNIT 4 Bertie Formation, Williamsville Member 1.56m

Dolostone: light to medium brown, weathers buff; sub- to fine-crystalline; thin bedded with irregular contacts, bituminous or shaly partings; slightly sucrosic; calcite mineralization in the upper part; rare bryozoans and eurypterids; becomes more mottled upward; lower unit contact is transitional.

UNIT 3 Bertie Formation, Scajaquanda Member 2.72m

Interbedded dolostones and shaly dolostones: dark brown to dark grey, weathers blue-grey; sub- to fine-crystalline and fine grained; thin to medium bedded, contacts are sharp with shaly partings; laminated with calcisiltites and calcilutites; calcite mineralization present in fractures, iron staining occurs throughout; rare fossil debris on bedding and laminae planes; lower contact is sharp.

UNIT 2 Bertie Formation, Falkirk Member 4.75m

Calcareous dolostone: light to dark brown, weathers medium to dark brown; very fine to fine crystalline; thin to medium bedded with sharp undulatory contacts; bituminous partings are abundant in upper horizon along with stylolitic partings; rare chert present in vugs, marcasite found in small pores; rare algal mounds and brachiopods; abundant pelletal material within laminations; lower contact is covered.

UNIT 1 Bertie Formation, Oatka Member 0.60m

Shaly dolostone: dark grey, weathers light blue-grey; sub- to fine-crystalline; medium bedded with abundant laminations and shaly partings along contacts; slaty bedding in part; pyrite nodules occur along laminations and bedding planes.

Total thickness · 14.25m

QUARRY OPERATIONS

The Ridgemount #2 quarry produces aggregate from two lifts of 9.5 m and 5.0 m. Drilling and blasting is carried out by Ridgemount on a 2.74 m x 2.74 m pattern with 7.6 cm diameter holes. Powermex 300 and Amex are used as bulk explosives, initiated with electric caps. Blasted stone is loaded by a Cat. 980 to two 22-ton Terex haulage trucks. A 35-ton Haulpak truck is used as a spare and a 35-ton Mack is used in stockpiling. A VME L190 loader is used to recover material from the stockpile.

PROCESSING

Crushing and screening are performed with portable equipment: a primary circuit of a Pioneer 3042 jaw crusher and a 5 ft. x 16 ft. triple-deck Tyler screen; a secondary circuit of a Nordberg 4 ft. standard cone crusher and a 6 ft. x 20 ft. Eljay triple-deck screen; and a tertiary crushing circuit of a Telsmith 48S standard cone and a Nordberg 4 1/4 ft. short head crusher that feed the Eljay screen.

PRODUCTS

Gabion Stone
2 in. Crusher Run
Granular "A"
HL3, HL5, HL6

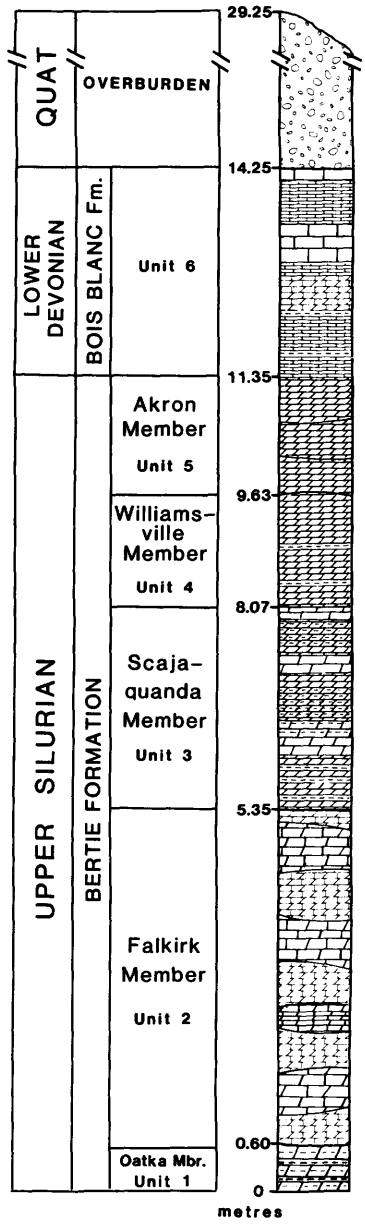


Figure NI-15-2. STRATIGRAPHIC COLUMN FOR PITS 2 AND 3 OF RIDGEMOUNT QUARRIES LTD.

1/2 in., 3/8 in. chips
Screenings

REFERENCES

Best, 1953, p.51
Caley, 1940, pp.79, 80, 81
Goudge, 1938, p.285
Hewitt, 1960, p.128-130
Hewitt, 1964a, p.60-61
Hewitt and Vos, 1972, p.57-58

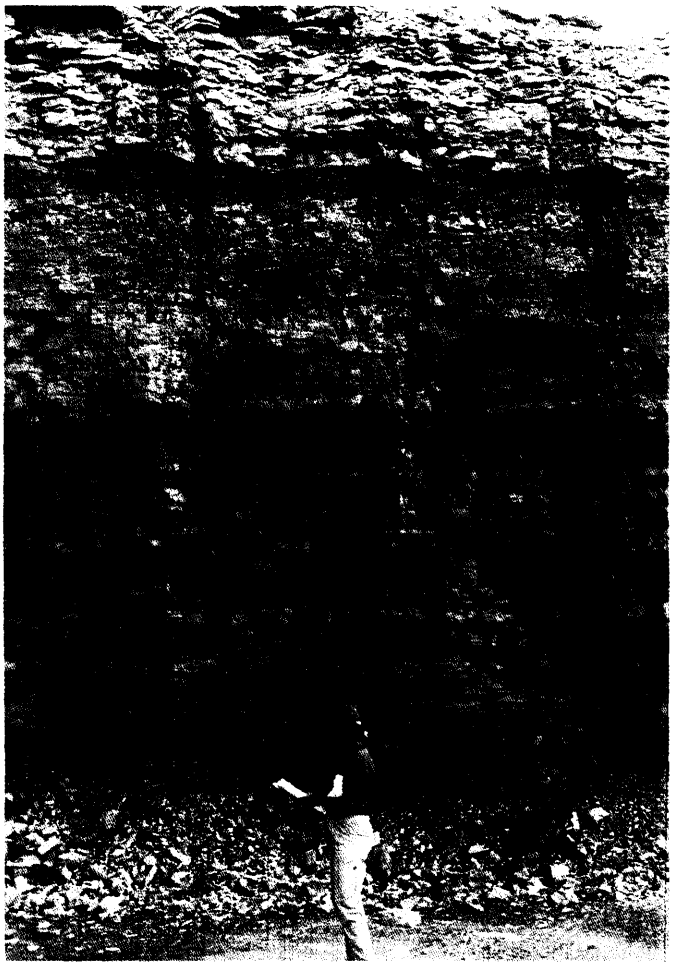


Photo NI-15-1. TYPICAL QUARRY SECTION AT PITS 2 AND 3 OF RIDGEMOUNT QUARRIES LTD.

Telford and Johnson, 1984, p.16–17
ARIP 117, 1985, p.22

MAPS

Caley, 1941c, GSC Map 584A
Telford and Tarrant, 1975b, ODM Map P.989

NI-16 CLINTON QUARRY LTD.

LOCATION AND OWNERSHIP

The Clinton Quarry is located 3 km southwest of Vineland, in Lots 5 and 6, Concessions 5 and 6, Town of Lincoln (Clinton Township), Regional Municipality of Niagara (Figure NI-16-1). Owned and operated by Walker Industries Holdings Limited, the Clinton Quarry was opened in 1986 to supplement the supply of stone to the crushing facilities at the Vineland Quarry (NI-2), an adjacent quarry also owned and operated by Walker Industries Holdings Limited. The quarry licence covers an area of 111.3 ha. Products include all sizes of clear, crusher run, granulars, concrete stone, manufactured sand and armour stone. Armour stone is supplied for use along the shores of Lakes Ontario and Erie.

GEOLOGY

The adjacent Vineland quarry (NI-2) exposes a total of 8.95 m which consists of Middle Silurian rocks from the Rochester and Decew Formations, and of the Goat Island and Gasport Members of the Lockport Formation. The basal Rochester Formation consists of 0.30 m of shaly dolostone which is overlain by the Decew Formation, 1.22 m of a fine-crystalline, massive-and irregular-bedded dolostone. The Lockport Formation exposure is 7.43 m of a medium- to coarse- crystalline, fossiliferous dolostone (Gasport Member) and a subcrystalline, massive dolostone of the Goat Island Member.

QUARRY OPERATION

The quarry is worked on a single lift of about 7.0 to 8.2 m. Drilling is carried out with a Gardner-Denver 123, on a 2.74 m x 2.74 m drill pattern with 7.6 cm diameter holes. Blasting conditions are dry and prilled ammonium nitrate is used as a bulk explosive. The blasted stone is loaded by one 992B Caterpillar loader onto three 50-ton Euclid trucks. The trucks haul approximately 700 m to the primary crusher at the Vineland crushing facilities.

A bridge to span the quarry floor has been constructed along Cherry Avenue, allowing the haul trucks to pass beneath between the Clinton and Vineland Quarry properties.

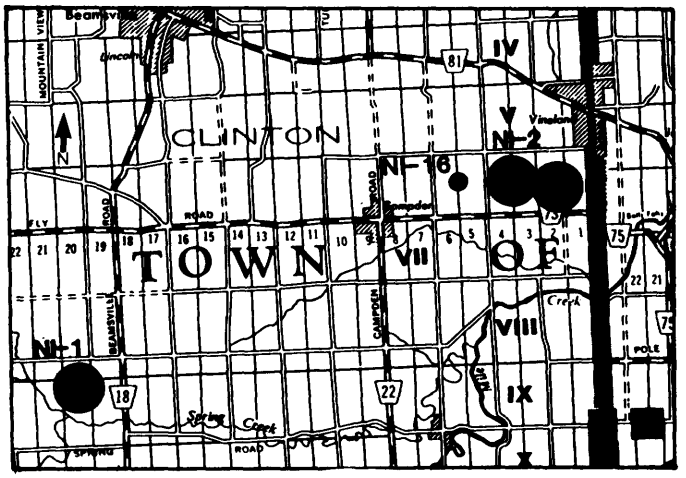


Figure NI-16-1. LOCATION MAP FOR CLINTON QUARRY.

PROCESSING

Stone from the Clinton Quarry is processed at the Vineland Quarry (NI-2), and the process flow sheet is shown on Figure NI-2-3.

The primary crusher, a Jeffrey 536 impact unit, reduces the stone to -8 in. which is then fed by a 48 in. conveyor to a 6 ft. x 16 ft. double-deck screen. The screen produces Granular "A" and +4 in. -6 in. rubble rock, both of which are stockpiled by conveyor, and -8 in. material that is carried to a surge pile by a 42 in. conveyor. The surge pile material is recovered by a vibrating feeder onto a 36 in. tunnel conveyer that feeds a second 6 ft. x 16 ft. double-deck screen. This screen produces +1 1/2 in. oversize that is sent to a Symons 5 1/2 ft. cone crusher, -1 1/2 in. and +7/8 in. material sent to either a Penn or Jeffrey impact crusher, and -1/2 in. fines that are added to the output of the Symons cone crusher and fed to another 6 ft. x 16 ft. double-deck screen. This screen produces 3/4 in. clear, -5/8 in. granular stone and screenings. Stone crushed by the two impactors is screened by two parallel 7 ft. x 20 ft. double-deck screens that return +3/4 in. oversize for recrushing and feed the -3/4 in material to an 8 ft. x 22 ft. double-deck screen. This screen produces -3/4 in. +1/2 in. concrete stone and -1/2 in. material that is split by a 5 ft. x 12 ft. screen into -1/2 in. +3/16 in. chips and -1/4 in. screenings.

Different grades of concrete, asphalt and crusher run stone can be produced by varying the screen sizes.

PRODUCTS

Vineland Quarries and Crushed Stone Ltd. has the capability to produce different grades of concrete, asphalt and crusher run stone by varying the screen sizes. Products include but are not restricted to, the following:

Rubble Rock
1 1/2 in. Granular
3/4 in. Granular
-5/8 in. Granular
3/4 in. Clear
3/8 in. Washed
1/8 in. Washed
-1/4 in. Washed
-3/4 in. + 1/2 in. Concrete Stone
Screenings
Manufactured Sand

REFERENCES

None

MAPS

None

Part 2
Southwestern Ontario

Owen Sound District

INTRODUCTION

Owen Sound District is the northernmost district in the Southwestern Ontario region and includes the Bruce Peninsula and most of Bruce and Grey Counties (Figure O–0–1). The district is bounded by Lake Huron, Georgian Bay, and the Districts of Huronia, Cambridge and Wingham.

Thirty–six quarries in Owen Sound District are documented in the Quarry Inventory (Appendix IV, Volume I); nine of these are currently active, two report intermittent production, and the balance represent past producing quarries of geological significance.

All of the active quarries, one intermittently active quarry (O–9) and one abandoned quarry (O–4) were visited during the study and include the following:

- *O–1* *Arriscraft Corporation – Adair Marble Quarry (active)*
- *O–2* *Moor Developments Inc. Quarry (active)*
- *O–3* *Amsen Quarry Ltd. – Ross Quarry (active)*
- *O–4* *J. S. Cook – Cook Quarry (abandoned)*
- *O–5* *Owen Sound Ledgerock – Wiarton Quarry (active)*
- *O–6* *R. G. Ebel – Ebel Quarry (active)*
- *O–7* *C. E. McCartney – McCartney Quarry (active)*
- *O–8* *Owen Sound Ledgerock Ltd. – Owen Sound (Cruickshank) Quarry (active)*
- *O–9* *E.C. King Contracting – Tolhurst Quarry (intermittent)*
- *O–10* *E.C. King Contracting – Sydenham Quarry (active)*

REGIONAL GEOLOGY

The dominant geomorphic feature in the Owen Sound District is the Niagara Escarpment. In the northern half of the district, on the Bruce Peninsula, the Escarpment forms steep bluffs (up to 60 m high) along the Georgian Bay shoreline with exposed rock strata gently sloping to the west into Lake Huron. In this area the gently rolling and irregular bedrock surface is covered by a thin veneer of Quaternary deposits and wet swampy basins and lakes. In the southern half of the district, the Niagara Escarpment is less prominent and follows the Georgian Bay shoreline to the southeast. The Quaternary deposits become thicker and more varied, especially to the southwest. The Niagara Escarpment is indented by a number of northeast trending valleys, such as those at Colpoy's Bay, Owen Sound, Bighead River Valley, and the Beaver Valley.

Middle Ordovician to Middle Devonian strata are exposed in this district (see Figure O–0–2). The bluffs and caprock of the Niagara Escarpment consist of Silurian strata, and the Ordovician strata occur as a thin belt of recessively weathering units at the base of the Escarpment. The Devonian strata only underlie the extreme southwest corner of this district.

Current quarrying activities in the Owen Sound District are almost exclusively limited to Middle Silurian dolostones, which are extracted for building stone, landscaping stone, and aggregate. Historically, however, various units throughout the whole stratigraphic interval exposed in the district have been quarried, primarily for building stone.

The oldest strata exposed in the Owen Sound District are the black organic–rich calcareous shales and limestones of the Middle to Upper Ordovician Collingwood Member of the Lindsay Formation, which outcrop only in the extreme eastern end of the district.

The Lindsay Formation is overlain by the soft, grey, greenish–grey and bluish–grey fissile shales of the Upper Ordovician Blue Mountain Formation which outcrop in a narrow southeast trending belt.

The Blue Mountain Formation is overlain by the interbedded grey limestones and blue–grey shales of the Upper Ordovician Georgian Bay Formation. In the southeastern part of the district, this formation outcrops below the Escarpment in a relatively wide belt which narrows considerably to the north as the Georgian Bay Formation disappears into the subsurface approximately half–way up the Bruce Peninsula.

The uppermost Ordovician strata in this district are the predominantly red shales of the Queenston Formation. These overlie and may be interbedded with the blue–grey shales of the Georgian Bay Formation. The Queenston Formation thins to the north and pinches out north of the Bruce Peninsula.

The oldest Silurian strata in the Owen Sound District, the sandstones of the Lower Silurian Whirlpool Formation, are reported to occur only in the extreme southern portion of the district (Liberty and Bolton, 1971). The thin–bedded grey to blue–grey dolomitic limestones and dolostones of the Lower Silurian Manitoulin Formation overlie the Whirlpool Formation in the south and the Ordovician Queenston or Georgian Bay Formations in the remainder of the district. In some places the Manitoulin Formation forms a secondary escarpment below the main Niagara Escarpment. The Manitoulin Formation is intermittently quarried for aggregate at the Tolhurst Quarry (O–9) in Sarawak Township, Grey County.

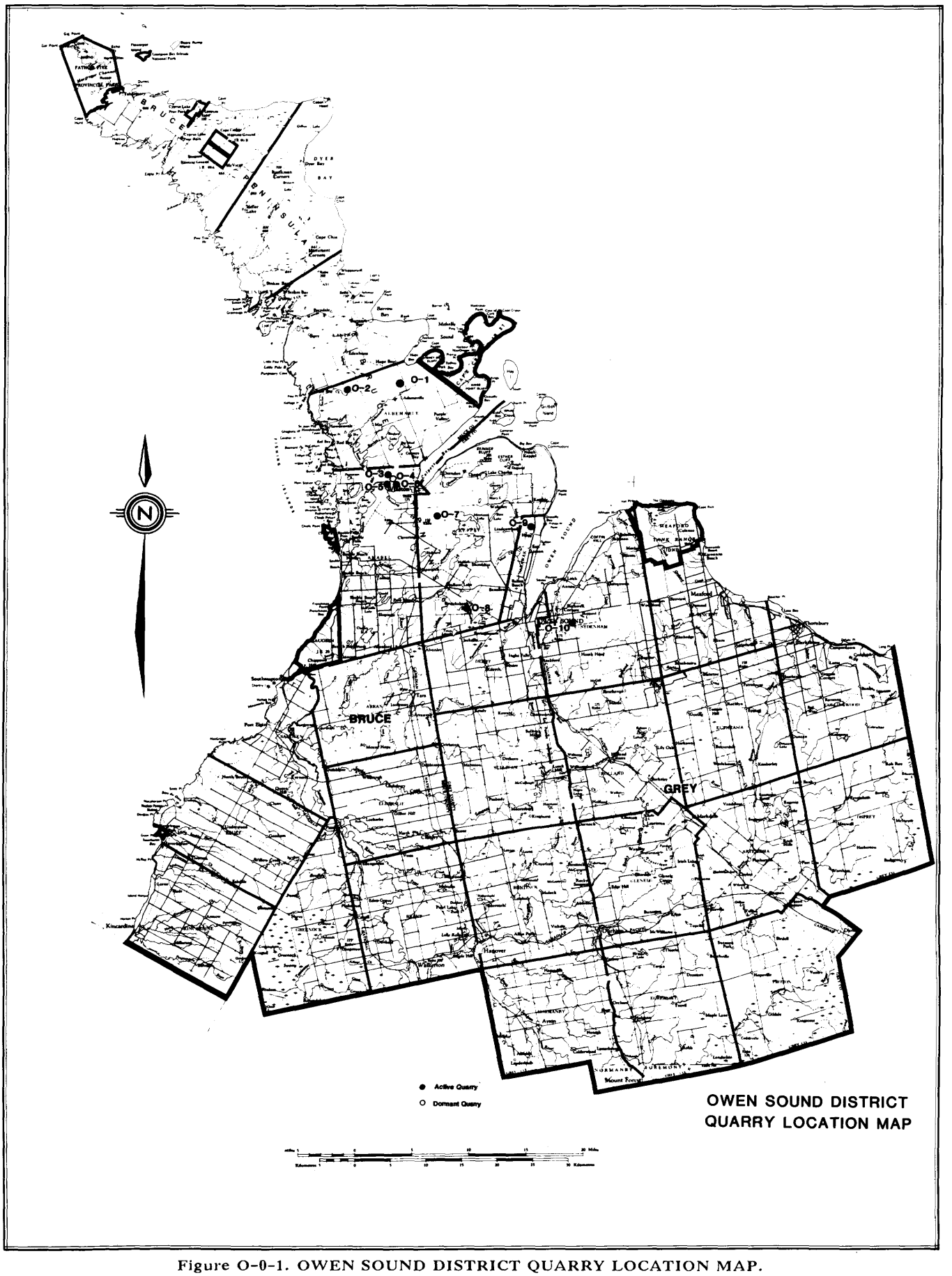


Figure O-0-1. OWEN SOUND DISTRICT QUARRY LOCATION MAP.

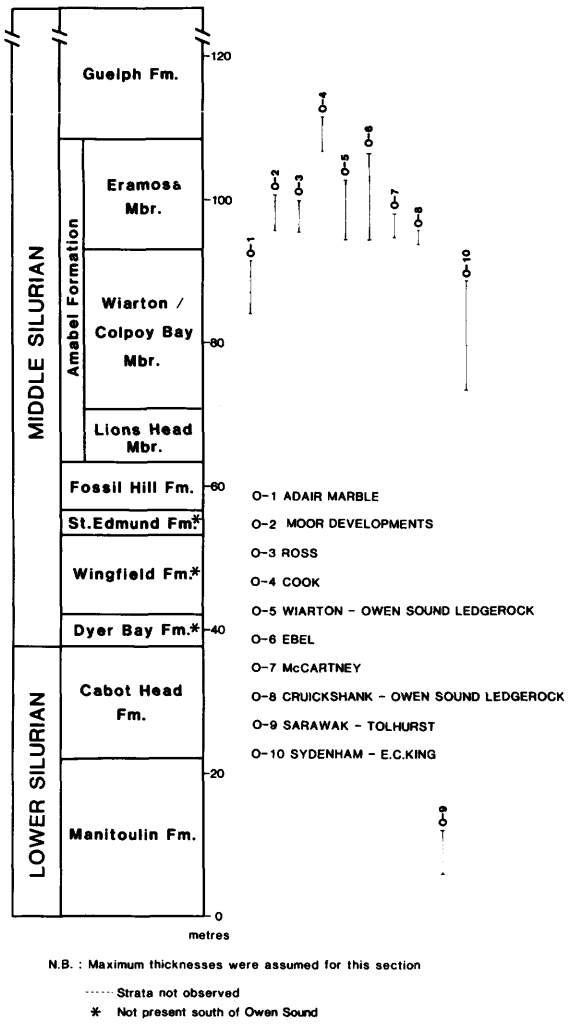


Figure O-0-2. STRATIGRAPHIC COLUMN SHOWING PRINCIPAL QUARRIES OF OWEN SOUND DISTRICT.

The Manitoulin Formation is overlain by the green, grey, and red shales of the Lower Silurian Cabot Head Formation. Due to their recessive weathering characteristics these shales commonly occur in the Escarpment in relatively steep, vegetation covered slopes below the near vertical bluffs of overlying, more resistant, dolostones.

On the Bruce Peninsula (north of Owen Sound), the Cabot Head Formation is overlain by shales and dolostones of the Middle Silurian, Dyer Bay, Wingfield, and St. Edmund Formations (in ascending stratigraphic order). These are in turn overlain by the fossiliferous, buff- to grey-brown, thin-and irregular-bedded, fine- to coarse-crystalline dolostones of the Middle Silurian Fossil Hill Formation. South of Owen Sound, the Dyer Bay, Wingfield, and St. Edmund Formations are not present, and the Fossil Hill Formation directly overlies the Cabot Head Formation.

The Fossil Hill Formation is overlain by the dolostones of the Middle Silurian Amabel Formation which is subdivided into three members (in ascending order): the Lions Head, Wiarton/Colpoy Bay, and Eramosa Members. The Lions Head Member consists of thin-bedded, light buff, fine-crystalline dolostone. The thick- to massive-bedded Wiarton/Colpoy Bay Member consists of white weathering, grey to blue-grey, fine- to coarse-crystalline dolostone with local vuggy zones and variably developed blue mottling. This member forms the resistant white cliffs of the Niagara Escarpment on the Bruce Peninsula and forms a smooth undulating surface which slopes westward from the Escarpment face for several kilometres. Topographic highs of low relief on this surface are bioherms (reefs) in the Wiarton/Colpoy Bay Member. The Eramosa Member consists of grey-brown to black, thin-bedded, laminated, fine-crystalline, generally bituminous dolostone, interbedded with light brown, thin- to thick-bedded, weakly bituminous dolostone. The Eramosa Member is interpreted to be an inter-reefal facies associated with bioherms in the Wiarton/Colpoy Bay Member (or bioherms at the base of the overlying Guelph Formation). The Eramosa Member is absent where Wiarton/Colpoy Bay Member bioherms grade up into Guelph Formation bioherms.

The Wiarton/Colpoy Bay Member hosts two currently active quarries. It is quarried for building stone at the Adair Marble Quarry (O-1) in Albemarle Township and for aggregate at the E. C. King Quarry (O-10) in Sydenham Township near Owen Sound.

Building and landscaping stone are currently excavated from the Eramosa Member at six quarries (O-2, O-3, O-5, O-6, O-7, and O-8) on the Bruce Peninsula. A seventh quarry in the Eramosa Member, the Cook Quarry (O-4) near Wiarton, is presently abandoned, but because of its historical and geological significance (it exposes the upper contact of the Eramosa Member with the Guelph Formation), it has been included in this report.

The Middle Silurian Guelph Formation overlies the Amabel Formation and occurs in a broad belt west of the Niagara Escarpment, from the central and western areas of the Bruce Peninsula, across the district to the southwest. The Guelph Formation is typically a light brown, fine- to medium-crystalline, thin- to thick-bedded dolostone with minor thin bands of wispy dark brown stylolites and local vuggy zones. Bioherms are common in the Guelph Formation and typically form low ridges on the western side of the Bruce Peninsula.

In the southwestern part of the Owen Sound District, the Guelph Formation is overlain by the poorly exposed Upper Silurian Salina and Bass Islands Formations. In this district the Salina Formation consists of alternating grey dolostone, green shale, brown dolostone, and red

shale, and the Bass Islands Formation consists of cream to brown, fine–crystalline, thin– to thick–bedded dolostones.

In the extreme southwestern corner of the district, Middle Devonian strata which include (in ascending stratigraphic order) the Bois Blanc Formation and the Detroit River Group (Amherstberg and Lucas Formations), disconformably overlie the Upper Silurian strata. Although these units consist of limestones and dolostones they are not currently quarried by the limestone industry in this district.

LIMESTONE INDUSTRIES

The principal limestone industries in Owen Sound District are building stone and aggregates. Fertilizer grit, glass grade dolostone, agricultural lime and coarse mineral fillers are also produced at the Sydenham Quarry (O–10).

Stone production in 1986 from Bruce County totalled 106,141 tonnes, from five active building stone quarries (O–1, O–2, O–3, O–5 and O–6). Stone production in 1986 from Grey County totalled 204,000 tonnes from two building stone (O–7, O–8) and two aggregate quarries (O–9, O–10).

The largest producing operation was E. C. King Contracting – Sydenham Quarry (O–10), which produces a variety of sizes of aggregate stone, including that used by its subsidiary Owen Sound Dolomite for the production of agricultural lime and fillers.

O–1 ARRISCRAFT CORPORATION — ADAIR MARBLE QUARRY

LOCATION AND OWNERSHIP

The Adair Marble Quarry is located 2.5 km south of Hope Bay on Bruce County Road 9, in Lots 7 and 8, Concession 8, Albemarle Township, Bruce County (Figure O–1–1). The licensed area of the quarry is 64 ha. In 1987 it was being worked on a continuous basis by Adair Marble Quarries, a division of Arriscraft Corporation, and quarry blocks of the Silurian dolostone were being trucked to the company's dressing plant at Cambridge, Ontario (site CB–14, Cambridge District). Building stone from this quarry has been used on the new Ottawa Courthouse, the restoration of the Rideau Locks #1–5 in Ottawa, and the Canadian Chancery in Washington, D.C. The present quarry was opened in 1979 to replace an earlier operation owned by Arriscraft in Lot 4, about 1 km to the north. The former "Adamsville" and "Scott" quarries, inactive since the 1950s, were worked in Lot 8. The present capacity is approximately 30,000 tonnes per year.

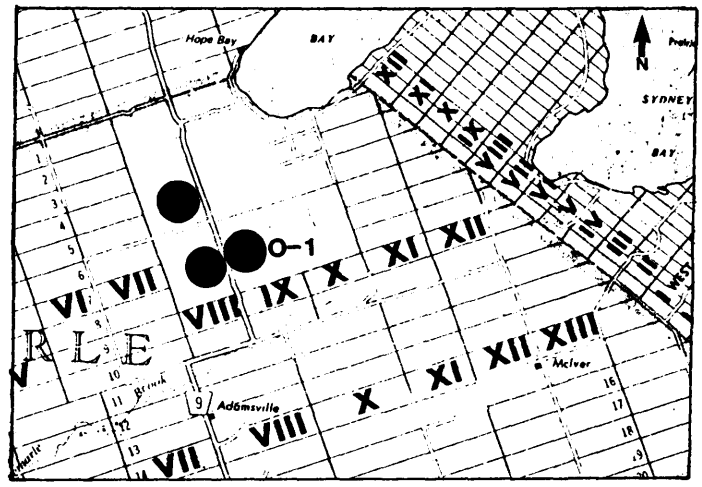


Figure O–1–1. LOCATION MAP FOR ADAIR MARBLE QUARRY.

The original quarry in Lot 4, Concession 8, was opened and briefly operated by R. G. Ebel. In 1968 it was acquired by Angelstone Limited and was worked continuously until 1979, producing mill blocks at the rate of about 10,000 tonnes per year. In 1971 the original quarry was reported (Hewitt and Vos, 1972, p.46) to be developed on three levels of nearly 2 m each. The quarry is now licensed for 6 ha.

GEOLOGY

This quarry consists of three excavations, which expose a total of approximately 7 m of the Wiarton/Colpoy Bay Member of the Middle Silurian Amabel Formation. The bedrock surface is irregular, glacially scoured and fluted (fluting may in part follow irregular bedding planes), and therefore overburden varies in thickness from 0 to 3 m. Large mill blocks (approximately 4 cu. m) are drilled off in approximately three lifts, each up to 2 m thick. Lifts are taken along natural bedding planes which are planar to undulating.

The Wiarton/Colpoy Bay Member, as exposed in this quarry, is a light grey to white, fine– to coarse–crystalline dolostone with attractive blue–grey mottles, and local vuggy zones. Blocks containing concentrations of vugs are generally discarded. Shale partings and disseminated pyrite crystals are virtually absent. Occasional stylolites may form lines of weakness. Large areas are virtually free of joints, but scattered vertical east–west jointing is present at intervals of 3 m to 5 m.

The Wiarton/Colpoy Bay Member was not subdivided into further units in this quarry. The lithology is

Photo 0-1-1.
BEDDING IRREGULARITIES IN WIARTON/COLPOY BAY MEMBER (AMABEL FORMATION); ADAIR MARBLE QUARRY.

similar to that exposed in the two inactive Arriscraft quarries in the area.

Geological Section

	Thickness
UNIT 1 Amabel Formation, Wiarton/Colpoy Bay Member	*7.0m*
Dolostone: white to light grey with blue-grey mottles, weathers light grey; fine to coarse crystalline; medium to thick bedded, with planar to undulating contacts; abundant fossil fragments (crinoids, corals); vugs (up to 5 cm in diameter) occur scattered throughout or concentrated in vuggy zones and are usually calcite rimmed or filled; mottles vary in abundance (5 -50%) and vary in shape from irregular to planar and parallel to bedding; fluted, glacially scoured subcrop surface.	
Total thickness	*7.0m*

QUARRY OPERATION

The active Adair Marble Quarry is largely in Lot 7 and is worked on three levels over an area of 300 m by 100 m. Each level varies in thickness up to about 2 m. The top level is particularly variable because of an undulating glaciated surface. Air drills are mounted in pairs on 3 m beams which travel on horizontal quarry bars (of the company's own design) up to 7.5 m long. Final splitting of the mill block from the face is accomplished by hydraulic plug and feather equipment capable of pressures of 55 MPa (8,000 p.s.i.), or rarely by light blasting. Compressed air for the drills is provided by two electrically powered Joy screw compressors which are housed in a portable trailer. Mill blocks are taken from the face and loaded onto flat-bed trucks by a rubber-tired Clark #275 forklift.

In 1987, 25 men were employed and the quarry was operated on a 24-hour, 5 days per week basis. Drilling averaged 15,000 m to 20,000 m per week. Substantial quarry wastage was the result of shipping only uniform-sized blocks, ideally 235 cm by 185 cm by 80 cm, weighing about 10 tonnes. Blocks of this size were most efficiently slabbed by the circular saws in use at the Cambridge, Ontario, fabrication plant. Smaller blocks re-

TABLE O-1-1. WIARTON/COLPOY BAY DOLOSTONE, PHYSICAL PROPERTIES.

		(1)Adair Marble	(2)Scott Quarry
Average compressive strength	MPa	181.7	130.8
	p.s.i.	26,344	18,958
Abrasive hardness		11.08	19.7
Modulus of rupture	MPa	12.4	
	p.s.i.	1,797	
Absorption	%	0.71	0.93
Bulk specific gravity		2.68	2.63
Weight per unit volume	kg per m^3	2,677	2,629
	lbs. per $ft.^3$	167.2	164.2

Sources:
(1) Warnock Hersey; Arriscraft Corporation.
(2) Hewitt, 1964b, p. 22.

quired the same amount of time and effort but yielded fewer marketable slabs. The company has an extensive stone fabrication shop in Cambridge with modern stone shaping, sizing and hole–drilling capabilities.

Mill blocks are delivered to Arriscraft Corporation's Cambridge plant by truck, a distance of about 200 km.

REFERENCES

Hewitt, 1964b, p. 22
Hewitt and Vos, 1972, p. 46
Kanarek, 1986

O–2 MOOR DEVELOPMENTS INC. QUARRY

LOCATION AND OWNERSHIP

The quarry is located 1.5 km west of Highway 6, about 17 km north of Wiarton in Lot 3, Concession I EBR, Albemarle Township, Bruce County (Figure O–2–1). Licensed area of the site is 40.5 ha. From 1974 to 1982 it was operated under the name of Rouse Quarries Ltd., and in 1982 it was acquired by Clearstone Quarries Industries Inc. (but was inactive during 1983 and 1984). The quarry was reopened in 1985 by Bruce Marble and Stone Corporation and was subsequently taken over by Moor Developments Inc. in late 1986. The quarry is operated eight months of the year from March to November with a work force of ten. The quarry is briefly described by Hewitt (1964b, p. 19).

GEOLOGY

Quarrying in at least five small excavations at this site has exposed about 5 m of section consisting of two units of the Eramosa Member of the Amabel Formation (Figure O–2–2). The lower unit is similar to Eramosa Member strata exposed in other quarries on the Bruce Peninsula, except that it is lighter in colour, less bituminous, locally more vuggy, appears finer grained, and is more stromatolitic. Although the upper unit is similar in character to strata of the Guelph Formation exposed in the vicinity, mapping in other quarries on the Bruce Peninsula (e.g. O–5 and O–6) indicates that this unit is a "Guelph–like" interbed within the Eramosa Member.

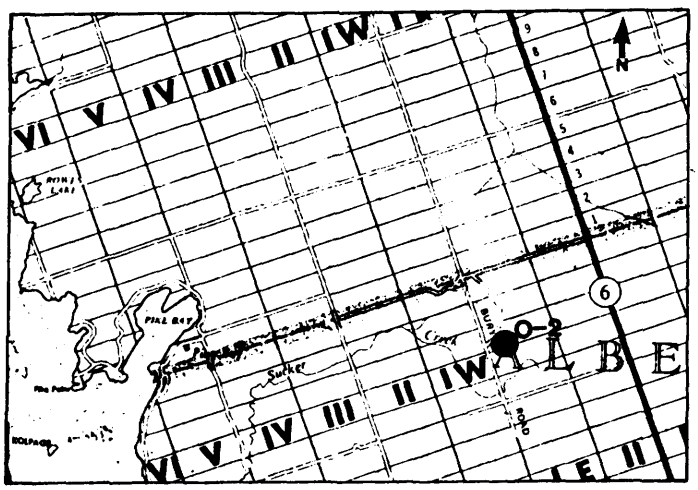


Figure O–2–1. LOCATION MAP FOR MOOR DEVELOPMENTS INC. QUARRY.

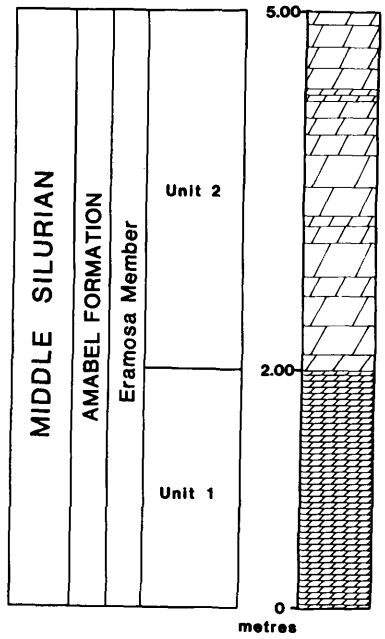


Figure O–2–2. STRATIGRAPHIC COLUMN FOR MOOR DEVELOPMENTS INC. QUARRY.

Abundant domal to linear (oriented roughly northwest) anticlinal features exposed on the property may be related to underlying Amabel Formation bioherms. Generally, horizontal parting separations on the tops of the domes are more abundant and closely spaced, whereas partings in the interdomal areas occur less frequently. Two joint sets are present in the quarry trending 074° and 335– 340° with average spacings of 1 to 3 m. Glacial overburden is generally less than 1 m thick on the property.

Geological Section

		Thickness
UNIT 2	*Amabel Formation, Eramosa Member*	*3.0m*

Dolostone: light grey–brown to light brown, weathers buff–brown, fine to medium crystalline; thin to thick bedded, with irregular to planar contacts which are generally related to thin bands of wispy dark brown styolites; rare silicified corals and crinoidal fragments; calcite mineralization occurs in scattered vugs; lower contact of the unit is sharp, at the top of a thin shaly bituminous bed.

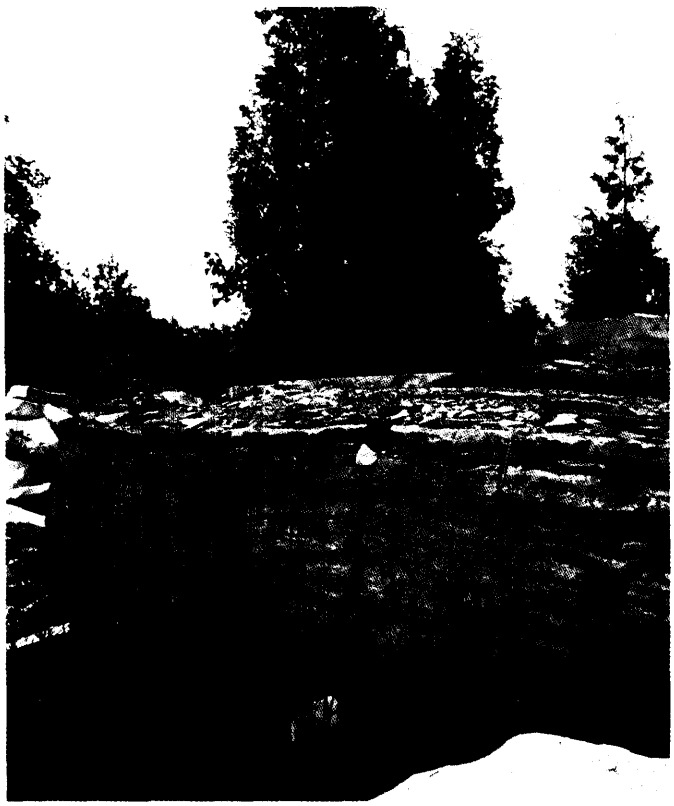


Photo O-2-1. THIN-BEDDED LAMINATED DOLOSTONE OF UNIT 1 AT MOOR QUARRY.

UNIT 1 Amabel Formation, Eramosa Member *2.0m*

Dolostone: light grey to light grey-brown, weathers light grey to light buff-brown; very fine to fine crystalline; laminated to thin bedded with planar to wavy and locally crenulated contacts; calcite, pyrite and fluorite mineralization in local vugs; locally stromatolitic; thin bituminous partings throughout.

Total thickness *5.0m*

QUARRY OPERATION

The main quarry excavation is in Unit 1 and is worked on a single bench over an area 100 m by 30 m. Jointing is not a particular problem in quarrying, but rolls in the Eramosa caused by underlying reefs are responsible for curved bedding planes and variable parting separations.

Quarrying is accomplished with bars and wedges and occasionally plug and feather techniques. Slabs are lifted by front-end loader or forklift and carried to storage for subsequent cutting and polishing as desired. There are three guillotines and one gang saw plus polishing equipment at the quarry. The company produces a variety of thin Eramosa rock products, plus sawn and polished sills, copings, ashlar, interior slabs, and table tops. Sills are marketed in 15 cm and 25 cm thicknesses; copings in 25 cm, 30 cm, 35 cm, 40 cm, 45 cm, and 50 cm thicknesses; flagstone in 5 cm thickness and marble slabs in 2 cm thickness.

REFERENCES

Hewitt, 1964a, p. 59
Hewitt, 1964b, p. 19

O-3 AMSEN QUARRY LTD. — ROSS QUARRY

LOCATION AND OWNERSHIP

This building stone quarry is located in Lots 10 and 11, Concession 25, Amabel Township, Bruce County, 5.7 km northwest of Wiarton on a sideroad north of Oliphant Road (Figure O-3-1). The quarry license covers 40.5 ha.

The active Ross Quarry (located in Lot 11) was opened in 1970 by Donald R. Ross. On March 1, 1987, the quarry was sold to Franc and Georgina Amsen and is currently operated by W. R. McKendrick. The Smithson Quarry (located in Lot 10) is just east across the sideroad from the Ross Quarry. Although licensed for 9.3 ha, the Smithson Quarry has been inactive since 1980.

GEOLOGY

The quarry excavations expose up to 4 m of the Eramosa Member of the Amabel Formation which is subdivided into two units in this quarry. The lower unit, a laminated, thin-bedded light grey-brown dolostone, is the main source for building stone products in the quarry. The upper unit, a thin- to medium-bedded, nonlaminated, locally vuggy, light brown dolostone is not unlike the dolostones of the overlying Guelph Formation. Exposures of the Eramosa Member in nearby quarries on Oliphant

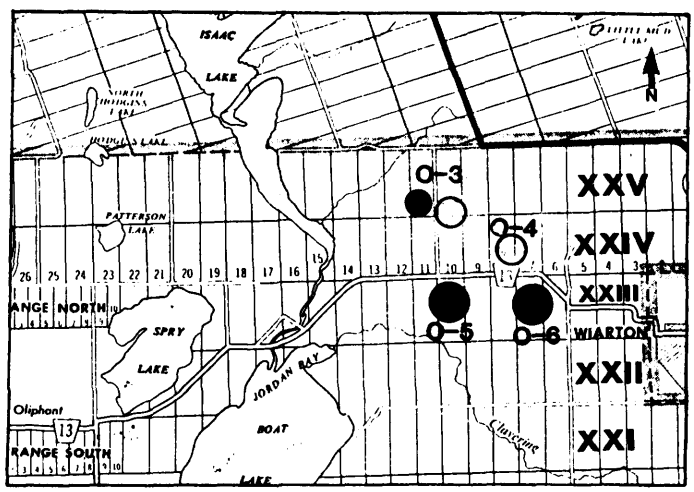


Figure O-3-1. LOCATION MAP FOR ROSS QUARRY.

Photo O-3-1.
CUTTING UNIT 1 OF ERAMOSA MEMBER WITH A DIAMOND SAW AT ROSS QUARRY. A THIN LAYER OF LIGHTER, UNIT 2 OVERLIES UNIT 1.

Road (quarries O–5 and O–6), indicate that this unit is in fact an interval of "Guelph–like" lithology within the Eramosa Member and not the true Guelph Formation. The thickness of this upper unit varies somewhat over the quarry property due to an irregular bedrock surface.

The strata in this quarry exhibit low amplitude warping and rolls. There are two main vertical joint sets in the quarry, that trend approximately 360° and 74°–80° with spacings of 2 m to 4 m. Glacial overburden is generally less than 1 m thick.

Geological Section

		Thickness
UNIT 2	*Amabel Formation, Eramosa Member*	*2.0m*
	Dolostone: light grey-brown to light brown, weathers buff-brown; fine to medium crystalline; thin to medium bedded, with planar to irregular contacts; rare corals and crinoidal fragments; calcite mineralization present in local vugs; lower contact of unit is sharp.	
UNIT 1	*Amabel Formation, Eramosa Member*	*2.0m*
	Dolostone: light grey-brown to brown, weathers light grey to light grey-brown; very fine to fine crystalline; laminated to thin bedded, with planar to slightly wavy contacts; minor stromatolitic laminae throughout and especially in the top 1 to 3 cm.	
Total thickness		*4.0m*

QUARRY OPERATION

The Ross Quarry is 200 m by 200 m with a working depth of 3 m on 4 benches, and is operated by a work force of 20 men.

The quarry produces a variety of stone products including natural cut flagstone, random flagstone, drywall stone and ashlar coursing. Dimension stone will be produced in April of 1988. Much of the production is sawn in place and subsequently lifted by bars and wedges. Powered equipment includes a portable electric diamond saw, a small forklift and a hydraulic guillotine.

The currently inactive, adjacent Smithson Quarry is 60 m by 30 m and about 3 m deep. Although the jointing pattern is similar in both quarries, numerous fractures in the Smithson Quarry render much of the stone unusable. Stone products produced there were similar to those from the Ross Quarry.

Quarry Equipment

3 – portable electric diamond–tipped saws
1 – 36" diameter diamond–tipped saw
1 – 60" diameter diamond–tipped saw in operation May 1, 1988
1 – Gangsaw
3 – Guillotine 48" tooth
1 – Guillotine for cobble stone production
1 – Multi–blade cut–off saw
2 – Front–end loaders
1 – Forklift

REFERENCES

None

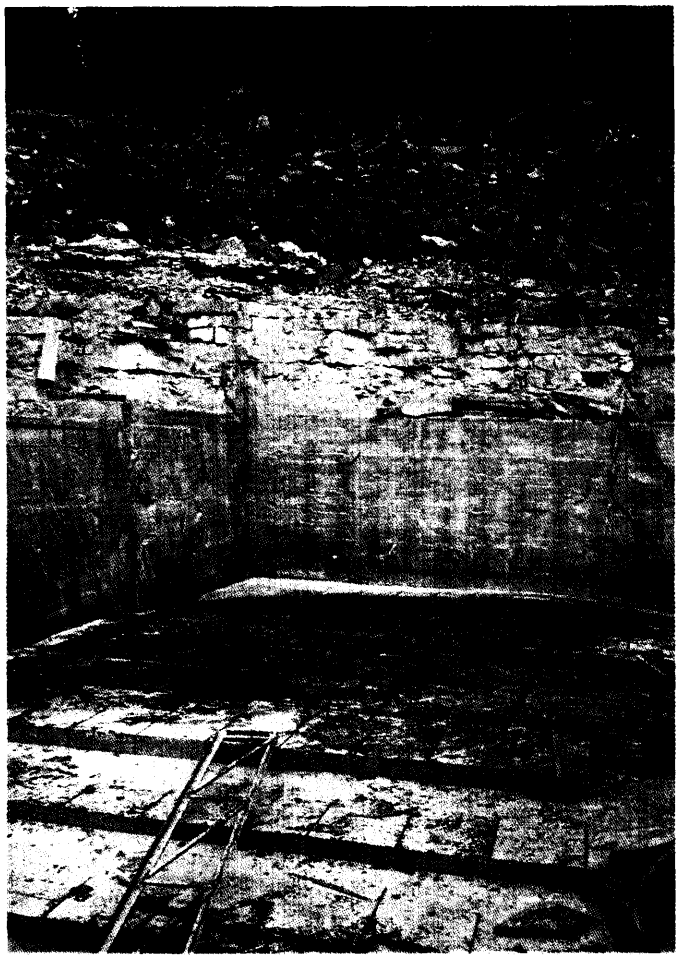


Photo O-3-2. MEDIUM-BEDDED DOLOSTONE OF UNIT 2 OVERLYING THIN-BEDDED DOLOSTONE OF UNIT 1, BOTH OF THE ERAMOSA MEMBER; ROSS QUARRY.

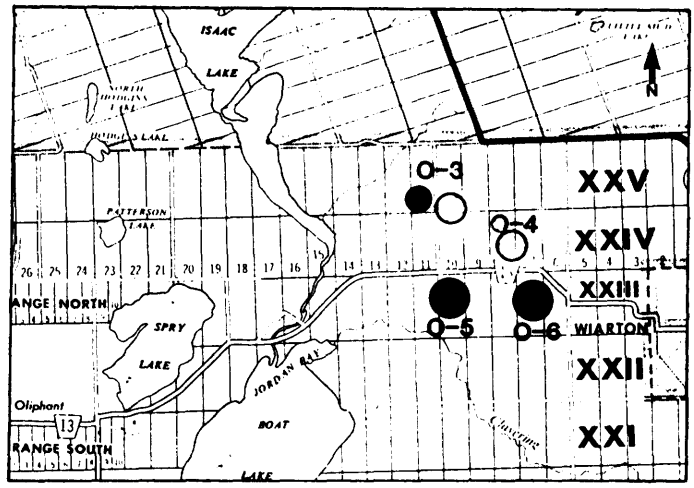


Figure O-4-1. LOCATION MAP FOR COOK QUARRY.

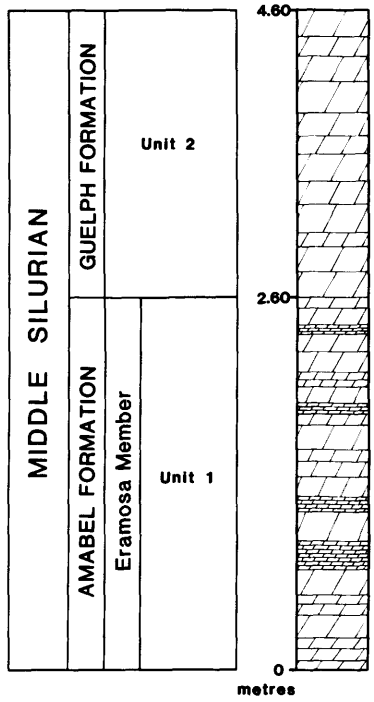


Figure O-4-2. STRATIGRAPHIC COLUMN FOR COOK QUARRY.

O-4 J.S. COOK — COOK QUARRY

LOCATION AND OWNERSHIP

The Cook Quarry is an abandoned building stone quarry located in Lots 7 and 8, Concession 24, Amabel Township, Bruce County, on the north side of Oliphant Road, 3.2 km west of the Town of Wiarton (Figure O-4-1).

GEOLOGY

This quarry exposes 2.6 m of the Eramosa Member of the Amabel Formation and approximately 2.0 m of the overlying Guelph Formation (Figure O-4-2). The Eramosa Member consists of interbedded dark brown, laminated, bituminous dolostones and thin to medium-bedded, light to dark brown dolostones. The thick-bedded, massive-textured, light brown Guelph Formation dolostones are exposed in old workings northwest of the main excavation. Ridges up to 10 m high, of biohermal rocks of the Guelph Formation, outcrop north of the quarry excavations.

The strata exposed in this quarry overlie that of the Ebel and Owen Sound Ledgerock Quarries (O-6 and

O–5, respectively) and are equivalent to the rocks exposed in the adjacent, abandoned Bruce Peninsula Stone Quarry (*see* Appendix IV, Volume I). The glacial overburden thickness in the Cook Quarry is generally less than 0.5 m.

Geological Section

	Thickness
UNIT 2 Guelph Formation	*2.0m*

Dolostone: light grey-brown to light brown, weathers buff-brown; fine to medium crystalline; medium to massive bedded; sparsely fossiliferous with scattered corals and large brachiopods; underlying or interbedded with biohermal build-ups to the north; bioherms contain an assemblage of abundant large brachiopods, corals, stromatoporoids, and other fossils; lower contact is not well exposed.

UNIT 1 Amabel Formation, Eramosa Member	*2.6m*

Interbedded bituminous dolostones: (a) light to dark brown, weathering light grey-brown; fine to medium crystalline; thin to medium bedded; with variable bitumen content; abundant small brachiopods in some beds; and (b) dark brown to black, weathers dark grey-brown; fine to medium crystalline; laminated to thin bedded; bituminous.

Total thickness	*4.6m*

REFERENCES

Parks, 1912, p. 261
Goudge, 1938, p. 206
Hewitt, 1960, p. 126
Hewitt, 1964a, p. 59
Hewitt, 1964b, p. 15
Liberty and Bolton, 1971, p.46
Hewitt and Vos, 1972, p. 49

MAPS

Caley, 1945b, GSC Map 45–18
Liberty, 1966, GSC Map 19–1965
Liberty and Bolton, 1971, GSC Map 1194A

O-5 OWEN SOUND LEDGEROCK — WIARTON QUARRY

LOCATION AND OWNERSHIP

This building stone quarry is located in Lots 10 and 11, Concession 23, Amabel Township, Bruce County, south of Oliphant Road, and 4.1 km west of Wiarton (Figure O–5–1). The licensed area is 44.9 ha. The quarry supplies an area from Detroit to Montreal and Ottawa.

GEOLOGY

The quarry is situated on the south flank of a hill (bedrock high). Excavation of the quarry has exposed up to 6.3 m of the Eramosa Member of the Amabel Formation, with an additional 2.0 m of this member exposed in outcrops at the south end of the property.

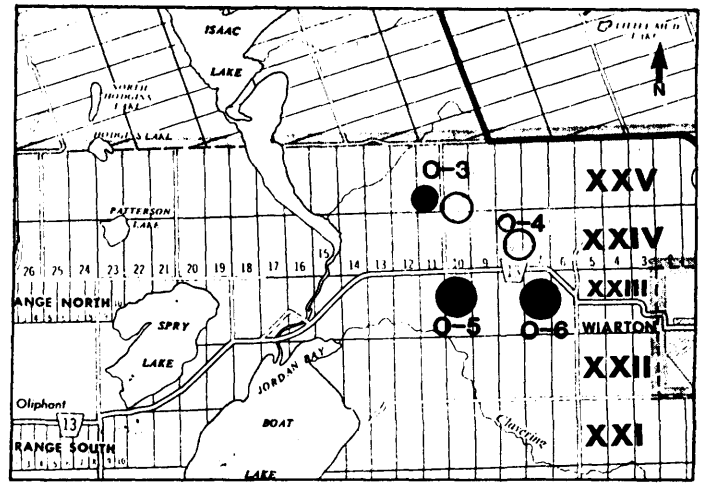


Figure O–5–1. LOCATION MAP FOR WIARTON QUARRY.

The Eramosa Member in this quarry can be subdivided into three units in the main excavation, with a lower fourth unit exposed in the interval below and south of the quarry. The lowermost unit exposed in the quarry (unit 2), locally termed the "Marble" beds, occurs in other Eramosa Member quarries in the vicinity. The uppermost unit (unit 4) contains locally abundant chert nodules or beds, is generally more bituminous than the other units and exhibits extreme warping, which may be related to a stromatolitic bioherm that outcrops north of the quarry. Two main joint sets occur in the quarry and trend at 75–85° and 335–345° with 1 to 3 m spacing. Glacial overburden is generally less than 0.5 m thick.

The stratigraphy exposed in this quarry can be correlated with that exposed in the Ebel Quarry (O–6), 1.3 km to the east. Owen Sound Ledgerock also owns a currently inactive, licensed property (*see* site O–15, Appendix IV, Volume I) on the north side of Oliphant Road, which exposes rocks stratigraphically above this quarry (possibly into the Guelph Formation).

TABLE O–5–1. ERAMOSA MEMBER DOLOSTONE, PHYSICAL PROPERTIES.

Compressive strength,	MPa	Maximum	123
		Minimum	120
		Average	122
Absorption			1.62%
Bulk specific gravity,			2.53
Weight per unit volume,	PSI		158
	kg/cu. m		2,530
Abrasive hardness			18.1

Source: Hewitt, 1964b, p.18.

Photo O-5-1. INTERBEDDED LIGHT BROWN AND BLACK DOLOSTONES OF UNIT 4. (ERAMOSA MEMBER - AMABEL FORMATION); WIARTON QUARRY.

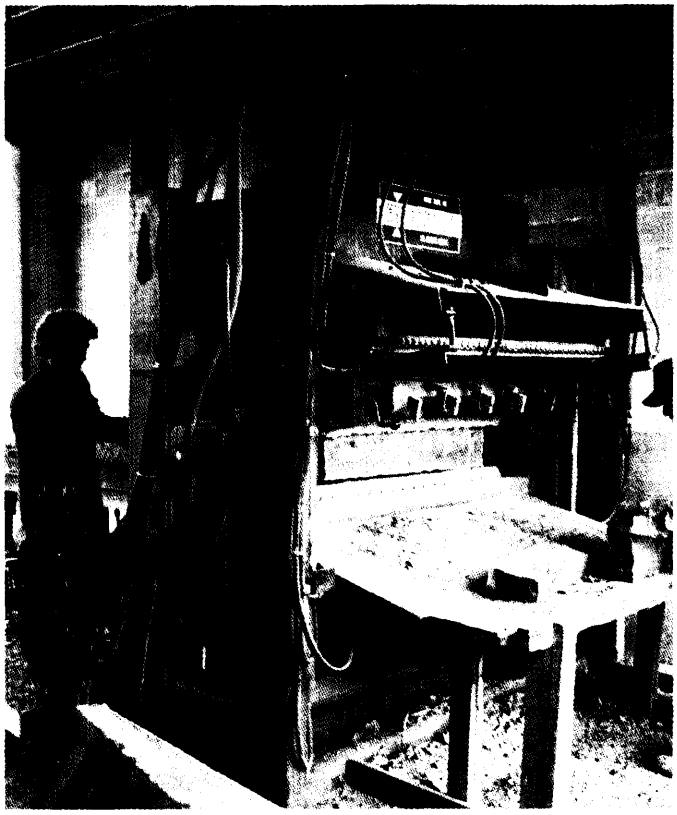


Photo O-5-2. PARK HYDRASPLIT GUILLOTINE AT WIARTON QUARRY.

Geological Section

Thickness

UNIT 4 Amabel Formation, Eramosa Member *2.4m*

Interbedded bituminous dolostones: (a) light to dark brown, weathers buff- brown; fine to medium crystalline; thin to medium bedded; with variable bitumen content; and (b) dark brown to black, weathers dark grey-brown; fine to medium crystalline; laminated to thin bedded; bituminous.

For both (a) and (b): bed thicknesses vary laterally and bedding is significantly warped at the north end of the property; some chert nodules and beds; pyrite occurs disseminated and with calcite infilling vugs and burrows; sphalerite is associated with a stromatolitic mound at north end of property; abundant small brachiopods in some beds; rare graptolites, cephalopods, corals, eurypterids, and stromatolites; some bedding planes with burrows and trails; the lower contact of the unit is taken at the base of the lowest dark brown to black laminated bed.

UNIT 3 Amabel Formation, Eramosa Member *2.4m*

Dolostone: light grey-brown to light brown, weathers buff-brown, fine to medium crystalline; thin to thick bedded with planar to slightly irregular contacts; calcite occurs in small (<5 cm) vugs scattered throughout and locally in vuggy bands; sparsely fossiliferous with rare corals and crinoidal fragments; lower contact of unit is sharp.

UNIT 2 Amabel Formation, Eramosa Member *3.0m*

Dolostone: light grey to grey-brown, weathers light grey-brown; very fine to fine crystalline; laminated to thin bedded with planar to wavy contacts and locally significant bituminous partings (especially in the uppermost beds); occasional stromatolitic laminae, especially abundant in the lower 1 m and uppermost 1 to 3 cm; local soft sediment deformation features; lower contact of unit is sharp.

UNIT 1 Amabel Formation, Eramosa Member *0.5m*

Dolostone: light grey-brown to light brown, weathers grey to buff-brown; fine to medium crystalline; thin to medium bedded, with bedding related to thin bands of wispy dark brown stylolites.

Total thickness *8.3m*

QUARRY OPERATION

Horizontal bedding planes provide flat quarry floors in most places except for a single broad synclinal roll which creates slightly uneven floors in one part of the quarry. Three shallow benches are worked.

The stone is quarried by cutting with portable electric diamond saws, or simply by raising the layers by forklift. An air compressor, Darda hydraulic rock splitter, and plug and feather equipment are also used.

Stone is dressed using a large Park Hydrasplit guillotine, capable of splitting stone 2 m wide and 35 cm thick, using its 270 tonne breaking capacity. Products include 1 cm to 5 cm thick flagstone, and randomly sized, eroded and vuggy landscape stone. Some stone is also shipped to the Owen Sound plant (O–8) for sawing. In 1986, waste rock from past years was being crushed and trucked from the quarry under contract for aggregate uses.

REFERENCES

Hewitt, 1964b, p. 18
Hewitt and Vos, 1972, p. 55

O–6 R.G. EBEL — EBEL QUARRIES

LOCATION AND OWNERSHIP

This quarry is located on the south side of Oliphant Road, 3 km west of Wiarton. The property includes parts of Lots 6, 7 and 8 in Concession 23 (the quarry is largely in Lot 7), Amabel Township, Bruce County (Figure O–6–1). The property is owned and operated by R. Griffith Ebel. The quarry licence covers an area of 12.1 ha.

GEOLOGY

The rock in this quarry was deposited on the south side of a protecting reef and exposes an exceptional number of undisturbed strata.

Excavations in this quarry have exposed up to 7 m of flat–lying dolostones of the Eramosa Member of the Amabel Formation, with a further 5 m of this member exposed in outcrop below and south of the quarry (Figure O–6–2).

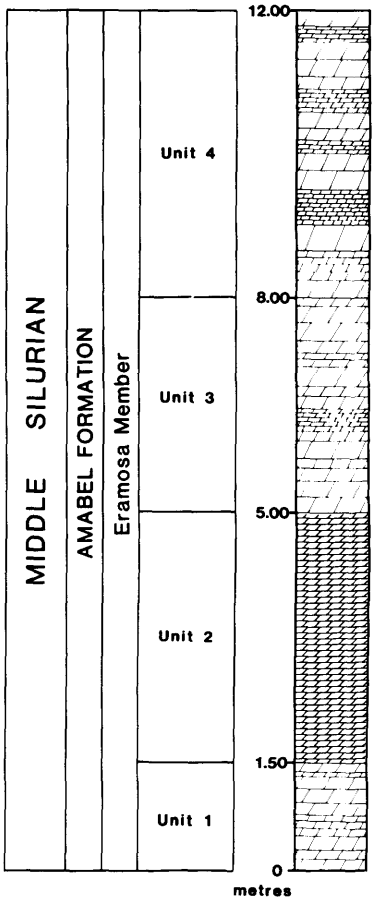


Figure O–6–2. STRATIGRAPHIC COLUMN FOR EBEL QUARRIES.

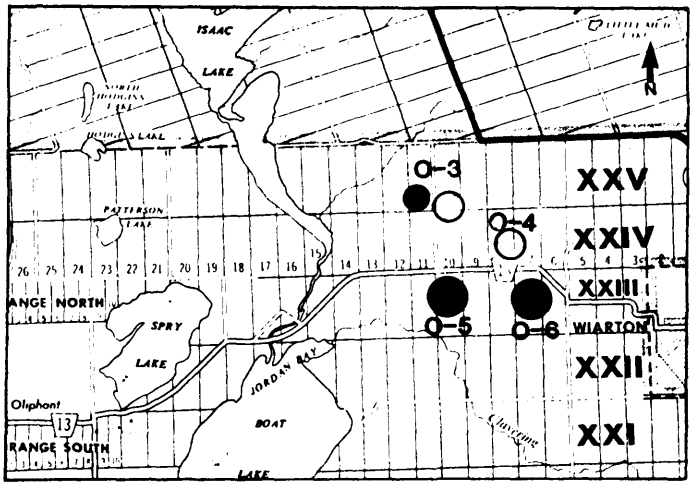


Figure O–6–1. LOCATION MAP FOR EBEL QUARRIES.

The Eramosa Member in this quarry can be subdivided into two units in the main excavation (units 4 and 3), with two additional units (units 2 and 1) exposed in outcrop to the south. Overlying strata, including the Amabel (Eramosa)/Guelph Formation contact, are exposed on the north side of Oliphant Road in the abandoned Bruce Peninsula Stone Quarry (*see* site O–16, Appendix IV, Volume I) and Cook Quarry (O–3) and the Charles Ebel Quarry. Although the uppermost unit in the Ebel Quarry is correlative with the upper unit (4) of the Owen Sound Ledgerock Quarry (O–5), the former is more extensive, contains less chert and does not exhibit the severe warping of the latter. Vertical jointing is widely spaced on both north–south and east–west direc-

tions, the latter spaced at 2 to 10 m. Quaternary overburden in this quarry is generally less than 0.5 m thick.

Geological Section

Thickness

UNIT 4 Amabel Formation, Eramosa Member *4.0m*

Interbedded bituminous dolostones: (a) light to dark brown, weathering buff-brown; fine to medium crystalline; thin to medium bedded with variable bitumen content; and (b) dark brown to black, weathers dark grey-brown; fine to medium crystalline; laminated to thin bedded; bituminous.

For both (a) and (b): local chert as nodules (some with sphalerite), in beds, and replacing fossils; vugs filled with calcite and pyrite; abundant small brachiopods in some beds, rare stromatoporoids, eurypterids and cephalopods; a few bedding planes with burrows and trails; lower contact of unit is at base of lowest dark brown to black laminated bed.

UNIT 3 Amabel Formation, Eramosa Member *3.0m*

Dolostone: light grey-brown to light brown, weathers buff-brown; fine to medium crystalline; thin to medium bedded, with planar to slightly irregular contacts which are generally related to thin bands of dark brown stylolites; calcite occurs as vug infills; small (<5 cm) vugs occur scattered throughout and locally in bands; sparsely fossiliferous with rare crinoidal fragments, stromatoporoids, and corals; lower contact of unit is sharp.

UNIT 2 Amabel Formation, Eramosa Member *3.5m*

Dolostone: light grey to grey-brown, weathers light grey-brown; very fine to fine crystalline; laminated to thin bedded with planar to wavy contacts and locally significant bituminous partings; local soft sediment deformation structures; stromatolitic beds locally present (especially in the lowermost beds); lower contact is sharp.

UNIT 1 Amabel Formation, Eramosa Member *1.5m*

Dolostone: light grey-brown to light brown, weathers grey- to buff-brown; fine to medium crystalline; thin to medium bedded with planar to slightly irregular contacts which are related to thin bands of wispy dark brown stylolites; small (<5 cm) vugs are locally abundant and filled with calcite and pyrite.

Total thickness *12.0m*

QUARRY OPERATION

The quarry covers an area about 400 m by 50 m and is worked on three shallow benches. Quarrying of the thin Eramosa beds is accomplished by cutting with three portable diamond circular saws and lifting the slabs with bars and forklift. A Massey Ferguson front end loader can be equipped with either a 7 yd. bucket or 2 m forks, and it is capable of handling an 11-tonne load. A smaller (3 yd.) loader is also available. These loaders serve the multiple functions of overburden and waste removal, plus the lifting and transport of quarried slabs to the finishing plant.

TABLE O-6-1. ERAMOSA MEMBER DOLOSTONE, PHYSICAL PROPERTIES.

Compressive strength,	MPa	Maximum	171
		Minimum	136
		Average	158
Absorption			1.20%
Bulk specific gravity,			2.60
Kg per cubic metre			2,605
Abrasive hardness			27.1

Source: Hewitt, 1964b, p.15.

PROCESSING

At the finishing plant the thicker stone is guillotined into sills, cobbles, steps, mantles and random ashlar in thicknesses of 6 cm to 20 cm. Thinner stone is cut into paving tiles of various sizes: 125 mm thick and 50 cm square, 50 mm thick and 19 cm square, plus random flagstone. An attractive "walnut marble" can be fashioned from dark brown stone by slabbing slightly across the laminations and polishing the exposed face.

PRODUCTS

Copings
Steps (50 mm to 200 mm thick)
Paving tiles 125 mm thick and 50 cm square
50 mm thick and 19 cm square
Random flagstone
Cut flagstone (25 mm to 50 mm thick (30 cm to 90 cm rectangular))
Cobbles
Mantels and hearthstones
Flooring tiles (10 mm to 20 mm thick)
Large black or tan slabs for marble

REFERENCES

Hewitt, 1960, p. 126
Hewitt, 1964a, p. 58
Hewitt, 1964b, p. 13
Hewitt and Vos, 1972, p. 50

MAPS

Caley, 1945b, GSC Map 45-18
Liberty, 1966, GSC Map 19-1965
Liberty and Bolton, 1971, GSC Map 1194A

O-7 C.E. McCARTNEY QUARRY

LOCATION AND OWNERSHIP

Since 1970, dolostones of the Eramosa Member have been quarried solely for flagstone in this small quarry in part of Lots 7, 8 and 9, Concession 18, Keppel Township, Grey County (Figure O-7-1). The quarry is located 8 km south of Wiarton, about 3 km east of Highway 6 and is licensed for 12.5 ha. Two men are employed for a six month season from May to October.

GEOLOGY

This quarry exposes up to 3.4 m of the Eramosa Member of the Amabel Formation in three small excavations (1

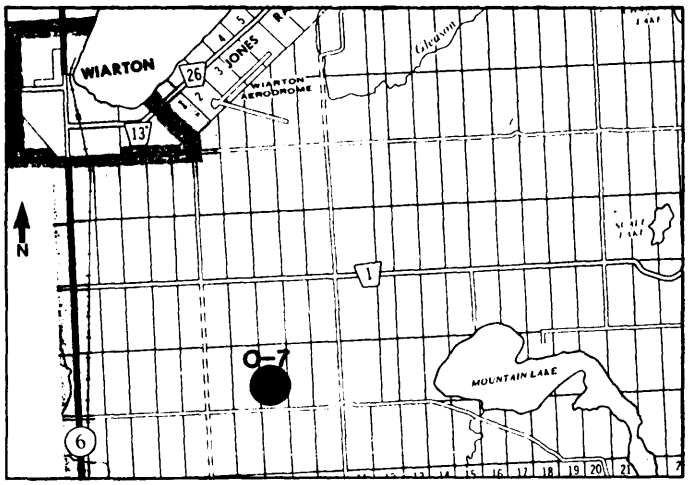


Figure O-7-1. LOCATION MAP FOR McCARTNEY QUARRY.

Photo O-7-1. EVENLY LAMINATED DOLOSTONE OF UNIT 1 BENEATH VUGGY DOLOSTONE OF UNIT 2; McCARTNEY QUARRY.

m of this interval is exposed in an exploratory excavation). The uppermost of the two units present, a buff-brown, medium- to thick-bedded dolostone, is exposed in all three excavations although it is not present (due to erosion) in the northern half of the property. The lower unit, a grey-brown, laminated dolostone, quarried for flagstone, is similar in lithology to the locally termed "Marble" beds found in other Eramosa Member quarries on the Bruce Peninsula.

The strata in this quarry exhibit broad low amplitude warping. Two vertical joint sets are present in the quarry, trending 350 to 360° and 65 to 85° with 1 to 3 m spacing. Glacial overburden is generally less than 1 m thick.

Geological Section

		Thickness
UNIT 2	*Amabel Formation, Eramosa Member*	*1.2m*
	Dolostone: light brown, weathers buff-brown; fine to medium crystalline; thin to medium bedded, with planar to irregular contacts; calcite infills locally abundant small (<5 cm) vugs; lower contact of unit is sharp.	
UNIT 1	*Amabel Formation, Eramosa Member*	*2.2m*
	Dolostone: light grey to grey-brown; very fine to fine crystalline; laminated to thin bedded, with some wavy contacts; thin bituminous partings (especially in the uppermost 30 cm); thin stromatolitic laminae in uppermost few centimetres.	
Total thickness		*3.4m*

QUARRY OPERATION

The quarry is small, about 35 m by 15 m and is worked on a single 2 m bench. A thin layer of medium-bedded dolostone (Unit 2) at the top of the section is sometimes saved for general gardening and rockery stone. The dolostone of Unit 1 is quarried with bars and wedges and is stacked in random sizes on wooden pallets for subsequent handling by forklift. Two forklifts comprise the only quarry equipment other than the manual tools used in removing the flagstone from the working face.

REFERENCES

ARIP 119, 1985, p. 21

O-8 OWEN SOUND LEDGEROCK LTD. — OWEN SOUND (CRUICKSHANK) QUARRY

LOCATION AND OWNERSHIP

This quarry is located in Lot 17, Concession 4, Keppel Township, Grey County, approximately 8.6 km northwest of Owen Sound (Figure O-8-1). The quarry license covers 11.3 ha. The quarry is just west of Highway 70 on Ledgerock Road and is the site for much of Owen Sound Ledgerock's processing, marketing, and administration.

GEOLOGY

This quarry exposes up to 3.2 m of the Eramosa Member of the Amabel Formation, which is subdivided into two units in this quarry. Quarrying has concentrated on the lowermost unit, a laminated dolostone, which is lithologically similar to the "Marble" beds of Eramosa Member quarries northwest of Wiarton (O-3, O-5 and O-6). The upper unit at this quarry is a thin-bedded, light brown dolostone, which is only present in thin patches in the southwest corner of the property. Stromatolitic beds pre-

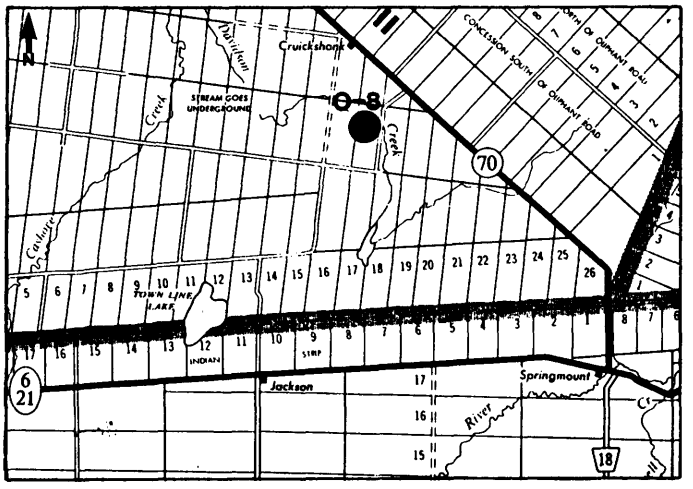


Figure O-8-1. LOCATION MAP FOR OWEN SOUND (CRUICKSHANK) QUARRY.

sent in the lower unit, below the quarry floor, are exposed in outcrop north of the quarry and in a small exploratory excavation (1 m deep) in the main quarry.

Two subparallel, linear anticlinal rolls, oriented 325° and 335°, trend through the centre of the quarry. Major vertical joints occur at 335 to 345° and 74 to 80° with spacings of 1 to 3 m. Glacial overburden thickness varies from less than 0.5 m to 1.5 m on the property.

Geological Section

		Thickness
UNIT 2	*Amabel Formation, Eramosa Member*	*0.3m*
	Dolostone: light brown, weathers buff-brown; fine to medium crystalline; thin bedded; calcite infilling vugs; rare corals and crinoidal fragments, some small brachiopods; lower contact of unit is relatively sharp, but not well exposed.	
UNIT 1	*Amabel Formation, Eramosa Member*	*2.9m*
	Dolostone: light grey to grey-brown, weathers light grey-brown; very fine to fine crystalline; laminated to thin bedded, with local wavy contacts, thin bituminous partings; local soft-sediment deformation structures.	
Total thickness		*3.2m*

QUARRY OPERATION

Quarry faces are about 1 m in height, and the quarry covers an area of about 7 ha. Quarrying is accomplished by a Darda hydraulic splitter using short vertical drill holes; less commonly by plug and feather, and portable diamond saws. Blocks are removed by bars and wedges, or by forklift.

PROCESSING

Products are dressed by a variety of diamond saws and a guillotine. Three large diameter diamond saws, 1 m and 1.5 m in diameter, and about six smaller ones are used as well as an automatic marble polishing line. A Park Hydrasplit guillotine can accommodate slabs up to 125 cm in width by 30 cm in thickness, using a splitting pressure of 135 tonnes. Some stone from the Wiarton Quarry (O–5) is trucked to this location for dressing. It is interesting to note that random flagstone priced at $8 per ton in 1964 (Hewitt, 1964b, p. 11) was selling for $58 per ton in 1986.

PRODUCTS

Cut and random flagstone
Sills
Mantels*
Wall Flag
Coursing Stone
Hearths*
Coping
Landscaping Stone
* Polished products prepared on request.

REFERENCES

Hewitt, 1960, p. 125
Hewitt, 1964a, p. 58
Hewitt, 1964b, p. 10
Hewitt and Vos, 1972, p. 55
ARIP 119, 1985, p. 21

O-9 E.C. KING CONTRACTING — TOLHURST QUARRY

LOCATION AND OWNERSHIP

This quarry is located at the Tolhurst Farm, in Lot 37, Concession 2, Sarawak Township, Grey County, 14 km north of Owen Sound (Figure O–9–1). Licensed area of

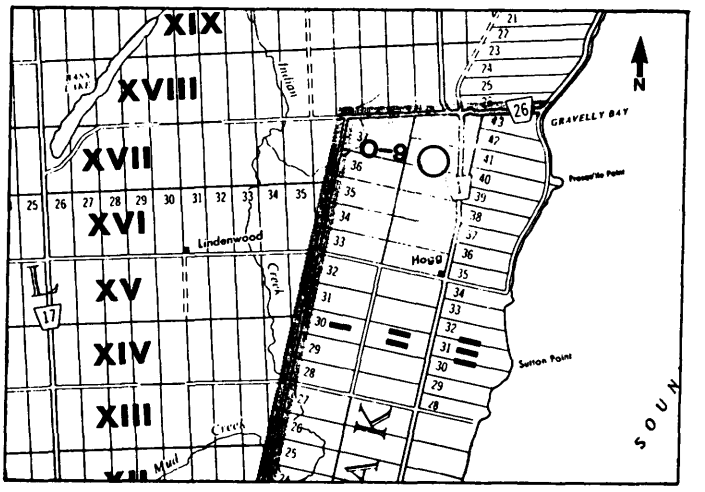


Figure O-9-1. LOCATION MAP FOR TOLHURST QUARRY.

the quarry is 33.4 ha. E. C. King Contracting produced crushed stone at this quarry during the summer of 1986.

GEOLOGY

The Tolhurst Quarry exposes approximately 6 m of the Lower Silurian Manitoulin Formation. The lithology in this quarry varies from a light brown, thin-bedded dolostone in the uppermost metre down to a shaly green- to blue-grey, argillaceous, and slightly calcareous dolostone in the lower unit. The quarry was inactive and water-filled when visited, so information regarding its total depth and the depth of the unit contact was obtained from the operator.

Geological Section

	Thickness
UNIT 2 Manitoulin Formation	*1.0m*
Dolostone: light brown; medium crystalline; thin bedded; chert as nodules and beds; calcite crystals fill vugs and occur as disseminated crystals; locally abundant fossil debris; lower contact appears gradational (below water level).	
UNIT 1 Manitoulin Formation	*5.0m*
Dolostone: green- to blue-grey; fine to medium crystalline; thin to medium bedded; slightly calcareous; argillaceous, with shaly partings; increasingly shaly with depth; locally fossiliferous beds with abundant shelly material; bioturbated; erosional scour surfaces throughout.	
Total thickness	*6.0m*

REFERENCES

None

O-10 E.C. KING CONTRACTING — SYDENHAM QUARRY

LOCATION AND OWNERSHIP

E. C. King Contracting, a Division of Miller Paving Limited, is the operator of a dolostone quarry on Lot 25, Concession 2 South of Central Road, Sydenham Township, Grey County (Figure O-10-1). The company also owns parts of Lots 23 and 24, Concessions 1 and 2 (SCR). The property is 6.5 km east of Owen Sound and just south of Highway 26. The total licensed area is 101 ha.

GEOLOGY

The single lift in this crushed stone quarry exposes up to 15 m of the Wiarton/Colpoy Bay Member of the Middle Silurian Amabel Formation. This member consists here of a single unit of light blue-grey, medium- to thick-bedded, fine- to medium-crystalline dolostone. A thin (6 m) zone at the top of the quarry section is rust-stained and fractured, probably due to surface weathering. Quaternary overburden thickness around the quarry is less than 1 m.

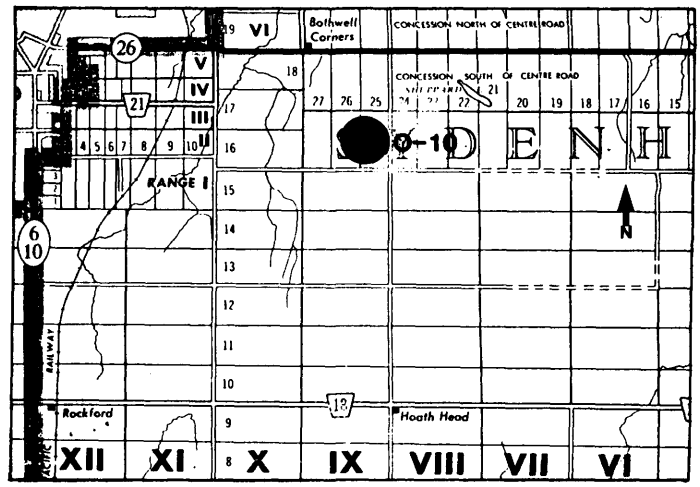


Figure O-10-1. LOCATION MAP FOR SYDENHAM QUARRY.

Geological Section

	Thickness
UNIT 1 Amabel Formation, Wiarton/Colpoy Bay Member	*15m*
Dolostone: white to light grey with blue-grey mottles, weathers light grey to tan-brown (directly beneath overburden); fine to medium crystalline; medium to thick bedded; blue-grey mottling varies in intensity, from 5 to 90%; calcite crystals fill vugs and fractures; vugs up to 5 cm in diameter occur scattered throughout and are sometimes concentrated in zones; fossiliferous with abundant crinoidal fragments and rare corals; upper 6 m is weathered to tan-brown colour, fractured, and thin bedded.	
Total thickness	*15m*

QUARRY OPERATION

The quarry is operated on a single bench with a face height of 11 m to 15 m. Potential exists for an additional 6 m lower lift. Overburden is removed and used for making berms and ultimately for quarry reclamation.

The rock is drilled with a 10 cm rotary drill and blasted with aluminized AN/FO. Shot rock is loaded with a 5 1/2 yd. front end loader and transported to the feed hopper of the primary crusher.

PROCESSING

A 36 in. x 46 in. Telsmith mobile jaw crusher with a reciprocating plate feeder is moved as required to maintain an economic haulage distance from the rock face. Minus 8 in. discharge from the primary crusher is conveyed to a surge bin feeding a 5 ft. x 18 ft. triple-deck vibrating screen.

Plus 4 in. oversize from the screen is either used as +4 in. -8 in. gabion stone or diverted to the secondary crusher. Undersize from the top screen can be a group 1 "B" gravel, or 1 1/2 in. clear and Granular "A". In the

Photo O-10-1. MEDIUM- TO THICK-BEDDED WIARTON/COLPOY BAY MEMBER (AMABEL FORMATION). UPPERMOST 6 m IS THIN BEDDED AND FRACTURED; SYDENHAM QUARRY.

latter case, the product from the second screen deck is diverted to the secondary crusher. Primary screen products are transported by belt and radial stacking conveyors to individual stockpiles.

The secondary crusher is a 4 1/4 ft. Allis–Chalmers cone, typically operated in open circuit. Secondary discharge is conveyed by belt to a 5 ft. x 16 ft. triple–deck vibrating screen producing 3/4 in. clear stone, 1/2 in. clear stone and class "D" screenings. Oversize from the top deck is diverted to a Spokane vertical impact tertiary crusher operated in closed circuit with the secondary screen.

Electrical power at the quarry site is generated by E. C. King with a 525 Kw diesel plant. All screens, belts, conveyors and the cone crusher receive power by buried ground cable.

The primary jaw crusher and the Spokane vertical impact crusher are powered by diesel engines.

OWEN SOUND DOLOMITE PLANT

Screenings from the secondary screening plant, or 3/4 in. or 1/2 in. clear stone, are used to provide feed for the plant of Owen Sound Dolomite, a division of E. C. King Contracting. This plant produces glass grade dolomite, fertilizer diluent, agricultural lime and coarse mineral filler products and is located in Owen Sound near the plant of Pittsburgh Plate Glass, a large consumer of glass grade dolomite.

Stone from the Sydenham Quarry is trucked to the Owen Sound Dolomite plant for further processing. This stone is fed directly via a truck hopper to a gas–fired rotary drier, the dried stone being screened on two double–deck 4 ft. x 8 ft. hummer screens.

Top deck oversize from the hummer screens (+8 mesh) is diverted to a Hazemag A.P.K. 30 impact crusher in closed circuit with the hummer screens.

Product from the second deck can either be returned to the Hazemag crusher or be diverted to 5 ft. horizontal vibratory Sweco screens to produce –8 +12 mesh fertilizer grits.

Undersize from the hummer screens is –16 mesh and is further processed with an air classifier to produce a –16 +100 mesh glass grade dolomite and a fine fraction that is utilized as agricultural lime or coarse mineral filler.

Fertilizer grits are stored in a 5,000 ton capacity beehive storage dome, while glass grade and agricultural lime products are stored in individual silos. A small amount of coarse filler product is bagged. All other products are sold in bulk truck loads.

PRODUCTS

Gabion Stone 4 in. –8 in.
Group 1 "B" Gravel
Granular "A"
1 1/2 in. Clear Stone
3/4 in. Clear Stone
1/2 in. Clear Stone
Screenings
Glass Grade Dolomite
Fertilizer Diluent
Agricultural Lime
Coarse Mineral Fillers

HAROLD SUTHERLAND CONSTRUCTION LTD. QUARRY

At the time of field work and writing of the report, a quarry was being licensed by Harold Sutherland Construction Ltd. The quarry is located in Lot 5, Con. 5, St. Vincent Township, Grey County, about 5 km south of Meaford.

The quarry face varies from 1.5 m to 4.9 m. The upper part of the face exposes light brown, thin–bedded dolostone of the Lower Silurian Manitoulin Formation. In the lower 1.5 m to 3 m of the face, the Manitoulin Formation consists of blue–grey, fossiliferous massive dolostone. The contact between the Manitoulin Formation and the underlying Upper Ordovician Queenston Formation lies less than a metre under the quarry floor, and is exposed in a drainage ditch. Overburden at the quarry site is thin, but deepens to the west.

Prior to licencing, the quarry was operated temporarily under a wayside permit. While under permit, the quarry output was Granular "A" and "B" produced by a portable crusher. The products were being used for repair and maintenance of local roads.

Simcoe District

INTRODUCTION

The Simcoe District is located in the Southwestern Region of Southern Ontario, bounded by Lake Erie and the districts of Aylmer, Cambridge and Niagara. The District includes parts of Brant and Oxford Counties and the Regional Municipality of Haldimand–Norfolk (Figure S–0–1).

A total of twenty–nine quarries in the Simcoe District are documented in the quarry inventory (*see* Appendix IV, Volume I); three of these are licensed under the Pits and Quarries Control Act and only one, the Norfolk Quarry (S–2) is currently active.

The two quarries visited during the study were the active Norfolk Quarry (S–2) and the abandoned Pierce Quarry (S–1) which displays the Silurian/Devonian contact.

REGIONAL GEOLOGY

The Simcoe District has relatively low relief with a southward–sloping plain; some hummocky morainic topography occurs in the northwest corner. A discontinuous ridge, the Onondaga Escarpment, crosses the northeastern part of the district through Hagersville and Springvale. Along the eastern margin of the area, the thickness of the Quaternary deposits averages less than 8 m, therefore bedrock exposures are relatively abundant along streams and the Lake Erie shoreline, although in 1986 most were obscured by high water levels. Several large, operating or abandoned quarries near Hagersville, Port Dover, and Nanticoke provide the best exposures for Paleozoic strata. West of Port Dover, Quaternary deposits average over 70 m in thickness and, therefore, no bedrock exposures occur and rock unit boundaries are based on subsurface data.

The oldest unit in this area, the Upper Silurian Salina Formation, does not outcrop, but is known from

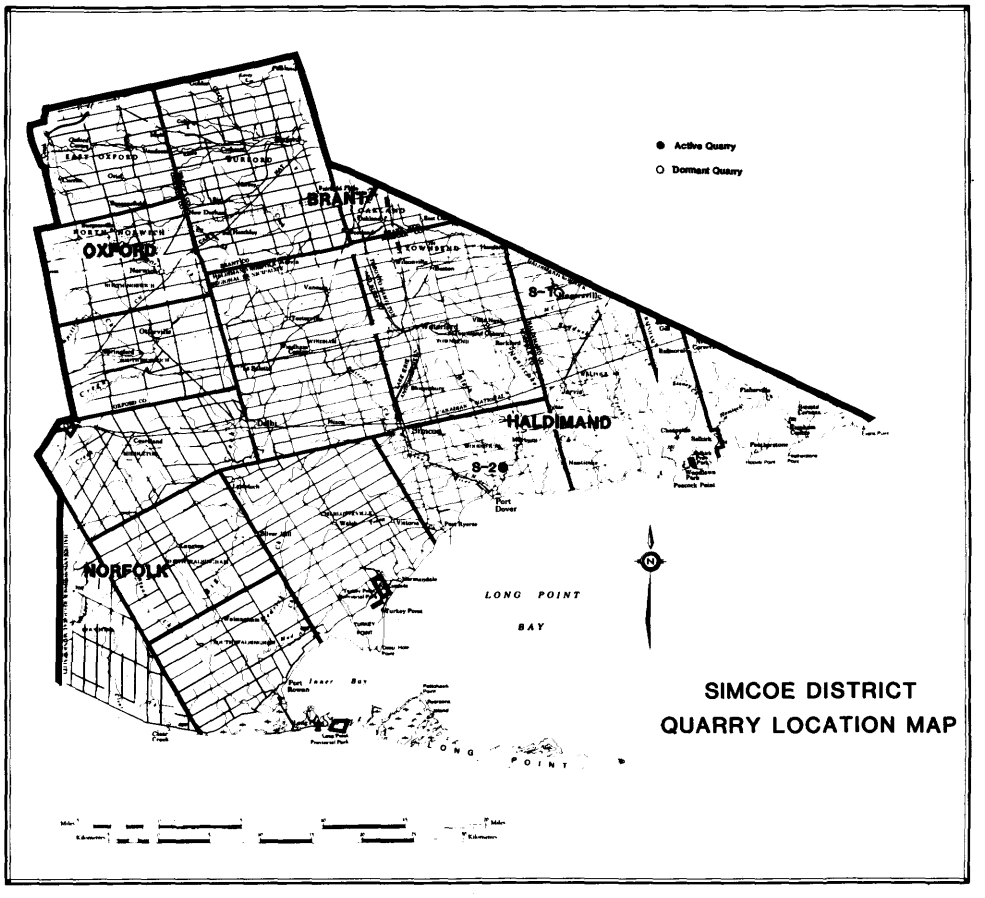


Figure S–0–1. SIMCOE DISTRICT QUARRY LOCATION MAP.

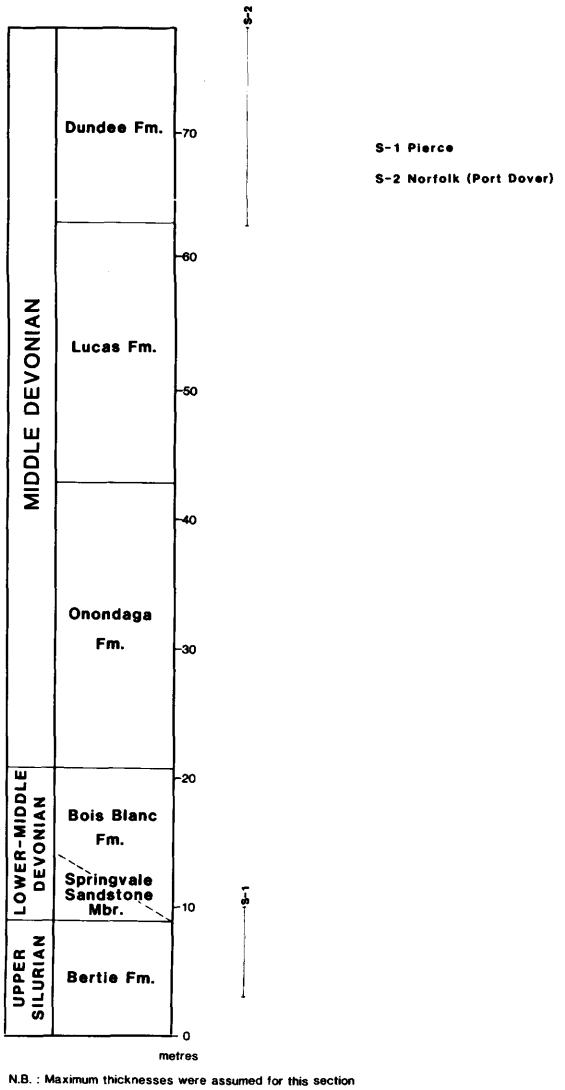


Figure S-0-2. STRATIGRAPHIC COLUMN SHOWING PRINCIPAL QUARRIES OF SIMCOE DISTRICT.

subsurface records. It consists of argillaceous dolostones, shales, and evaporites (predominantly gypsum). The overlying Upper Silurian Bertie Formation is well exposed in this district, especially around Hagersville and Springvale, but subdivision into members (as in southern Niagara District) is difficult to apply here. A variety of lithologies occurs in the lower 3.5 m of the Bertie Formation, which mainly include argillaceous dolostones and mottled dolostones. The upper 5 m consist of fine-crystalline, laminated dolostone. The upper contact of the formation is a major disconformity and its surface may be very pitted, brecciated and infilled with sand, chert or conglomeratic sediments, best seen in the Pierce Quarry (S-1). The resistant dolostones of the Bertie Formation form part of the Onondaga Escarpment.

The Lower Devonian Bois Blanc Formation, which overlies the Bertie Formation, occurs in the northeastern part of the district and is best seen in quarries around Hagersville. The Springvale Sandstone Member can occur at the base of the unit and consists of a green-grey, glauconitic, quartzose sandstone and limestone. The Bois Blanc Formation, aside from the Springvale Sandstone Member, is a cherty, fossiliferous, bioclastic limestone. The upper contact with the Onondaga Formation is sharp and disconformable.

The Middle Devonian Onondaga Formation is well exposed along the eastern margin of the district along Nanticoke, Sandusk, and Stoney Creeks and near the towns of Cheapside and Selkirk. The Edgecliff, Clarence and Moorehouse Members of the Onondaga Formation that could be easily identified in the Niagara District, are not so easily delineated in Simcoe District. All three members, however, can be seen in the extreme eastern corner along the Lake Erie shoreline and around Sweets Corners.

The Edgecliff Member (around Hagersville) consists of a very cherty, very fossiliferous, argillaceous limestone, interbedded with crinoidal bioclastic limestone. The middle part of the Onondaga (the Clarence Member), is best exposed along Nanticoke Creek near Rockford and Sandusk Creeks and consists of alternating beds of very fossiliferous, moderately cherty, bioclastic limestone and very cherty argillaceous limestone. The Moorehouse Member consists of a coralline bioclastic limestone with shale laminae.

The Onondaga Formation is restricted to the Appalachian Basin, and its presence in Simcoe District is its most westerly extension. Along the western edge of the district it grades into its approximate Michigan Basin equivalent, the Amherstburg Formation of the Detroit River Group. The Middle Devonian Lucas Formation (also Detroit River Group), overlies the Onondaga Formation and only extends eastward to the Town of Simcoe and then pinches out. The Lucas Formation consists of a uniformly textured, bioclastic limestone. This is the most easterly extension of this unit. Its upper contact with the overlying Dundee Formation is a major disconformity.

The Middle Devonian Dundee Formation forms much of the bedrock in the southern half of the district (Figure S-0-2). It is best seen in the Norfolk Quarry (S-2) and is a cherty, somewhat fossiliferous limestone. The lower portion contains two excellent marker beds (1.0 and 0.6 m thick), which consist of brown-black, very fine-crystalline, bituminous limestone (located 3.6 and 0.8 m, respectively, from the base), and are also best seen in the above mentioned quarry.

Only one quarry in this district, the Norfolk Quarry (S-2), is presently operating. The excavated rock mate-

rial from the Dundee Formation in this quarry is used for crushed stone, chips and rock dust. There are twelve abandoned quarries in the Simcoe District which have utilized the Dundee Formation, whereas nine quarries have used the Bois Blanc Formation. Minor operations have also used the Onondaga and Bertie Formations.

LIMESTONE INDUSTRIES

The single active quarry in Simcoe District produces limestone aggregates in various sizes from armour stone down to screenings.

Stone production in 1986 for the Regional Municipality of Haldimand–Norfolk totalled 1,234,960 tonnes, though by far the bulk of this production came from three quarries in Niagara District (NI–5, NI–8, NI–10), in the eastern part of Haldimand–Norfolk. Stone production in Simcoe District accounted for 10–15% of the total.

S–1 C. MATTICE — PIERCE QUARRY

LOCATION AND OWNERSHIP

This small abandoned quarry is located 0.5 km south of Springvale in Lot 7, Concession 14, City of Nanticoke (Walpole Township), Regional Municipality of Haldimand–Norfolk (Figure S–1–1). The quarry is owned by Chuck Mattice of Springvale.

GEOLOGY

The quarry exposes 7.1 m of Upper Silurian and Lower Devonian strata from the Bertie and Bois Blanc Formations, respectively. The Bertie Formation consists mainly of subcrystalline to fine–crystalline dolostone, whereas the Bois Blanc Formation is represented by the Springvale Sandstone Member, a calcareous, glauconitic sandstone. Although this quarry ceased operating in 1950, it displays the Silurian/Devonian contact and therefore is included in this report.

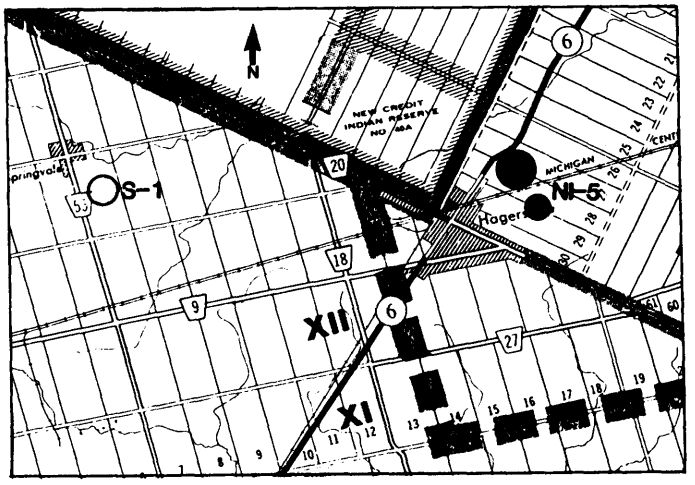


Figure S–1–1. LOCATION MAP FOR PIERCE QUARRY.

Geological Section

		Thickness
UNIT 3	*Bois Blanc Formation, Springvale Sandstone Member*	*1.6m*

Calcareous glauconitic sandstone: white to cream, weathers tan; coarse grained; medium bedded, beds are poorly delineated; the unit is a brecciated mixture of carbonates and silty glauconite in a matrix of coarse–grained sandstone; lower contact is transitional and irregular.

UNIT 2	*Bertie Formation*	*1.7m*

Dolostone: cream to white, weathers brown; subcrystalline to fine crystalline; medium bedded with sharp contacts which are irregular and pinch and swell; shaly partings occur throughout; lower contact is sharp at a 5 cm thick shale bed.

UNIT 1	*Bertie Formation*	*3.8m*

Dolostone: cream to white, weathers brown; sub– to fine crystalline; thin to medium bedded (less than 30 cm), gets thinner bedded upwards, contacts are sharp and undulating; slightly sucrosic; faint grey laminations present; thin bituminous partings present.

Total thickness	*7.1m*

REFERENCES

ARIP 59, 1984, p. 20

MAPS

Telford and Hamblin, 1980, OGS Map P.2234

S–2 NORFOLK QUARRIES COMPANY — NORFOLK (PORT DOVER) QUARRY

LOCATION AND OWNERSHIP

The Norfolk Quarry is located 4 km northeast of the town of Port Dover on Regional Rd. 3, in Lots 13 and 14, City of Nanticoke (Woodhouse Township), Concession 2, Regional Municipality of Haldimand–Norfolk (Figure S–2–1).

The quarry was first opened in 1963 by the present owner and operator, Norfolk Quarries Company, which is itself owned by Trent Valley Sand and Stone Ltd.

GEOLOGY

This unusually–shaped quarry extends sinuously along a stream valley exposing 15 m of section through the lower Dundee Formation (Middle Devonian) (Figure S–2–2). The strata in the quarry are typically cherty, fossiliferous limestone with chert occurring in discrete, thin beds. A bituminous limestone bed which contains large colonial corals occurs approximately 3.5 m above the base of the quarry face. The rarely exposed contact between the Onondaga and Dundee Formations was, at one time, exposed in a sump at the eastern end of the quarry.

Geological Section

Thickness

UNIT 5 Dundee Formation *10.53m*

Limestone: light brown, weathers grey; fine crystalline, (coarse where shelly material occurs); massive bedded at base, becomes medium bedded at the top, with sharp, irregular stylolitic contacts and bituminous partings; the unit becomes cherty upwards which occur as nodules and beds - the chert is cream in colour and some nodules have black centres; brachiopod and crinoid debris are abundant, along with rare coral the lower contact is sharp.

UNIT 4 Dundee Formation *0.90m*

Shaly limestone, argillaceous: dark brown, weathers brown; very fine to fine crystalline; thin bedded, contacts are sharp and planar, bituminous partings are common; chert is present as nodules and lenses, calcite crystals occur in fractures; some sedimentary features are present such as flame structures and scouring, sparsely fossiliferous with rare bryozoans; lower contact is sharp.

UNIT 3 Dundee Formation *0.45m*

Limestone: brown, weathers light brown; medium to coarse crystalline; medium bedded, with undulating contacts and rare bituminous partings; chert is present as lenses and nodules; lower contact is sharp.

UNIT 2 Dundee Formation *0.90m*

Bituminous limestone: grey-brown, weathers light grey; fine to medium crystalline; sucrosic texture; one massive bed; porous coral heads are abundant, solitary corals are rare; fractures are abundant (in all directions); lower contact is sharp and undulating.

UNIT 1 Dundee Formation *2.21m*

Cherty limestone: dark brown, weathers dark grey-brown; fine crystalline, sucrosic texture; thin to medium bedded, contacts are sharp but irregular; rare argillaceous zones; cream coloured chert occurs as nodules and as irregular thin lenses, black chert occurs in middle of unit; calcite mineralization is present along fracture faces; abundant coral heads and rugose corals present.

Total thickness *14.99m*

CHEMICAL ANALYSIS - GRANULAR "A"*

SiO_2	22.0	CaO	39.5
Al_2O_3	0.50	P_2O_5	0.02
Fe_2O_3	0.34	SO_3	0.28
MgO	3.20	L.O.I.	34.5
		Total	100.3

** Sample from crushed stone stockpile reported in Hewitt and Vos, 1972, p.70.*

QUARRY OPERATION

The quarry extends approximately 1,200 m in length and 60 m in width along the course of an old riverbed exposing bedrock on the surface. A limit of about 3 m to 4.6 m of overburden is removed on either side of the quarry though as much as 14 m exists.

The quarry has been excavated on two lifts of 9.1 m each. Drilling and blasting is contracted, a 2.9 m x 2.9 m pattern being used with 8.9 cm diameter holes. Holes are

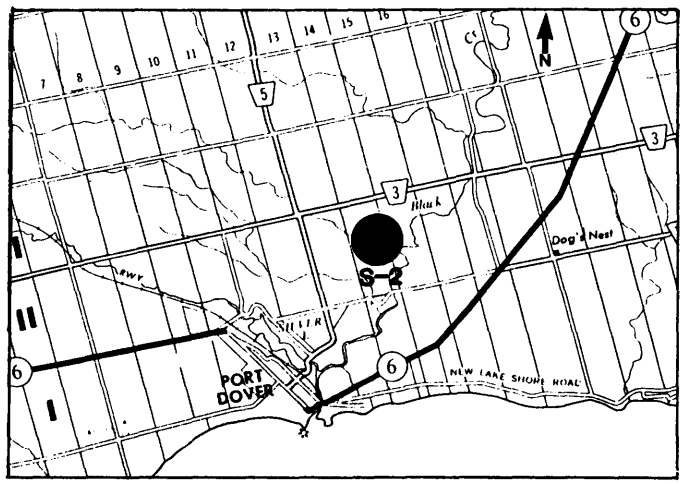


Figure S-2-1. LOCATION MAP FOR NORFOLK (PORT DOVER) QUARRY.

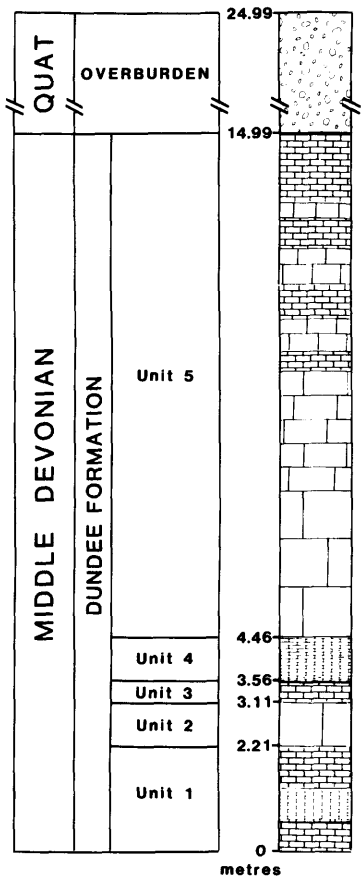


Figure S-2-2. STRATIGRAPHIC COLUMN FOR NORFOLK (PORT DOVER) QUARRY.

Photo S-2-1. NORFOLK (PORT DOVER) QUARRY FACE (LOOKING NORTHWEST).

loaded with AN/FO, primed with a slurry cartridge and initiated with electric caps. At the face a 1.5 yd. Linkbelt shovel loads the blasted rock into two 22–ton Euclid trucks.

Ground water in the quarry is controlled using a 6 in. Flygt pump.

PROCESSING

Primary crushing is by Cedarapids 40 in. x 40 in. double impact crusher. The crushed stone is screened by a 2–deck 5 ft. x 14 ft. screen. Secondary crushing of the oversize is handled by a Symons short head cone crusher in closed circuit with the 5 ft. x 14 ft. screen. The end products are conveyed approximately 900 m to a Barber–Greene 150 ft. stacker or to a specialty products triple–deck 5 ft. x 14 ft. tertiary screening plant as per customer requirements.

PRODUCTS

Armour Stone
Granular "A" and "B"
2 in. Crusher Run
4 in. Crusher Run
3/4 in. Clear
2 in. Clear
Screenings
3/8 in. Chips
Additional size fractions are available on request.

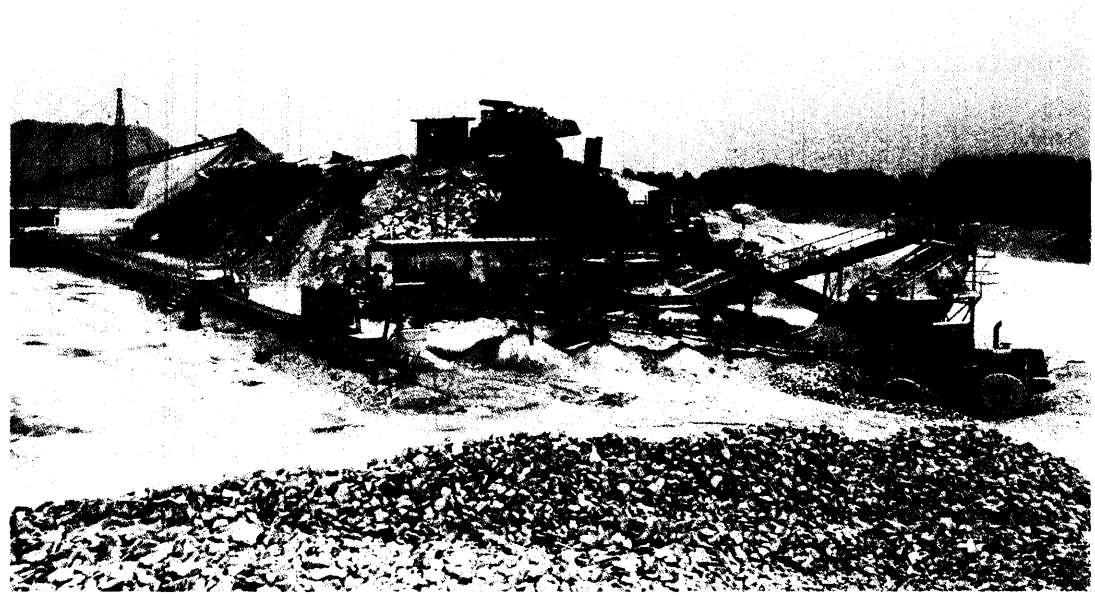
REFERENCES

Hewitt and Vos, 1972, p. 69–70
Hewitt, 1964a, p. 66–67
Telford and Johnson, 1984 GAC–MAC Field Trip 1, p. 28
ARIP 59, 1984, p. 20

MAPS

Telford and Hamblin, 1980, OGS Map P.2234

Photo S-2-2. EUCLID TRUCK LOADING CEDARAPIDS PRIMARY CRUSHER AT NORFOLK (PORT DOVER) QUARRY.



Aylmer District

INTRODUCTION

Aylmer District is centrally located in the Southwestern Region of southern Ontario, bounded by Lake Erie to the south and the districts of Chatham, Wingham and Simcoe to the west, north and east, respectively (Figure A-0-1).

Four active quarries in the district are documented in the quarry inventory (*see* Appendix IV, Volume I), all of which were visited during the study. A separate cement plant that receives its feed from one of the quarries is also noted.

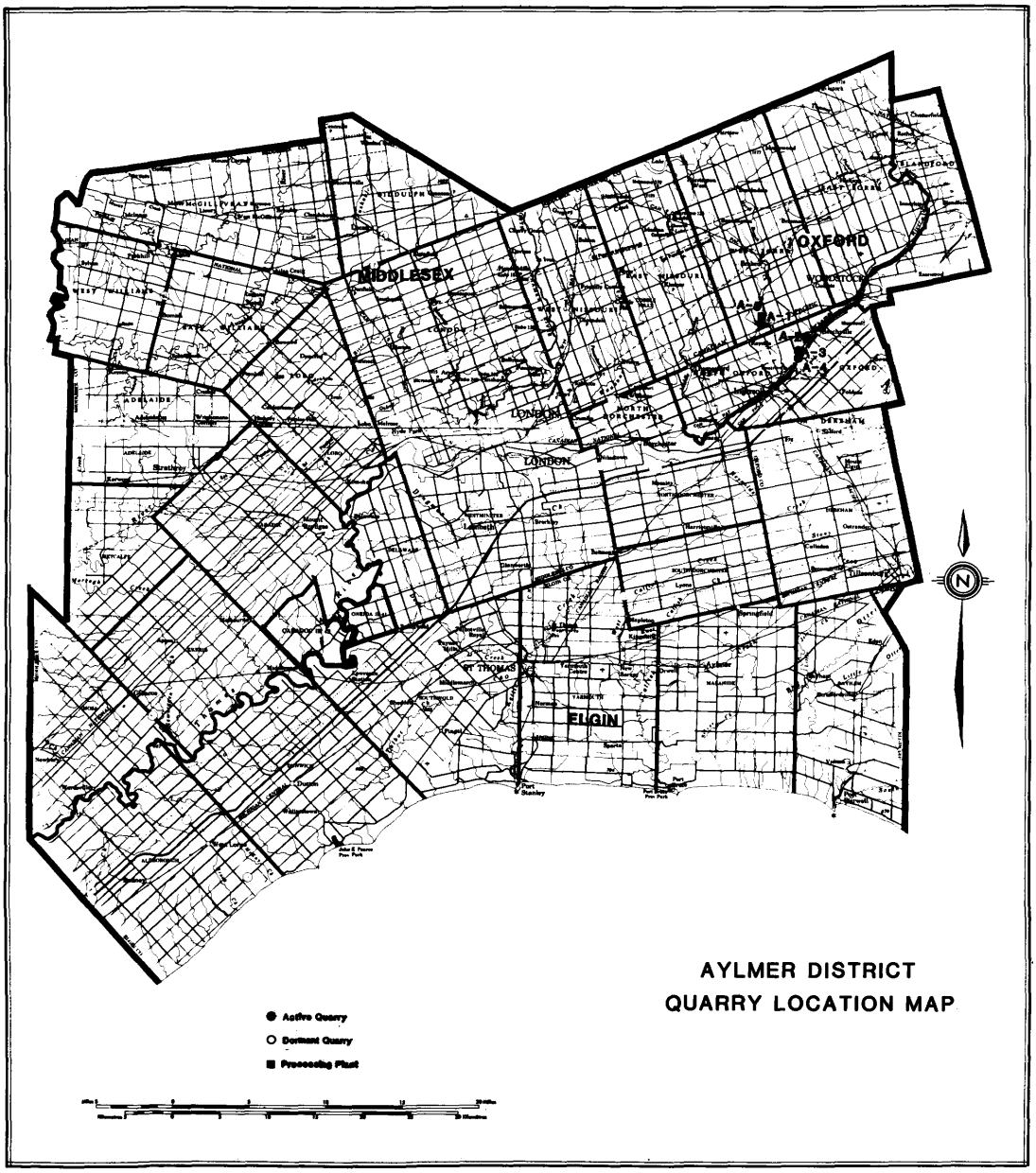


Figure A-0-1. AYLMER DISTRICT QUARRY LOCATION MAP.

The properties include:

A–1	*Lafarge Canada Inc. – Woodstock (Zorra) Quarry and Plant (active)*
A–2	*BeachviLime Ltd. Quarry and East Plant (active)*
A–3	*BeachviLime Ltd. Quarry and West Plant (active)*
A–4	*Stelco Inc. Quarry and Plant (active)*
A–5	*Federal White Cement Ltd. – Woodstock Plant (active)*

REGIONAL GEOLOGY

The main geomorphic feature in Aylmer District is the Thames River. The Algonquin Arch, a major bedrock structure, is present in the subsurface and trends southwest to northeast through the district. Natural bedrock exposures are non–existent in this district due to the thick Quaternary cover, the only exposures being provided by four large operating quarries in the Ingersoll to Woodstock area.

The Middle Devonian Amherstburg and Lucas formations of the Detroit River Group are exposed within quarries in the district and represent the transition from Appalachian Basin rock units found on the Niagara Peninsula to Michigan Basin rock units seen west of the Algonquin Arch (Figure A–0–2). The lateral relationships of these Paleozoic rock units are not clear in this area due to the absence of outcrop and minimal subsurface data.

The oldest stratigraphic unit subcropping in the district is the Upper Silurian Bass Islands Formation (dolostone). It is disconformably overlain by the Lower Devonian Bois Blanc Formation, a cherty limestone, which is in turn overlain by the exposed Detroit River Group (Middle Devonian). Overlying this are the following, unexposed, units (all Middle Devonian and in ascending stratigraphic order); the Dundee Formation (limestone); the Marcellus Formation (grey shale) and the Hamilton Group (grey shales and limestones).

The Amherstburg Formation is predominantly a cherty limestone with abundant bituminous partings and abundant stromatoporoids. It is presently only being extracted from the lower lifts of the Woodstock (Zorra) Quarry (A–1).

The Lucas Formation is represented in all four operating quarries and consists predominantly of a high purity limestone interbedded with brown to tan bioclastic limestones, microcrystalline limestones, and calcarenites. Bituminous partings and large football–shaped stromatoporoids can be abundant. The high purity portion of the Lucas Formation is referred to as the Anderdon Member in the Ingersoll area. The uppermost portion of the Anderdon Member in the Stelco Quarry (A–4) exposes a 5 m section of sandy limestone, a massive bedded, brown,

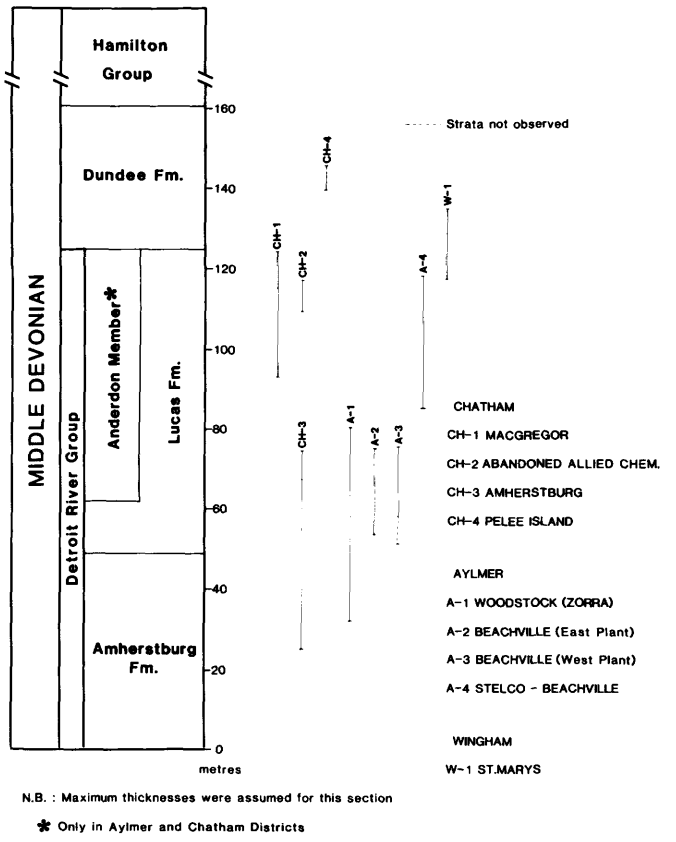


Figure A–0–2. STRATIGRAPHIC COLUMN SHOWING PRINCIPAL QUARRIES OF AYLMER, CHATHAM AND WINGHAM DISTRICTS.

silty and fossiliferous unit. This sandy facies is found only in the Ingersoll and Amherstburg (Chatham District) area.

BeachviLime Ltd., (A–2 and A–3), extracts high purity limestone from the Amherstburg and Lucas formations (Anderdon Member).

LIMESTONE INDUSTRIES

The principal limestone industries in Aylmer District are cement and lime production, with minor amounts of granular limestone. All the producing quarries (A–1, A–2, A–3 and A–4) and the Federal White Cement Plant (A–5) are located in Oxford County.

Cement production in 1986 totalled approximately 494,000 tonnes (1987 Ontario Mineral Score), principally from the Lafarge Canada Inc. plant (A–1). Lafarge Canada Inc. markets a wide variety of products including, but not restricted to, Normal Portland, High Early Strength Portland, Sulfate Resisting Portland, Low Heat of Hydration Portland and Masonry Cement.

The high purity limestone extracted from the Lucas Formation is also used for the manufacture of high cal-

cium lime, some of which is used as metallurgical flux for the steel industry in Hamilton. The sandy limestone facies of the Anderdon Member (Lucas Formation) was formerly considered a waste rock by the operator of the Stelco Quarry (A–4), though a market has now been found for this material. The 1986 production of lime in Aylmer District totalled some 690,000 tonnes (1987 Ontario Mineral Score).

Stone production in 1986 totalled 2,584,000 tonnes (1987 Ontario Mineral Score), almost all of which was internally consumed by the cement and lime plants. The BeachviLime East plant (A–2) also produces dried granular limestone for use in agriculture, animal feed, glass and roofing shingle industries.

A–1 LAFARGE CANADA INC. — WOODSTOCK (ZORRA) QUARRY AND PLANT

LOCATION AND OWNERSHIP

Lafarge Canada Inc. operates a large quarry and a 500,000 tonne per year wet process cement plant in Lots 2 to 5, Concession 2 and 3 and Lots 1 to 3, Concession 4, Township of Zorra (West Zorra Township), Oxford County. The quarry and plant are located approximately 23 km west of Woodstock on Highway 2 at County Road #6, as shown in Figure A–1–1. A line of the Canadian Pacific Railway runs through the property.

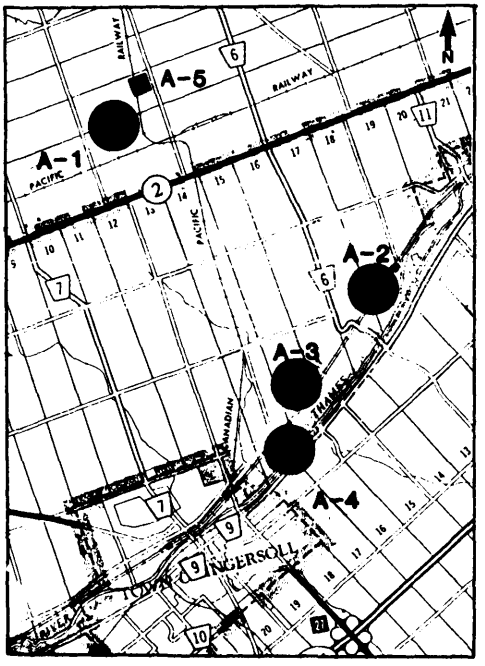


Figure A-1-1. LOCATION MAP FOR WOODSTOCK (ZORRA) QUARRY.

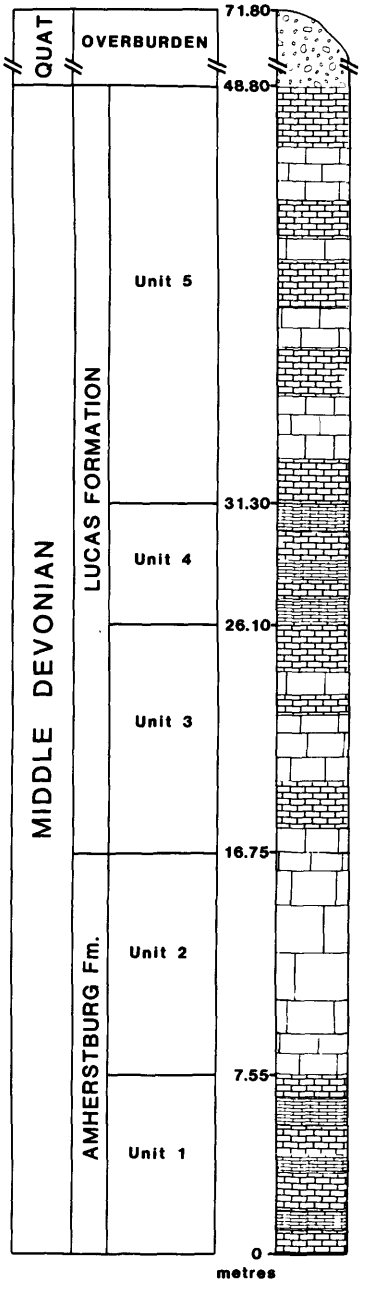


Figure A-1-2. STRATIGRAPHIC COLUMN FOR WOODSTOCK (ZORRA) QUARRY.

GEOLOGY

A total of four lifts expose a 48.8 m section from the Middle Devonian Detroit River Group (Figure A–1–2). The two lower lifts expose 16.75 m of the Amherstburg Formation, a cherty, banded and fossiliferous limestone. Silica content tends to increase down the section and

Lafarge Canada Inc. is deepening the quarry to take advantage of this silica-rich limestone. A very prominent stromatoporoid zone occurs within the second lift.

The upper lifts expose a 32.05 m section of the Lucas Formation, a bioclastic and microcrystalline (lithographic) limestone. There is a well-defined contact with the underlying Amherstburg Formation.

Geological Section

Thickness

UNIT 5 Lucas Formation *17.5m*

Limestone: brown to tan, weathers tan; sub to very fine crystalline; medium to thick bedded (up to 1 m), contacts are sharp, slightly irregular with thin bituminous partings; upper 5.65 m is thin to medium bedded, lithographic texture; with calcite present in vugs; coralgal debris and large stromatoporoids (up to 1 m) scattered about; beds vary slightly in colour throughout; lower contact is top of lift #2.

UNIT 4 Lucas Formation *5.2m*

Limestone: tan to light brown, weathers buff; subcrystalline; thin to medium bedded (3 to 30 cm), contacts are sharp, irregular, and some are slightly stylolitic and bituminous; lithographic texture; calcite mineralization in small pores and replaces fossils and burrows; fossils are recrystallized; gradational lower contact (colour change).

UNIT 3 Lucas Formation *9.35m*

Interbedded bioclastic limestone and non-fossiliferous limestone: light brown to tan, weathers tan to buff; bioclastic limestone is fine crystalline; non-fossiliferous limestone is micro- to subcrystalline; medium to thick bedded (up to 80 cm), contacts are fairly sharp, some are stylolitic and bituminous; lithographic texture; bituminous partings are not as abundant as unit above; laminations are only present in bioclastic limestones; fossils include very abundant coralgal debris and rare brachiopods and bryozoans, scattered burrows are present on bedding planes; lower contact is sharp, irregular and is mainly a colour change.

UNIT 2 Amherstburg Formation *9.2m*

Cherty limestone: dark brown to tan, weathers light to medium grey; fine to medium crystalline; thick to massive bedded (up to 1.5 m), contacts are not sharp, but are irregular and have bituminous partings; chert is blue-white (about 30%) and nodular shaped; upper 1.15 m are more thinly bedded and weathers rubbly, and chert nodules are smaller; abundant large stomatoporoids (up to 1 m in diameter) occur throughout, some coralgal debris present, with rare bryozoans and brachiopods; lower contact is gradational.

UNIT 1 Amherstburg Formation *7.55m*

Cherty limestone: medium grey to tan, weathers grey-brown; medium to coarse crystalline; thin to medium bedded (3 to 30 cm), contacts are sharp and very irregular; chert (about 40%) is mainly black with white rims, occurs as very irregular nodules or beds; beds have laminations; some chert replaces burrows and fossils; rare lenses of interbedded subcrystalline limestones (lithographic texture); very abundant thin bituminous laminae with a strong petroliferous odor; rare calcite in large vugs (3 to 4 cm); solitary corals are abundant (some are up to 35 cm long).

Total thickness *48.8m*

Chemical analyses of drill core from a typical hole, No. 17, drilled by Lafarge Canada Inc., are presented in Table A-1-1.

Typical bench analyses as reported by Lafarge Canada Inc. are tabulated in Table A-1-2.

The stone in the quarry is very consistent in its chemical analysis within each bench. Working the 4th (bottom) bench will allow the plant to obtain a high silica stone and provide for a natural cement mix. Overburden in the pit area is thick, averaging over 23 m, and is removed by means of stripping operations involving scrappers, trucks, and bulldozers.

QUARRY OPERATION

The present quarry occupies a surface area of approximately 65 ha. Three benches are currently being worked, with a fourth bench being developed. Bench heights are 18 m, 12 m, 20 m and 15 m respectively.

Drilling and blasting are performed under contract using a 171 mm rotary percussion drill on a 6 m x 6 m pattern. Nordex is used as the explosive. Shot rock is loaded by two 7 yd. Caterpillar front-end loaders into three dump trucks of 30-50 ton capacity. The average haul distance to the primary crushers is 1.2 km.

TABLE A-1-1. A-1 LAFARGE CANADA INC. WOODSTOCK (ZORRA) QUARRY.

	Composite Bench Analyses - Hole 17		
Elements	Bench 1 + 2	Bench 3	Bench 4
CaO	54.87%	47.34%	27.25%
SiO_2	0.48%	7.15%	40.71%
Al_2O_3	0.05%	0.29%	1.22%
Fe_2O_3	0.09%	0.15%	0.45%
MgO	0.98%	4.33%	4.20%
K_2O	0.01%	0.06%	0.53%
Na_2O	0.01%	0.01%	0.02%

Courtesy of Lafarge Canada Inc. - Company Files.

TABLE A-1-2. A-1 LAFARGE CANADA INC. WOODSTOCK (ZORRA) QUARRY.

	Typical Composite Bench Analyses		
Elements	Bench 1 + 2	Bench 3	Bench 4
CaO	53.0%	48.0%	23.5% - 43.0%
SiO_2	1.0%	4.0%	10.3% - 45.6%
Al_2O_3	0.4%	0.4%	0.2% - 1.6%
Fe_2O_3	0.3%	0.3%	0.1% - 0.6%
MgO	--	2.7%	2.75% - 5.83%
K_2O	--	0.1%	0.04% - 0.3%
Na_2O	--	0.1%	0.01% - 0.016%

Courtesy of Lafarge Canada Inc. - Company Files.

Photo A-1-1. LUCAS FORMATION, UNIT 1 EXPOSED IN THE FIRST LIFT; WOODSTOCK (ZORRA) QUARRY.

PROCESSING

Primary crushing is carried out with a Traylor T 54 in. gyratory crusher. Minus 6 in. material is carried by a 42 in. underground belt conveyor to a secondary CB 15–50 impact crusher, operating in closed circuit with screens to reduce the material to –3/4 in.. Belt conveyors move the stone to raw material storage at the plant (30,000 tonnes capacity).

Gypsum–anhydrite is stored in open piles near the mill feed storage adjacent to the finish mill. Gypsum–anhydrite is supplied by Canadian Gypsum Company.

Crushed stone (from the various benches), fly ash, and iron oxide mill scale are recovered from raw mill storage area by a 5 yd. bucket overhead crane and pan conveyors for blending and feeding to the raw mills.

The raw mill consists of three 2–compartment Unidan ball mills. The raw mix is ground to 90% passing 200 mesh and pumped to blending basins as 32% moisture. The two 33.5 m diameter blending basins are equipped with rotating and air agitation systems.

The blended mill feed slurry (30% solids) is pumped to two F.L. Smidth coal/coke fired kilns (convertible to natural gas or oil), that are each 12 ft. x 450 ft. in size. Refuse (municipal garbage) derived fuel (RDF), blended with coal or another fuel substitute, has been successfully experimented with in the past, but for various reasons, is not currently in use. The kilns are fitted with electrostatic precipitators to control dust.

Clinker is cooled in two 7 ft. x 44 ft. Fuller inclined grate systems and passed through an impact crusher prior to transfer by pan conveyor to storage. Clinker storage is approximately 20,000 tonnes.

Clinker is recovered from storage by belt conveyors and fed to a series of F.L. Smidth ball mills. A 40/60 anhydrite/gypsum mixture is added to the clinker at a rate of approximately 5%. The ball mills range in size from a 4,000 hp 24 ft. x 36 ft., 70 tons per hour unit to six 1,100 hp 9 ft. x 24 ft. units. Finished cement is pneumatically conveyed to storage silos for loading into rail cars, tanker trucks and bags.

PRODUCTS

Normal Portland Cement
High Early Strength Portland Cement
Sulfate Resisting Portland Cement
Low Alkali Cement
Masonry Cement
Oil Well Cement

REFERENCES

Hewitt, 1960, p. 158–161
Hewitt, 1964a, p.65
Blair, 1965, p.52–54
Hewitt and Vos, 1972, p.67–68
Telford and Johnson, 1984, p.29–31

A-2 BEACHVILIME LTD. QUARRY AND EAST PLANT

LOCATION AND OWNERSHIP

The East plant of BeachviLime Ltd. is located southwest of Beachville in Lots 17 and 18, Concessions 1 and 2, Township of Zorra (North Oxford Township), Oxford County (Figure A–2–1). The quarry and plant, formerly owned by Domtar, form a fully integrated production facility for hydrated lime, pulverized lime, pebble lime and granular limestone. In 1929 the Gypsum, Lime and Alabastine Co. purchased three quarries and two lime plants from Standard White Lime Co. The entire operation was consolidated and purchased in 1959 by Domtar. BeachviLime Ltd. purchased the operation in 1984.

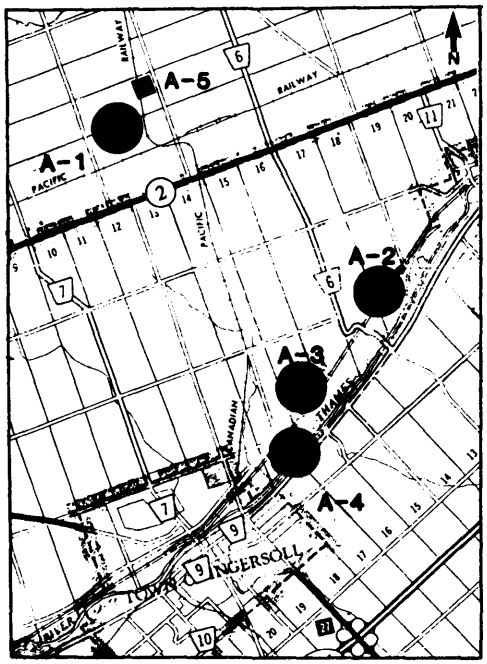


Figure A-2-1. LOCATION MAP FOR BEACHVILIME PLANT #2.

GEOLOGY

The quarry exposes 20 m of the Middle Devonian Lucas Formation (Anderdon Member), which consists of bioclastic limestones, interbedded microcrystalline limestones, and calcarenites. Distinctive large, football-shaped stromatoporoids occur at various horizons. The geological section is very similar to that in quarry A-3, immediately to the southwest, where it is described in more detail. Overburden is about 23 m thick.

QUARRY OPERATION

Quarry operations for the East plant are now located north of the C.N. Railway line and are connected by a tunnel to the processing plants in the abandoned south quarry. High purity limestone is mined from a single 20 m bench. Overburden is removed by a contractor and the rock surface is washed clean prior to drilling.

Production drilling is with a 159 mm percussion drill, on a hole spacing of 6 m x 6 m to 5% below grade.

Drill holes are pumped dry before loading with hydromex and AN/FO explosives, the latter being mixed on site by supplier's equipment. A single row of holes is blasted in each shot, providing 11,000 to 22,000 tons of broken rock.

The blasting sequence is designed to achieve a fine break and is geared to loader and crusher capability. Oversize rock is sorted out and secondary breaking is by drop-ball. The final quarry floor is level and smooth.

Broken stone is loaded by 6.5 yd. front-end loaders equipped with "spade nose" buckets into four 16.5-ton side-dump trailers and hauled by Mack diesel tractors. The size of haulage equipment is restricted by the size of the tunnel connecting the quarry with the plant facilities.

PROCESSING

Primary crushing is by a 30 in. Allis-Chalmers gyratory crusher, installed level with the quarry floor. This crusher has no dump pocket feeder or grizzly, and the rock is dumped directly into the crusher via a hook and cable system controlled by the crusher operator.

The secondary crusher is a 40 in. Nordberg Symons shorthead cone which reduces the stone to -4 in. and discharges it through a grizzly with 5 1/2 in. square openings.

Secondary crushed rock is transported by return belt and transfer conveyor to a stockpile located over a single drawpoint. Crushed rock is then recovered from beneath the stockpile with a Syntron feeder and carried on a 35 in. x 377 ft. inclined conveyor belt to the screenhouse, located on top of seven large, flat-bottom concrete silos. Crushed rock is screened in three stages on double-deck inclined vibratory screens located above the silos; seven product sizes are produced.

The first screen is a 5 ft. x 16 ft. Symons vibrating screen equipped with 4 in. and 2 1/4 in. screen decks, which yield -6 in. + 4 in. and -4 in. + 2 1/4 in. products.

The -2 1/4 in. undersize is conveyed by belt to a secondary 5 ft. x 16 ft. Tyler screen, equipped with 1 1/4 in. and 7/8 in. screen decks, that yield -2 1/4 in. + 1 1/4 in. and -1 1/4 in. + 7/8 in. products.

The -7/8 in. undersize material from this stage is conveyed by belt to a tertiary 5 ft. x 16 ft. Symons vibratory screen, equipped with 1/2 in. and 1/4 in. screen decks, and these produce -7/8 in. + 1/2 in., -1/2 in. + 1/4 in. and -1/4 in. stone.

The seven product sizes discharge directly into seven large, flat bottom concrete storage silos of the following capacity:

Silo #	Capacity (tons)	Live/Capacity (tons)	Product
1	1,000	700	-1/4 in.
2	1,000	700	+1/4 in. - 1/2 in.
3	1,000	700	+1/2 in. - 7/8 in.
4	1,000	700	+7/8 in. - 1 1/4 in.
5	1,500	700	+1 1/4 in. - 2 1/4 in.
6	1,500	700	+2 1/4 inc. - 4 in.
7	1,500	700	+4 in. - 6 in.

Stone products are withdrawn from storage silos via bottom discharge feeders and conveyor belts. The large (+4 in. - 6 in.) stone is used as feed for the shaft kilns and +2 1/4 in. -4 in. stone is used as feed for the dried

Photo A-2-1.
BEACHVILIME LIMITED -
EAST PLANT.

stone plant or is recrushed for blast furnace stone. All other products (except −1/4 in.) are used as feed for the rotary kilns.

Lime Plant

Kiln stone is fed to a scalping screen to remove additional fines before it is transferred by overhead conveyor to three kiln feed silos. Kilns #1 and #2 have 100–ton feed silos, while kiln #3 has a 200–ton feed silo.

The plant is equipped with three rotary kilns with a combined capacity of 1,180 tons of lime per day. Two of the kilns are 249 ft. x 9 ft. Allis–Chalmers units equipped with quadrant heat exchangers and 3 ft. x 49 ft. reciprocating coolers. These kilns can be fired with a combination of natural gas and petroleum coke or with low sulphur coal.

The third rotary kiln is a 320 ft. x 11 ft. GATX–Fuller unit with a Neims cooler. The #3 kiln is fired with preheated bunker C oil or natural gas.

Lime Handling and Storage

Lime produced by any of the kilns can be transported to one of several storage silos. Two lime handling facilities are in operation and integrated to provide a high degree of flexibility.

Lime produced by #1 and #2 kilns is conveyed to four, 200–ton storage silos via a pan conveyor and bucket elevators or to the large 3,000–ton pebble lime storage silo. Lime to be stored in the large silo is first screened by two 4 ft. x 12 ft. Hewitt–Robins double deck screens located on top of the silo. The screens are equipped with 1/4 in. and 10 mesh decks and only the +1/4 in. oversize is stored in the pebble lime 3,000–ton silo. Fines are stored in a 300–ton concrete silo. The 3,000–ton silo is equipped with an internal spiral chute to prevent damage by free fall.

Pebble lime stored in the small 200 ton silos is screened with a double–deck Tyler F–300 before it is loaded into railcars or trucks.

As necessary, lime is crushed by a J. B. hammermill and conveyed via bucket elevator and belt to the hydrate plant.

The combined systems have a high degree of flexibility allowing products to be stored in a number of silos. Total lime storage in the silos is approximately 4,300 tons or roughly three days production at peak capacity.

Shaft Kilns

There are six gas–fired shaft kilns on this site, four of which are in operational condition and have a combined capacity of 240 tons per day. The kilns are fed coarse (+4 in. −6 in.) stone by an automated shuttle car system controlled by mechanical level controls within the shaft kiln.

Shaft kiln lime is crushed with a Hazemag crusher prior to entering one of two hydrating units and is preferred for the production of hydrated lime.

Hydrate Plant

The hydrate plant contains two complete hydrating units with a combined design capacity of 16 tons per hour. One of the hydrators is rated at 10 tons per hour while the other is rated at 6 tons per hour and both hydrators are equipped with high pressure drop Venturi type, wet scrubbers. Milk of lime produced in the scrubbers is recycled to the pre–mixer.

Hydrated lime is stored in four 100–ton elevated silos located above a rail track system. The plant is also equipped with modern bagging and automated palletizing equipment.

Photo A-2-2.
THE OUTPUT FROM THESE SHAFT KILNS IS USED FOR HYDRATED LIME MANUFACTURE.

Dried Stone Plant

The dried stone plant produces a range of granular and fine products used in the agricultural, animal feed, glass and asphaltic industries and has a capacity of approximately 24 tons per hour. The dried stone plant is fed via two separate truck hoppers.

Coarse rock is reduced in a Hazemag F–50 impact crusher and is lifted by bucket elevator to a 59 ft. x 8 ft. gas–fired Stackett rotary drier. Dried stone is transported by screw conveyor and bucket elevator to a 4 ft. x 14 ft. Tyler "Hummer" screen equipped with 6 and 12 mesh screen decks. Plus 6 mesh oversize is conveyed to a storage silo feeding a regrind circuit. The –6 + 12 mesh product is sold as poultry feed in bag or bulk. Minus 12 mesh undersize from the previous circuit is fed via bucket elevator to a 14 ft. Gayco classifier. Fines from this classification, after scalping over a 4 ft. Sweco vibratory screen, are stored in small silos and sold for use as fillers in asphalt roofing shingles. The coarse fraction from the classifier is glass grade limestone and is stored in a small bulk silo.

PRODUCTS

Quicklime

–10 mesh
4 mesh by 10 mesh
–4 mesh
–3/4 in.
–3/4 in. + 4 mesh
–2 in. + 4 mesh

Hydrate

Pulverized Stone

Grade 30
Calgro Pulverized Limestone B–2
Calgro Pulverized Limestone B–1
Calgro #3 Grits
Shellroc
Limestone screenings
Limestone chips
2 in. by 1 1/4 in. limestone
1 1/4 in. by 3/4 in. limestone

REFERENCES

Goudge, 1938, p.260–263
Caley, 1941a, p.51–52
Ehlers and Stumm, 1951
Hewitt, 1960, p. 149–152
Hewitt, 1964a, p. 64
Hewitt and Vos, 1972, p. 69
Oliver, 1976, p.134
Uyeno et al., 1982, p.44

MAPS

Williams, 1918, GSC 1715
Caley, 1941d, GSC 624A

A-3 BEACHVILIME LTD. QUARRY AND WEST PLANT

LOCATION AND OWNERSHIP

This large operating quarry and plant, owned by BeachviLime Ltd., a subsidiary of Dofasco Inc., is located 2.5 km southwest of Beachville in Lots 14, 15 and 16, Concession 3 and 4, Lots 16 to 18, Concession 2, Lots 15 to 17, Concession 3 in the Township of Zorra (North Oxford Township) and Lots 12, 14 and 15, Broken Front Concession in the Township of South West Oxford, (West Oxford Township), Oxford County (Figure A–3–1). The property has been active since 1907, when the Beachville White Lime Co. commenced sales of lime to Cyanamid of Canada Ltd. in Niagara. Cyanamid subsequently opened its own quarry and in 1929 purchased Beachville White Lime. Dofasco acquired the Cyanamid operation in 1973.

GEOLOGY

A total of 24.1 m of section is exposed in the quarry and consists entirely of the Anderdon Member of the Middle Devonian Lucas Formation. The strata in this quarry consist of bioclastic limestones, interbedded microcrystalline limestones, and calcarenites. Large football–shaped stromatoporoids are quite distinctive here and occur at various horizons. The East Plant (A–2) is located directly northeast of this quarry and exposes a similar section 20 m thick. Overburden averages 24 m in the vicinity of the quarry.

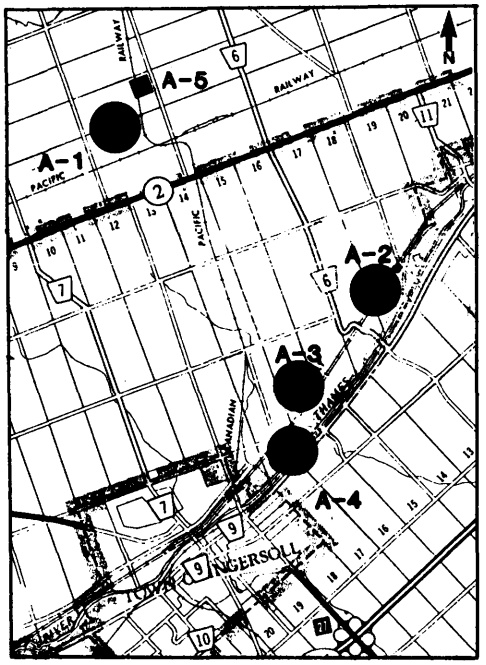


Figure A-3-1. LOCATION MAP FOR BEACHVILIME LTD. QUARRY.

Geological Section

Thickness

UNIT 7 Lucas Formation, Anderdon Member *1.6m*

Limestone: dark brown, some beds mottled light brown, weathers light brown; sub- to fine crystalline; thin to medium bedded (3–15 cm), contacts are sharp, very irregular and rubbly; abundant bituminous partings with a strong petroliferous odour; some coral debris present; large dark coloured coral heads surrounded by a light brown calcarenite matrix occur at the base; lower contact is sharp and very irregular.

UNIT 6 Lucas Formation, Anderdon Member *4.1m*

Limestone: brown, weathers light brown; microcrystalline to subcrystalline (lithographic); thick to massive bedded (beds averaging about 0.7 m each), sharp contacts, slightly irregular, shaly partings and stylolitic; calcarenite beds (fine to medium grained) with fossil debris scattered throughout; calcite mineralization present in fractures, orange-pink iron staining also present; abundant coralgal debris in some zones; lower contact is sharp, slightly irregular and slightly bituminous.

UNIT 5 Lucas Formation, Anderdon Member *0.8m*

Limestone: medium brown, weathers medium to light brown; fine to medium crystalline; one massive bed; contacts are sharp, slightly irregular and bituminous; appears calcarenaceous in some places; large stomatoporoids present (football-like, 4 to 35 cm), dark in colour; lower contact is sharp and almost planar, and stylolitic in places.

UNIT 4 Lucas Formation, Anderdon Member *6.1m*

Interbedded calcarenites and limestones (lithographic): tan to medium brown, weathers brown; microcrystalline and fine to medium grained; thick bedded (0.9–1.0 m), rare medium beds (10 cm) present, contacts are sharp, stylolitic or shaly; calcite mineralization in patches; coral debris and brachiopods present in calcarenite beds; lower contact is sharp and stylolitic.

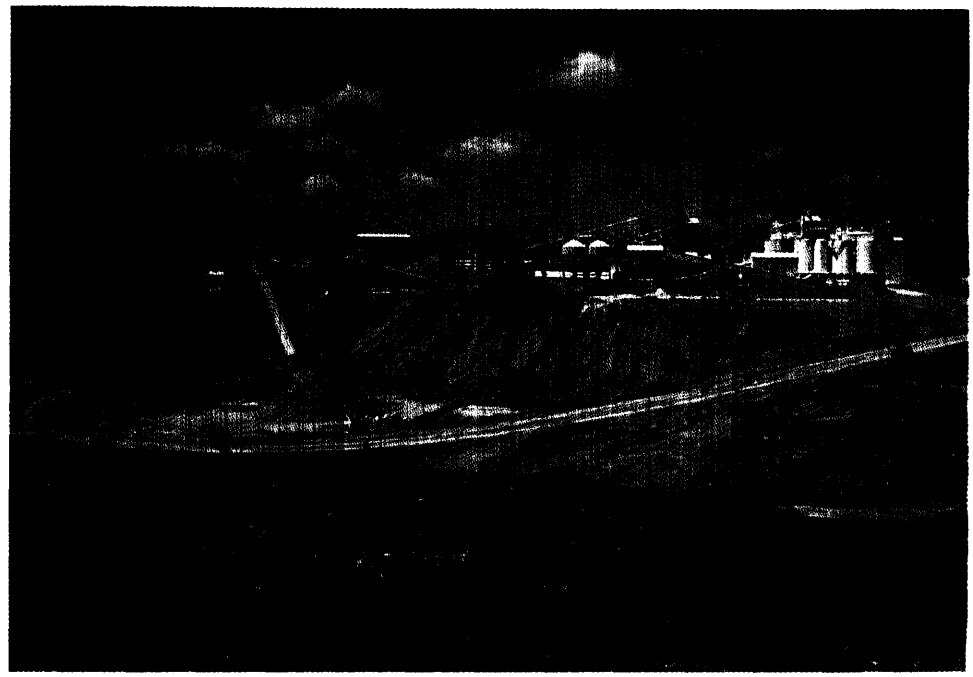
UNIT 3 Lucas Formation, Anderdon Member *4.8m*

Calcarenite: light to medium brown, weathers brown; fine to medium grained; thick bedded (up to 1 m), contacts are sharp, irregular, stylolitic and bituminous; very fossiliferous with large football-shaped stromatoporoids and coralgal debris; this unit is similar to Unit 5; stromatoporoids are larger and their internal structures are better preserved; one zone is thin bedded, lithographic, and barren of fossils; rare rugose corals and brachiopods present; lower contact is sharp.

UNIT 2 Lucas Formation, Anderdon Member *6.7m*

Interbedded calcarenites and limestones (50/50%): medium to dark brown, weathers light to medium brown; microcrystalline and fine to medium grained; thick bedded (up to 1 m), contacts are sharp, some beds are bituminous and stylolitic; the limestones are lithographic in texture, calcite mineralization present in lithographic limestones and in fractures; abundant coralgal debris, rare stromatoporoids; sharp lower contact.

Photo A-3-1.
BEACHVILIME LTD. -
WEST PLANT.



UNIT 1 Lucas Formation, Anderdon Member *~7.0m*

Bioclastic limestone: tan to light grey, weathers dark grey; fine to very coarse crystalline; thin to medium bedded, contacts are sharp, very irregular and bituminous; strong bituminous odor; beds have a very irregularly laminated appearance; prominent light and dark banding is present; rare beds are calcarenaceous; calcite mineralization present in some small patches; rare pyrite crystals present; very rare leached chert present replacing fossils; abundant stromatoporoids, coralgal debris, solitary corals, rare bryozoans and brachiopods; base of unit below water level.

Total thickness *24.1m*

QUARRY OPERATIONS

The West quarry is situated north of the CNR tracks and has access to the old quarry and plant through a tunnel beneath the tracks. Overburden ranging from 18 m to 27 m is removed by contract at a 1:1 stripping ratio and, once removed, exposes a 24.1 m section of high–calcium limestone.

Production drilling on the single lift is carried out with an Ingersoll– Rand Drillmaster (BL900) on a 23 ft. by 26 ft. pattern and produces 6 in. diameter holes. The holes are pumped dry before bottom–loading with CIL Magnafrac 300 (or 500), followed by bulk ammonium nitrate prills mixed with diesel fuel for the remainder.

The blasted rock is loaded by a Michigan 475B 12 yd. Payloader and a 6.5 cu. yd. P&H electric shovel onto three 60–ton Wabco Haulpak trucks for haulage to the primary crusher on the quarry floor.

PROCESSING

The primary crusher is a 42 in. Traylor gyratory. A 36 in. conveyor then carries the crushed stone to a surge pile at the secondary crushing plant. Stone from the surge pile is picked up by another 36 in. sublevel conveyor and subsequently reduced and screened to –2 3/4 in. in the secondary crusher, a 42 in. by 35 in. McLanahan heavy duty double roll.

Feed to the screenhouse and bin building is split between two (5 ft. x 14 ft.) Ty–Rock F800 triple–deck screens equipped with 2 3/4 in. openings on the top deck, 2 in. openings on the middle deck, and 3/4 in. openings on the bottom deck. The +2 3/4 in. stone is recrushed in a 51 in. Telsmith hydrocone, that is in a closed circuit with the screens. The two intermediate sizes, –2 3/4 in. + 2 in. and –2 in. + 3/4 in., are used as kiln feed in the lime operation. The –3/4 in. fines are split between two (5 ft. x 14 ft.) Ty–Rock F600, twin deck screens and –3/4 in. + 5/8 in., –5/8 in. + 1/4 in. and –1/4 in. fines are the products.

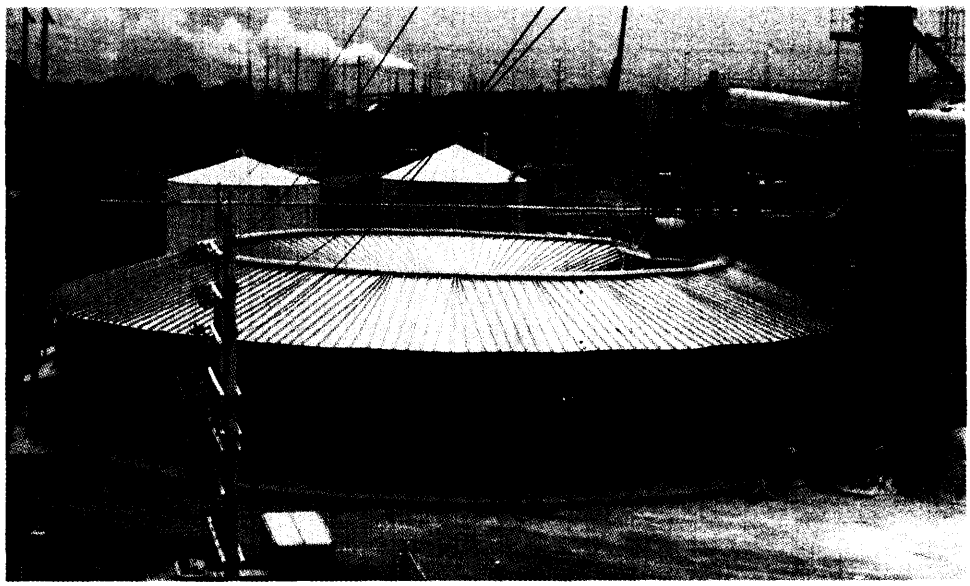
The crushing plant has a capacity of about 550 tons per hour and produces about 1.2 million tons annually.

Lime Plant

Lime is produced in two gas–fired rotary kilns and one gas–fired rotating hearth Calcimatic kiln. The lime products are used mainly in steel–making, carbide manufacturing, and for water treatment.

The #1 kiln, a F.L. Smidth rotary unit (with preheater) built in 1957, is 276 ft. x 10.5 ft. and has a

Photo A-3-2.
THE CALCIMATIC KILN AT THE BEACHVILIME WEST PLANT IS THE ONLY ONE IN USE IN ONTARIO.



production capacity of 496 tons of lime per day. Kiln #2 is a Calcimatic unit built in 1967 and has a capacity of 298 tons per day. The kiln has a doughnut-shaped refractory hearth that rotates the stone through two temperature zones up to a maximum of about 1300°C. The gas burners are arranged around the hearth and exhaust gases, which are expelled through a chimney, preheat the fresh kiln feed in the process. Kiln #3, 180 ft. x 12.5 ft., is also a rotary unit with preheater and is capable of producing 660 tons per day.

Dried Stone Plant

The DSP is similar to the one located at the East operation and is rated at 35 tons per hour.

PRODUCTS

Quicklime

150 mesh
1/4 inch by 0 mesh
-3/4 in.
-3/4 in. + 4 mesh
-2 in. + 4 mesh

Hydrate

Pulverized Stone

Grade 30
Calgro Pulverized Limestone B-2
Calgro Pulverized Limestone B-1
Calgro #3 Grits
Shellroc
Limestone screenings
Limestone chips
2 in. by 1 1/4 in. limestone
1 1/4 in. by 3/4 in. limestone

REFERENCES

Goudge, 1938, p.263-264
Caley, 1941a, p.52
Ehlers and Stumm, 1951
Best, 1953, p.111-115
Stumm et al., 1956, p.13
Hewitt, 1960, p.152-155
Hewitt, 1964a, p.65
Hewitt and Vos, 1972, p.68-69

MAPS

Caley, 1941d, GSC 624A

A-4 STELCO STEEL QUARRY

LOCATION AND OWNERSHIP

Stelco Steel operates a plant and quarry 3.5 km southwest of Beachville (Figure A-4-1). The plant and quarry straddle the boundary between the Township of Zorra (North Oxford Township) and the Township of South West Oxford (West Oxford Township). Partly in the Town of Ingersoll, the property covers an area of approximately 593 ha of which about 21 ha are occupied by the quarry.

GEOLOGY

The quarry exposes 33.4 m of the Anderdon Member of the Middle Devonian Lucas Formation in three lifts (Figure A-4-2). The lower 28.3 m predominantly consist of bioclastic and microcrystalline limestones and cal-

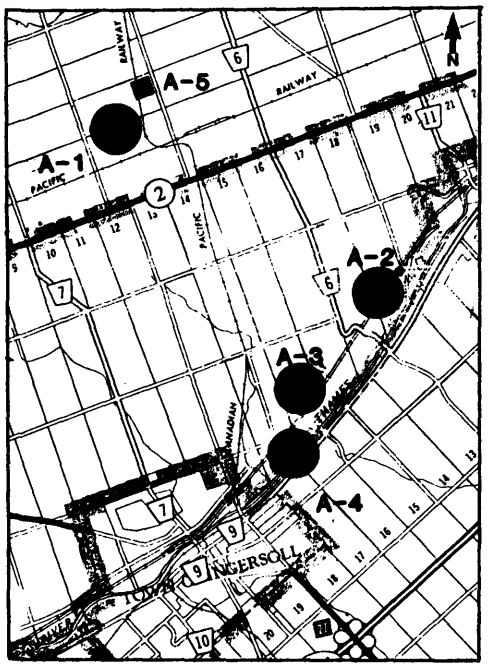


Figure A-4-1. LOCATION MAP FOR STELCO STEEL QUARRY.

carenites. Some beds contain prolific amounts of stromatoporoids. These beds are very similar to the strata in the BeachviLime Ltd. Quarry (A–3). The distinguishing feature in this quarry is the top 5.1 m of the Lucas Formation which is a sandy limestone facies of the Anderdon Member. It acts as a distinctive cap rock for the quarry. Overburden averages 7 m in the vicinity of the quarry.

Geological Section

Thickness

UNIT 5 Lucas Formation, Anderdon Member *5.1m*

Sandy limestone: cream–buff, mottled, weathers buff; fine-grained quartz-rich sand in fine-crystalline limestone; thick to massive bedded, contacts are sharp and undulating; acts as a distinctive cap rock; abundant orange coloured staining present; lower contact is sharp.

UNIT 4 Lucas Formation, Anderdon Member *17.5m*

Interbedded limestones and calcarenites: tan to medium brown, weathers brown; subcrystalline to fine and medium grained; thin to thick bedded (up to 1 m), contacts are sharp and well defined, undulating and stylolitic with abundant bituminous partings; lithographic texture; top 2.7 m is thin bedded; some stylolites develop into shaly partings (up to 4 cm thick); scattered calcite crystals in lithographic limestones; abundant zones of coralgal debris, especially in calcarenites; lower contact is sharp.

UNIT 3 Lucas Formation, Anderdon Member *2.8m*

Calcarenite: light to medium brown, weathers brown; fine to medium grained; thick bedded (up to 1 m), contacts are sharp, irregular, stylolitic, and bituminous; very fossiliferous with large football-shaped stromatoporoids and coralgal debris; lower contact is sharp.

UNIT 2 Lucas Formation, Anderdon Member *4.5m*

Interbedded calcarenites and limestones: medium to dark brown, weathers light to medium brown; subcrystalline and fine to medium grained; thick bedded (up to 1 m), contacts are sharp, bituminous and stylolitic partings; lithographic texture; calcite mineralization present in lithographic limestones and along fractures; fossiliferous with abundant coralgal debris and rare stromatoporoids; sharp undulatory lower contact.

UNIT 1 Lucas Formation, Anderdon Member *3.5m*

Bioclastic limestone: tan to light grey, weathers dark grey; medium to coarse crystalline; thin to medium bedded, contacts are sharp, irregular and very bituminous; possesses a strong bituminous odor; prominent light and dark banding present; some calcarenaceous beds present; abundant coralgal debris.

Total thickness *33.4m*

QUARRY OPERATION

The loose overburden, which consists essentially of sand and till, is removed by a Bucyrus–Erie 3 1/4 yd. electric shovel and 22–ton Euclid haul trucks for use as backfill in quarried–out areas. The sandy limestone caprock to the quarry is loosened by drilling and blasting and removed by loader and truck for use as fill or for sale as riprap.

High purity limestone (98.5% $CaCO_3$) is removed from two lifts; the upper 15.8 m high and the lower 14.3 m high. Blastholes (6.25 in. diameter) are drilled with a diesel rotary drill on a 5.8 m x 6.1 m pattern. Tovex, Hydromex T–3 and AN/FO are used as explosives at a rate of 0.32 lb./ton. Due to the proximity of the Town of Ingersoll, all blasts are monitored for noise and vibration.

The broken rock is removed by a 7 yd. Cat 988B loader and transferred to 22–ton Euclid trucks for haulage to the primary crusher.

The quarry has a rated capacity of 810,000 tons of limestone per year operating on five shifts per week.

PROCESSING

The primary crusher, a 48 in. x 60 in. Traylor jaw, is located on top of the lower lift. The crushed stone is transported to the secondary crusher building by a 42 in. conveyor and discharged onto a 5 ft. x 14 ft. Tyler F800 single deck scalping screen. The screen has a split deck with 4 1/2 in. and 10 in. openings; +10 in. stone is sent to the secondary crusher; –10 in. + 4 1/2 in. stone is sent either to a bin as open hearth flux stone or to the secondary crusher; –4 1/2 in. stone is sent to a double deck 5 ft. x 10 ft. Tyler F600 screen (for removal of fines to a storage bin) and the –4 1/2 in. + 3/8 in. product is car-

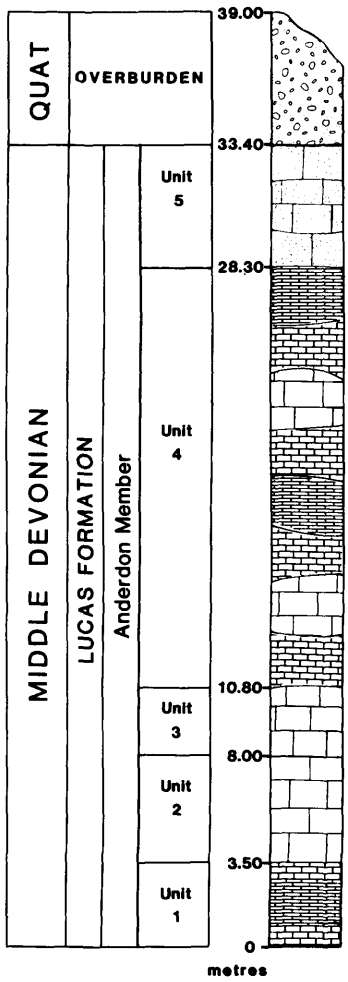


Figure A-4-2. STRATIGRAPHIC COLUMN FOR STELCO STEEL QUARRY.

ried on a 36 in. conveyor belt to the bin building. The −4 1/2 in. + 3/8 in. stone is discharged onto a double-deck 6 ft. x 14 ft. Tyler screen together with the −10 in. + 4 1/2 in. stone, and this combination produces −10 in. + 4 1/2 in. open hearth flux stone, −4 1/2 + 2 1/4 in. shaft kiln feed, and −2 1/4 in. fines for further processing.

The −2 1/4 in. stone is transferred by conveyor to two triple-deck Tyler F880 screens which generate −2 1/4 in. + 1 3/4 in. blast furnace flux stone, −1 3/4 in. + 1/2 in. rotary kiln feed, −1/2 in. + 3/16 in. small stone bottom and −3/16 in. screenings. Various blends of −2 1/4 in. stone can be used, as needed, to generate −3/16 in. sinter flux stone via a C38 Pennsylvania impactor in closed circuit with two Nordberg rod deck screens.

LIME PLANT

The Lime Plant consists of three vertical shaft kilns (installed in 1959) and a single Kennedy Van Saun short rotary kiln (installed in 1971); all are fired by natural gas. The vertical shaft kilns are charged with −4 1/2 in. + 2 1/4 in. limestone and have a combined capacity of 300 tons of lime per 24 hours. The KVS rotary kiln is charged with −1 3/4 + 1/2 in. limestone and has a rated capacity of 420 tons per 24 hours.

The shaft kilns discharge to elevator #1 and a lump lime silo that feeds a stationary grizzly, or is routed directly (by-passing the silo). Oversize from the grizzly is sent to a McLanahan double-roll crusher; the product rejoins the fines from the grizzly and is conveyed to elevator #2. The lime is fed to a triple-deck 4 ft. x 8 ft. Dillon screen and oversize is returned to the roll crusher; mid-sizes go to one of four bins (totalling 3,000 tons storage capacity), and the fines go either to load-out via elevator #3. Lime from the rotary kiln is added to the elevator #2 feed.

Lime is recovered from the storage bins to a 5 ft. x 12 ft. double-deck Tyler screen that routes the coarse material onto load-out, mid-size go either to load-out or return to elevator #2 and fines go to elevator #2. The lime plant has a rated capacity of 243,000 tons per year, on a 24 hour a day basis.

PRODUCTS

Riprap
Lime for steel-making flux.
Crushed and sized limestone.

REFERENCES

Goudge, 1938, p.264

Photo A-4-1. STELCO STEEL LIME PLANT.

Caley, 1941a, p.52
Ehlers and Stumm, 1951
Best, 1953, pp.107–111, 167–168
Stumm et al., 1956, p.14
Hewitt, 1960, p.155
Hewitt, 1964a, p.65
Hewitt and Vos, 1972, p.71–73
Winder and Sanford, 1972, p.67
Winder et al., 1975, p.151–152
Uyeno et al., 1982, p. 43–44
Telford and Johnson, 1984, p.32

MAPS

Caley, 1941d, GSC 624A

A-5 FEDERAL WHITE CEMENT LTD. — WOODSTOCK PLANT

LOCATION

Federal White Cement Ltd. operates a dry process cement plant near Woodstock, Ontario; the only white cement producer in Canada. The plant is located immediately to the north of the Lafarge Canada Inc. plant in the Township of Zorra, Oxford County, on Zorra Concession Road 3, approximately 23 km west of Woodstock, as shown in Figure A–5–1.

PROCESSING

The plant was built in 1979 to designs provided by Lafarge Canada Inc. The plant uses a Fuller oil/gas/coke–fired kiln. No other details on the equipment and production process are available from the company.

PRODUCT

The plant has truck and rail shipping facilities. Although white portland cement is as durable as standard portland cement it is used mainly in decorative architecture where the concrete surface is exposed. Because of this feature, white cement is able to command a high price.

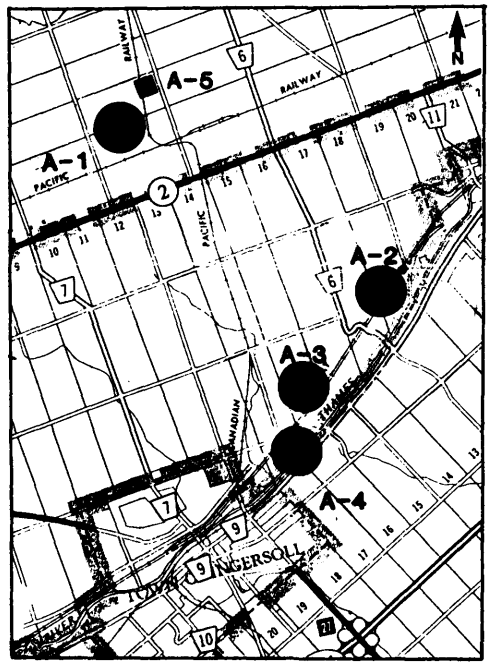


Figure A-5-1. LOCATION MAP FOR WOODSTOCK PLANT.

Wingham District

INTRODUCTION

Wingham District is located in Southwestern Ontario and is bounded by Lake Huron to the west and the Districts of Owen Sound, Cambridge and Aylmer to the north, east and south, respectively.

Nineteen quarries in the Wingham District are documented in the quarry inventory (*see* Appendix IV, Vol-

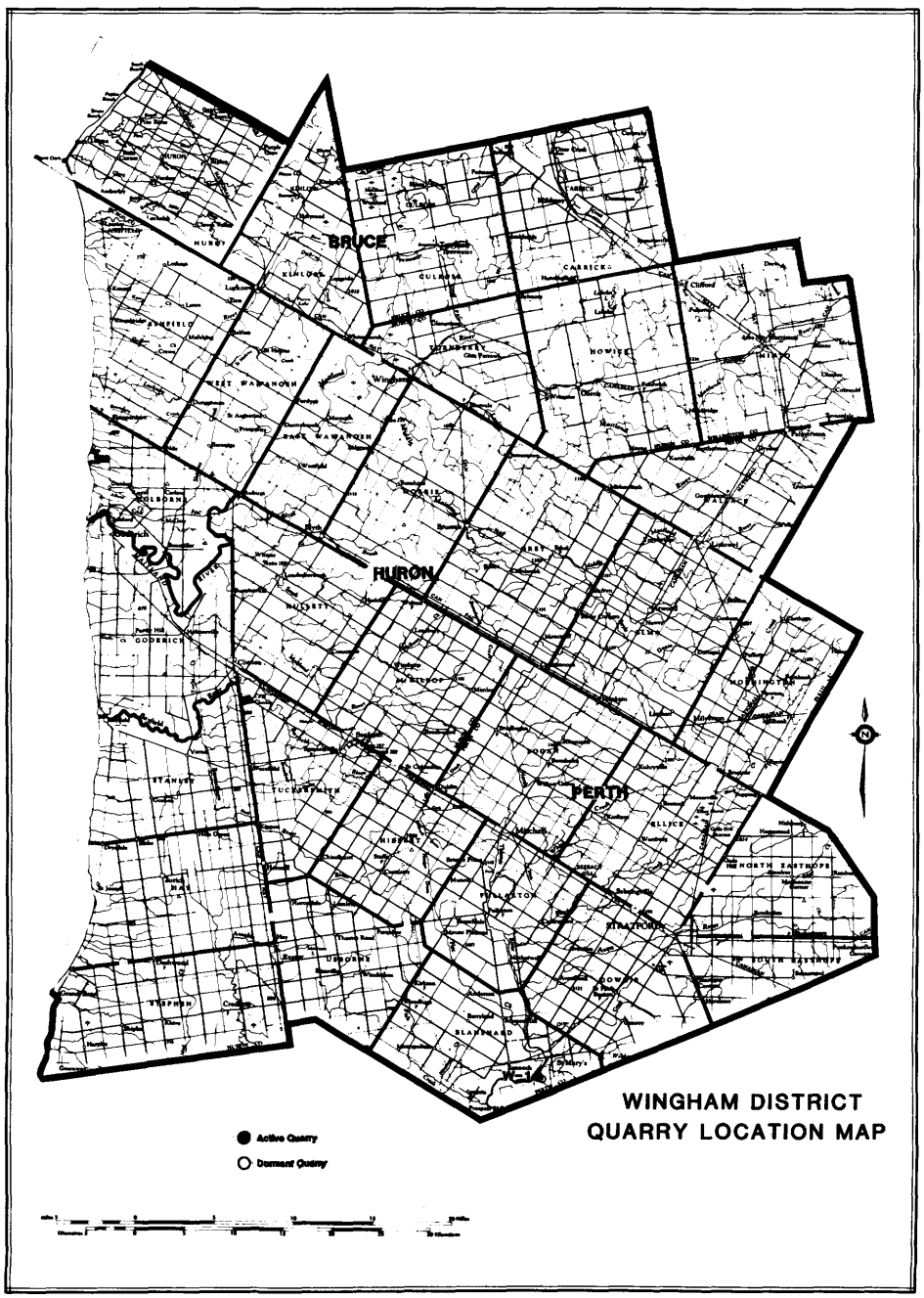


Figure W-0-1. WINGHAM DISTRICT QUARRY LOCATION MAP.

ume I), only one of which, the St. Marys Quarry (W–1) is currently active.

REGIONAL GEOLOGY

The Wingham District exhibits low relief and, due to thick Quaternary deposits, outcrops are sparse. The district is criss–crossed by numerous westward flowing streams and is bordered by Lake Huron to the west. The hummocky topography along the northern edge of the district is the surface expression of the Formosa Reef Complex, a reefal facies of the Amherstburg Formation (Detroit River Group). It is characterized by small knolls and hummocks, which were excavated for building stone at the turn of the century.

Rock exposures in the area are mainly found along river valleys near the towns of Gorrie, Goderich, Brussels, and St. Marys (where the only operating quarry is located), along with minor outcrops of the Formosa Reef Limestone facies near the town of Formosa. A typical section of the Formosa Reef Limestone is exposed 4 km north of Formosa. The stratigraphy present in subcrop includes units from the Upper Silurian Salina Formation to the Middle Devonian Dundee Formation (see Figure W–0–1). Most of these units are Michigan Basin rock units, but formational boundaries are difficult to define in the subsurface due to interfingering of Appalachian Basin units from the southeast.

The St. Marys Cement Co. Quarry (W–1), located west of the Thames River in the Town of St. Marys (Figure W–0–1), exposes 18.2 m of section from the Middle Devonian Detroit River Group (Lucas Formation) and the Middle Devonian Dundee Formation (Figure W–0–2). The Lucas Formation in the quarry here consists of a grey, very fine– to fine–crystalline, thin–to medium–bedded dolomitic limestone. It is sharply and disconformably overlain by the Dundee Formation, a grey, fine– to medium–crystalline, thin– to thick–bedded, somewhat shaly limestone. Other small and water filled abandoned quarries exist within the town and are of the same lithology, except those east of the Town of St. Marys where the rocks are Silurian in age. The Upper Silurian Bertie Formation occurs in some older quarries because of a pronounced anticlinal fold in the subsurface which has uplifted the underlying strata.

LIMESTONE INDUSTRIES

The principal limestone industry in Wingham District is cement production, from Middle Devonian limestones and dolomitic limestones of the Lucas and Dundee Formations. The single active quarry, St. Marys (W–1) also produces minor amounts of crushed stone.

The cement production in 1986 for Perth County was approximately 573,000 tonnes (1987 Ontario Mineral Score). The St. Marys Quarry (W–1) markets a wide variety of products including, but not restricted to,

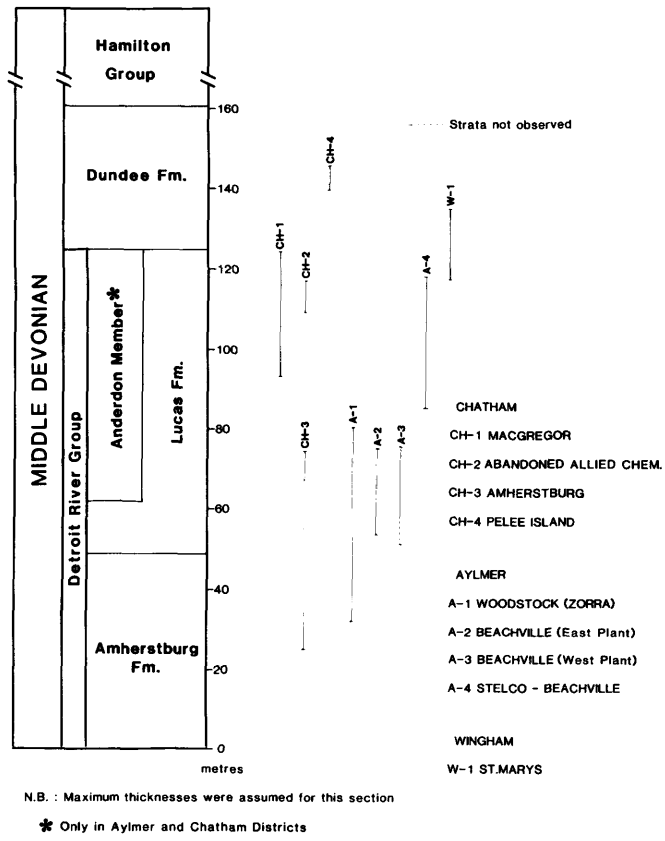


Figure W–0–2. STRATIGRAPHIC COLUMN SHOWING PRINCIPAL QUARRIES IN AYLMER, CHATHAM AND WINGHAM DISTRICTS.

Normal Portland, High Early Strength Portland, Sulfate Resisting Portland, Moderate Portland, Low Heat of Hydration Portland and Masonry Cement.

W–1 ST. MARYS CEMENT COMPANY — QUARRY AND PLANT

LOCATION AND OWNERSHIP

The quarry and cement plant of St. Marys Cement Company is located on the southern outskirts of St. Marys. The plant is located on the east side of the north branch of the Thames River, while the quarry is located approximately 0.8 km to the west on the west side of the river in Concessions 16 and 17, Blanshard Township, Perth County as shown in Figure W–1–1.

The Middle Devonian limestone in the St. Marys area has been a source of stone products since the mid–nineteenth century. Initially, small quarries were opened along the banks of the Thames River, both south and north of the village, to extract stone to supply the lime kilns built adjacent to the quarries. This lime was commonly used locally as the land was opened to agriculture.

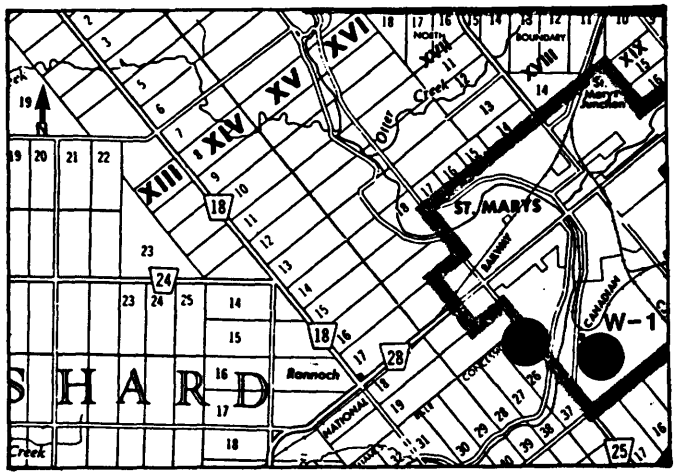


Figure W-1-1. LOCATION MAP FOR ST. MARYS QUARRY.

In addition to lime production, the thicker-bedded limestones were quarried for building stone. These operations also produced rough stone which was used in foundations, sills, lintels and coursings. A variety of dressed stone was provided by some quarries. These stone products were used across southwestern Ontario, as well as in various buildings in Toronto. Other products from these quarries included crushed stone (commonly the waste rock from the building stone operations), used in local road construction, flux stone supplied to the blast furnaces in Hamilton and limestone used in the manufacture of beet sugar. Most of these lime and building stone operations had ceased by the turn of the century, although a few did survive into the early twentieth century.

In 1912 the St. Marys Cement Company began to use the limestones south of St. Marys for the production of portland cement. The operations soon expanded and began to incorporate many of the older, now abandoned, quarries along the Thames River. Today the St. Marys Cement Company's quarries extend along both banks of the river.

The plant is a 2,000 tonne per day dry process kiln situated in the floor of the old quarry. A wet process, 4-kiln cement plant is located close by the new plant, but is not operated, except for finish grinding and storage purposes.

GEOLOGY

The new quarry exposes an 18 m section of Middle Devonian limestone and dolomitic limestone of the Dundee and Lucas Formations, respectively, (Figure W-1-2) in a single bench.

The new quarry was opened when magnesia and alkali contents in the old quarry were found to be increasing as it was developed to the southeast. The rocks of the Dundee and Lucas Formations strike northwest and dip to the southwest at 2.8 m per kilometre. Quaternary overburden in the area of the new quarry ranges up to 12 m thick and averages 7 to 9 m in thickness.

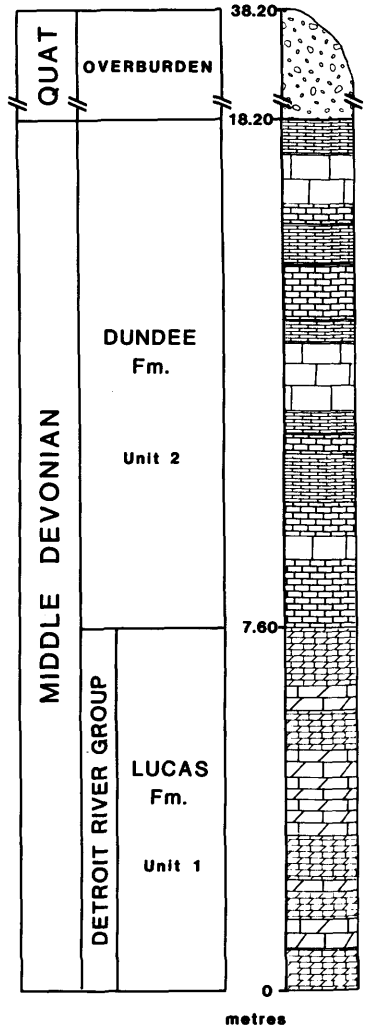


Figure W-1-2. STRATIGRAPHIC COLUMN FOR ST. MARYS QUARRY.

The lower 7.6 m consist of very fine- to fine-crystalline, thin- to medium-bedded, banded Lucas Formation limestone. These rocks are light grey to light buff, weather to a light brown, and contain a microcrystalline bed near the floor of the quarry. Dolostones averaging 17% MgO underlie the quarry floor for at least 30 m.

Overlying the Lucas Formation are 10.6 m of Dundee Formation limestones which are very fine to fine crystalline, grey to buff and in beds 3 to 40 cm in thickness with thin grey to black shale partings. The lower

TABLE W-1-1. DRILL HOLE ANALYSES
W-1 ST. MARYS CEMENT COMPANY
ST. MARYS QUARRY.

Hole	Formation	Thickness (m)	CaO (%)	MgO (%)
F2	Dundee	12.80	52.70	1.40
	Lucas	6.55	50.47	2.96
F3	Dundee	12.65	52.06	1.25
	Lucas	7.47	52.21	2.76
F4	Dundee	12.80	52.16	1.54
	Lucas	6.71	50.93	3.74
F7	Dundee	12.65	52.61	1.22
	Lucas	7.16	52.46	2.04

Data provided by St. Marys Cement Company.

contact of the Dundee Formation is sharp and erosional and is marked by a sulphurous clay seam, and by a rusty porous dolostone at the top of the Lucas Formation.

Exploration diamond drilling by St. Marys Cement Company tested the stratigraphy at various locations, within the licensed area. The analytical results from the drill core, as presented in Table W-1-1, are reported by St. Marys Cement to be representative of the chemical composition of the property stratigraphy.

Only CaO and MgO assays are available as the stone delivered to the raw mill has been so consistent. No deleterious elements such as sulphur, chlorine and phosphorous are reported.

Geological Section

Thickness

UNIT 2 Dundee Formation *10.6m*

Limestone: light grey-brown, weathers light grey; fine to medium crystalline; thin to thick bedded (3 to 40 cm), contacts are sharp, slightly irregular, and appear erosional and shaly; lower 25 cm is laminated with rip-up clasts and conglomerates, top of this bed is scoured with calcarenite laminations; scattered colonial coral heads (with oil seeps); scattered erosional horizons with thin clay seams; a 10 cm thick bed (5.4 m from base) is very fossiliferous (abundant crinoids and brachiopods, rare corals, trilobites, and bryozoa), and is clayey and recessive; lower contact is sharp at a sulphurous clay seam.

UNIT 1 Lucas Formation *7.6m*

Dolomitic limestone: tan, grey in some places, weathers same, though some areas are stained by sulphurous water; very fine to fine crystalline; thin to medium bedded (3 to 35 cm), contacts are sharp with thin shaly partings and slightly irregular; two prominent grey bands (0.95 m from the top, 0.20-0.25 cm thick) are present and are laminated, banded, and contain sedimentary features; some clay partings occur and weather platy; rare coral debris is present especially in clay seams; one clay seam, 1.3 m from the base, is filled with marcasite crystals and directly overlies a possible ash bed.

Total thickness *18.2m*

QUARRY OPERATION

Stripping of the overburden is done with a 3-yd. Marion electric shovel, loading a fleet of Euclid rear-dump trucks.

The quarry face is being developed on three sides at equal rates. Drilling is carried out by a 15 cm Gardner-Denver rotary drill on a 6 m x 6.6 m pattern. Holes are drilled to the quarry floor. Blasting is by AN/FO at a rate of 3,000 kg per 10 holes, with a fuel/hydro mix at a rate of 25 kg per hole using the I-L blasting system. Rock fragmentation is good, with no secondary crushing required.

Water inflow in the quarry averages approximately 1,000 gallons per minute, handled by an 8 in. submersible pump having a capacity of 1,500 gallons per minute.

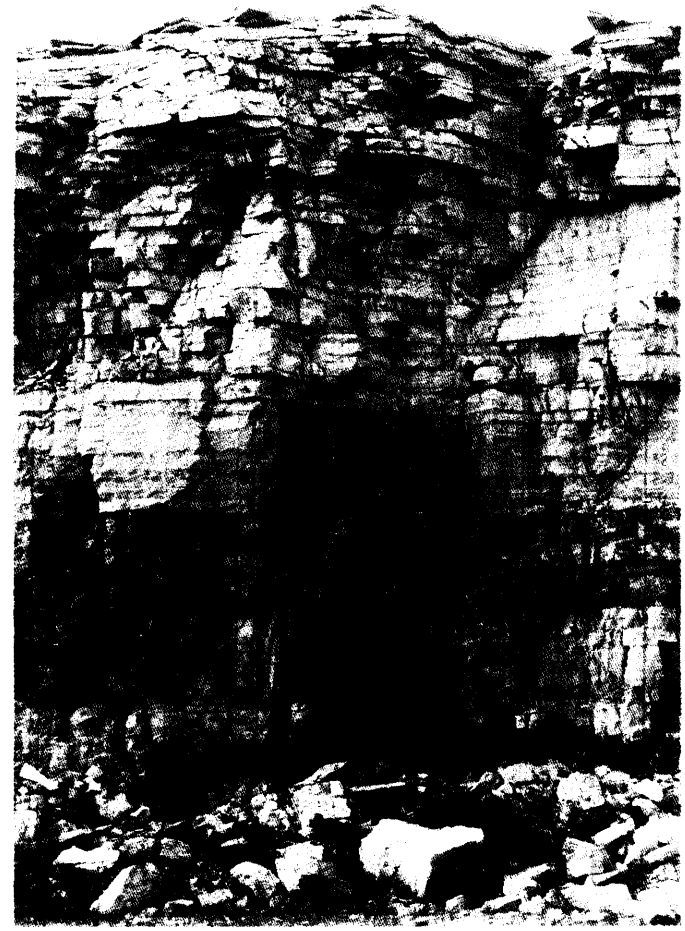


Photo W-1-1. EAST SIDE OF NEW ST. MARYS QUARRY SHOWING DOLOSTONE IRON STAINING AT THE CONTACT BETWEEN THE DUNDEE FORMATION AND THE DETROIT RIVER GROUP.

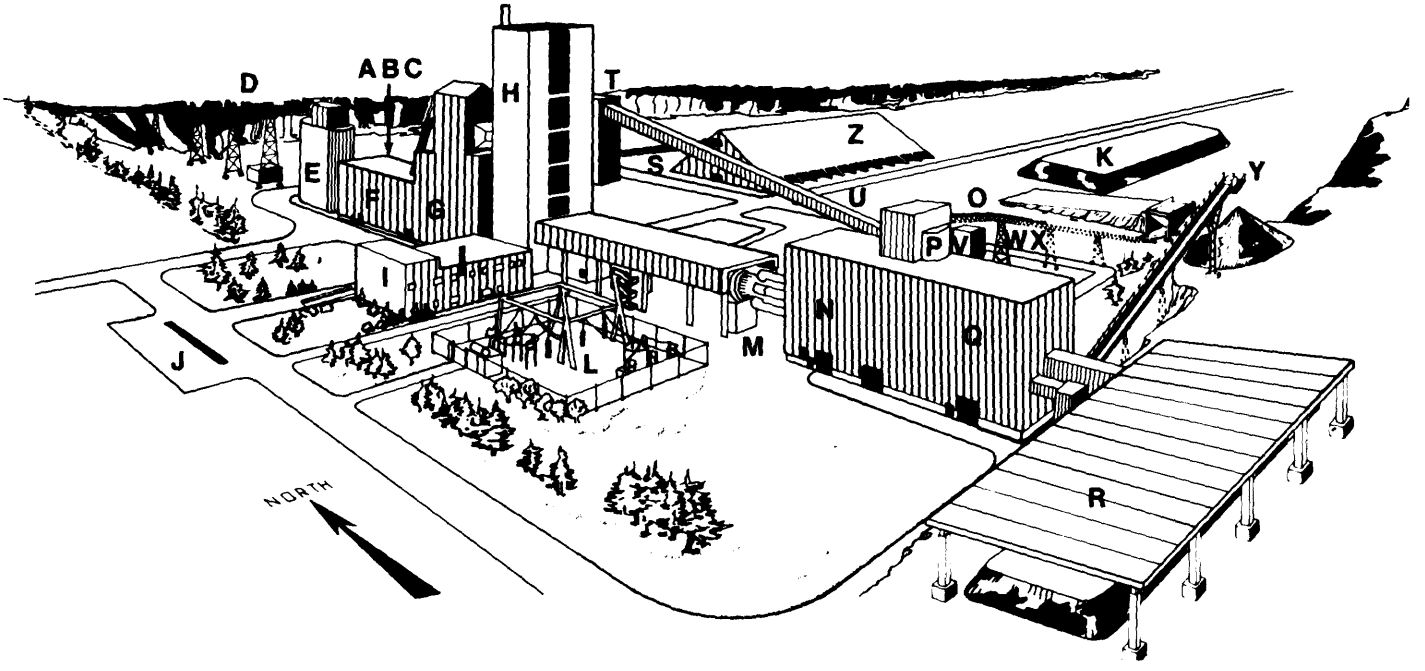


Figure W-1-3. GENERAL LAYOUT OF ST. MARYS CEMENT.

PROCESSING

A general layout of the St. Marys Plant is shown in Figure W-1-3.

The shot rock is recovered by a CAT 988B loader into three 40-ton Euclid rear-dumps. A 5-yd. Bucyrus-Erie electric shovel is located in the quarry as a standby. Stone is hauled approximately 600 m to a Traylor 52 in. gyratory primary crusher located in the quarry floor. The crusher is set at 6 in. and has a capacity of 1,000 tonnes per hour.

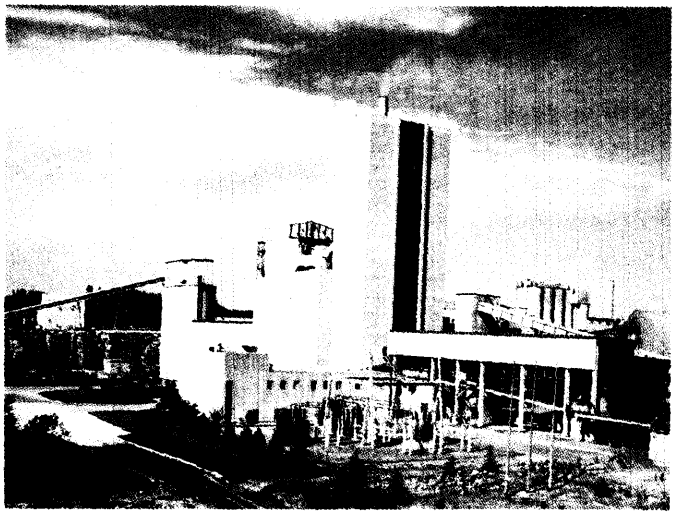


Photo W-1-2. ST. MARYS CEMENT PLANT.

Primary crushed stone is transported from the new quarry by a 42 in. covered belt conveyor approximately 800 m, to the secondary crusher located at the old cement plant. Here the material is reduced to -1 in. in a Pennyslvania impactor. After secondary crushing, the raw stone is conveyed to a 2500-ton storage silo located at the new plant.

Clay is obtained from a pit directly south of the new plant. The clay is removed by a CAT 245 3-yd. backhoe to a 40-ton, rear-dump truck, which transports the material to a covered area where it is fed to a variable speed Rexnord belt conveyor and thence to the clay mill. The clay mill is a 4.7 m diameter semi-autogenous Aerofall mill which grinds the material to -50 mesh, and has a capacity of 1,600 tonnes per day. The clay is dried and beneficiated and then pumped by an F.L. Smidth fluxo pump approximately 200 m to two 2500-ton storage silos adjacent to the raw limestone silo.

Other raw materials, chiefly silica flour, alumina and mill scale, are stored in a quadrated silo. Each quadrant holds 625 tons. Silica flour is purchased from Indusmin Ltd. in Midland, while mill scale is supplied from Hamilton.

Limestone and clay in a 2:1 ratio and other raw materials are ground in an Allis-Chalmers/Pfeiffer MPS 3150/2050 roller mill which uses waste kiln gases for drying the material. The mill has a bowl diameter of 3.15 m and three 2.05 m diameter rollers driven by a 750 kw motor. Material is ground to 90% passing 200 mesh at a rated capacity of 180 tonnes per hour.

The ground raw mill feed is pneumatically conveyed to the two 4,500 m^3 homogenizing silos, where it is blended using a GATX-Fuller airmerge system. Prior to homogenizing, the mill exit gases and the ground feed are processed through an American Air Filter/Elex electrostatic precipitator. The homogenized kiln feed overflows from the homogenizing silos to an 1,100 m^3 kiln feed silo.

KILN

Raw kiln feed is drawn from the kiln feed silo through Fischer vee-ball valves, and is carried to the top of the preheater tower by a double string of Webster belt buckle elevators and GATX-Fuller airslides. Each string has a rated capacity of 180 tonnes per hour. The raw kiln feed is discharged from a constant level box through two Fischer vee-ball valves onto two Merrick weigh-feeders and thence into the preheater system.

The preheater is a F.L. Smidth two-string, four-stage suspension system. The four first stage cyclones are 11.5 ft. in diameter, while the second and third and fourth stages are 16.5 ft. in diameter. There is a maximum 5% by-pass on the preheater for control of alkalis.

Kiln feed temperatures reach 1,000 degrees C at the bottom of the preheater. The preheater gas is treated with two gas conditioners.

The dry process kiln is an F.L. Smidth design meas uring 15.5 ft x 325 ft. and rated at 2,000 tonnes per day. The primary fuel is pulverized coal, with a capability for gas on dual coal/gas firing. Clinker cooling is in ten 6.4 ft. diameter x 67 ft. Unax planetary coolers. Additional clinker cooling is provided by an F.L. Smidth water cooling system attached to the planetary coolers. Cooled clinker is discharged to a Hazemag APK-40 impact crusher to reduce the larger clinker pieces, then transferred by conveyor belt to either a large pre-cast concrete 45,000 tonne storage hall adjacent to the new plant or to storage in silos at the old plant. Storage at the old plant is rated at 7,250 tonnes.

Finish grinding takes place in the old plant. Clinker and gypsum are fed to either two 10 ft. x 15.5 ft. 750 hp single chamber ball mills, which are run in tandem; or two 9.5 ft. x 26 ft. 1,250 hp two-chamber Unidan mills. The mills are in closed circuit with Sturtevant air classifiers. Cement is typically ground to a Blaine number of 3,700 for Type 10 product.

Shipment is by bulk road and rail transport and in bags. Rail shipment represents only a small proportion of tonnage.

Process control for the plant is achieved by an Interautomation digital system operated from a Nova 2 computer. Analog instrumentation provides a back-up system.

PRODUCTS

Normal Portland
Moderate Portland
High Early Strength Portland
Low Heat of Hydration Portland
Sulfate Resisting Portland
Masonry Cement

REFERENCES

Goudge, 1938, p.269-273
Caley, 1943, pp.37-38, 68, 71
Best, 1953, pp. 118-119, 178-179, 195-196
Stumm et al., 1956, p.15
Hewitt, 1960, p.161-164
Hewitt, 1964a, p.65-66
Upitis, 1964
Blair, 1965, p.52-54
Diffendal, 1971, p.128-140
Ferrigno, 1971
Hewitt and Vos, 1972, p.70-71
Winder and Sanford, 1972, p.68
Winder et al., 1975, p. 152-153
ARIP 9, 1980, p.18
Uyeno et al., 1982, p.44
Telford and Johnson, 1984, GAC-MAC Field Trip 1, p.34-36

MAPS

Caley, 1942, GSC Map 691A

Chatham District

INTRODUCTION

Chatham District is the westernmost district in the Southwestern Region of southern Ontario, bounded on the north by Lake Huron, on the west by the St. Clair River, Lake St. Clair and the Detroit River, on the south by Lake Erie and on the east by Aylmer District and includes Essex, Kent and Lambton Counties (Figure CH-0-1).

Fourteen quarries are documented in the Chatham District Quarry Inventory; seven are licensed. Three of the seven are currently active with the balance being operated on an intermittent basis.

All of the active quarries and one historic quarry were visited during the study and include:

CH-1	*General Chemical Canada Ltd. - MacGregor Quarry (active)*
CH-2	*General Chemical (Allied Chemical) Quarry (abandoned)*
CH-3	*Amherst Quarries (1969) Ltd. - Amherstburg Quarry (active)*
CH-4	*670026 Ontario Limited - Pelee Island Quarry (active)*

REGIONAL GEOLOGY

This district has relatively low relief, moderate to thick glacial cover, and is surrounded on three sides by the Great Lakes. The two bedrock highs which cross the district (the Algonquin and Findlay Arches), meet at a tectonic low called the Chatham Sag that trends northwest to southeast and is centered on the City of Chatham (see Figure 1.4, Volume I). These tectonic features are not particularly visible in surface topography. No outcrops occur in the extreme southwestern corner of the district (Essex County), although the Dundee Formation outcrops on Pelee Island. In the Thedford and Arkona area, some outcrops of the Hamilton Group and Kettle Point Formation occur.

The Detroit River Group, approximately 180 m thick in the district, is represented by the Amherstburg and Lucas Formations (in ascending order) (Figure CH-0-2). The Sylvania Sandstone, the basal member of the Amherstburg Formation, is also present in the district (but not exposed) and ranges in thickness from zero to 30 m from east to west across Essex County. It consists of a pure white, fine-grained, quartz-rich sandstone with well rounded grains and is conformably overlain by the dolostones of the Amherstburg Formation. The Amherstburg is best exposed in the Amherstburg Quarry (CH-3) where it consists of a medium- to massive-bedded, laminated bituminous dolostone with some zones of oolitic, bioclastic and coralgal-rich limestones, and rare calcarenites. The contact with the overlying Lucas Formation is present in the Amherstburg Quarry, but is transitional and difficult to pinpoint. The Lucas Formation consists of a variety of lithologies including bituminous dolostones, coralline bioclastic limestones and calcarenites. It can be very fossiliferous with abundant stromatoporoids. The Anderdon Member occurs in the upper portion of the Lucas Formation and is a high calcium, microcrystalline to very fine-crystalline, vuggy limestone. It is well exposed in the MacGregor Quarry (CH-1) and in the abandoned Allied Chemical Quarry (CH-2). A calcareous sandstone facies of the Anderdon Member can also be seen in the latter quarry.

The Detroit River Group is disconformably overlain by the Dundee Formation which subcrops extensively in Essex County beneath the Quaternary deposits. The upper portion of the Dundee Formation forms outcrops on Pelee Island and one operating quarry, Pelee Island Quarry (CH-4), exposes 6 m of a thin- to massive-bedded, fine- to medium-crystalline, bituminous bioclastic limestone. The Dundee Formation is succeeded by the Middle Devonian Hamilton Group which has a maximum thickness of 15 m in Essex County, increasing to approximately 93 m around the Thedford/Arkona area. It consists of the following formations (in ascending stratigraphic order): the Bell, Rockport Quarry, Arkona, Hungry Hollow, Widder and Ipperwash Formations. Lithologies range from shales to limestones. The upper portion of the Hamilton Group (Arkona to Ipperwash Formations) outcrops in the Thedford/Arkona and Ipperwash Beach areas. Several small quarries, now abandoned, around the Village of Thedford expose strata of the thin Widder Formation, essentially a fossiliferous shaly and bioclastic limestone.

The Hamilton Group is overlain by the Upper Devonian Kettle Point Formation which outcrops along the Lake Huron shoreline at the Kettle Point Indian Reservation No. 44. It is a dark grey to black siliceous shale with large calcareous concretions (locally called kettles). The Kettle Point Formation is succeeded in Ontario by the Port Lambton Group where it is represented by the Bedford Formation, a soft, grey shale. The Bedford Formation does not outcrop in Ontario and is restricted in subsurface to a small area in Lambton County bordering the St. Clair River south of Sarnia.

The two operating quarries in Essex County (CH-1 and CH-3) utilize both the Amherstburg and Lucas Formations for road construction and riprap. The MacGregor Quarry (CH-1) excavates the pure limestones of the Lucas Formation for chemical lime. The Dundee Formation is extracted from the quarry of 670026 Ontario Limited on Pelee Island where it is used as a source for aggregate. In the past, the abandoned

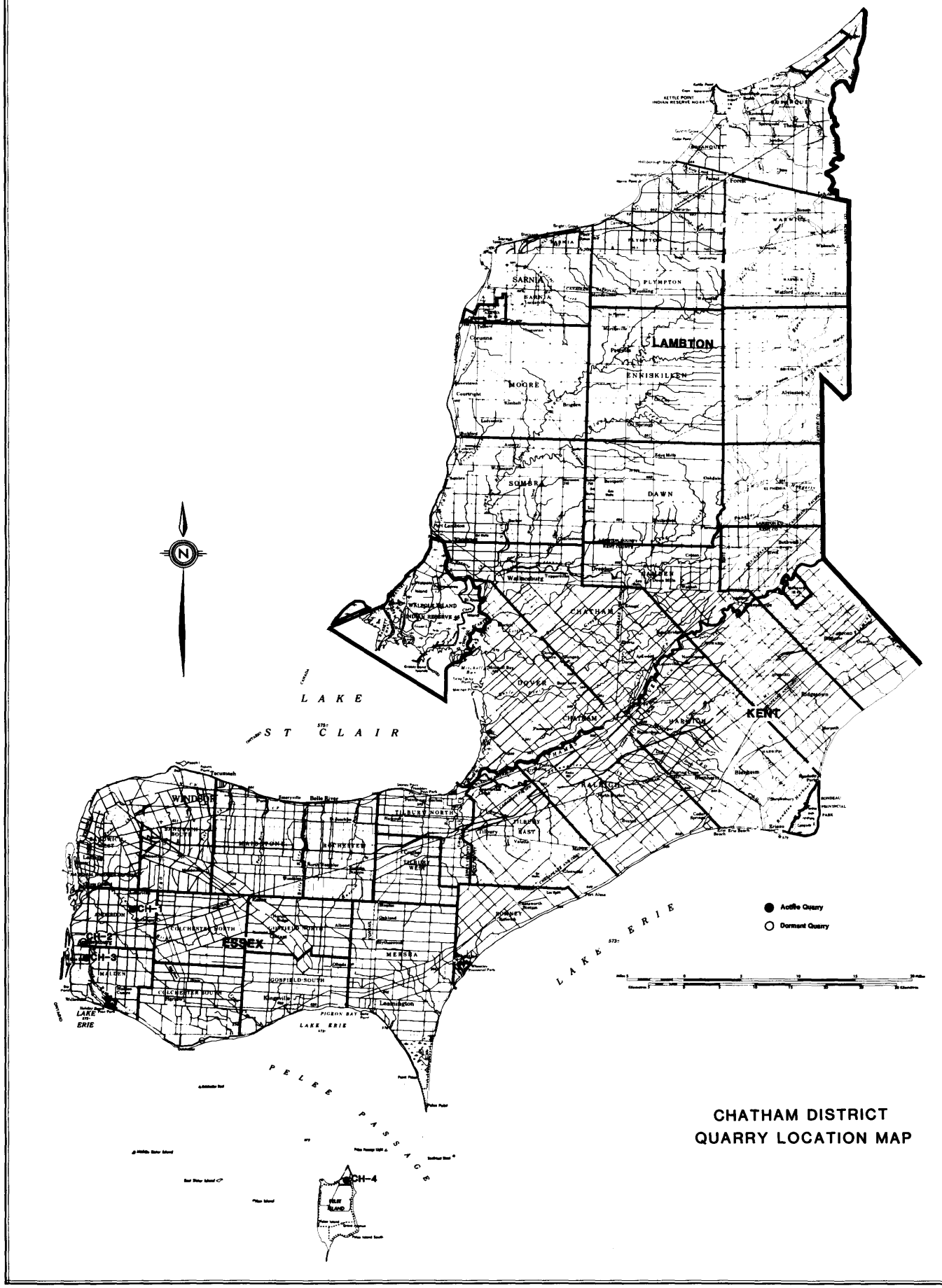


Figure CH-0-1. CHATHAM DISTRICT QUARRY LOCATION MAP.

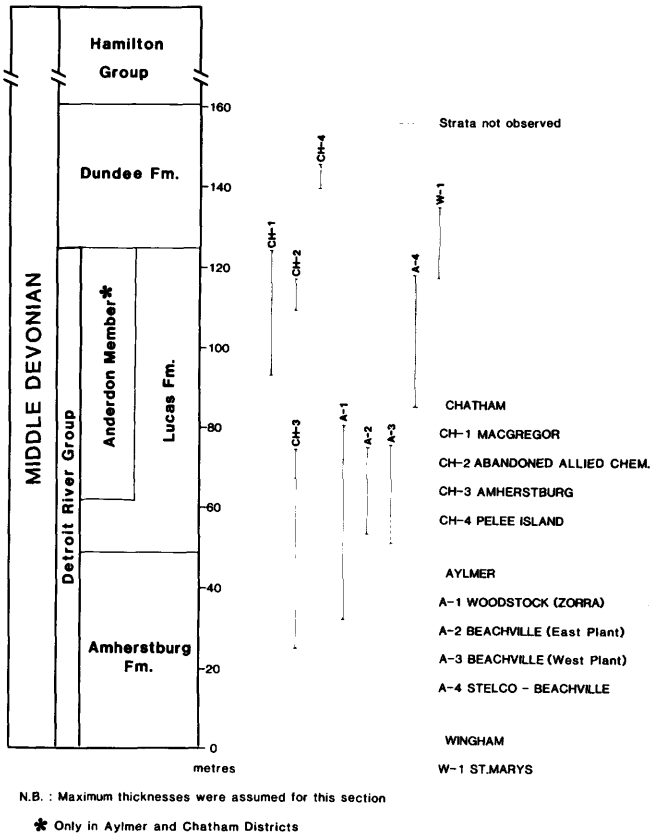


Figure CH-0-2. STRATIGRAPHIC COLUMN SHOWING PRINCIPAL QUARRIES OF AYLMER, CHATHAM AND WINGHAM DISTRICTS.

quarries around the Village of Thedford worked the shales from the Widder Formation to produce drainage tile.

LIMESTONE INDUSTRIES

The limestone industries in the Chatham District include chemical–metallurgical stone, lime, aggregate and building stone. Stone production in 1985 and 1986, as reported by the Ministry of Natural Resources, amounted to about 1,840,000 tonnes and 1,970,000 tonnes, respectively; approximately 50% as chemical–metallurgical stone with the balance being used in the construction industry as road and concrete aggregate. The building stone component of the total stone production is very small.

Lime production in 1986 was approximately 346,000 tonnes (1987 Ontario Mineral Score) and was manufactured by General Chemical Canada Ltd.

Almost all of the production reported for the limestone industries of the district was derived from quarry properties and/or plants in Essex County, most of which was derived from the MacGregor Quarry (CH–1) currently operated by General Chemical Canada Ltd. and under lease agreements by Amherst Quarries (1969) Ltd. and Kennette Contracting Ltd.

Building stone production in 1986 is reported to be in the order of 300 tonnes and is derived from the Amherstburg Quarry (CH–3). The stone is hand split and trimmed by a local stone mason from Harrow, Ontario.

CH–1 GENERAL CHEMICAL CANADA LTD. — MACGREGOR QUARRY

LOCATION AND OWNERSHIP

This large quarry is located in Lots 8, 9 and 10, Concessions 6 and 7, Anderdon Township, Essex County, 10 km northeast of Amherstburg (Figure CH–1–1). In June, 1986 the pit occupied about 77 ha of a total licensed area of 269 ha.

General Chemical Canada Ltd. changed its name from Allied Chemical Canada Ltd. in 1986, and is the operator of a chemical plant at Amherstburg that has been supplied for many years by local quarries. The MacGregor Quarry was opened in 1970 and is currently operated by General Chemical for chemical stone and, under lease agreements by Amherst Quarries (1969) Ltd. and Kennette Contracting Ltd., for aggregate stone.

The quarry is presently being worked to the south where several years of limestone reserves remain. After this area is extracted, a reserve east of the concession road will be tapped.

GEOLOGY

The MacGregor Quarry exposes 32 m of the Middle Devonian Lucas Formation (Figure CH–1–2). The upper

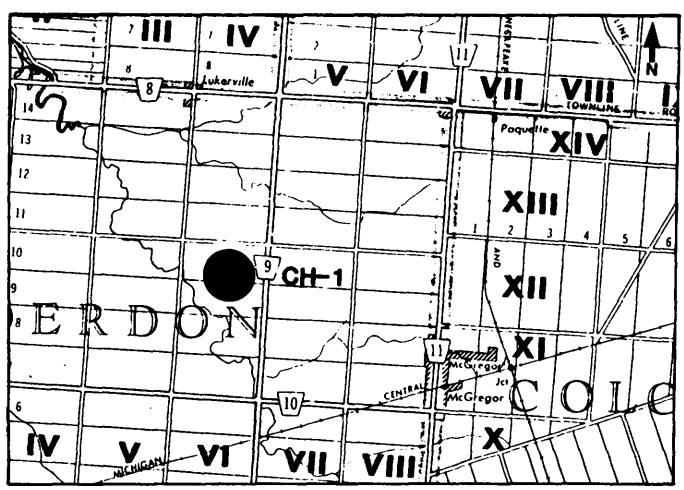


Figure CH-1-1. LOCATION MAP FOR MACGREGOR QUARRY.

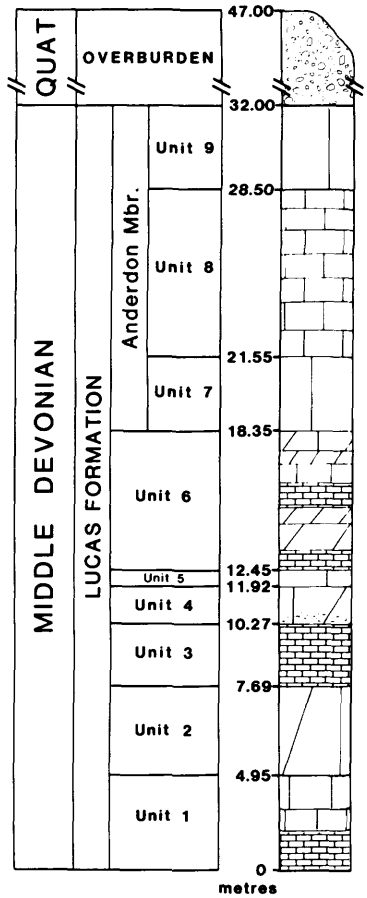


Figure CH-1-2. STRATIGRAPHIC COLUMN FOR MACGREGOR QUARRY.

13.65 m represents the Anderdon Member of the Lucas Formation, which has been shown by drilling to be elliptical in shape and elongated north–south and thins to 6 m at the eastern and western quarry limits. The Anderdon Member consists mainly of a pure, microcrystalline to very fine–crystalline, vuggy limestone with zones of interbedded rubbly limestone, and mottled and banded limestone. The lowermost bed contains abundant stromatoporoids. The balance of the formation consists of interbedded units of fossiliferous limestones, banded limestones and dolostones, dolomitic limestones, microcrystalline limestones and rare calcareous sandstone beds. Scattered zones are very fossiliferous, while others are barren.

A thin cap of dolomitic limestone of the overlying Dundee Formation has been encountered in parts of the quarry, and is known to reach 11 m in thickness in the future quarry site east of the concession road.

Overburden is thick, 12 to 15 m of a gritty clay–silt till overlies the bedrock surface.

Geological Section

Thickness

UNIT 9 Lucas Formation, Anderdon Member *3.5m*

Limestone: cream to very light grey, weathers cream; subcrystalline to very fine crystalline; one massive bed; very abundant calcite crystals in vugs and patches; stylolites common in places; some fossil debris present; lower contact is sharp and irregular.

UNIT 8 Lucas Formation, Anderdon Member *6.95m*

Interbedded limestones (lithographic, mottled, and banded): cream, blue-grey, tan; weathers buff-grey; sub- to fine-crystalline; thick bedded with sharp, welded and irregular contacts, some are stylolitic; rare sedimentary features (rip-ups and flame structures); banding is present in some beds; calcite crystals present in vugs in mottled zones; fossiliferous with abundant rugose corals present 2.5 m from top of unit, rare gastropods and fossil fragments; beds are very porous and vuggy; lower contact is covered.

UNIT 7 Lucas Formation, Anderdon Member *3.2m*

Limestone: light grey to light brown, weathers buff; fine to medium crystalline; one massive bed; appears sandy in places; unit stands out as a distinct resistant bed; fossiliferous, with very abundant stromatoporoids (up to 35 cm long) occur with well preserved internal structures; some stromatoporoids are surrounded by sand and silt laminae; abundant rugose corals also occur; lower contact is sharp.

UNIT 6 Lucas Formation *5.9m*

Interbedded limestones and dolostones: medium grey to brown buff, weathers grey to brown; fine crystalline; medium to thick bedded, contacts are sharp and welded, and sometimes stylolitic; these interbedded lithologies are similar to Units 2 and 4; abundant fossil debris is present in the more porous lithologies; a 45 cm thick, massive, fine-crystalline, grey dolomitic limestone bed caps this unit and contains abundant bituminous partings; lower contact is sharp and stylolitic.

UNIT 5 Lucas Formation *0.53m*

Limestone (lithographic): grey, weathers light to dark grey; micro-to subcrystalline; one massive bed; somewhat mottled (light to dark grey) separated by stylolites; lower contact is sharp, stylolitic, welded, and very irregular.

UNIT 4 Lucas Formation *1.65m*

Limestone, with sandstone and dolomitic limestone: tan, weathers buff-brown; fine crystalline; one massive unit; lower 35 cm is a calcareous sandstone, fine grained, with well developed stromatoporoids (containing grey laminations) that appear to be surrounded by sand; the sandstone grades up into a laminated limestone, which in turn is overlain by a porous, rubbly dolomitic limestone (similar to Unit 2); the upper 10–15 cm contains pelletoid material and is not porous; fossiliferous with abundant fossil fragments and crinoids present, and scattered rugose corals; sharp lower contact.

Unit 3 Lucas Formation *2.58m*

Limestone: tan, weathers buff; fine crystalline; medium bedded (approximately 15 cm); lightly banded, some beds are almost microcrystalline; calcite mineralization present in small vugs; some fossil molds; sharp, irregular and welded lower contact.

UNIT 2 Lucas Formation *2.74m*

Dolomitic limestone: light brown, weathers medium dark brown; fine crystalline; one massive bed; very porous with patches of calcite mineralization in vugs; fossiliferous, with abundant fossil debris and reefal; some iron staining; lower contact is sharp and welded.

UNIT 1 Lucas Formation *4.95m*

Limestone: brown and dark brown bands, weathers brown; fine crystalline; medium to thick bedded, sharp contacts, irregular bedding with thin bituminous partings; lower 0.5 m is banded with bituminous partings; petroliferous odor; thicker beds are microcrystalline and contain rip-up clasts; calcite crystals present in vugs; fossiliferous, with abundant brachiopods in lenses.

Total thickness *32.0m*

CHEMICAL ANALYSES*

	Components in Percent		
Unit	8	7	6 (top)
SiO_2	0.29	0.31	0.37
Al_2O_3	0.25	0.49	0.82
Fe_2O_3	0.26	0.20	0.29
MgO	0.26	0.51	16.0
CaO	55.2	54.9	37.3
L.O.I.	43.6	43.5	45.9
Total	99.86	99.91	100.68
CO_2	41.1	43.8	44.7

* *After Hewitt and Vos 1972, p.66.*

Photo CH-1-1. CONTACT BETWEEN UNITS 2 AND 3, LUCAS FORMATION; MACGREGOR QUARRY.

QUARRY OPERATION AND PROCESSING

General Chemical Canada Ltd. works the upper (Anderdon Member) bench at the south end of the quarry, while Amherst Quarries (1969) Ltd. works the lower benches at the north end. Kennette Contracting Ltd. operates a screening and washing plant on the floor of the upper bench.

After the overburden has been removed by a subcontractor, General Chemical drills blast holes in the limestone with an Ingersoll-Rand Drillmaster. Holes of 17 cm diameter are drilled to 1 m below grade on a 6 m x 7 m pattern, and blasted with M210 slurry powder in groups of 15 to 25 holes.

A portable crushing and screening plant is located close to the working face. Two Cat 992 loaders with 10 yd. buckets load the 44 in. x 48 in. primary jaw crusher directly from the face.

Discharge from the crusher passes over two 7 ft. x 20 ft. vibrating screens, and the -6 in. + 1 in. lump product is hauled 10 km to the chemical plant in Amherstburg in 40-tonne loads by a fleet of six Mack highway trucks pulling pup trailers. Weigh scale, administration office and maintenance shops are all located on the north side of the quarry. With fines removed, the stone grades 89-94% $CaCO_3$.

At the north end of the quarry, drilling is accomplished using a Gardner-Denver diesel quarry drill. A 42 in. x 36 in. jaw crusher is fed by three 35-ton Caterpillar 980 trucks which are loaded by two front-end loaders. Secondary crushing is done by two shorthead cone crushers: a 4 1/2 ft. Nordberg and a 3 1/2 ft. Hewitt-Robins, in closed circuit with three vibrating screens which provide a variety of stone products. Kennette Contracting works under a subcontract from Amherst Quarries to produce washed aggregate, using -1 in. screenings from the General Chemical plant and a single screen and washing plant.

PRODUCTS

General Chemical

Chemical Stone

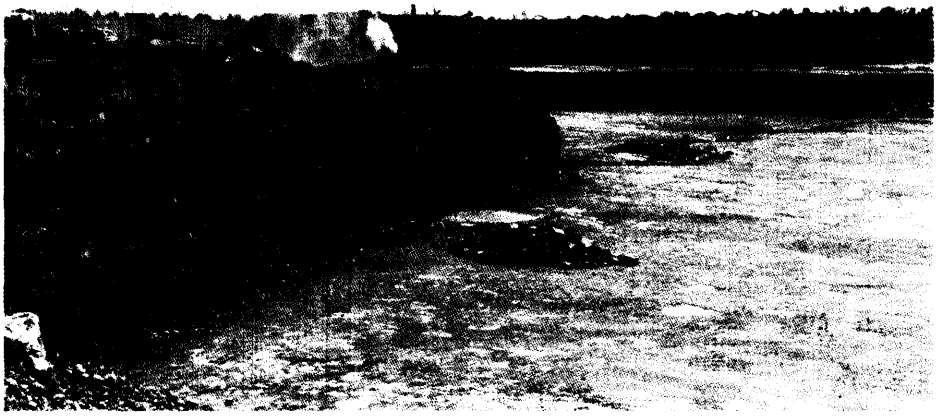
Amherst Quarries

Armour Stone
Gabion Stone (6 in.)
Crusher Run
-3/4 in. + 1/2 in.
- 1 1/4 in. + 7/8 in.
-7/8 in.
Granular "A"
Screenings and chips

Kennette Contracting

3/4 in. Clear

Photo CH-1-2.
SODA ASH AND CALCIUM CHLORIDE PLANTS; MACGREGOR QUARRY. *(Photo courtesy B.H. Feenstra, Ministry of Northern Development and Mines, London, 1983).*



1/4 in. Clear
Screenings

REFERENCES

Hewitt and Vos, 1972, p.65–66
Koniuszy and Katona, 1981, p.18–27
Uyeno et al., 1982, p.45

MAPS

Telford and Russell, 1981, OGS Map P.2396

CH-2 GENERAL CHEMICAL (ALLIED CHEMICAL) QUARRY (ABANDONED)

LOCATION AND OWNERSHIP

This quarry is located 0.5 km north of Amherstburg (Figure CH–2–1), in Lots 2 and 3, Concession 2, Anderdon Township, Essex County behind the General Chemical plant. The quarry exposes limestone of the Middle Devonian Lucas Formation. Two quarries are located here; one to the north that is now a waste pond for the plant and had previously been operated by Brunner Mond Canada Ltd., and the other abandoned quarry to the south which was operated by General (then Allied) Chemical which exposes 7 m of limestone.

GEOLOGY

The lower unit of the quarry face is a subcrystalline to very fine– crystalline, thin– to medium–bedded, pelletoidal limestone. The upper 5.9 m consists of the Anderdon Member of the Lucas Formation of which the lower 0.45 m is a calcareous sandstone, part of the sandy limestone facies of the Anderdon. The rest of the Anderdon is a fine–crystalline, thin–bedded and banded limestone. This abandoned quarry is partially water

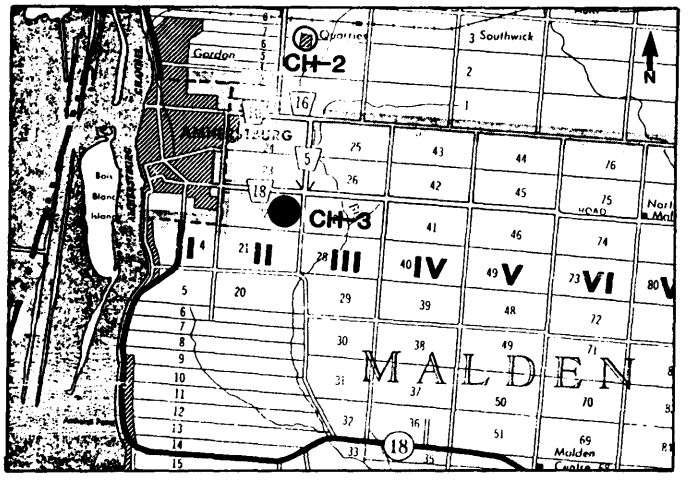


Figure CH-2-1. LOCATION MAP FOR GENERAL CHEMICAL (ALLIED CHEMICAL) QUARRY.

filled. The area is transected by an anticline (trending northwest).

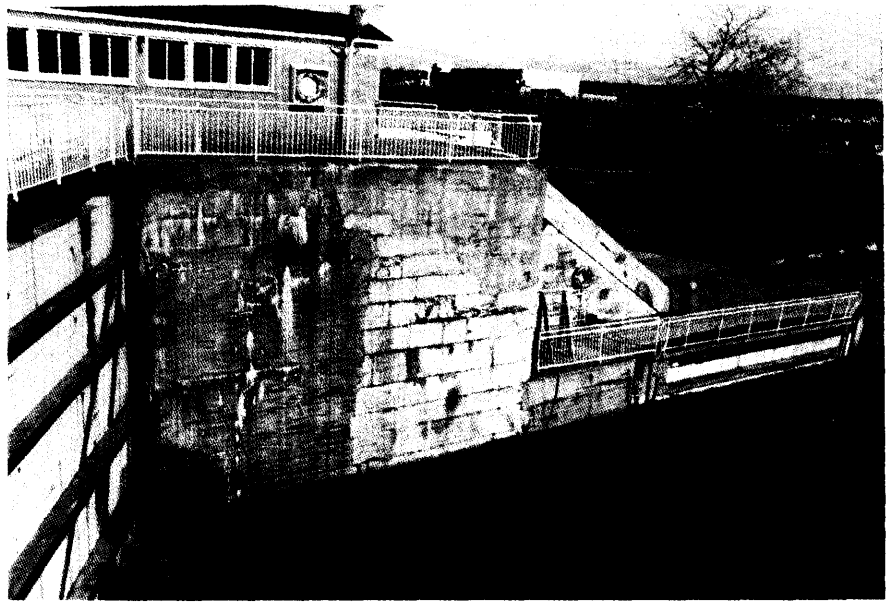
The infilled Brunner Mond Quarry exposed a different section (Hewitt, 1960, p. 164–167). Stone from this quarry had been used to provide blocks for the Sault locks at Sault Ste. Marie (Photo CH–2–1).

Geological Section

		Thickness
UNIT 3	*Lucas Formation, Anderdon Member*	*5.45m*

Limestone: brown–grey, weathers brown; fine crystalline; medium bedded (10 to 15 cm), thickens upward, contacts are transitional to somewhat sharp and irregular; banded in the middle of the unit with light and dark grey colours (1 m thick); very vuggy in the upper 1.5 m with calcite crystals filling vugs (vugs are up to 15 cm in diameter); the upper beds become massive, porous, possess a petroliferous odor, and are also dolomitic; the lower contact is sharp.

Photo CH-2-1.
LOCKS AT SAULT STE. MARIE BUILT WITH LIMESTONE BLOCKS OF THE LUCAS FORMATION FROM THE BRUNNER MOND QUARRY, 1887-1895. *(Photo courtesy B.H. Feenstra, Ministry of Northern Development and Mines, London).*



UNIT 2 Lucas Formation, Anderdon Member *0.45m*

Calcareous sandstone: light grey to tan, weathers buff; fine to medium grained; one massive bed; contains thin lenses of microcrystalline buff limestones; some mottled grey patches; lower contact is sharp.

Unit 1 Lucas Formation *1.10m*

Limestone: medium grey to medium brown; weathers grey-brown; microcrystalline to subcrystalline; thin to medium bedded (10 to 15 cm at base, 3 cm at top), contacts are sharp and slightly irregular; lower 0.6 m have a pelletoid appearance (1 to 3 mm in diameter); upper 0.50 m is more subcrystalline.

Total thickness *7.00m*

REFERENCES

Caley, 1946, p.32
Diffendal, 1971, p.19–20
Goudge, 1938, p.217–219
Hewitt, 1960, p.164–167
Hewitt, 1964a, p.67
Uyeno et al., 1982, p.14, 44–45

MAPS

Caley, 1945a, GSC Map 828A
Telford and Russell, 1981, OGS Map P. 2396

CH-3 AMHERST QUARRIES (1969) LTD. — AMHERSTBURG QUARRY

LOCATION AND OWNERSHIP

This large quarry is located 2 km east of Amherstburg in Lots 21 and 22, Concession 2, Malden Township, Essex County (Figure CH-3-1), and has been operating since

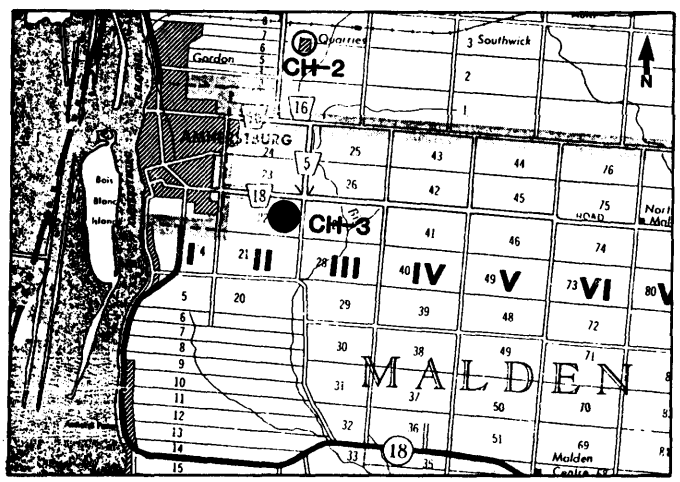


Figure CH-3-1. LOCATION MAP FOR AMHERSTBURG QUARRY.

1935. Initially operated by Industrial Construction Company Limited in the 1930s, this quarry was once the sole source of crushed aggregate products for Amherst Quarries. The Amherstburg Quarry now supplies only 20% of the company's annual production, the rest being obtained from the MacGregor Quarry (CH–1) under an operating agreement with General Chemical Canada Limited.

The quarry is operated on three lifts and covers an area of about 14 ha. Over a half of the licensed area is still available for quarrying to the south, and minor expansion is possible to the west. To the east and north, however, the quarry is confined by roads.

GEOLOGY

At the north end of the quarry, about 10 m of overburden overlies Middle Devonian Detroit River Group limestones, the Amherstburg and Lucas Formations making up 24.40 m and 25.75 m of the quarry face, respectively (Figure CH–3–2). The Amherstburg Formation consists of zones of bituminous dolostone and oolitic, bioclastic and coralgal limestones which occur in varying amounts. The Lucas Formation is similar to the Amherstburg, but becomes a more massive, bioclastic limestone (biostromal) at the top. The section spans the Amherstburg/ Lucas Formation boundary, but the precise contact cannot be easily identified.

Geological Section

Thickness

UNIT 8 Lucas Formation *2.20m*

Biostromal limestone: tan-buff, weathers yellow-buff; fine crystalline; massive bedded; base of unit contains coralgal debris, overlain by cone- shaped stromatoporoids (up to 20 cm high), which in turn is overlain by a crinoidal-rich debris zone; fossiliferous, with abundant coralgal debris, stromatoporoids, rugose corals (at top), and rare bryozoans; lower contact is gradational to unfossiliferous limestone.

UNIT 7 Lucas Formation *4.65m*

Limestone: light brown to tan (medium brown in porous zones), weathers buff; fine crystalline; one massive bed; calcite crystals in porous zones; porous zone (1 m thick) occurs 1.5 m above the base; faint laminations also present; rare fractures filled with calcite; lower contact is sharp.

UNIT 6 Lucas Formation *10.50m*

Interbedded banded limestones and dolostones: brown to tan, weathers brown; subcrystalline to fine crystalline; massive bedded (average 1 to 2 m), contacts are sharp, irregular, stylolitic and some are bituminous; coralgal debris abundant in some bands; scattered prominent bituminous layers that are recessive; this unit is similar to Units 4 and 5, but is more banded and lacks the vuggy zones and mineralization; lower contact is very sharp and stylolitic.

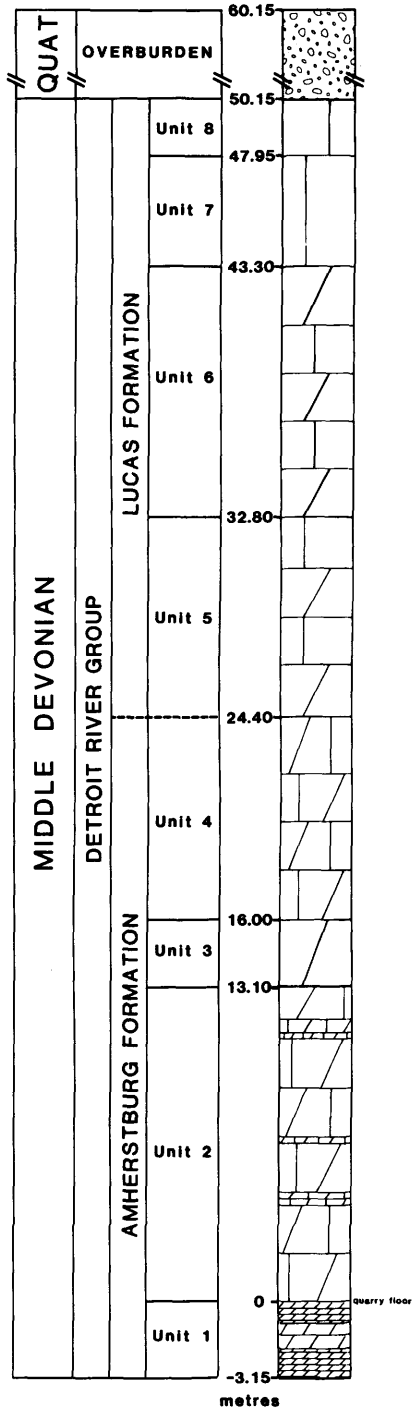


Figure CH–3–2. STRATIGRAPHIC COLUMN FOR AMHERSTBURG QUARRY.

UNIT 5 Lucas Formation *8.40m*

Interbedded limestones and dolostones: tan, cream to buff, weathers same; very fine to fine crystalline; massive bedded with sharp contacts, very irregular, often stylolitic, rip-up clasts; calcite and celestite mineralization in vugs; oolitic limestone (0.75 m thick) present at base of unit; calcarenite beds (up to 3 cm thick) are also present; lower contact is gradational.

UNIT 4 Amherstburg Formation *8.40m*

Calcareous dolostone: dark brown, weathers brown to tan; subcrystalline to fine crystalline; massive bedded and banded; calcite mineralization occur in vugs as a band 8 m above the base; celestite also occurs in vugs 5.2 m above the base, vugs range from 5 to 10 cm in diameter; sparsely fossiliferous, with scattered stromatoporoids, some replaced by chert (some of this chert is leached); lower contact is base of lift #2.

UNIT 3 Amherstburg Formation *2.90m*

Dolostone: medium brown, weathers buff; fine to coarse crystalline; massive bedded, contacts are sharp, slightly irregular, some have bituminous partings; calcite crystals and other exotic minerals occur in vugs; this unit is marked by 2 to 3 cm thick dolomitic calcarenites and massive dolostones which display pinch and swell features and are very irregular; unit stands out as a prominent ledge; lower contact is sharp and slightly irregular.

UNIT 2 Amherstburg Formation *9.95m*

Calcareous dolostone: tan to grey, weathers buff-grey; fine to medium crystalline; mainly massive bedded (approximately 1 m thick), with some minor thin beds (up to 5 cm), contacts are sharp and irregular, some are stylolitic or bituminous; calcite, celestite, and exotic crystals occur within vugs (up to 7 cm in diameter); iron staining present; banding and laminations are very prominent; lower contact is covered.

UNIT 1 Amherstburg Formation *3.15m*

Bituminous dolostone: dark brown to black, weathers medium dark brown to black; medium crystalline; thin to medium bedded (quite variable, 3 to 50 cm), contacts are sharp, very irregular and sometimes bituminous; large crystals of calcite and celestite occur in vugs (up to 15 cm); fossiliferous, with abundant coralgal debris and bryozoa and scattered crinoidal debris; unit is very banded and laminated; slight petroliferous odor present; rare vertical fractures filled with calcite.

Total thickness *50.15m*

CHEMICAL ANALYSES - UNITS 4 AND 5*

Components in Percent			
SiO_2	0.66	P_2O_5	0.02
Al_2O_3	0.12	SO_3	4.16
Fe_2O_3	0.10	SO	5.12
MgO	18.2	L.O.I.	42.9
CaO	28.8	Total	100.1

** After Hewitt and Vos, 1972, p.66.*

QUARRY OPERATION

The quarry is worked by drilling and blasting, using an RD40 Gardner–Denver diesel drill. Secondary breaking of the shot rock is done with a Dominion dropball. The stone is loaded at the face into two 40–ton quarry trucks by front–end loader and delivered to the processing plant.

PROCESSING

The delivered stone is dumped into a 48 in. primary impact crusher. A 42 in. belt conveys the stone to a 36–inch Hewitt–Robins secondary impact crusher. Screening is done in two stages, one of which is in closed circuit with the secondary crusher. There is no washing plant.

PRODUCTS

Armour Stone

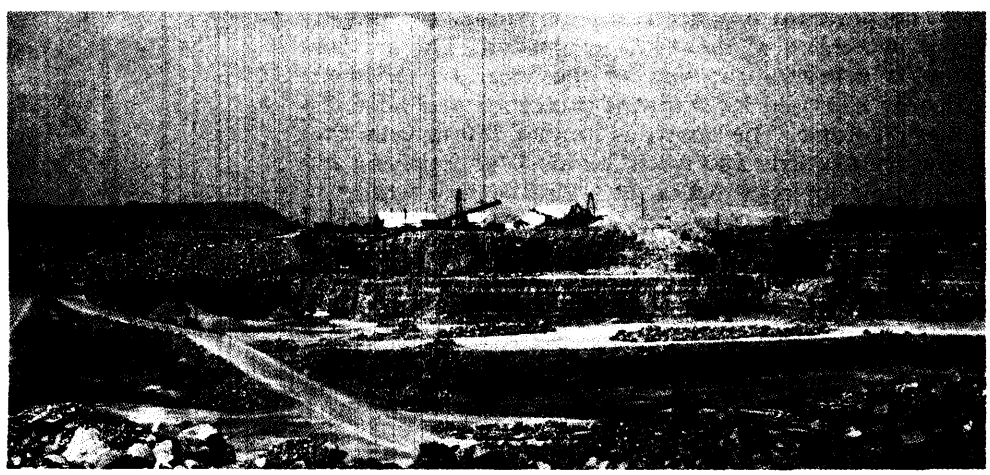


Photo CH-3-1.
QUARRY OVERVIEW, 1983; AMHERSTBURG QUARRY.
(Photo courtesy B.H. Feenstra, Ministry of Northern Development and Mines, London).

Gabion Stone
2 1/2 in. Crusher Run
7/8 in. Crusher Run
3/4 in. Clear
Screenings
-1 1/4 in. + 7/8 in. Stone
-3/4 in. + 1/2 in. Stone

The stone generally does not meet specifications for asphalt or concrete stone.

Building stone blocks and ashlar from 10 cm to 20 cm thick are hand split and trimmed by a local stone mason from Harrow. Production amounts to less than 300 tonnes per year.

REFERENCES

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Hewitt, 1960, p.168
Hewitt, 1964a, p.67-69
Hewitt and Vos, 1972, p.66
Koniuszy and Katona, 1981, p.28-37

MAPS

Caley, 1945a, GSC Map 828A
Telford and Russell, 1981, OGS Map P.2396

CH-4 670026 ONTARIO LIMITED — PELEE ISLAND QUARRY

LOCATION AND OWNERSHIP

This is the only active operation on Pelee Island and is located in Lots 1 and 2, Concession Registered Plan 35, Pelee Island Township, Essex County (Figure CH-4-1). The quarry was acquired in 1986 by 670026 Ontario Limited from Marentette Bros. Ltd. Approximately 10 ha have been licensed for extraction, 9 ha of which have been disturbed on a single lift of 6 m.

The principal product is armour stone, comprising about two-thirds of the 1986 production. The armour stone is primarily supplied to the local conservation authority and used for shoreline protection and rehabilitation programs. The quarry is located 150 m from the shore of Lake Erie and would be ideal for supplying armour stone for construction of a local marine facility.

The Pelee Island Quarry also supplies crushed stone products for local construction projects.

GEOLOGY

The Pelee Island Quarry exposes 6.0 m of limestone from the Dundee Formation (Middle Devonian). The lower 5 m are medium crystalline, massive, very fossiliferous, with a strong petroliferous odor and scattered oil seeps. The top 1 m of the unit is fine to medium crystalline, thin bedded and fossiliferous. Across the road to the south, a water-filled abandoned quarry exposes 1.9 m of the upper unit described in the operating quarry. It is a thin-bedded, cherty, very fossiliferous pelletoid limestone.

Overburden is thin to nil in thickness.

Geological Section

		Thickness
UNIT 2	*Dundee Formation*	*1.0m*

Limestone: brown, weathers buff; fine to medium crystalline; thin bedded (2 to 5 cm), contacts are sharp and planar; fossiliferous with abundant corals and brachiopods; lower contact is sharp and appears to scour into the lower unit.

UNIT 1	*Dundee Formation*	*5.0m*

Limestone: brown, weathers buff to light brown; medium crystalline; thick bedded; chert nodules present which replace corals; calcite crystals present; very fossiliferous with abundant bryozoans, corals, brachiopods, crinoids, rugose, fragments and pellets; very strong petroliferous odor, with some oil seepage occurrence; darker argillaceous laminations are present; coarser grained zones containing pelletoid material are also present.

Total thickness	*6.0m*

QUARRY OPERATION

The quarry normally operates during the period May to November. Water seepage into the quarry is minimal (current quarry floor is below lake level).

Drilling and blasting is performed by the company, while crushing is contracted. A drill pattern of 1.8 m x

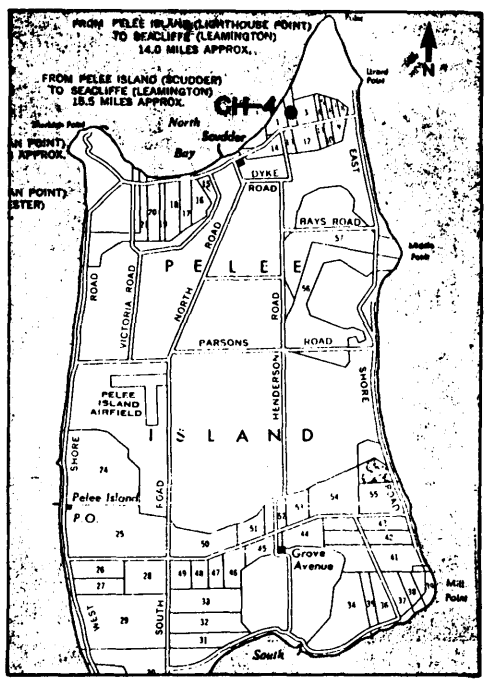

Figure CH-4-1. LOCATION MAP FOR PELEE ISLAND QUARRY.

1.8 m with 63.5 mm diameter blast holes is currently used. Blast holes are loaded with a decoupled charge of Xactex explosive to a height of about 3.4 m. Decoupling is achieved by using a packaged explosive of considerably less diameter than the blast hole (charge does not touch blast hole surface). Xactex is a semi-gelatin explosive bound in a rigid paper tube 15 mm in diameter and 600 mm in length, used primarily for presplit or preshearing blasting applications. The Xactex explosive provides a high velocity, high pressure detonation but, when decoupled, breaks the limestone structure in tension eliminating excessive shattering and fragmentation. A 1 m gap in the blast hole is allowed above the Xactex charge followed by a plug and crushed stone stemming (2 m) to collar. This blast design results in a low bulk density charge relative to the drill pattern, producing the desired size of armour stone.

PRODUCTS

Armour Stone

REFERENCES

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Koniuszy and Katona, 1981, p.38-45

MAPS

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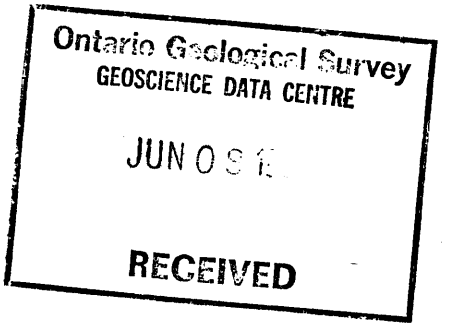

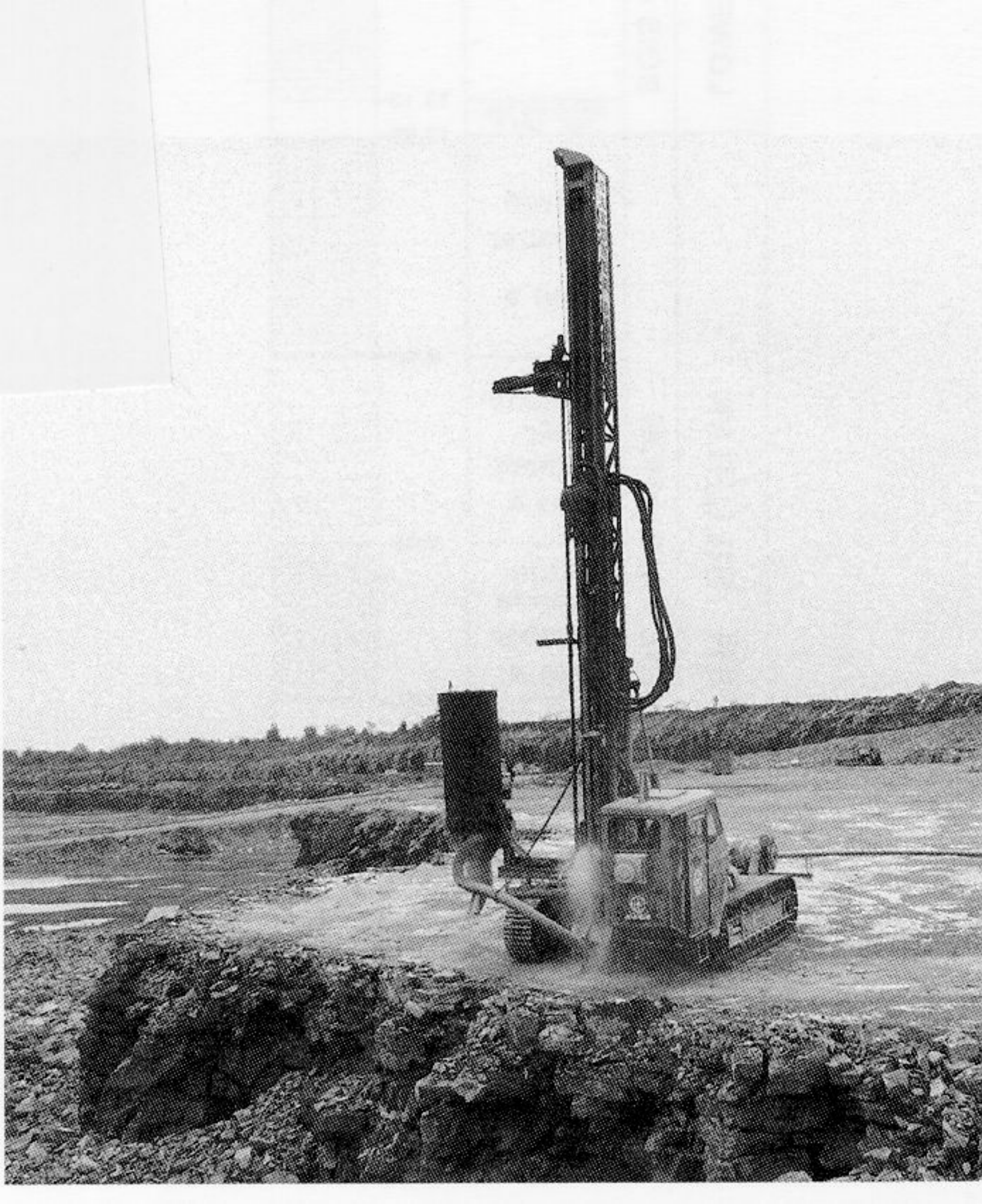

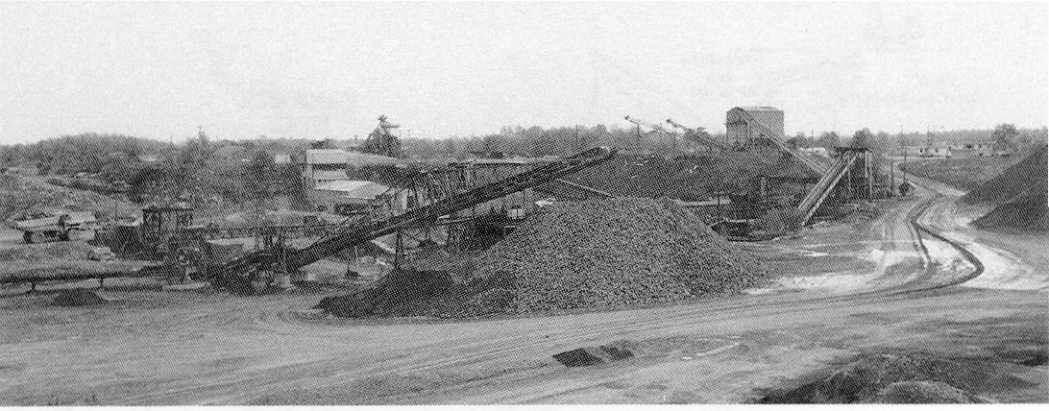

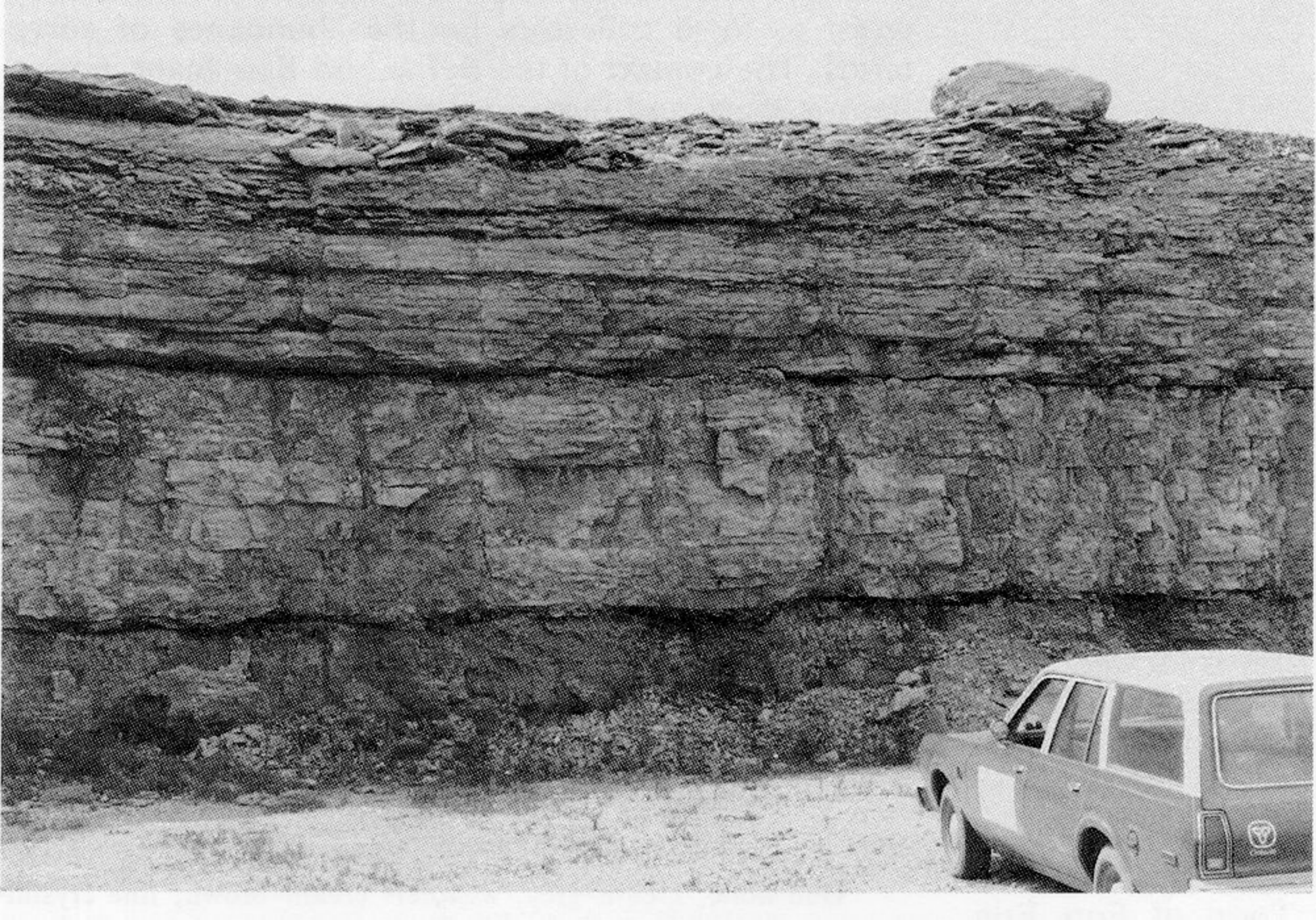

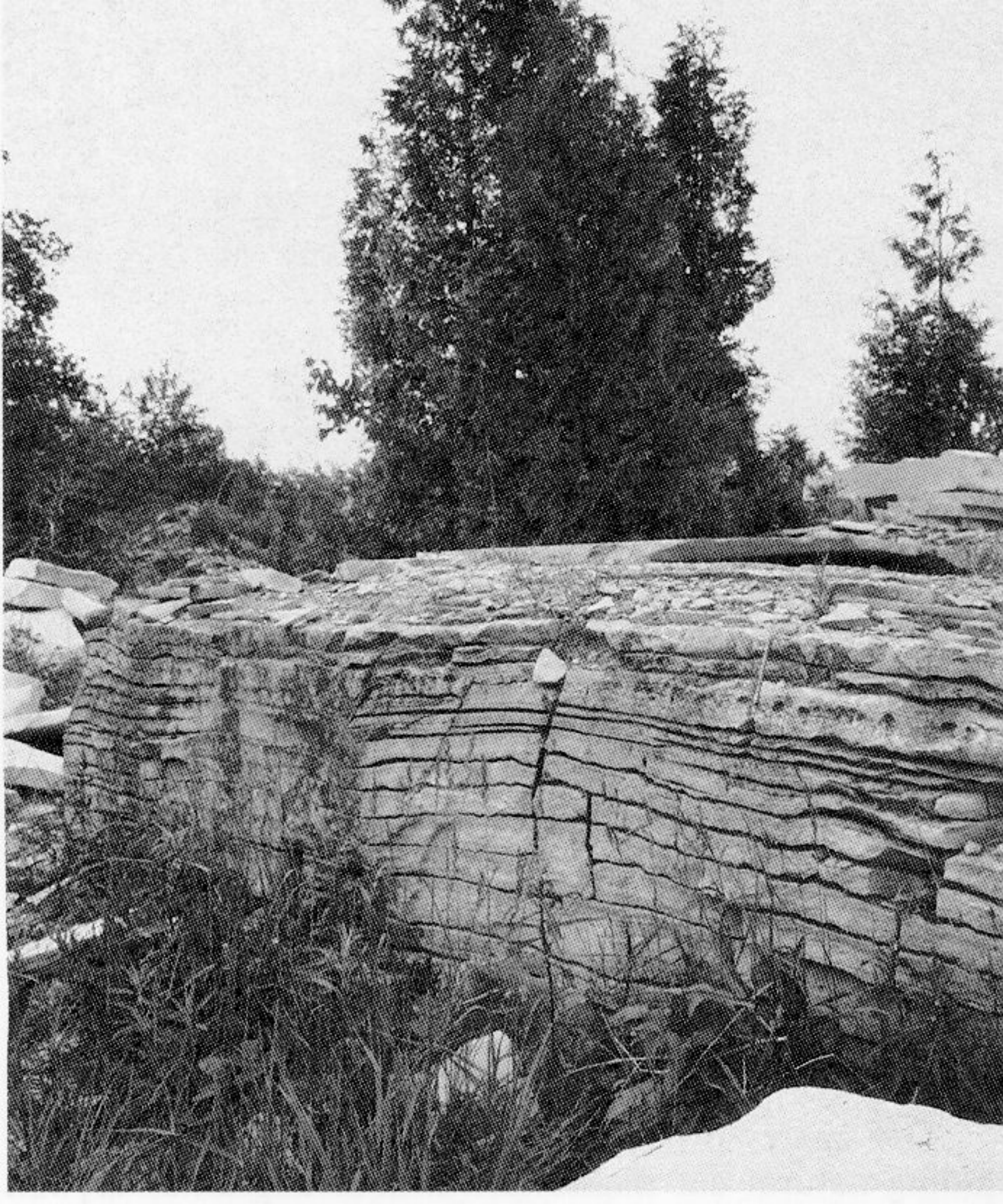

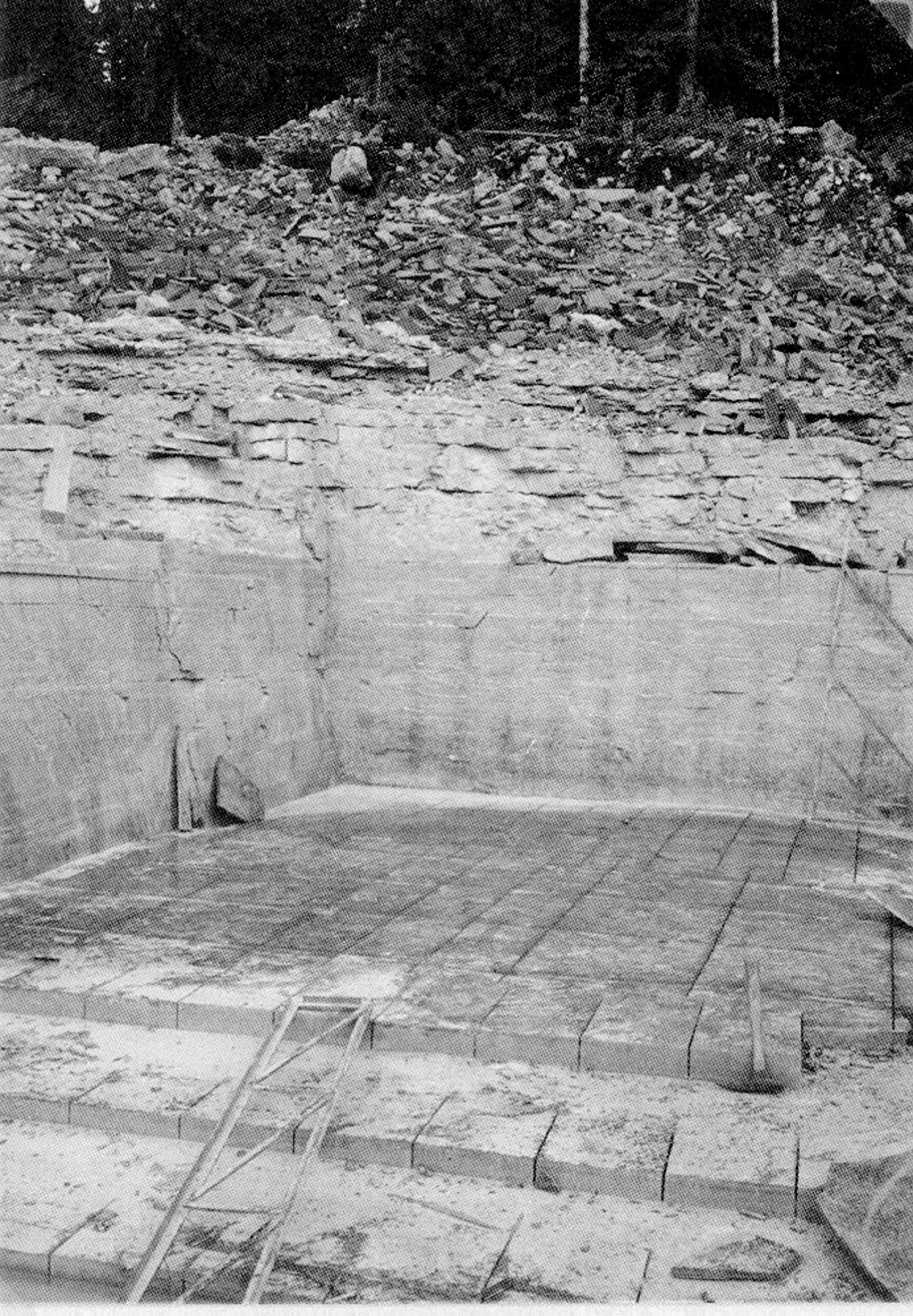

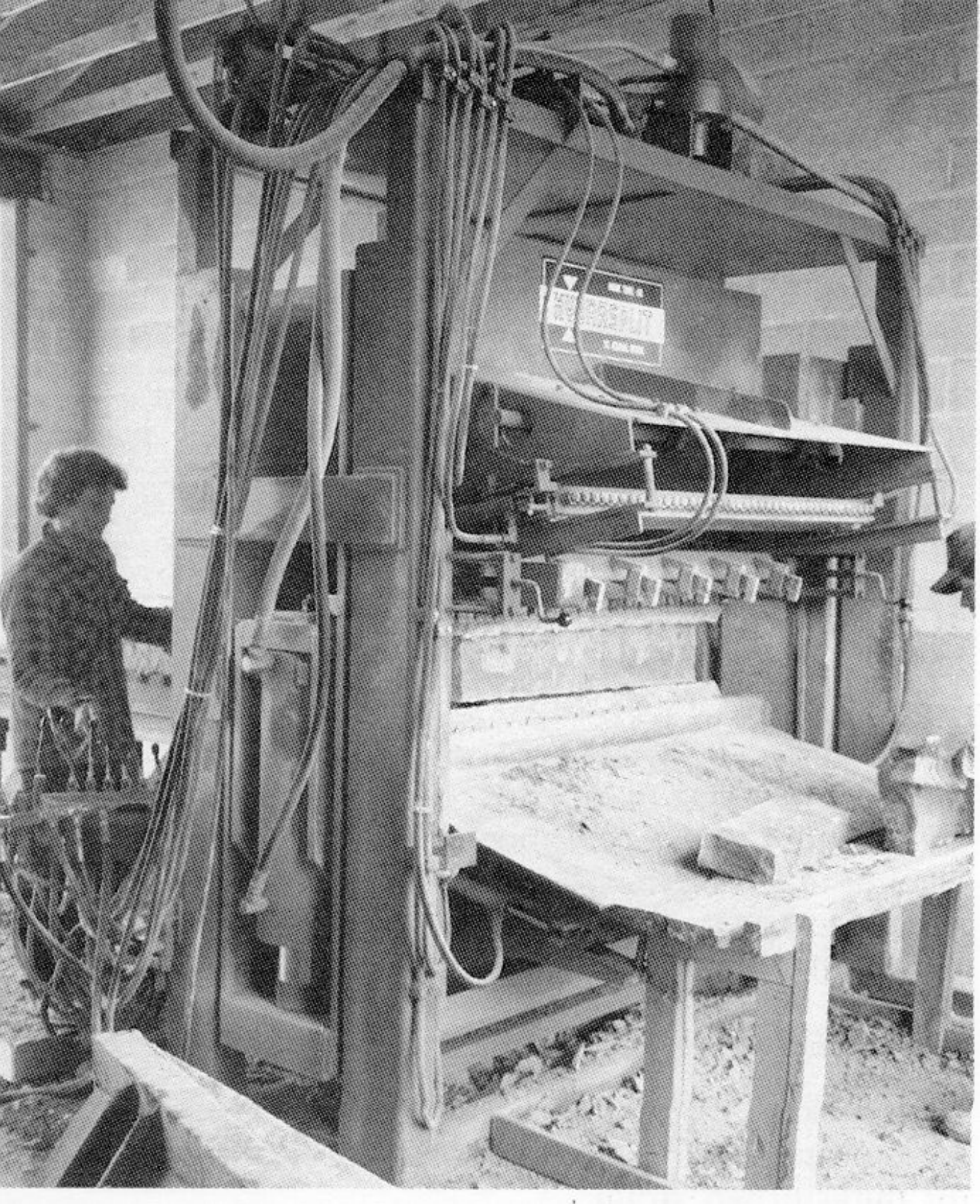

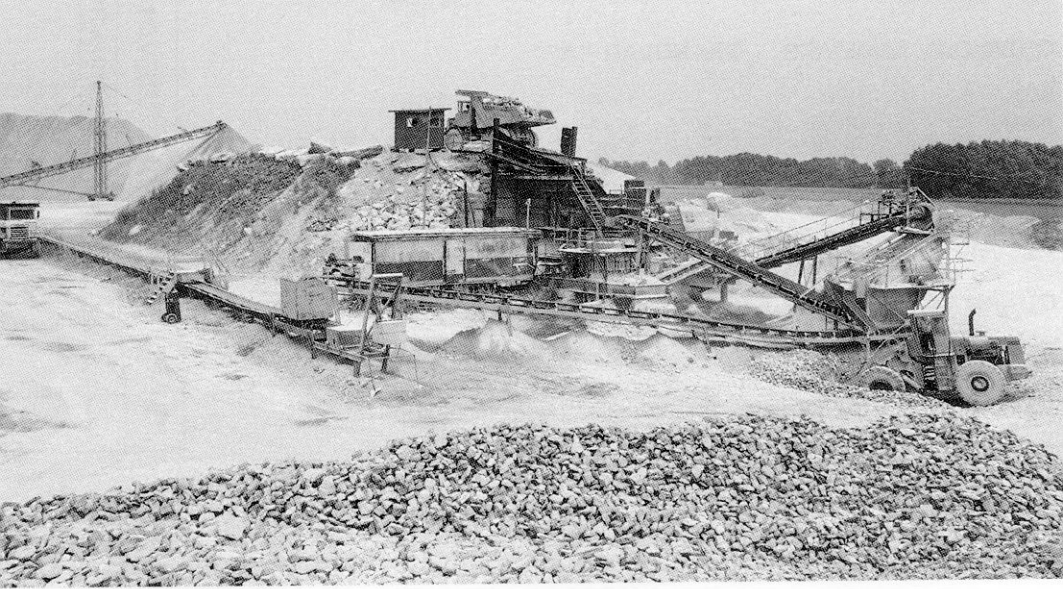

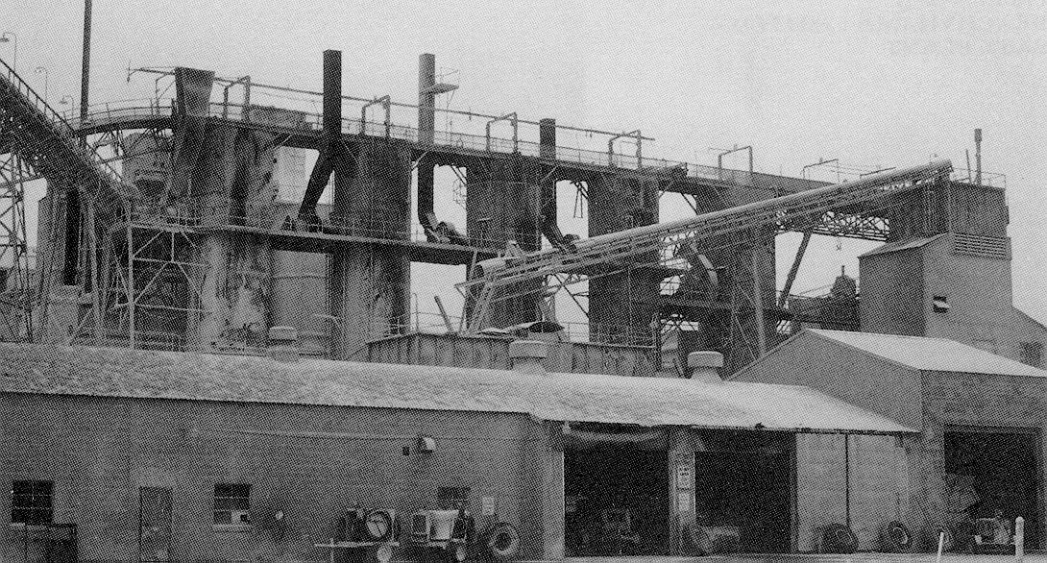

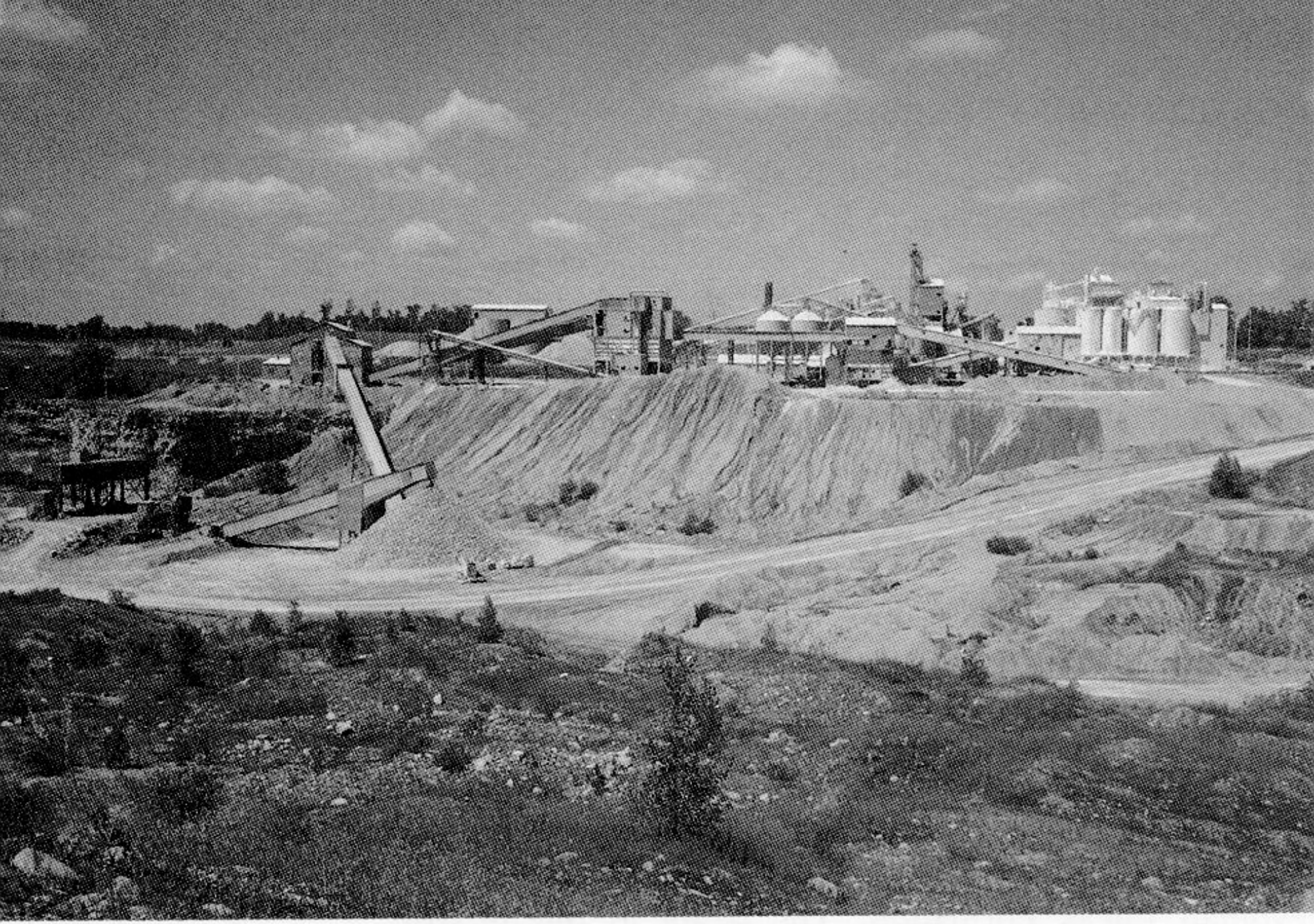

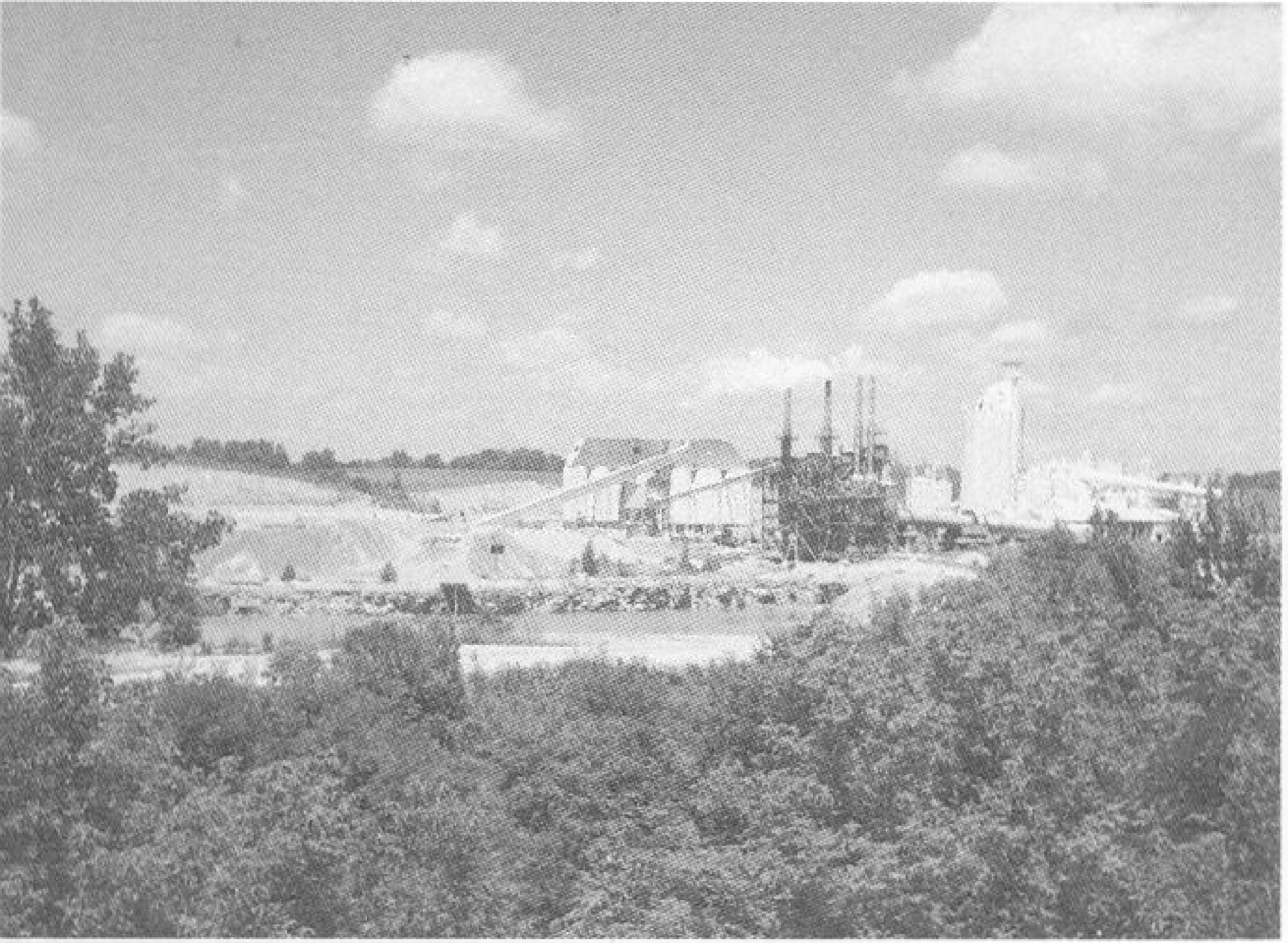

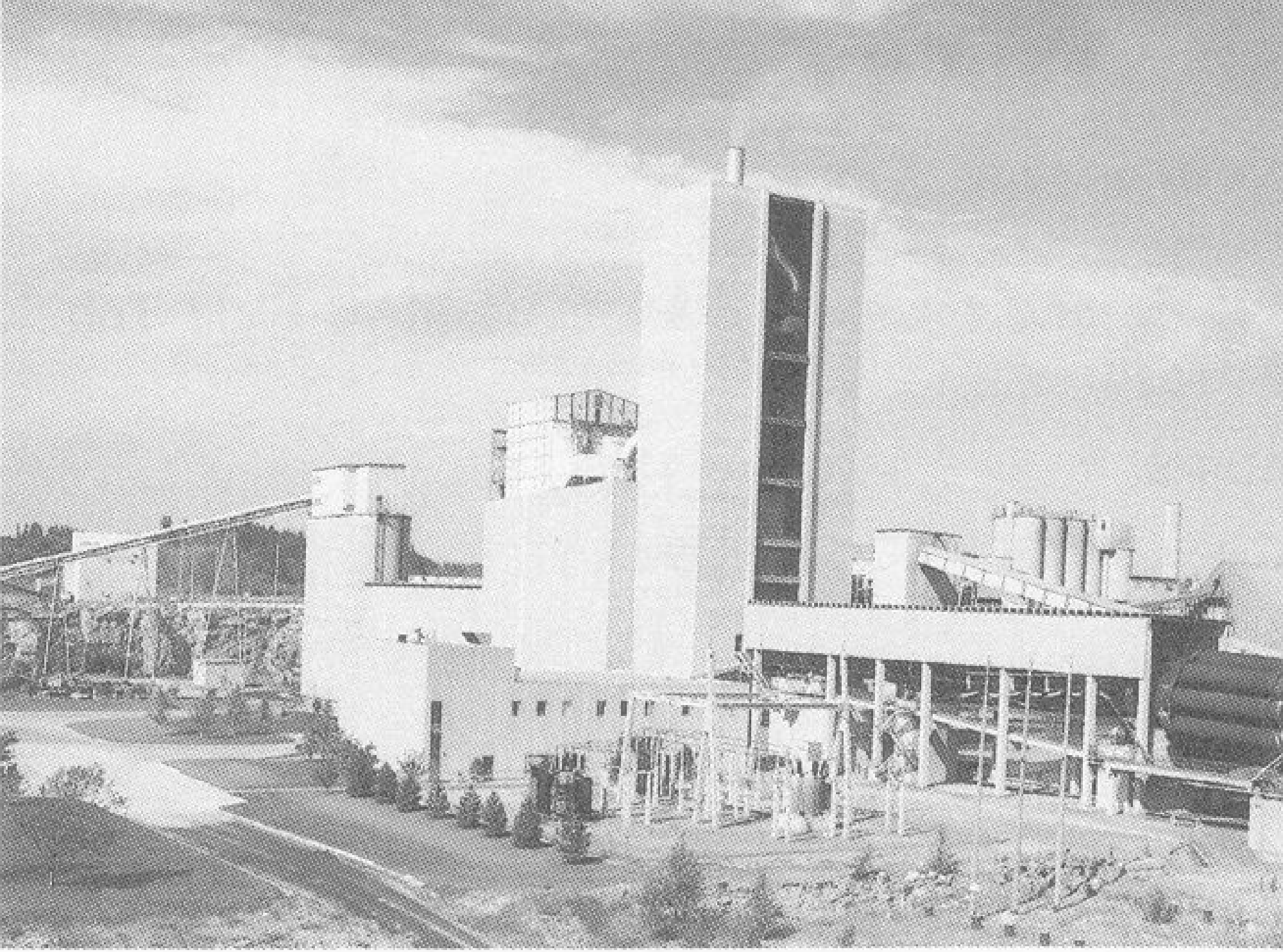

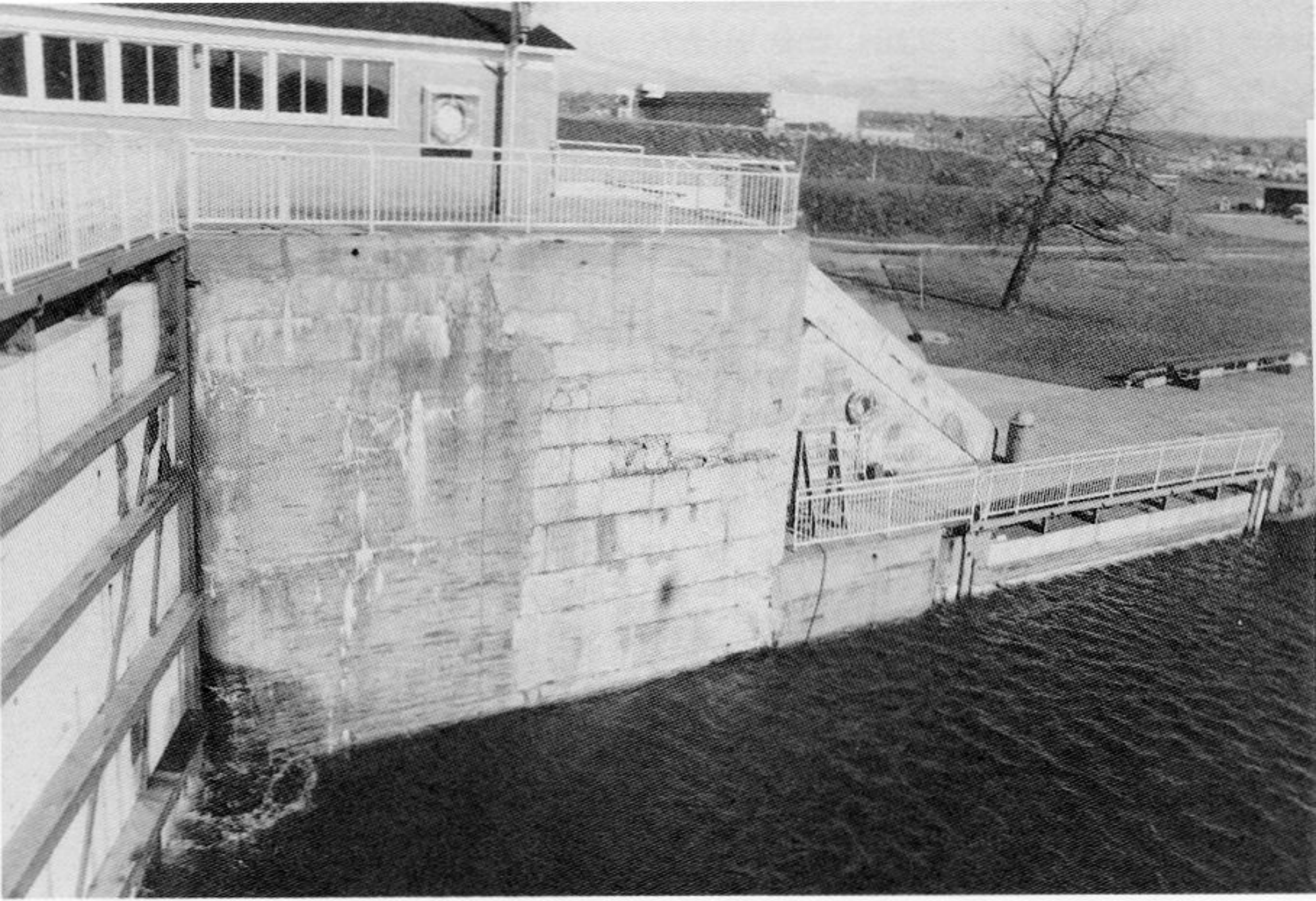

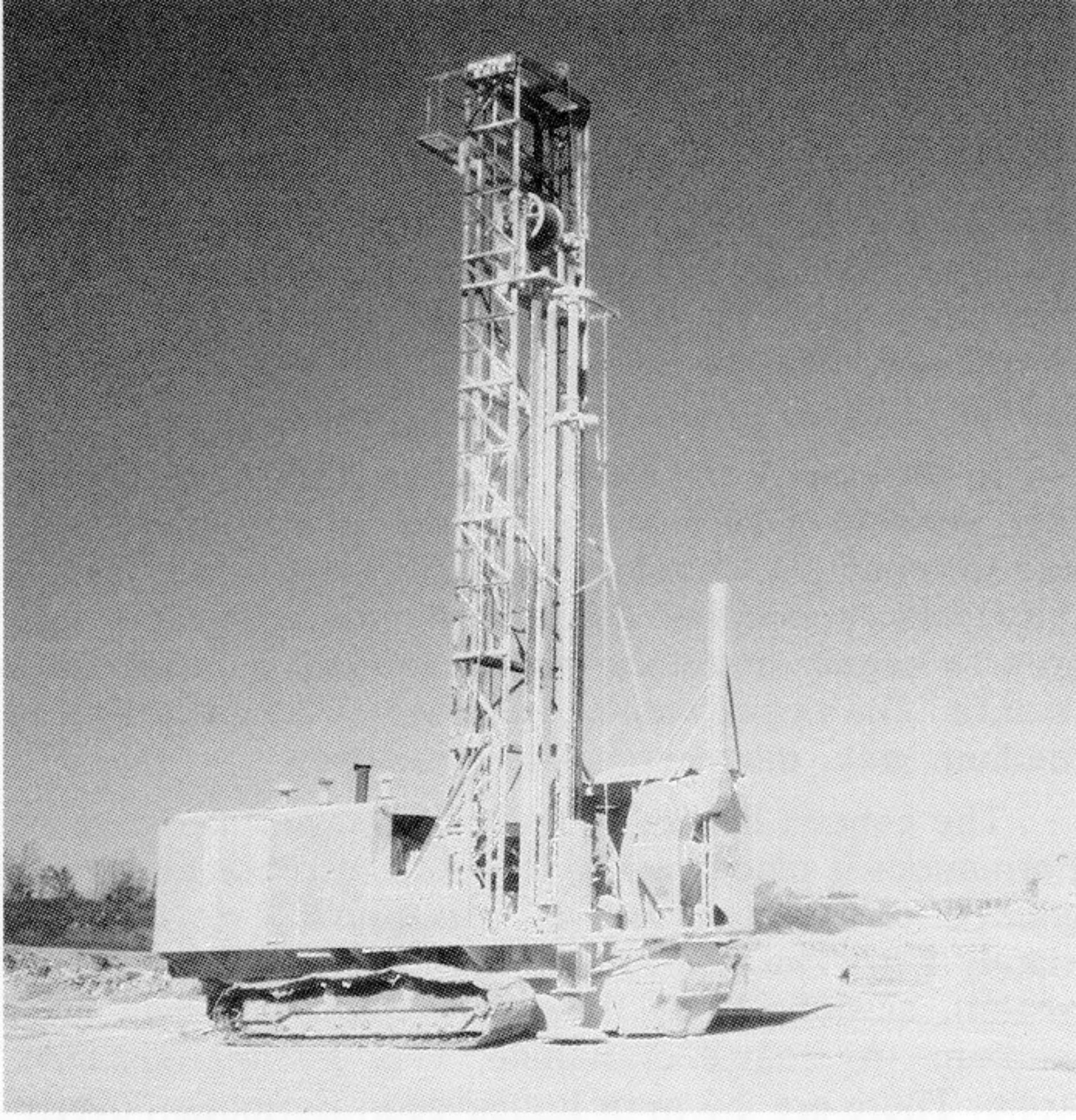

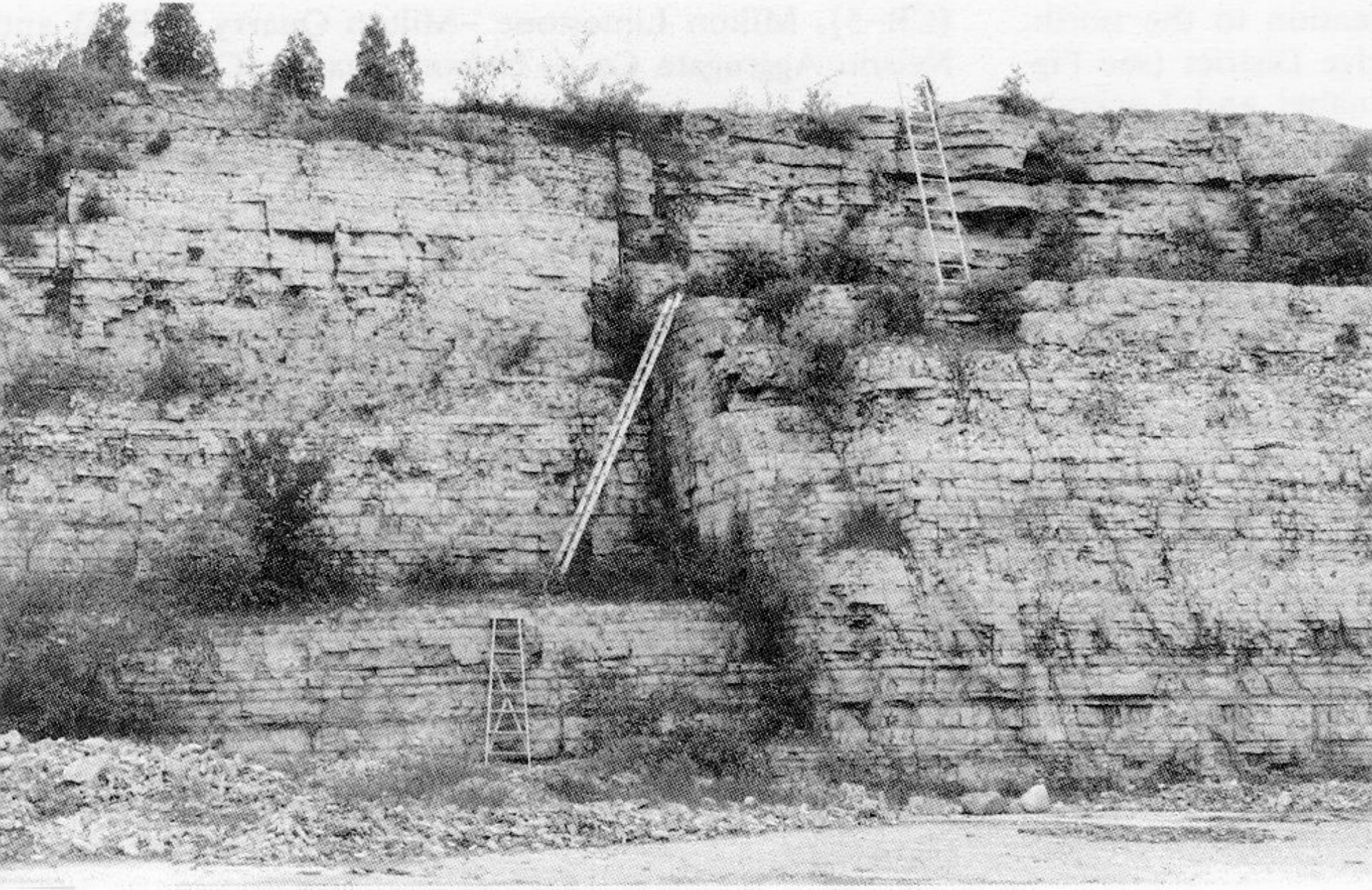

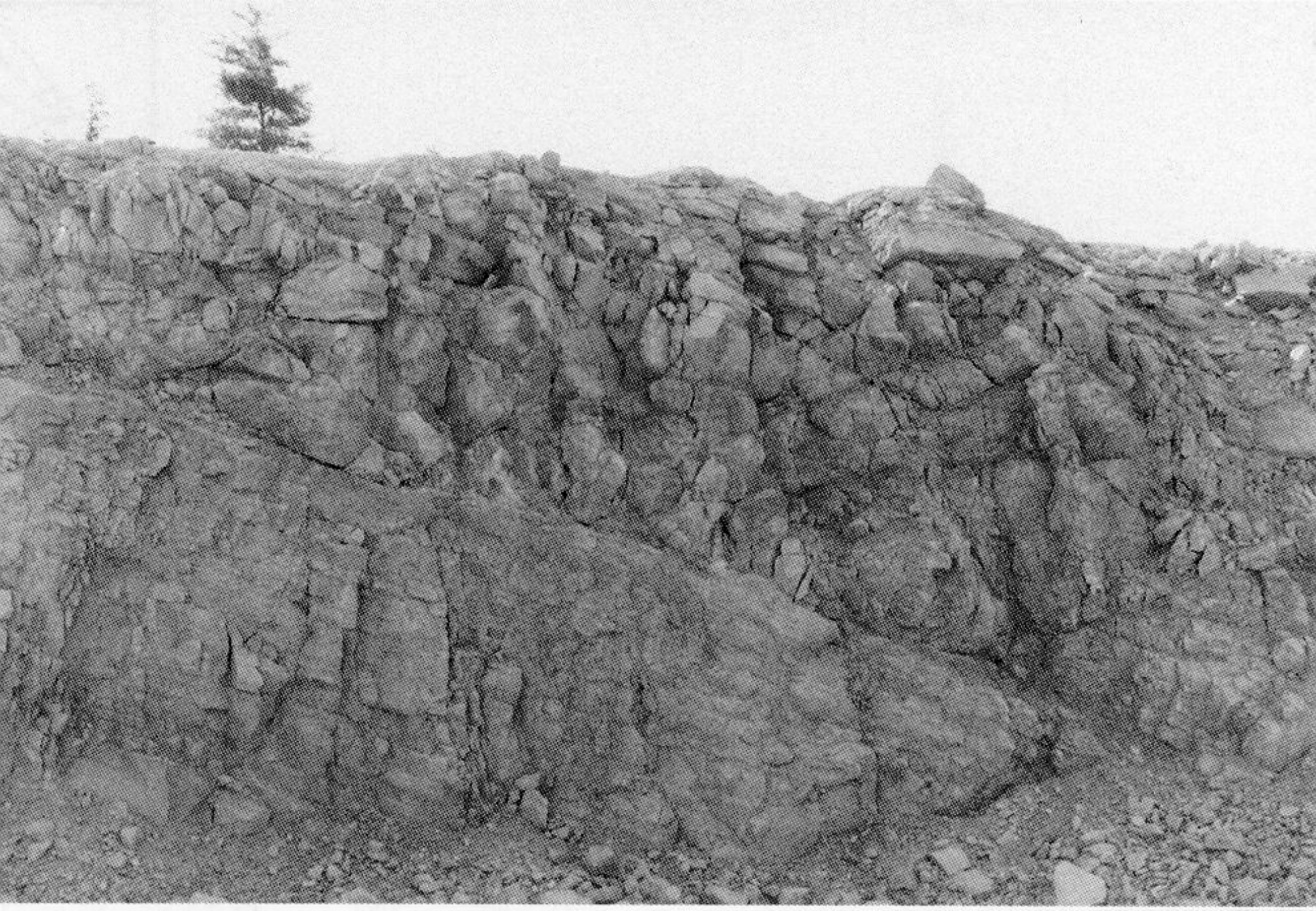

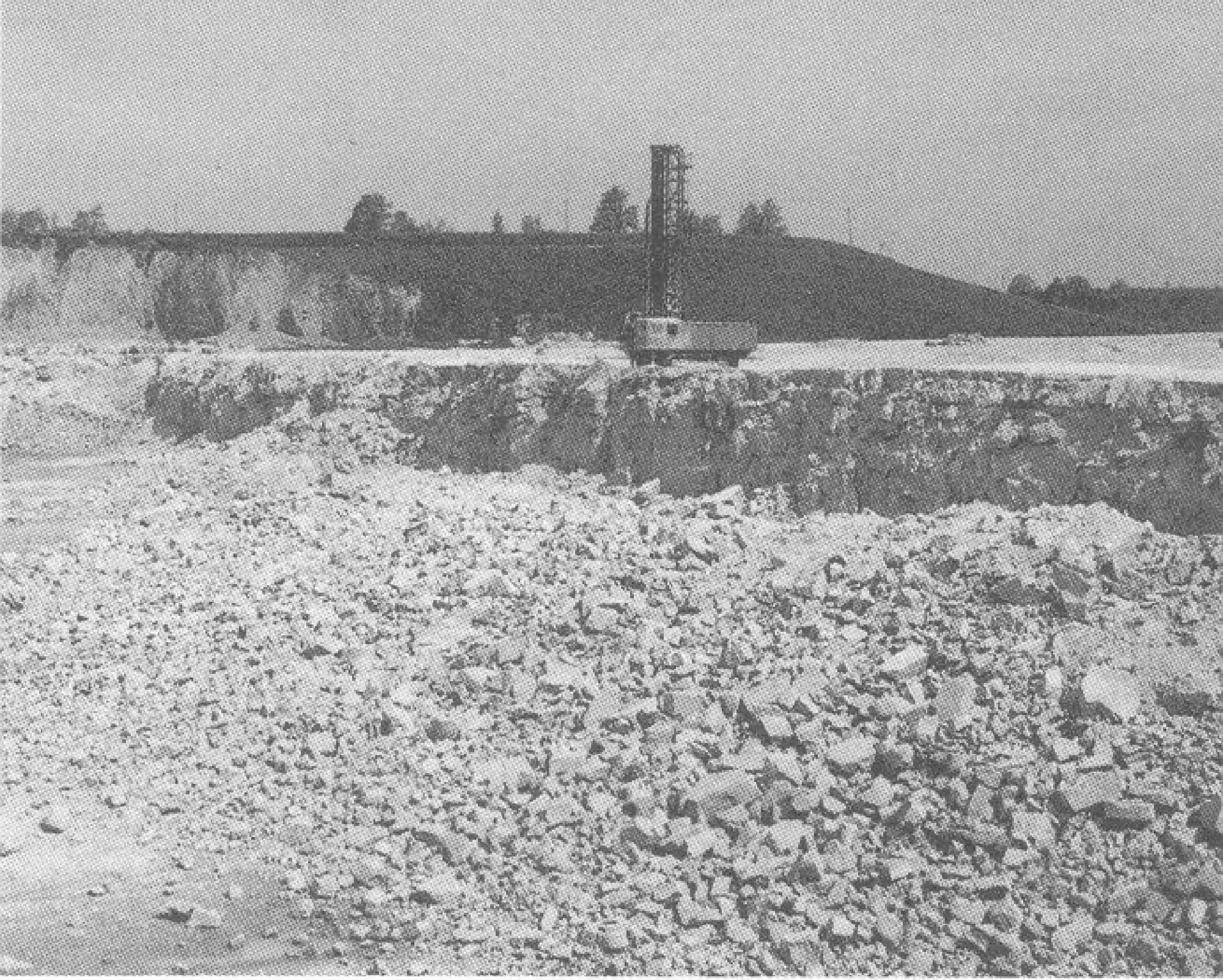

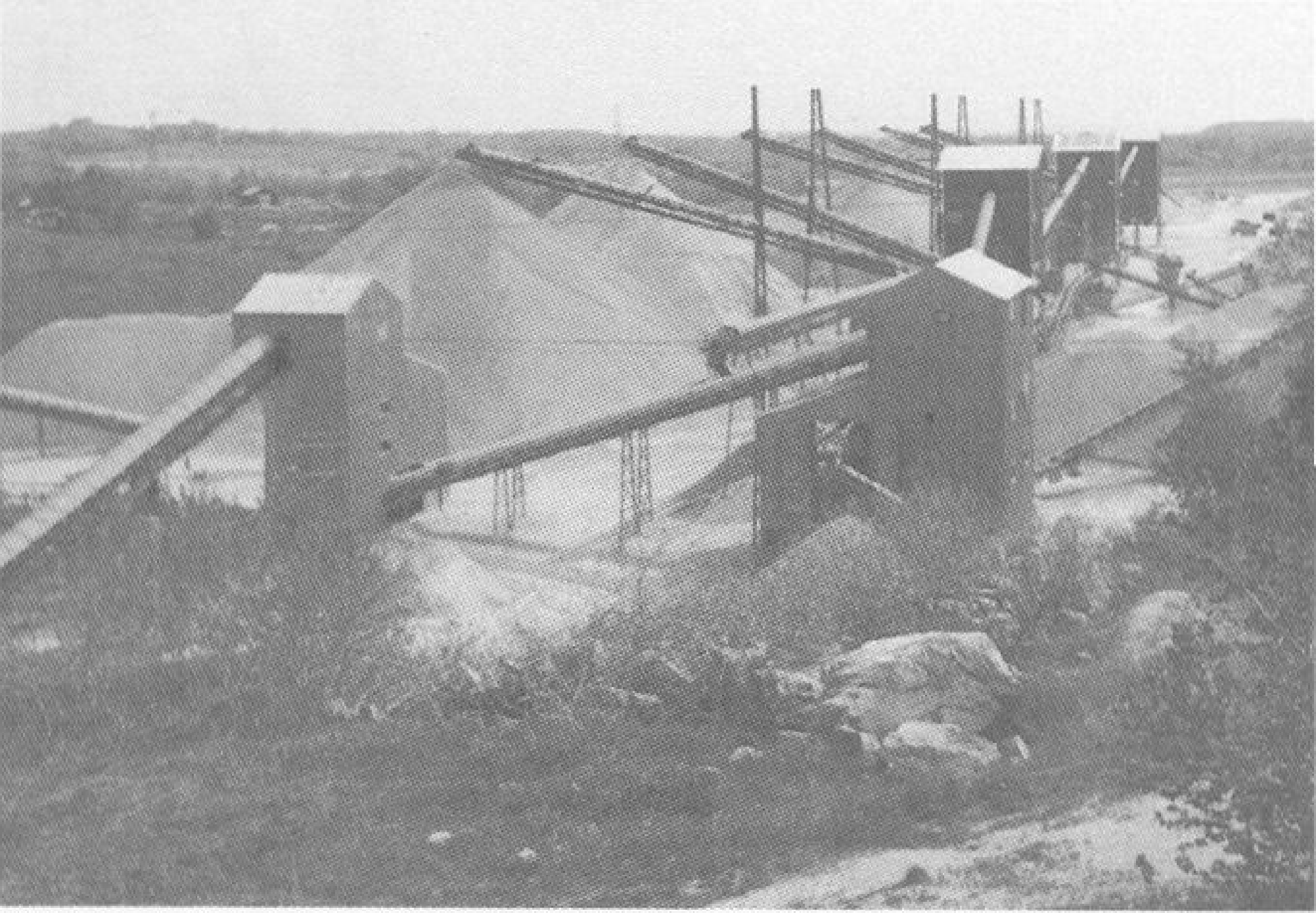


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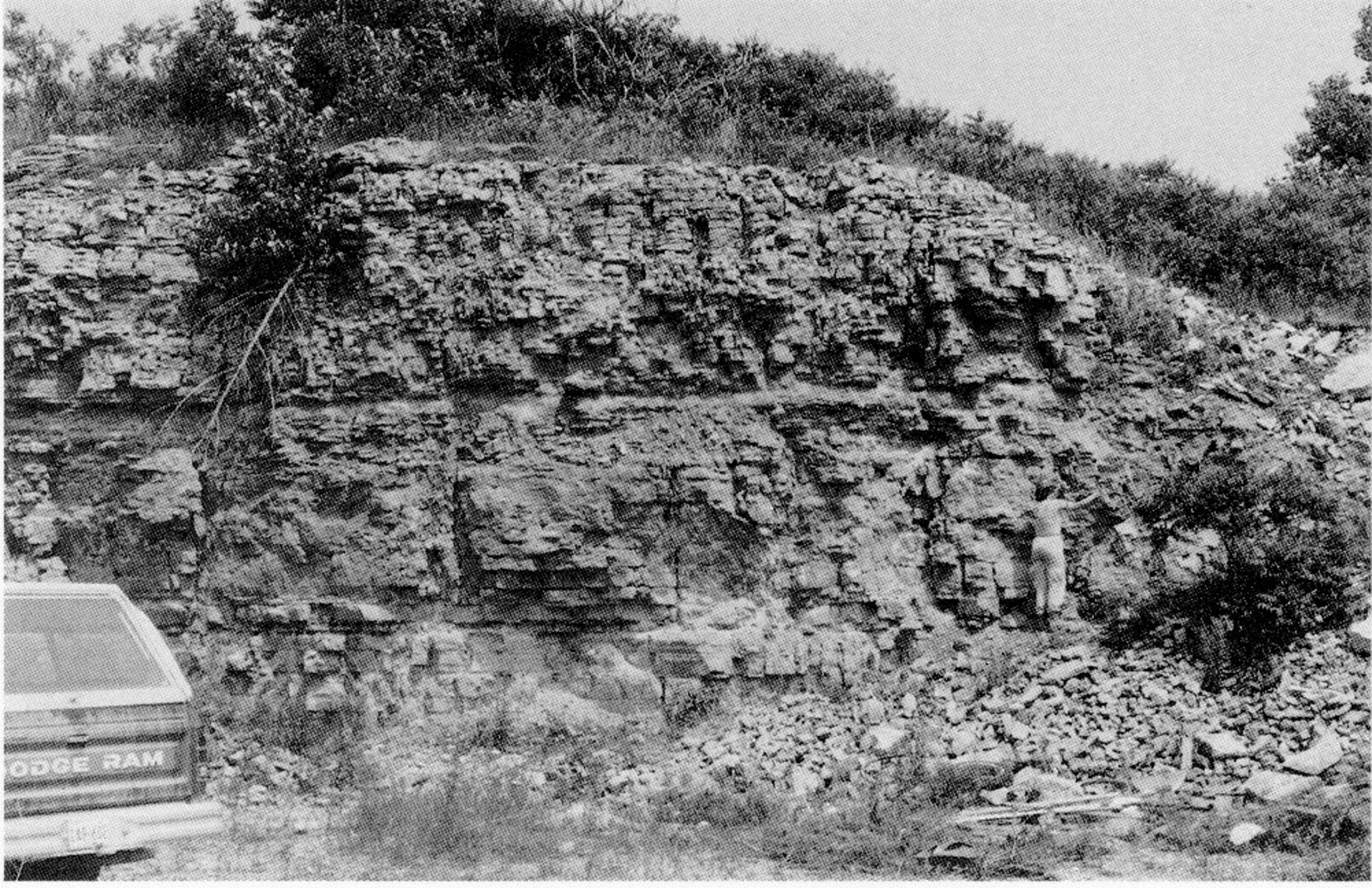
DODGE RAM