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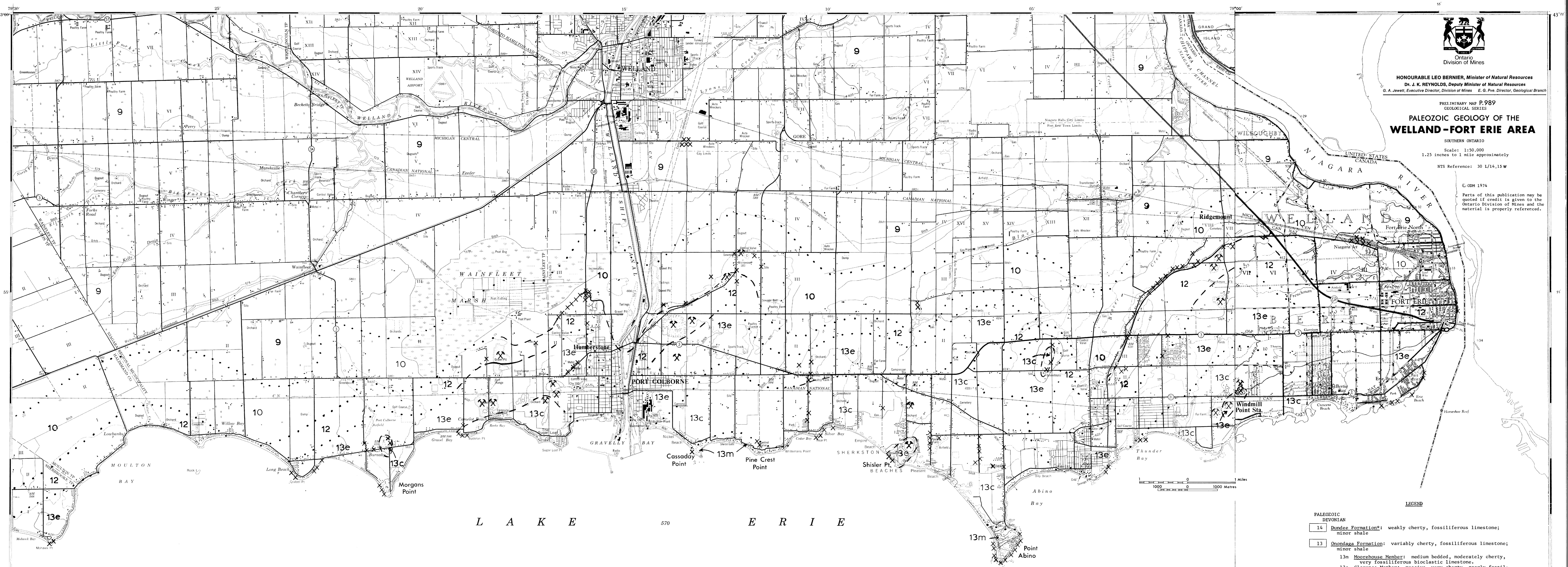


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PRELIMINARY MAP P.989  
 GEOLOGICAL SERIES  
**PALEOZOIC GEOLOGY OF THE  
 WELLAND-FORT ERIE AREA**  
 SOUTHERN ONTARIO

Scale: 1:50,000  
 1:25 inches to 1 mile approximately  
 NTS Reference: 30 1/14, 15 W

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- LEGEND**
- PALEOZOIC**
- DEVONIAN**
- 14 Dundee Formation: weakly cherty, fossiliferous limestone; minor shale
  - 13 Onondaga Formation: variably cherty, fossiliferous limestone; minor shale
    - 13m Moorehouse Member: medium bedded, moderately cherty, very fossiliferous bioclastic limestone.
    - 13c Clarence Member: massive, very cherty, poorly fossiliferous limestone.
    - 13e Edgcliff Member: medium bedded, variably cherty, very fossiliferous, bioclastic or argillaceous limestone; massive, biohermal and reefal limestone; minor shale.
  - 12 Bois Blanc Formation: thin to medium bedded, cherty, fossiliferous, bioclastic or argillaceous limestone; minor shale and dolostones; occasional glauconitic sandstone in basal part (Springvale Sandstone Member).
  - 11 Oriskany Formation: massive, white or grey, fossiliferous, quartzose sandstone.
- SILURIAN**
- 10 Bertie Formation: dark brown, bituminous dolostone; grey, argillaceous dolostone; brown and cream mottled dolostone; light brown, finely laminated dolostone.
  - 9 Salina Formation: argillaceous dolostone, shale, evaporites. (\* not present in map-area)

**REFERENCES**

Best, E.W. 1953: Pre-Hamilton Devonian Stratigraphy of Southwestern Ontario; unpubl. Ph.D. thesis, University of Wisconsin, Madison, Wisconsin.

Feenstra, B.H. 1972: Quaternary Geology of the Welland Area, Southern Ontario; Ontario Div. Mines, Prelim. Map P.796, Geol. Ser., scale 1:50,000. Geology 1972.

Hewitt, D.F. and Vos, M.A. 1972: The Limestone Industries of Ontario; Ontario Div. Mines, IMP39, 79p. Accompanied by map 2264, scale 1 inch to 16 miles.

Koepke, W.E. and Sanford, B.V. 1966: The Silurian Oil and Gas Fields of Southwestern Ontario; Geol. Surv. Canada, Paper 65-30, 138p.

Oliver, W.A., Jr. 1967: Stratigraphy of the Bois Blanc Formation in New York; United States Geological Survey, Prof. Paper 586-A, 8p.

Sanford, B.V. 1964: Catalogue of Ontario Well Samples at the Geological Survey of Canada, Ottawa; Geol. Surv. Canada, Paper 63-46, 41p.

1969: Geology Toronto-Windsor Area, Ontario; Geol. Surv. Canada, Map 1263A, scale 1:250,000.

**SYMBOLS**

- X Bedrock outcrop
- Geological boundary
- - - Geological boundary, approximate
- Geological boundary, interpreted
- X Quarry

**SOURCES OF INFORMATION**

Geology of Welland and Fort Erie West map-sheets by P.G. Telford and G.A. Tarrant, 1974.

Topography from Maps 30 1/14 and 30 1/15 West of the National Topographic Series.

Issued 1975.

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Telford, P.G., and Tarrant, G.A. 1975: Paleozoic Geology of the Welland-Fort Erie Area, Southern Ontario; Ontario Div. Mines, Prelim. Map P.989, Geol. Ser., scale 1:50,000. Geology 1974.

**MARGINAL NOTES**

Most of the map-sheet area is of very low relief, with only the dunes and bluffs along part of the Lake Erie shoreline and the discontinuous ridge of the Onondaga Escarpment (Feenstra 1972) providing some topography. Outcrops of Paleozoic rocks are relatively sparse due to a mantle, of varying thickness, of Quaternary glacial and lacustrine sediments (Feenstra 1972). The majority of outcrops occur along the lakeshore although many previously described exposures (E.G. Best 1953) are obscured by the present high lake level. The Onondaga Escarpment extends approximately east-west across the area and, where it is not buried by Quaternary sediments, affords many bedrock exposures. Several operating and numerous abandoned quarries also provide excellent exposures. There is an abundance of subsurface data available for this map-sheet area, resulting from oil and gas exploration activities (Sanford 1964).

**STRATIGRAPHY**

**Salina Formation (Upper Silurian)**  
 This unit constitutes the bedrock of the northern half of the area. It consists of easily weathered argillaceous dolostone, shale and evaporites and therefore is poorly exposed. One good outcrop was discovered, by the author, occurring in a railway and road cutting beneath the new Welland Canal, along Townline road south of Welland. Here a 20-foot (6 m) thick section is exposed, consisting of grey, very finely crystalline, laminated, argillaceous dolostone, with abundant shale partings and numerous gypsum veins and lenses of varying thickness (up to 18 inches; 46 cm). According to subsurface data the Salina Formation is about 375 feet (115 m) thick in this map-sheet area.

**Bertie Formation (Upper Silurian)**  
 Previously referred to as the Bertie-Alkon Formation, this unit extends in a narrow outcrop belt approximately east-west across the map-sheet area. It is composed dominantly of resistant dolostones which form the Onondaga Escarpment, imparting up to 25 feet (7.6 m) of relief. The lower boundary of the unit with the Salina Formation is somewhat gradational; the lower 12 to 15 feet (3.6 to 4.5 m) of the Bertie Formation consists of thick-bedded, dark brown, bituminous dolostone while the upper Salina is only slightly lighter in colour and more finely crystalline.

Overlying the dark brown dolostones are 8 to 11 feet (2.4 to 3.4 m) of grey, very argillaceous (weathers shaly) dolostone, followed by about 5 feet (1.5 m) of grey-brown, very finely crystalline, even textured dolostone. At the top of the unit are 7 to 10 feet (2.1 to 3 m) of irregularly medium- to thin-bedded, mottled brown dolostone. This sequence is best exposed in the Humberstone quarry of Port Colborne Quarries Limited. The upper contact with the Bois Blanc Formation is a distinct erosional surface, representing a major disconformity.

**Bois Blanc Formation (? Lower Devonian)**  
 There has been some argument about definition of the Bois Blanc Formation in the Niagara Peninsula region. Best (1953) included all Devonian strata of the Peninsula in the Bois Blanc. Oliver (1967) limited the Bois Blanc to the lower part of the Devonian sequence and suggested correlation of the overlying strata with the Onondaga Formation of New York. Sanford (1969) also used a restricted definition of the Bois Blanc but equated the overlying strata with the Amherstburg Formation of the Michigan Basin. The present study has confirmed the restricted definition of the Bois Blanc Formation in the Fort Erie-Welland map-sheet area.

Definition of the Springvale Sandstone Member of the Bois Blanc Formation is also a problem. Medium- to coarse-grained, greenish grey or white, calcareous, quartz sandstone with interbeds of green glauconitic sandstone, sandy limestone, dolostone, and brown chert is often developed at the base of the Bois Blanc Formation. Commonly the sandy material is present in cracks and joints of the upper 2 feet (0.6 m) of the Bertie Formation. However, the sandstone lithology is very irregularly developed and it is difficult to ascribe accurate geographic and stratigraphic limits to it. A maximum 4-foot (1.2 m) thickness of this lithology has been observed in the map-sheet area.

The remainder of the Bois Blanc Formation consists mainly of cherty limestone with shale partings and minor dolostones, and is characterized by its diversity of texture and composition. The limestones are irregularly laminated, medium- to thin-bedded, greenish grey to light grey brown, medium- to fine-grained, argillaceous or finely bioclastic. Fossils are common and local con-

centrations of brachiopods or corals are developed. Light grey or brown chert is abundant as thin beds or nodules. Small forms of the brachiopod *Amphigenia elongata* are characteristic of the formation.

Total thickness of the formation varies from 11.5 feet (3.5 m) in the Ridgeway area to about 14 feet (4.2 m) in the Port Colborne area. The upper contact with the Onondaga Formation is sharp and probably disconformable.

**Onondaga Formation (Middle Devonian)**  
 As previously mentioned, Oliver (1967) correlated the strata overlying the Bois Blanc Formation with the Onondaga Formation of New York while Sanford (1969) referred them to the Amherstburg Formation. Oliver's interpretation, with some slight revision, is followed herein. It has been possible to subdivide the Onondaga into three distinct lithological members, also previously recognized in New York. Best (1953) actually recognized these three units in Ontario but relegated them to informal lithological zones within his more broadly defined Bois Blanc Formation.

**Edgcliff Member**  
 This unit is best exposed in the Ridgeway quarry of Ridgeway Quarries Limited, and in several abandoned quarries west of Port Colborne south of Highway 3. Limestones of the unit exhibit great diversity but can be grouped into three main facies-types. The most widespread is the biostromal facies which consists of medium-bedded, fine- to medium-grained, dark grey (weathers light grey or buff), fossiliferous, bioclastic limestone. Black chert is common as nodules or irregular thin beds. Solitary rugose and tabulate corals are the dominant fossils; large crinoid stems are abundant and brachiopods and trilobites are present. These biostromal limestones often surround or overlie reefal and biohermal bodies that constitute the second major facies. The reefal limestones are massive, light grey, very porous, coarse-grained, and constructed mainly of colonial rugose corals. They occur separate from or within large biohermal mounds up to 1,000 feet (300 m) in diameter. The remaining limestones within the mounds are irregularly bedded, grey, medium- to coarse-grained, and very fossiliferous with abundant black chert nodules. Thin beds and partings

of greenish shale are commonly associated with the reefs. The combined thickness of the biostromal and reefal-biohermal facies varies considerably; a 27.5-foot (8.38 m) section was measured in the Ridgeway quarry.

The third major facies is developed only in the Port Colborne region, in the lower part of the member. It consists of medium-bedded (weathers to thin beds), dark greenish grey, very argillaceous, fossiliferous limestone with rare chert. The limestones weather readily into soft, shaly material so that the profuse fossil fauna is easily examined and collected. Fossils include rugose and tabulate corals, bryozoa, brachiopods, gastropods, trilobites (particularly fragments of the large *Yonca Petraspis*), crinoids, and fish plaques. This third facies unit is about 10 feet (3 m) in thickness; its upper boundary with the biostromal limestone is gradational.

**Clarence Member**  
 This unit conformably overlies the Edgcliff Member and its distribution or outcrop pattern is controlled by the occurrence of biohermal mounds in the latter. At Windmill Point Station and Shisler Point, members of the Edgcliff biohermal facies are surrounded by limestone of the Clarence Member, while near Morgans Point and Cherry Hill (1.5 miles (0.45 m) northwest of Ridgeway) the Clarence Member occurs as outliers, presumably overlying Edgcliff bioherms.

The Clarence Member consists of massive-bedded, dark grey-brown, fine-grained, poorly to non-fossiliferous, extremely cherty limestone. The chert is dark grey or dark brown and often opaline, occurring as thin beds and irregular nodules which may constitute over 50 percent of the rock. Upper and lower contacts of the unit are nowhere exposed so that thickness cannot be determined accurately. Best (1953) estimated a thickness of 26 feet (8 m); a minimum 17-foot (5 m) thick section occurs in an abandoned quarry at Windmill Point.

**Moorehouse Member**  
 Several small exposures at Point Abino and near Pine Crest and Cassaday Points may be referred to this member. They consist of medium-bedded, brown, fine- to medium-grained, fossiliferous, variably cherty limestone. The

chert is dark grey or brown, occurring as thin beds or rounded nodules. Fossils are dominantly corals and brachiopods. The lower boundary of the unit with the Clarence Member is gradational. Best (1953) estimated a minimum thickness of 25 feet (7.6 m) for the unit (his Zone D).

**ECONOMIC GEOLOGY**  
 Four major quarries are presently operated in the map-sheet area. These include the properties of George C. Campbell Company Limited and Ridgeway Quarries Limited (Ridgeway), Port Colborne Quarries Limited (Humberstone), and R.E. Law Crushed Stone Limited (Port Colborne). All are described by Hewitt and Vos (1972). The Ridgeway quarry is in the Bois Blanc and Onondaga Formations while the others are excavating the Bertie and Bois Blanc Formations. Numerous areas of extensive outcrop or low overburden exist where the Silurian dolostones or Devonian limestones could be further exploited.

The large Welland gas field is situated within the map-sheet area (Koepke and Sanford 1966). Silurian sandstones of the Whitpool, Grimby, and Thorold Formations and the crinoid dolostones of the Silurian Irondequoit Formation are the most important reservoir rocks. The Whitpool sandstone is also being used for gas storage.