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GEOLOGY OF THE BRUCE PENINSULA, ONTARIO

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B.A. Liberty

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CONTENTS

ABSTRACT

Upper Ordovician, Silurian, and Middle Devonian rocks on the Bruce Peninsula are subdivided into 13 map-units. Brief, lithic descriptions of and nomenclature for the formations are presented. Thirteen two-tone map-sheets on the scale of 1 inch to 1 mile accompany the report.

GEOLOGY OF THE BRUCE PENINSULA, ONTARIO

INTRODUCTION

The following notes are brief descriptions of the formations that outcrop within the Bruce Peninsula map-area, and are intended to supplement the information given on the accompanying geological maps. Thirteen 1 inch to 1 mile maps are being issued at this time for reasons of expediency and economic interest, thus making available results of the detailed mapping on the manuscript scale. A compilation of these maps, on the scale of 1 inch to 4 miles will accompany the Geological Survey of Canada memoir "Palaeozoic Geology of the Bruce Peninsula District" by B.A. Liberty and T.E. Bolton, currently being prepared for publication. Parts of this map-area are included in previously published reports by J.F. Caley (1943, 1945).

The units herein described are all of formational rank except the upper member of the Whitby Formation; accordingly they are all rock-units. Lithic information is solely from outcrop studies. Sections where each unit may be seen to advantage are listed for each formation.

The terms Whitby and Georgian Bay appear in a forthcoming Geological Survey memoir on the Lake Simcoe District (Liberty, in press); Whitby was first introduced by Liberty in 1955 and was again used in 1964; Georgian Bay was first introduced by Liberty in 1964. In addition, the term Norfolk is here reinstated in the Devonian nomenclature for the map-unit between the Detroit River and Hamilton Formations. Problems and nomenclature are dealt with in a forthcoming memoir in the geology of the Bruce Peninsula. In the following descriptions reference is given opposite each formational name to the original source of the name.

TABLE OF FORMATIONS

SYSTEM	SERIES	FORMATION	SYMBOL
DEVONIAN	MIDDLE	Norfolk Formation	Dn
		Detroit River Formation Biohermal Facies	Ddrb
		Detroit River Formation	Ddr
		Bois Blanc Formation	Dbb
SILURIAN	UPPER	Bass Island Formation	Sbi
		Salina Formation	Ss
	MIDDLE & LOWER	Guelph Formation	Sg
		Amabel Formation	Sa
		Fossil Hill Formation	Sfh
		Cabot Head Formation	Sch
		Manitoulin Formation	Sm
ORDOVICIAN	UPPER	Queenston Formation	Oq
		Georgian Bay Formation	Ogb
		Whitby Formation, upper member	Ow

LITHOSTRATIGRAPHY

ORDOVICIAN

WHITBY FORMATION, UPPER MEMBER Ow (Liberty, 1955)

Most of these strata belong to the Blue Mountain biostratigraphic unit; uppermost strata belong to the Dundas. The upper member of the Whitby Formation consists of soft, grey, greenish grey, and bluish grey shale and clay shale. They also appear in place as mudstone. The member is 140 feet thick and moderately fossiliferous. It can be seen to good advantage in creek exposures near Camperdown, and at the mouth of the East Meaford Creek. This member has been mapped in the Georgian Bay area and is traceable southward into the Toronto area and northward onto Manitoulin Island.

The Whitby Formation embraces the shales lying above the limestones (Cobourg beds) of the Lindsay Formation (Simcoe Group, Liberty, 1963) and below the Georgian Bay Formation. It is divisible into three members, of which the lower comprises black shale, the middle brown shale, and the upper the above described blue shale. The lower and middle members do not outcrop within the map-area.

GEORGIAN BAY FORMATION Ogb (Liberty, 1964)

Georgian Bay strata belong to both the Dundas and Meaford biostratigraphic units. The lower member consists of blue and grey shale with limestone bands alternating; the limestone bands range in thickness from a few inches to more than a foot. Both shale and limestone are fossiliferous. The upper member is poorly developed in the Bruce Peninsula. On Manitoulin Island it comprises the carbonate beds of the Meaford and Kagawong biostratigraphic units and is the facies equivalent of the Queenston Formation of the Bruce Peninsula. It consists of limestone with but a few shale beds and shale partings. The formation ranges in thickness from 300 feet at the north end of the Bruce Peninsula to 418 feet on East Meaford Creek. It can be seen to advantage on a creek flowing into Georgian Bay, across Highway No. 26, 2 miles west of Meaford.

QUEENSTON FORMATION Oq (Grabau, 1908)

The Queenston Formation consists of red and green, arenaceous, and micaceous shales, and is of Richmond age. Three fossiliferous biostromes interbedded with the red and green shale are traceable throughout the Bruce Peninsula and northward onto Manitoulin Island into the upper member of the Georgian Bay Formation. The formation ranges from 200 to 291 feet in thickness. It can be seen at Owen Sound, on the east side of the bay where, in an escarpment, it is overlain by the Manitoulin Formation.

SILURIAN

MANITOULIN FORMATION Sm (Williams, 1913)

This formation consists of grey-weathering, brown, fine- and medium-crystalline dolomite with some dolomitic limestone. Some argillaceous carbonate and grey chert occur at a few localities. Fossils are present (sparsely), and are generally silicified. The unit is about 45 feet thick, but may increase to about 70 feet. The formation is well exposed in the quarries in Owen Sound on the east side of the bay.

CABOT HEAD FORMATION Sch (Grabau, 1913)

This map-unit embraces four members and comprises the strata between the top of the Manitoulin Formation and the base of the Fossil Hill Formation (= the base of Williams' Lockport Formation). These members are:

(top of section)		
St. Edmund member	12'	dolomite
Wingfield member	32'	dolomite with shale
Dyer Bay member	15'	dolomite
Cabot Head (restricted) member	51'	shale
(base of section)		

The Cabot Head (restricted) member is soft, red and green shale with thin limestone beds and gypsum; the Dyer Bay (named by Williams, 1919) is bluish grey, fine-crystalline dolomite; the Wingfield (named by Williams, 1936) consists of thin ribbon (2 inch beds) greenish grey, fine-crystalline and sublithographic dolomite with interbedded green shale; the St. Edmund (named by Williams, 1919) has 8 feet of massive, mottled brown and greyish brown, medium crystalline dolomite, which is overlain by 4 feet of soft green shale that was assigned to the St. Edmund by Williams.

This map-unit is about 110 feet thick. The type section of the Cabot Head, Wingfield, and St. Edmund members is at Rocky Bay, 3 miles west of the Cabot Head lighthouse at the northeast tip of the Bruce Peninsula. Elsewhere, the Wingfield and St. Edmund members cannot be seen to advantage; the Dyer Bay may be seen on Dyer Bay about 1 mile north of the hamlet of the same name. The Cabot Head can be seen at Inglis Falls road-cut, south of Owen Sound.

FOSSIL HILL FORMATION Sfh (Bolton, 1953)

Fossil Hill strata are thin and thick bedded, grey weathering, brown, irregularly fine- and medium-crystalline, porous dolomite. The lowest 20 feet is generally very fossiliferous and may be subdivided into sublithographic and crystalline units. The formation is fairly fossiliferous; some fossils have been silicified. Brown and white chert is locally present. The formation ranges between 12 and 22 feet in thickness and may be seen to advantage on Isthmus Bay, north of Lions Head.

AMABEL FORMATION Sa (Bolton, 1953)

The Amabel Formation is divisible into three lithic units. It comprises for the most part the Lockport of Williams (1919), who included the Fossil Hill strata in the base of the Lockport. The lower member (Lions Head of Bolton, 1953) is grey weathering, tan, sublithographic dolomite in medium beds. The middle member (Colpoy Bay–Wiarton of Bolton, 1953) is typical Lockport lithology – grey weathering, bluish grey and blue mottled, fine-crystalline dolomite. Beds are massive and well jointed; biohermal strata are non-bedded; porous zones and vugs are present. The upper member (Eramosa of Williams, 1915) is present in some places, absent in others, dependent on the geographic location with respect to the reef. If a specific location is between bioherms the upper member comprises inter-biohermal strata: thin bedded to laminated, grey, dark grey, to black, petroliferous, fine-crystalline dolomite. Black chert nodules and small micro-reefs are often present. This upper member is absent at localities where the biohermal facies passes directly from Amabel to Guelph strata. The Amabel Formation is in reality a reefal complex, presenting biostromal, biohermal, and interbiohermal (interreef) facies. Thickness of the formation is about 150 feet. It can be seen best in the Wiarton road-cut. The upper member can be seen in the Cook quarry at Wiarton, underlying the Guelph Formation.

GUELPH FORMATION Sg (Logan, 1863)

The Guelph Formation is also a reefal complex. It is similar in many ways to the Amabel Formation, but is more reefal (to an even greater degree). Biohermal, interbiohermal, bedded clastic flank deposits and knoll-interknoll facies are known. Detailed descriptions are included in the discussion of the Guelph in Bolton and Liberty (1955).

For the most part, the formation comprises tan to brown, evenly textured, fine- and medium-crystalline dolomite. Strata weather brown, massive and scraggy. Lowest strata include dark thin bituminous lines; beds range from 4 to 24 inches in thickness. Sublithographic and lithographic textures are known and algal structures are commonly preserved. Calcarenites are also present; vugs are known to occur; fossils are few.

The formation ranges from 100 to 170 feet in thickness. It may be seen north of the Wiarton road-cut above the level of the Campbell Monument, and in the Cook quarry, west of Wiarton.

SALINA FORMATION Ss (Dana, 1863)

The exposed part of the Salina Formation is predominantly red and green shale with anhydrite, mineral molds, and thin bituminous partings. Also present is buff, fine-crystalline dolomite, and some greenish grey and bluish grey shale. Salt beds occur within the formation south of Kincardine. The entire formation can be studied only in well cuttings as it is not fully exposed anywhere within the Bruce Peninsula area. It is about 600 feet thick and can be seen on outcrop near Walkerton, on a creek 1.8 miles north of Dunkeld.

BASS ISLAND FORMATION Sbi (Grabau, 1908)

The Bass Island Formation consists of buff- and brown-weathered, buff, cream and brown, fine-crystalline dolomite in even 2- to 12-inch beds. Mineral molds, thin bituminous ('line') partings, and oolites are also present. In the Walkerton area, two excellent marker oolite beds occur at the 55- and 90-foot levels above the base of the formation; the lower one is 14 inches thick, the upper one 3 feet thick. Large algal concretions are present; fossils are generally sparse. The formation ranges from 130 to 160 feet in thickness and can be seen almost in its entirety on a creek, 1.8 miles north of Dunkeld, northwest of Walkerton.

DEVONIAN

BOIS BLANC FORMATION Dbb (Landes, Ehlers, and Stanley, 1945)

The strata of the Bois Blanc Formation are brownish grey and grey, fine-crystalline to lithographic, fossiliferous limestone and dolomite. They weather grey and into irregular beds ranging from 1 inch to 12 inches in thickness. White-weathering chert occurs as nodules, thin lenses, anastamosing layers, and thin to thick beds. Small amber-coloured spore cases are commonly present; thickness of the formation is about 150 feet. Lowest strata can be seen on a creek 1.8 miles north of Dunkeld, northwest of Walkerton.

DETROIT RIVER FORMATION Ddr (Grabau, 1908)

The Detroit River Formation is generally a buff to brownish grey, fine-crystalline dolomite. Minor interbedded limestone and fine-grained textures are known. Bedding ranges from 2 to 20 inches in thickness. Mineral molds, minor chert, and dark bituminous ('line') partings are present.

Included within the above described unit, as a matrix facies, are small patch reefs or bioherms. Their known areal distribution is enclosed in an oval 'centred' on Formosa. This is designated Ddrb on the Walkerton and Wingham maps that accompany this report. These bioherms vary in size from a part of one acre to several acres. They do not all occur at the same stratigraphic level. Typically the reef lithology is light grey to bluish grey, sublithographic to lithographic, hard, fossiliferous limestone. This limestone is pure and occurs as a well jointed, non-bedded, massive rock that weathers vuggy and scraggy and appears to have some porous portions. Where fossils are sparse, the limestone varies from fine grained to sublithographic in texture. Where the bioherm is very fossiliferous, the lithology of the enclosing rock is barely discernible; the texture varies from fine to coarse calcarenites, and from lithographic to coarse-crystalline. Stromatoporoids, corals, bryozoans, brachiopods, pelecypods, gastropods and trilobites are known. Laminar stromatoporoids make up a considerable portion of the bioherm.

Thickness of the bioherms is known to range between 35 and 90 feet; the Detroit River Formation generally is between 250 and 500 feet thick. A bioherm lying on low Detroit River strata can be seen in the base of

the old road-cut, 2 1/2 miles north of Formosa. Detroit River strata lying on the bioherm can be seen in lot 4, con. III, Culross township, about 4 miles southeast of Teeswater and below the falls on the Teeswater River.

NORFOLK FORMATION Dn (Caley, 1941)

This formation is generally a grey, brownish grey, medium- to fine-grained, fine-crystalline limestone and dolomitic limestone. Some sublithographic textures, calcareous sandstones, lenses of bioclastic material, carbonaceous partings, gypsum, and stylolites are known. Chert is often present in the form of nodules and thin beds. Strata weather grey and into irregular beds up to 18 inches in thickness. The formation is moderately fossiliferous, and is from 80 to 137 feet thick. It can be seen to advantage at the top of the Maitland River section, east of the bridge at Goderich.

The term Norfolk, as finally defined by Caley (1946, page 31, para. 5, line 5) is herewith reinstated. The formation overlies the Detroit River Formation and is overlain in turn by the black shales of the Hamilton Formation. Its lowest 18 to 28 feet (depending on the locality) correspond to the incorrectly designated Onondaga for this area (Stauffer, 1915). Neither of the terms Delaware or Dundee is used for this unit, for neither can be used in preference to the other, across Southern Ontario. By reinstating the term Norfolk, the palaeogeography is more easily reconcilable, the stratigraphy is more easily treated, and the historical background and sedimentation are more easily explained. The Norfolk Formation is considered to be a natural lithic unit.

ECONOMIC GEOLOGY

The upper member (Eramosa) of the Amabel Formation is presently being quarried for sills and facing stone 2 miles west of Wiarton by J.S. Cook Quarry Ltd., Ebel Quarries, and Bruce Peninsula Stone Quarry. Owen Sound Ledgerock Ltd. is quarrying the same unit both at the above location and 3 miles south of Shallow Lake.

Salt is recovered in the Goderich area by the Sifto Salt Division, Domtar Chemicals Ltd., salt mine.

There are many small sand and gravel pits, which are of local importance.

Gas was produced commercially from the Hepworth gas field between 1900 and about 1935, but the only extensive oil and gas exploration in the area in recent years was drilling carried out by Imperial Oil Ltd. in 1954 and 1955.

Two zinc prospects are known north of Owen Sound: the Amabel township occurrence 3 miles northwest of Wiarton, and the Albemarle township occurrence 15 miles east of Tobermory, north of Umbrella Lake (Williams, 1919, and Caley, 1946). A small showing of sphalerite was found by the writer 7 1/4 miles south of Ferndale, on No. 6 highway. At these three localities, sphalerite occurs at the top of the Amabel Formation. The writer

favours an origin related to the known reefal growth in the Amabel–Guelph (Niagaran) strata. The hypothesis concerns extraction of the zinc from the Amabel (Lockport) sediments by reefal circulating waters and deposition of the zinc sulphide where brecciation, cavities, and pore space in the reef rock permit favourable temperatures and pressures. This explanation is supported by: the presence of mineralized fossil remains, stratigraphic restriction of mineralization, mineralization of low permeability rocks, simple mineralogy, low temperature of deposition, lack of evidence of igneous activity and apparent lack of migration routes, i.e. faults, for hydrothermal solutions. With the reefal growth being so very extensive, with zinc mineralization being known at many localities associated with reefs, and with mineralization being found at three localities in the map-area, the writer considers more prospecting to be warranted.

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