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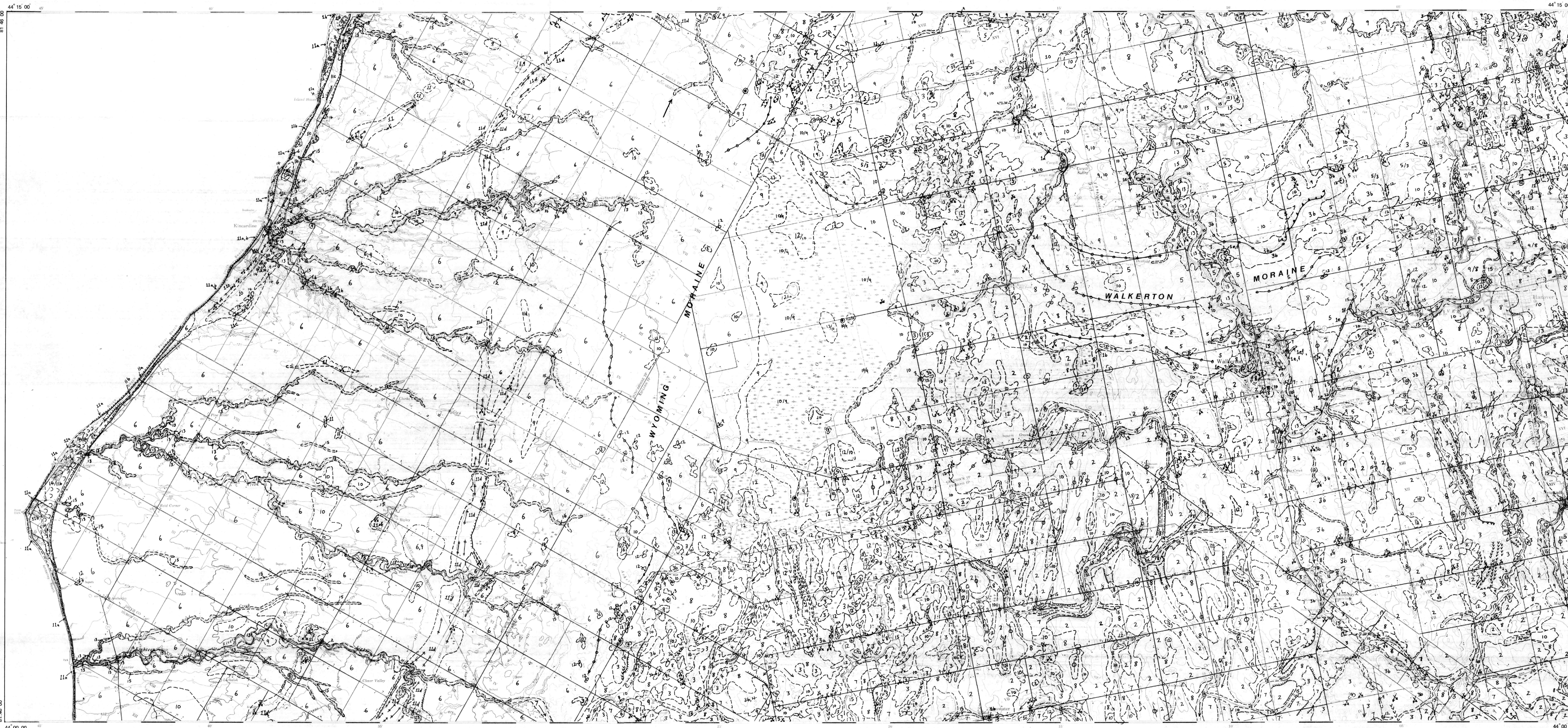
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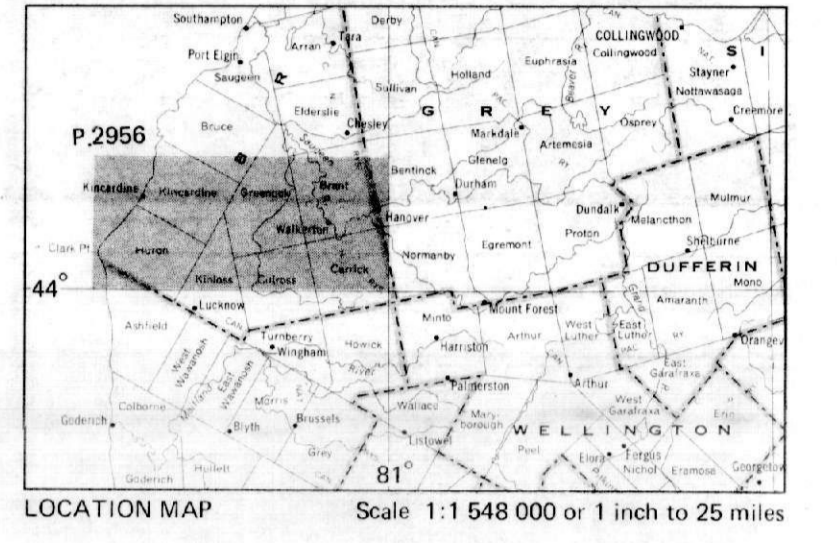
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QUATERNARY GEOLOGY
WALKERTON-KINCARDINE AREA
 SOUTHERN ONTARIO

Scale 1:50 000
 NTS Reference: 41 A/3,4
 ODM Geological Compilation Map: 2441

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LEGEND

- CENOZOIC**
QUATERNARY
RECENT
- 15 Modern alluvium: silt, sand, gravel
 - 14 Eolian fine sand
 - 13 Older alluvium: sand and gravel
 - 12 Organic deposits: muck and peat
- PLEISTOCENE AND RECENT**
- 11 Beach and near shore sand and gravel
 - 11a Lake Huron
 - 11b Lake Nipissing
 - 11c Lake Algonquin
 - 11d Lake Warren
- PLEISTOCENE**
LATE WEICHSENIAN
- 10 Lacustrine sand, some silt
 - 9 Lacustrine clay and silt, some sand
 - 8 Glaciofluvial outwash sand; minor gravel
 - 7 Glaciofluvial outwash gravel and gravelly sand
 - 6 St. Joseph Till: clayey silt to silt till, very low stone content
 - 5 Dunkeld Till: silt till; low stone content
 - 4 Rannoch Till: silt to sandy silt till
 - 3 Ice-contact stratified drift: sand, gravel silt and till
 - 3a Mainly gravel
 - 3b Mainly sand
 - 2 Elma Till: stony, sandy silt to silt till
- UNCONFORMITY**
- PALEOZOIC**
DEVONIAN
- 1 Bedrock
 - 1a Dundee Formation: limestone
 - 1b Detroit River Formation: dolostone
 - 1c Detroit River Formation: Silurian facies limestone
 - 1d Bois Blanc Formation: limestone with chert
- SILURIAN**
- 1e Silina Formation: shale and dolostone
- Notes:**
 Deposits on this sheet are mapped where they reach one or more metres in thickness. Thinner deposits are usually not shown.
 Legend symbols such as 3/4 indicate unit 3 is the predominant surface material overlying unit 4.
 Legend symbols (6, 7) indicate interbedded silt-clay material (6) and lacustrine materials (9).

SOURCES OF INFORMATION

Topography from Maps 41 A/3 and 41 A/4 of the National Topographic Series.
 Aerial Photography, Ontario Ministry of Natural Resources, Toronto, and National Air Photo Library, Ottawa.
 Metric conversion factor: 1 foot = 0.3048 m

CREDITS
 Geology by W.R. Cowan (1975-1979), J.J. Finch (1975), and assistants.
 Every effort has been made to ensure the accuracy of the information presented on this map; however, the Ontario Ministry of Northern Development and Mines does not assume any liability for errors that may occur. Users may wish to verify critical information; sources include both the references listed here, and information on file at the Regional or Regional Geologist's office and the Mining Recorder's office nearest the map area.
 Issued 1986
 Information from this publication may be quoted if credit is given. It is recommended that reference to this map be made in the following form:
 Cowan, W.R., and Finch, J.J.
 1986: Quaternary Geology of the Walkerton-Kincardine Area, Southern Ontario. Ontario Geological Survey, Map P.2956, Geological Series—Preliminary Map, scale 1:50,000. Geology, 1975-1979.

MARGINAL NOTES

INTRODUCTION
 Geological mapping of the Walkerton-Kincardine area commenced in 1975 and was completed in 1979 with most of the mapping being carried out in 1975, 1977, and 1978 (Cowan 1975, 1977, 1978). In addition, several boreholes were drilled in 1977 and 1978 in order to increase stratigraphic control in 1975. A person served as senior assistant and was responsible for field mapping of most of Carleton and Ottawa Townships and part of Kincardine Township, all in Bruce County. Additional valuable field assistance was provided by E.H. Conlin and P. Culnan in 1975; B. Answorth and H. Matthews in 1977; and J.G. Leyland in 1978.

Field techniques included the examination of natural and man-made exposures as well as hand augering and test pitting. Air photographs at scales of 1:40 000 and 1:16 840 were used as were water well records provided by the Ontario Ministry of Environment.

BEDROCK GEOLOGY
 The bedrock was most recently mapped by Liberty (1966) and described by Liberty and Bolton (1971). Most outcrops observed during the present survey were previously mapped excepting outcrops of Silurian Salina Formation near Neustadi and Hanover and of the Devonian Dundee Formation about 2 km south of Westport. All rocks comprise part of the Michigan structural basin and dip westerly; a structural inlier of Silurian Formation north of Walkerton has been interpreted as a monocline by Liberty and

Bolton (1971) though they suggested faulting may be the underlying cause.

The oldest rocks occurring in the area are of Silurian age and comprise the Salina Formation. These consist of greenish-grey shales, reddish shales, and thin to thick beds of dolostone. These rocks outcrop near Neustadi, Hanover, and Walkerton and are up to 150 m in thickness. Overlying the Salina Formation are thin bedded dolostones having a thickness of 40 m, two kilometres north of Dundee. Devonian rocks comprise the Bois Blanc, Detroit River, and Dundee Formations in ascending order. The Bois Blanc Formation forms a north-west-south-east trending band 2 to 7 km wide immediately west of the Bois Blanc Formation. Outcrops occur along the Westwater River between Chestnut and Pinkerton and 2 km north of Dundee. The rocks consist of thin-bedded cherty, fossiliferous limestones up to 45 m thick. Younger events in the western part of the area were from west to east out of Lake Huron and from north to south in the Sauguen River area. All deposits present are believed to be less than 25 000 years old. The oldest till in the area is the Elma Till which forms north-south trending drumlins and ground moraine in the area east of Riverside. This till is estimated to be about 14 000 years old; however, it has been suggested by Cowan et al. (1978) and Sharpe and Edwards (1979) that it may span a time frame from 25 000 to 14 000 years before present and represents continuous ice cover during this period.

Elma Till is a stony, sandy silt till having a high total carbonate content which is strongly dolomitic. West of Riverside a till of similar composition occurs in the subsurface, notably in river

sections near Lake Huron. Till fabrics on this material suggest a north-south flow through the area was generally from north to south. Younger events in the western part of the area were from west to east out of Lake Huron and from north to south in the Sauguen River area. All deposits present are believed to be less than 25 000 years old. The oldest till in the area is the Elma Till which forms north-south trending drumlins and ground moraine in the area east of Riverside. This till is estimated to be about 14 000 years old; however, it has been suggested by Cowan et al. (1978) and Sharpe and Edwards (1979) that it may span a time frame from 25 000 to 14 000 years before present and represents continuous ice cover during this period.

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flow into Glacial Lake Sauguen. Silt till occurring locally south of the Sauguen River between Midway and Neustadi may represent local extensions of this advance of it may be local silt till related to the retreating Elma ice. One of the authors previously referred to this till informally as "Dunkeld Till" (Cowan 1977); it is here proposed to formally name it Dunkeld Till having its type area adjoining the dam which is located near the northern margin of the Walkerton Moraine. It is estimated to have been deposited about 13 700 years ago (Cowan et al. 1978).

The youngest till in the area is the St. Joseph Till which extends over much of the surface from Lake Huron to the Wycroft Moraine and represents the Port Huron readvance estimated to be about 13 000 years old. It is a clayey silt till with low stone content; it generally occurs as a silt till, however, facies of waterlain silt and deformation till are present locally. No attempt was made to subdivide these facies due to the lack of adequate outcrop; however, in places the waterlain facies is indicated by a compound map unit (6/9).

Ice-contact deposits occur within the Wawanosh Moraine and the Walkerton Moraine, and are associated with large features in the Midway-Hanover area which are believed to represent deposition within re-entrants in the retreating Elma ice. The predominant material in all of these deposits is sand with local pockets of pebbles and cobble gravel.

Glaciofluvial outwash includes channel fill, outwash plain and deltas, loess, sand and gravel. South of Walkerton, outwash occurs primarily as terrace and fill deposits related to a network of channels developed during retreat of the Elma ice. North of Walkerton and Hanover, it occurs primarily as loess facies of deltaic features. Sand is the dominant material.

Lacustrine sediments include glaciolacustrine and post-glacial sand deposits. Four major types of deposits exist: 1) ice-contact deltaic sediments; 2) the thick glaciolacustrine sediments of the Greenoch Swamp; 3) the glaciolacustrine sediments north of the Walkerton Moraine and of Hanover and of Kincardine and a barrier bar at western part of the area. Many of the sediments mapped as ice-contact in origin are deltas. Typically these have an upper coarse grained topsoil unit which overlies a primary sand and containing clay bands and bands of flow till. The Greenoch Swamp deposits exceed 25 m in thickness in many places. At the surface there is generally a veneer of organic material overlying fine to medium sands and some silt. A lens hole located centrally within the swamp penetrated 26 m of lacustrine sediment before entering coarse sand. This hole is also lacking in coarse sand and silt. In addition to beach and eolian sediments, postglacial materials include alluvium and organic sediments. Older alluvium consists of sand and gravel occurring as terraces above the modern stream flood levels and below material judged to be glaciofluvial outwash. On the Lake Huron slope, Karrow et al. (1975) and Karrow (1978) studied these terraces in some detail. The highest ones are apparently graded to Lake Algonquin levels and have been dated at about 10 500 years before present. On the Sauguen River, no dates are available and some material mapped as high level alluvium may be outwash. Post-Algonquin alluvium occurring on terraces 1.5 to 2 m above present day low water levels near Kincardine have been dated between 1500 and 8000 years before present (Cowan 1978). As these terraces are not always above present flood levels, they have been mapped as modern alluvium in most instances.

Bog deposits in the area consist of peat and muck and are generally <2 m in thickness.

Sand and gravel deposits of economic importance in the area are widespread but are generally limited by area, thickness, or grading at any one site. Ice-contact deposits tend to be very stony and no large deposits of outwash material were identified. Similarly, outwash deposits have size or grading limitations for major operations. Beach deposits tend to be shallow, linear, and containing several metres of beach sand and gravel. This material may be overlain by windblown sand. The Nipissing bluff has an elevation about 124 m at Kincardine.

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SYMBOLS

- Sand and gravel pit
- Rock quarry or clay pit, inactive
- Geological contact, approximate
- Geological contact, gradational
- Erosional scarp
- Glacial stratification
- Drumlin
- Glacial fluting, not all shown
- Esker
- Ice-contact slope
- Name
- Offshore or beach star, not all shown
- Small bedrock outcrop
- Sand dunes, not to scale
- Meltwater channel with inferred direction of flow
- Borehole location
- End moraine crest
- Slope failure