A Detailed Magnetic Survey of the St. Lawrence River:

Massena to Oak Point, New York

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New York Sea Grant Institute
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ABSTRACT

Canadian aeromagnetic maps and recent magnetic maps of the St. Lawrence River and adjacent area between Massena and Oak Point, New York, indicate no fault of large lateral displacement trending along the St. Lawrence River into Lake Ontario.

INTRODUCTION

This report presents the findings of a detailed magnetic survey of the St. Lawrence River conducted during the summer of 1974 under a grant provided by the New York Sea Grant Program. The objective of the survey was to investigate a possible major geologic structure running along the St. Lawrence River into Lake Ontario. Both Woollard (1969) and Fox (1970) note the high seismic activity near the St. Lawrence River and suggest it is related to a major fault system there. Kumarapeli and Saull (1966) compared the St. Lawrence system to the East African Rift system and suggested they are similar. This investigation was undertaken to determine whether any such fault system might be revealed by a magnetic survey.

A total of 336 magnetic traverses were made at intervals of one-quarter mile (402 meters) across the St. Lawrence River from Massena to Oak Point, New York (Figure 1). Over 6,000 total magnetic field measurements were made along the traverses at 200 to 400 foot (61 to 122 meter) intervals. These measurements were plotted on a base map with a scale of 1:22,200 and contoured at intervals of 100 and 200 gammas.

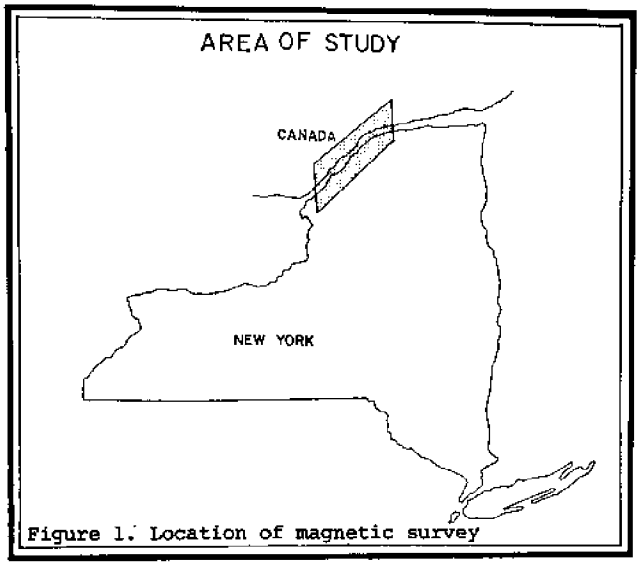

Figure 1. Location of magnetic survey

FIELD PROCEDURE

All measurements were made in a 15 foot (4.6 meter) nonmagnetic fiberglass boat. Preliminary measurements on the boat and near the motor while in operation indicated that the boat had no magnetic effect. The proton sensor was placed in the front of the boat and connected to the magnetometer with a 6 foot (1.8 meter) sensor cable. The sensor was free from any stray magnetic materials.

The magnetic stations were located on the most recent National Oceanic and Atmospheric Administration maps of the St. Lawrence River with a scale of 1 inch equal to 2,500 feet (1 inch equal to 762 meters). Station locations were established by running straight line traverses by dead reckoning. Boat velocity was constant and measurements were made at equal time intervals to enable us to establish the location of the station on the traverse.

EQUIPMENT

A Varian M-50 Portable Proton Precession Magnetometer with a sensitivity of ±1 gamma was used for all magnetic measurements. This instrument gives a direct readout in gammas of the total intensity of the earth's magnetic field. The instrument is ideally suited for this project because of its compact size and light weight. The instrument requires no leveling.

The instrument requires three 18v DC rechargeable lead acid batteries, which were charged fully each night to assure best operation of the instrument. The field intensity range of the instrument is 25,000 to 85,000 gammas. All measurements in this

project were between 57,000 and 60,000 gammas. The operating range of the instrument is 14°F to 120°F, well within the temperature variation recorded in the field. The accuracy of the instrument is reported as ± 3 gammas.

REDUCTION OF OBSERVATIONS

The total intensity magnetic measurements were not corrected for any diurnal variations of the earth's magnetic field and instrumental drift. A correction for the diurnal variation assumes the earth's magnetic field varies linearly with time; this assumption is not true. There is no instrumental drift associated with the instrument so this correction was not made. It was not necessary to correct the observed magnetic intensity values for latitude since inspection of the Total Magnetic Intensity Map of the United States indicates that the 58,000 gamma contour runs along the St. Lawrence River. This 58,000 gamma regional magnetic value was subtracted from each total field magnetic measurement and the difference plotted on a base map for contouring.

DISCUSSION OF MAGNETIC ANOMALIES

Magnetic anomalies reveal the location and configuration of various types of geologic structures. When the structures are buried, the magnetic method provides an economic means for detecting and examining them. Magnetic anomalies in the St. Lawrence River between Massena and Oak Point, New York, are shown in the accompanying magnetic map series.

The magnetic anomalies are interpreted as originating from rocks in the Precambrian basement complex. The total intensity contour map shows a conspicuous variation in the character of the magnetic anomalies from northeast to southwest. Northeast of Galop Island the anomalies have relatively low amplitudes and gradients. In sharp contrast, the anomalies southwest of Galop Island are characterized by steep gradients and large amplitudes over 1,000 gammas. The magnetic data in the area of St. Lawrence Valley adjacent to the river shows a similar change.

The magnetic anomalies in the map series are discussed in the following paragraphs under the geographic areas from Croil Island to Galop Island, Galop Island to Nevins Point, and Nevins Point to Point Comfort.

Croil Island to Galop Island

The magnetic anomalies between Croil Island and Galop Island have low magnitudes (400 to 800 gammas) and gentle gradients (300 gammas/mile). A broad elliptical shaped magnetic high occurs just north of Croil Island and a magnetic low southwest of the island. These two anomalies in the vicinity of Nairn Island correlate well with a projection of the Kempville Fault. Seismic data collected from this area by Dames and Moore (1973) indicated several down-faulted blocks, a possible narrow horst and deformed surficial deposits.

Two magnetic highs (600 gammas) occur between Wilson Hill and Morrisburg. These highs are located on an apparent depression of the bedrock surface in the Gooseneck Shoal area (Dames and Moore 1973).

Just east of Ogden Island, near Waddington, is a magnetic high that correlates well with an adjacent magnetic high on land. According to Dames and Moore (1973), the first discontinuity in a seismic reflection survey occurs here. A seismic reflection traverse indicates one or two upthrown bedrock blocks. These upthrown bedrock blocks correlate with a magnetic high on this area. Between Ogden Island and Galop Island, the magnetic lines extend smoothly across the river in a north by northwest direction.

The magnetic anomalies in the area between Croil Island and Galop Island correlate well with the magnetic anomalies shown on adjacent Canadian aeromagnetic maps and with a

magnetic map of the St. Lawrence Valley. The magnetic contour lines and anomalies extend smoothly across the river, indicating no large offset has occurred in the Precambrian basement complex beneath the river. Most of the magnetic anomalies on land adjacent to the river can be traced into the river.

Galop Island to Nevins Point

At Galop Island there is an abrupt change in the magnetic pattern. The magnetic anomalies between Galop Island and Brockville have higher magnitudes (1,000 to 2,000 gammas) and steeper gradients (1,000 gammas/mile). Just north of Galop Island is a circular magnetic high of 1,000 gammas. East of Galop Island is a magnetic low extending continuously across the river. North of Chimney Point are two magnetic highs of 1,300 gammas, flanked to the south by a magnetic low.

Offshore from Prescott is a circular-shaped magnetic high of 2,000 gammas and northeast of Ogdensburg is an elliptically shaped magnetic high of 1,900 gammas. A very interesting, elongated, elliptically shaped magnetic high extends for 5 miles (8 kilometers) down the center of the river between Ogdensburg and Nevins Point.

Nevins Point to Point Comfort

From Nevins Point to Point Comfort the magnetic anomalies have irregular or elliptical shapes and low magnitudes and gradients. At Holmes Point there are magnetic contours as low as -1,200 gammas while just southwest of this the magnetic contours reach values of 1,800 gammas. This magnetic anomaly of 3,000 gammas could be due to a change in the magnetic susceptibility contrast in the Precambrian basement rocks. A possible explanation for the high magnetic measurements is a belt of metavolcanic rocks extending across the river in this area.

CONCLUSION

The Precambrian basement rocks cause the magnetic anomalies over the St. Lawrence River between Massena and Oak Point, New York. The magnetic contours trend continuously across the river, indicating no large offsets have occurred in the Precambrian complex beneath the river. Most magnetic anomalies on land adjacent to the river can be traced into the river.

The increase from northeast to southwest in the amplitude and gradients of the observed anomalies over the river may be explained by a decrease in burial depth of the magnetic bodies or by an increase in the susceptibility contrast in the Precambrian rocks.

LITERATURE CITED

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Fox, F.L. 1970. Seismic geology of the eastern United States. *Assoc. Eng. Geolog. Bull.* 7:21-43.

Kumarapeli, P.S., and Saull, V.A. 1966. The St. Lawrence Valley system, a North American equivalent to the East African Rift Valley system. *Canad. J. Earth Sci.* 3.

Dames and Moore. 1973. *Regional Geologic and Tectonic Study, St. Lawrence River Valley.* NYS Atomic and Space Development Authority.

MAGNETIC MAP OF THE ST. LAWRENCE RIVER

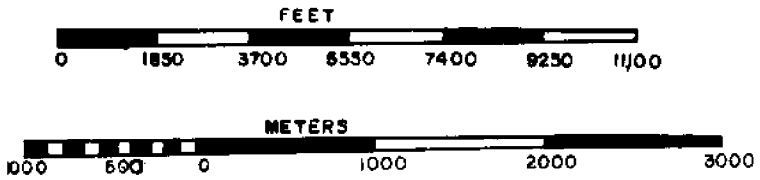
(Covers area between Massena and Oak Point, New York)

By Frank Revetta, John Cardinal, and William Lilley

Scale 1:44,400

The magnetic data were compiled by students Jerry Moore and Bob Albert. The total magnetic intensity contours are relative to an arbitrary datum of 58,000 gammas.

The map series here reproduced were originally on one piece of acetate 17 feet long. The reductions incorporate a slight overlap on the left side.

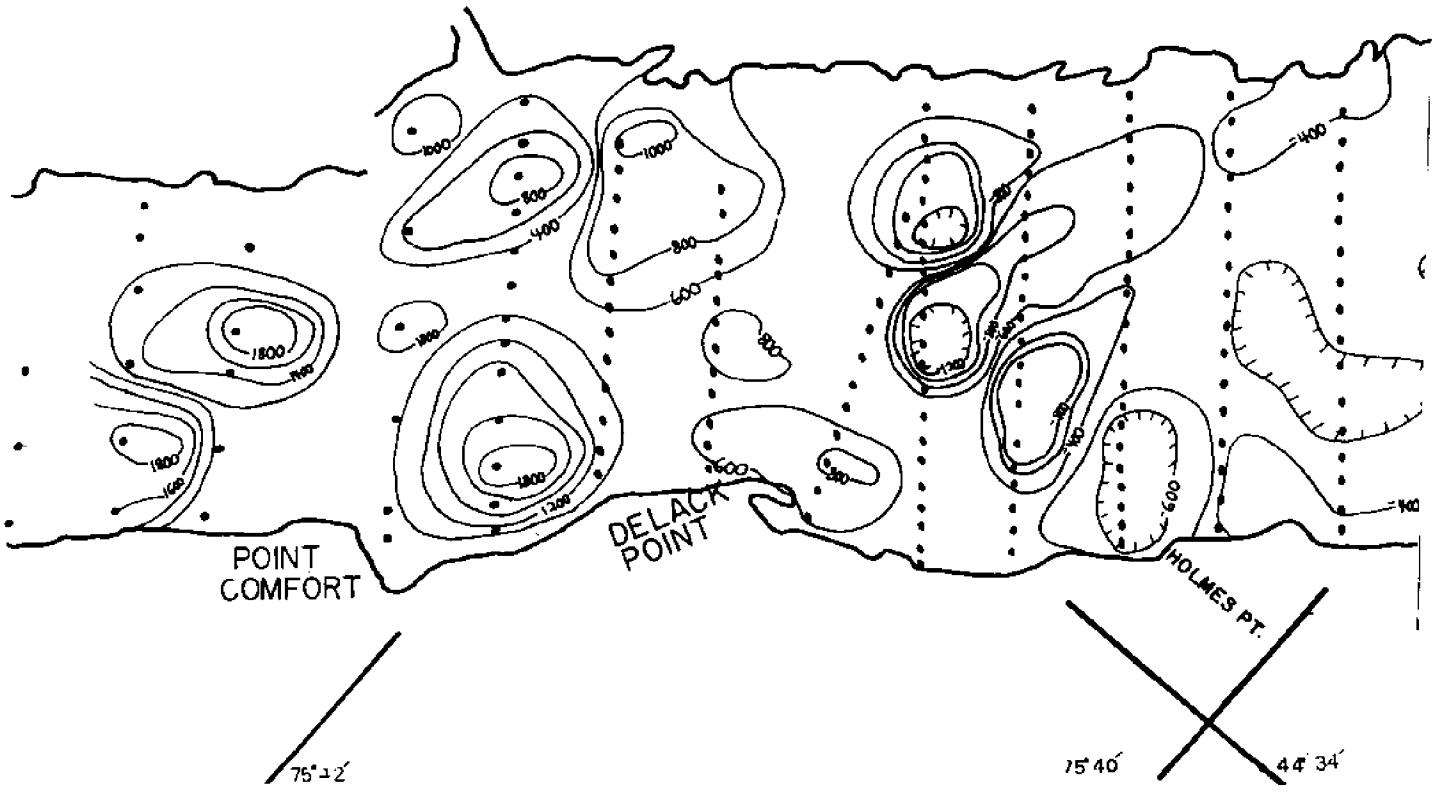


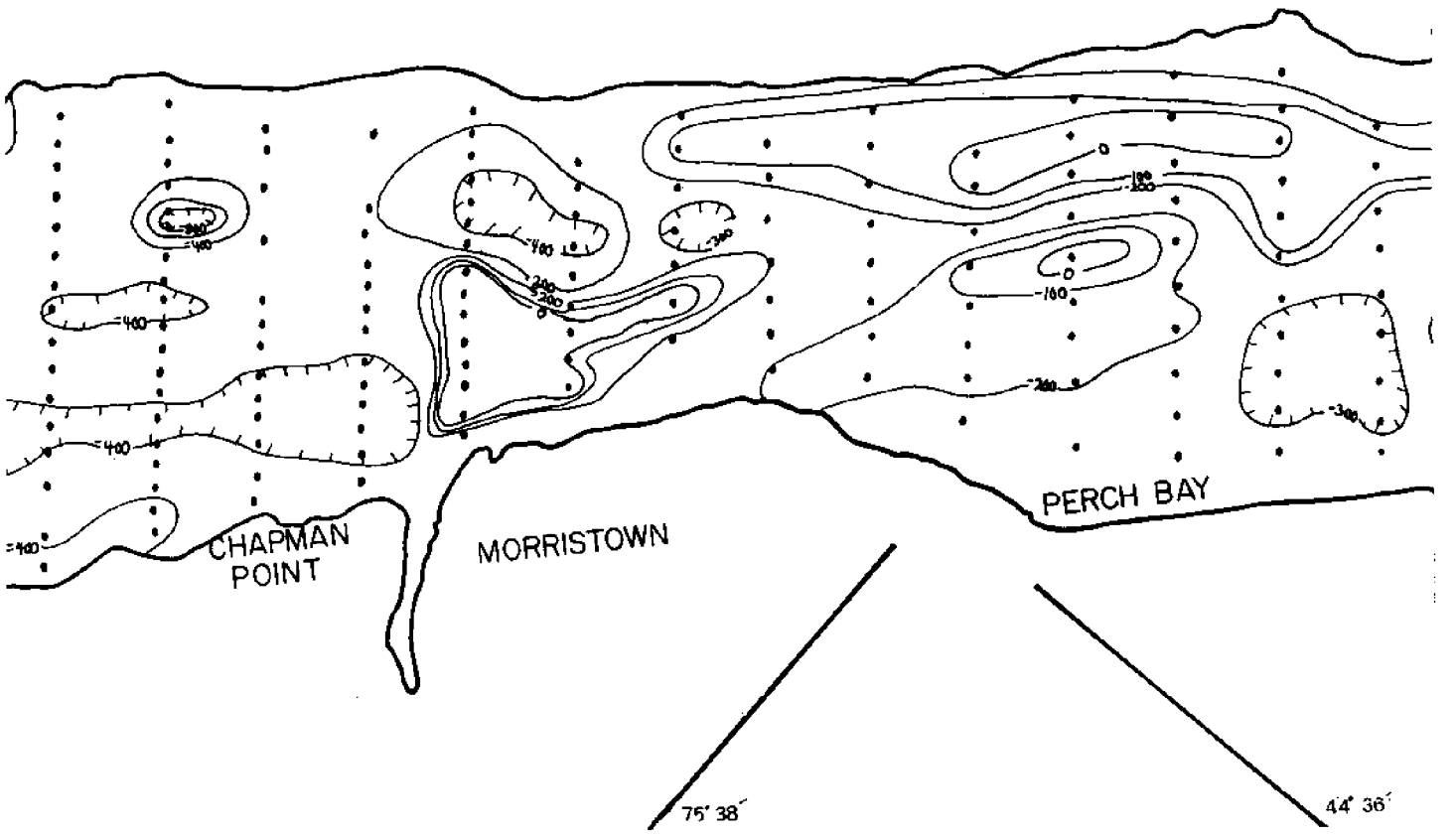
EXPLANATION

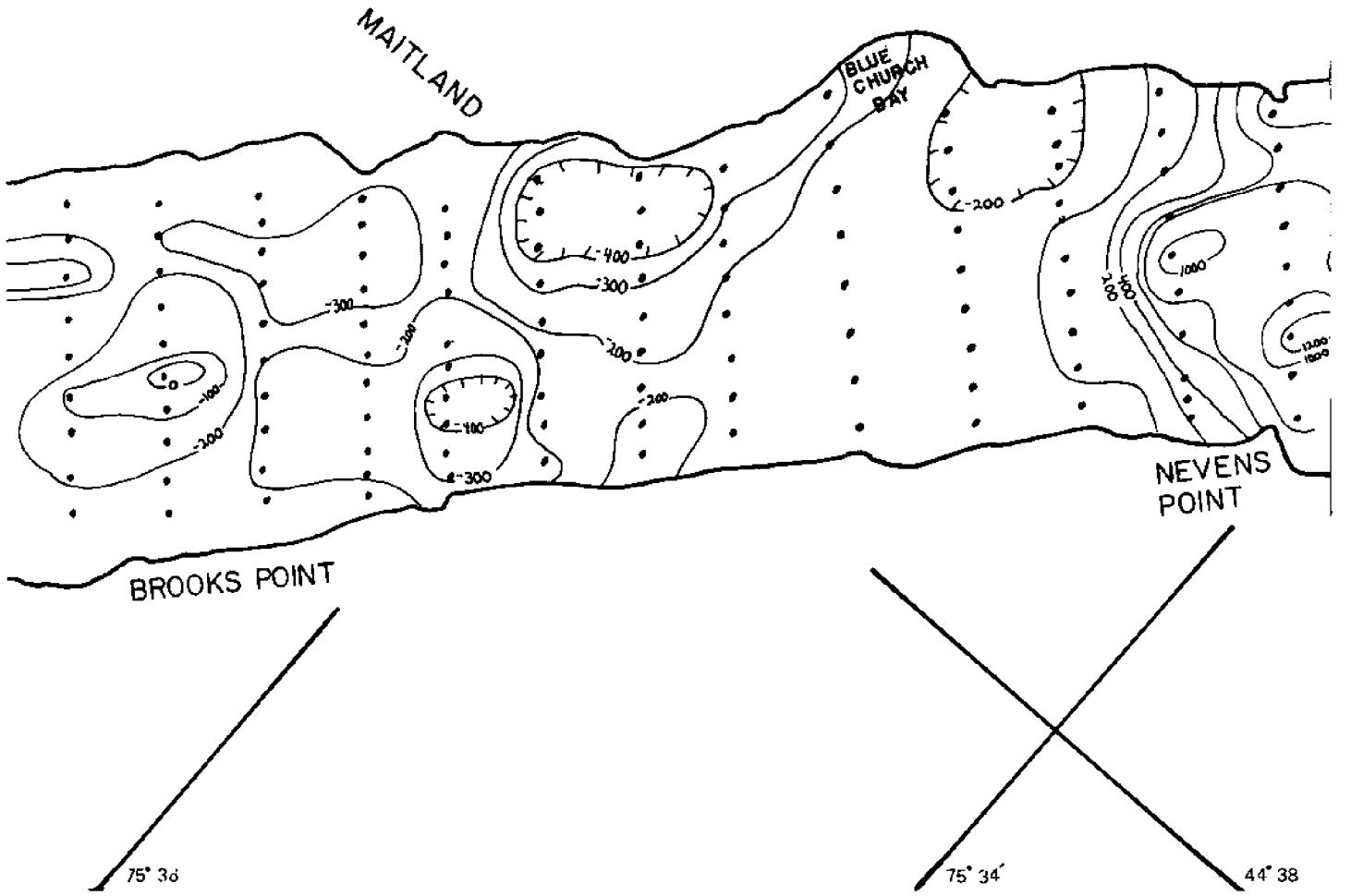
• STATION LOCATION

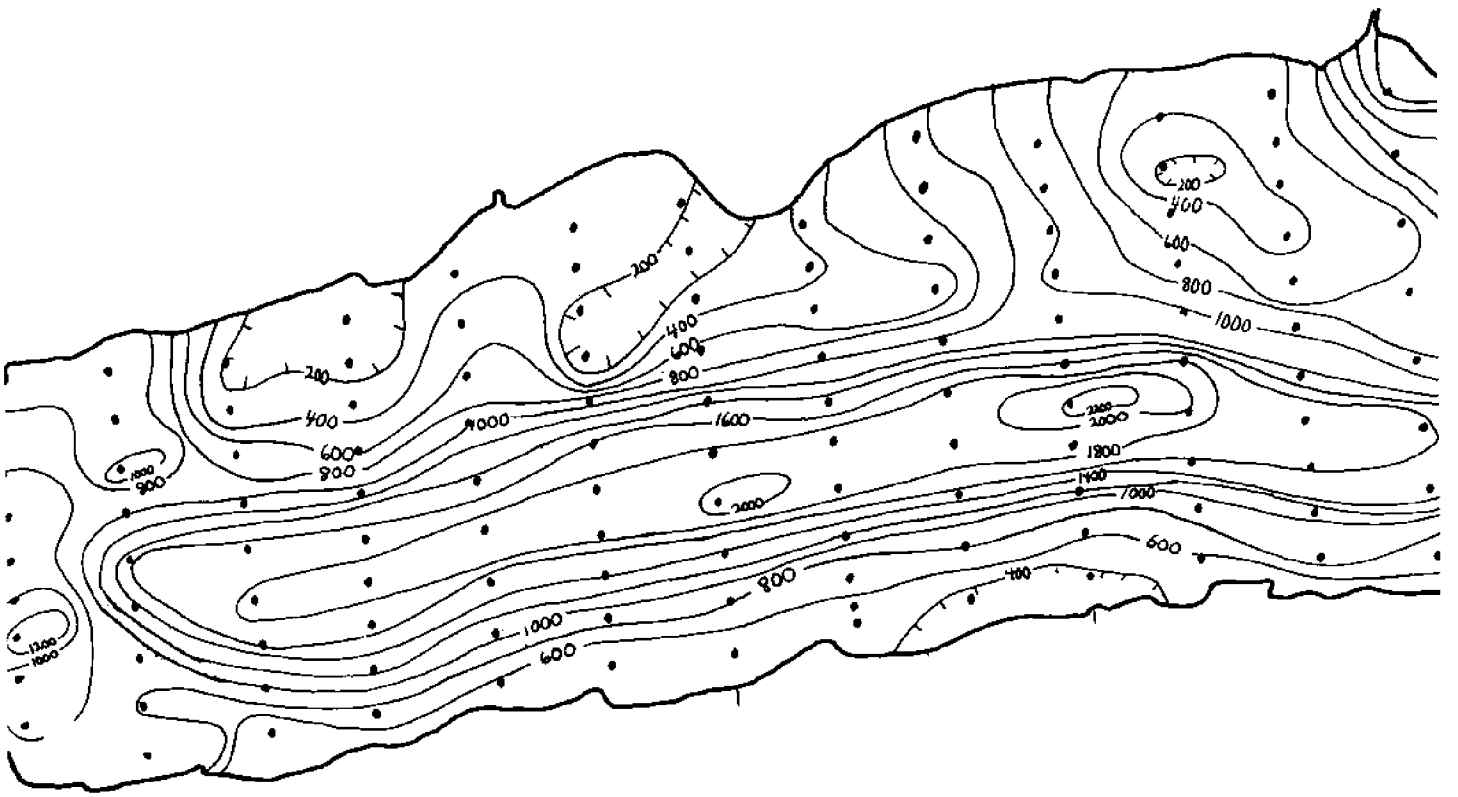
MAGNETIC CONTOUR

100, 200 GAMMAS CONTOUR INTERVAL




CHAPMAN POINT
MORRISTOWN
PERCH BAY
75° 38´
44° 36´


MAITLAND
BLUE CHURCH BAY
-400
-300
-200
-100
-300
-200
-100
-200
-300
-200
-400
-1000
-2000
NEVENS POINT
BROOKS POINT
75° 36
75° 34
44° 38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600
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1600
1800
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1200
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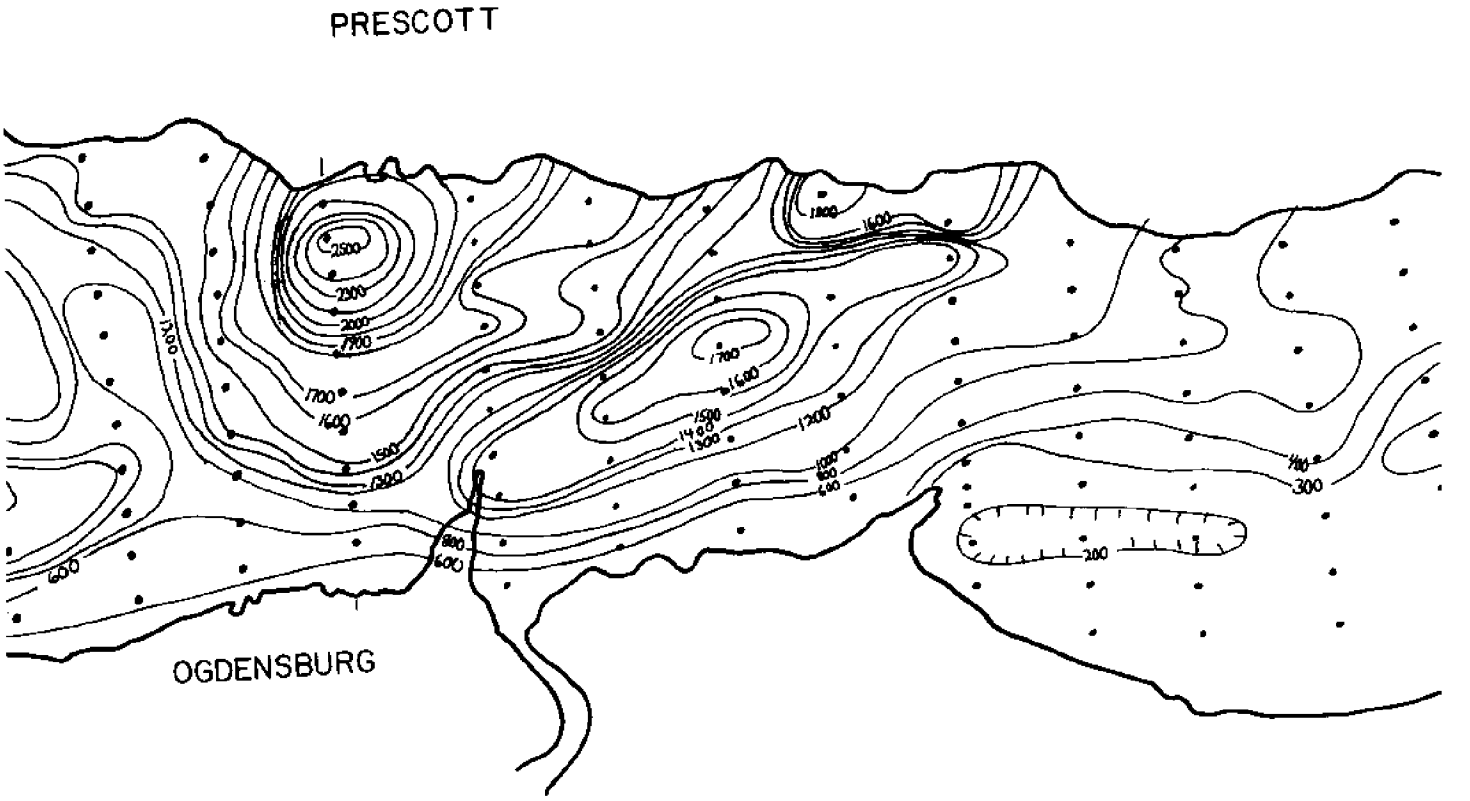
600
400
200

38´

4 4' 40"

75


PRESCOTT
OGDENSBURG
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
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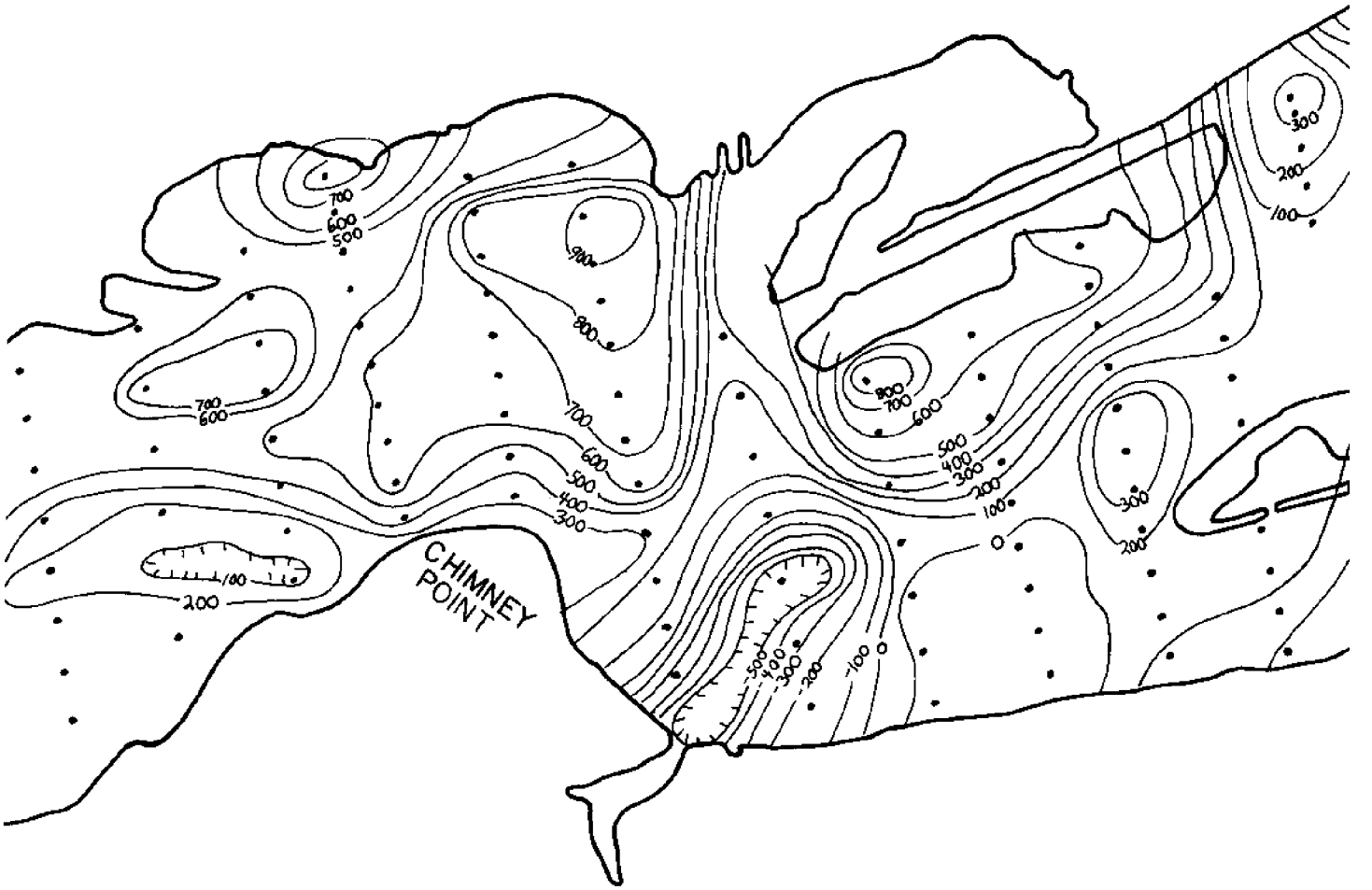
700
600
500
400
300
200
100

75° 30'

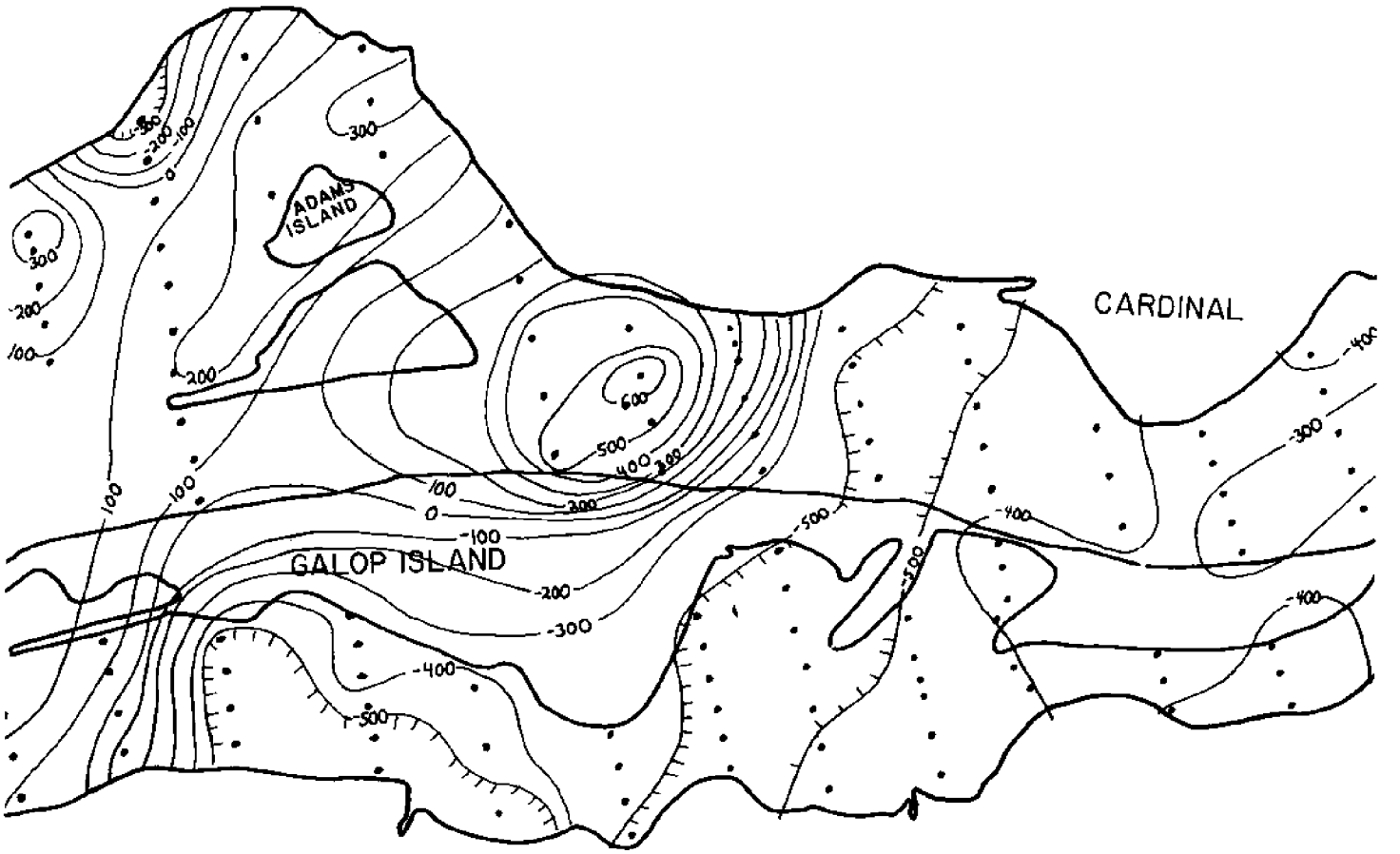
75° 28'

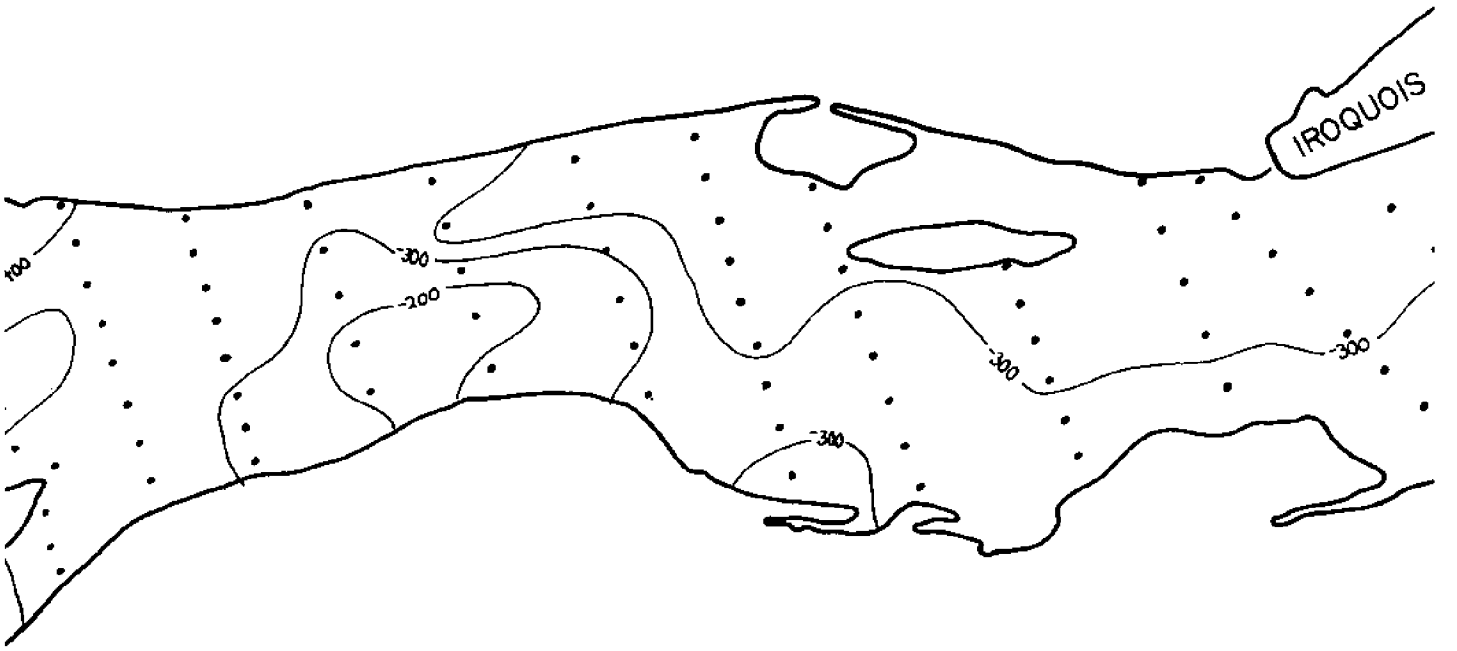


44° 42′

75° 26′

75° 24′


ADAMS ISLAND
CARDINAL
GALOP ISLAND
300
200
100
0
-100
-200
-300
-400
-500
600
400
44° 44'
75° 22'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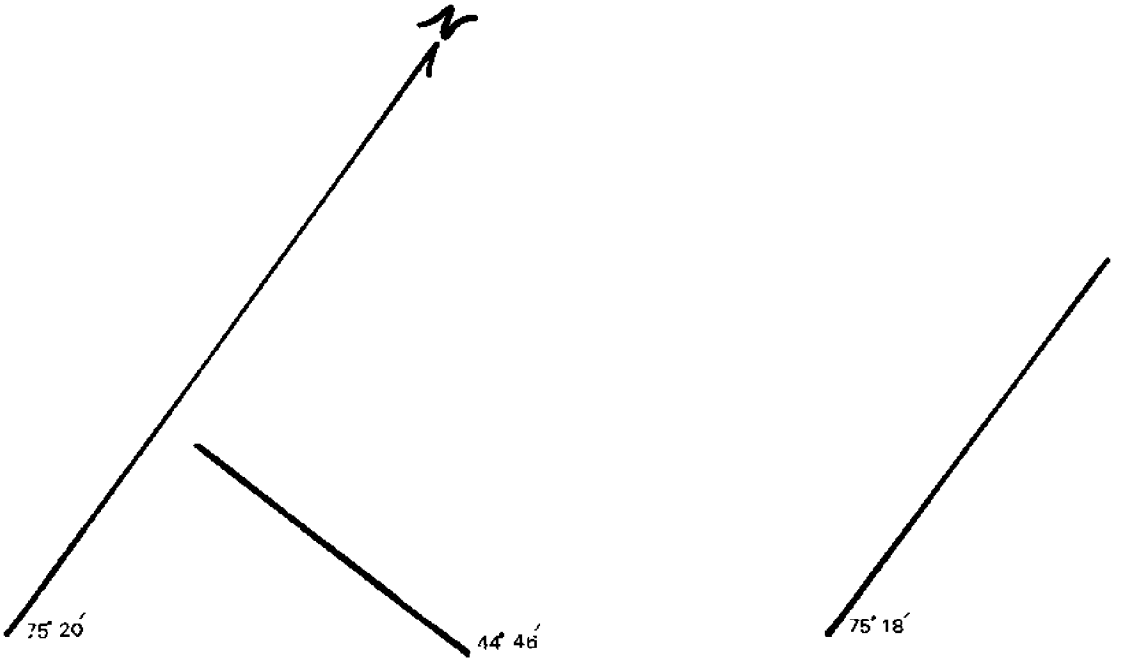
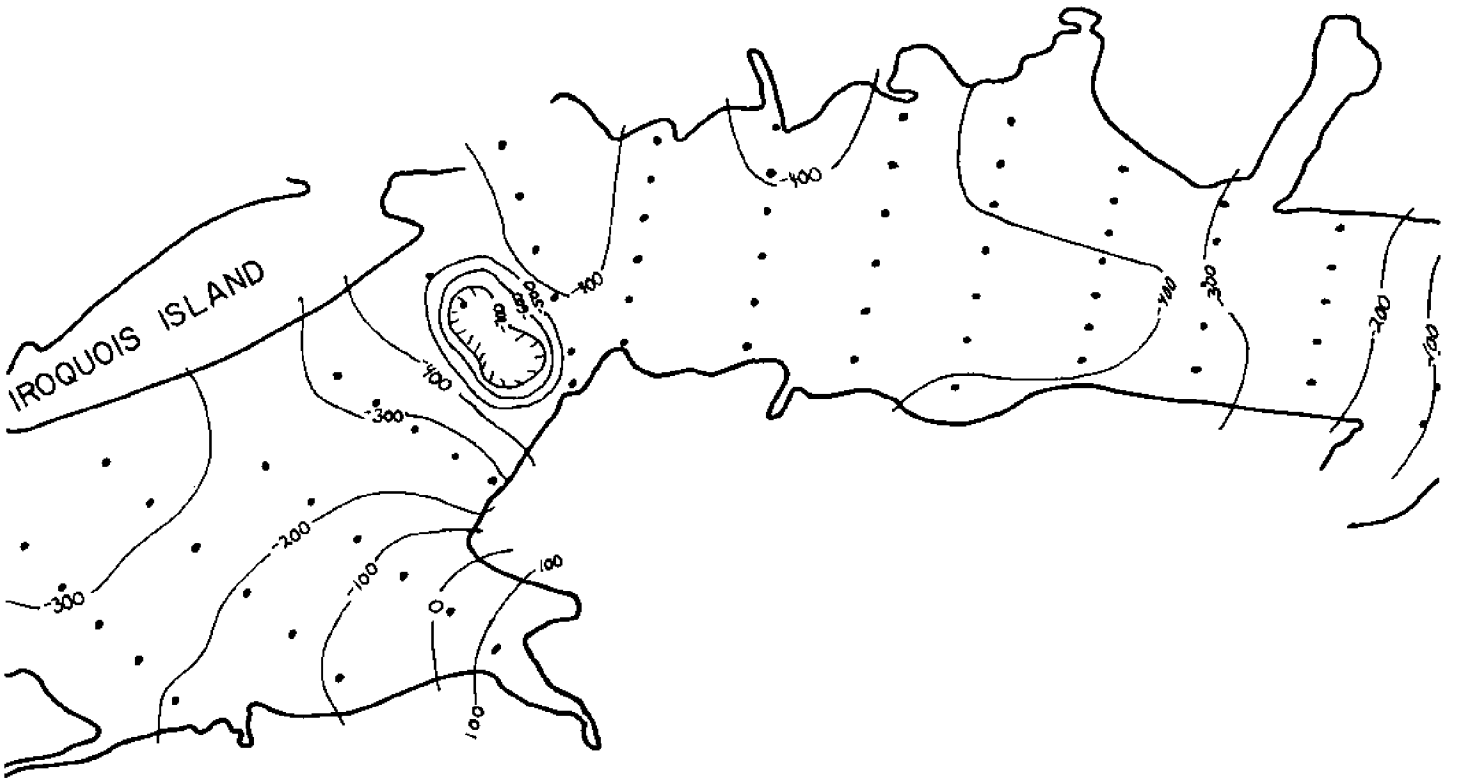
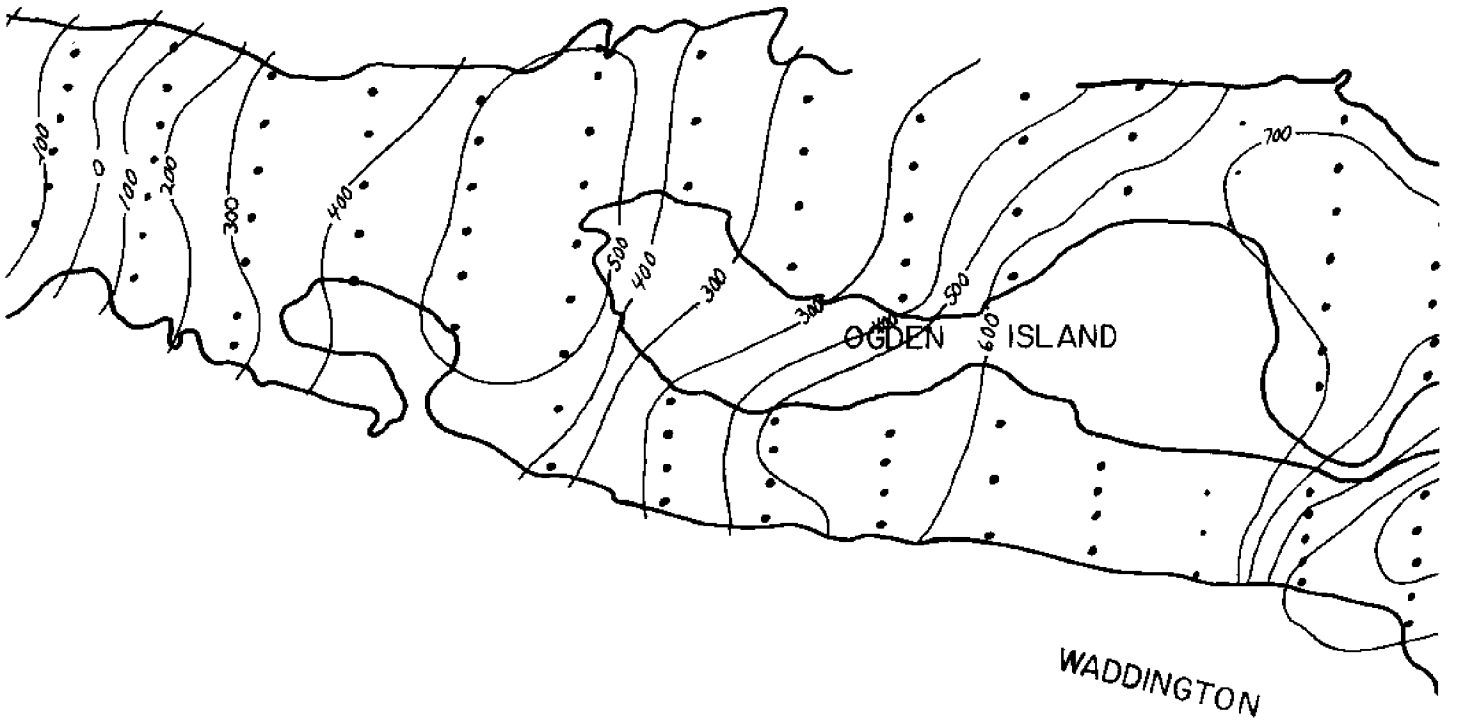
-300
-300


75° 20´
44° 46´
75° 18´



75° 16′ 44° 48′ 75° 14′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0
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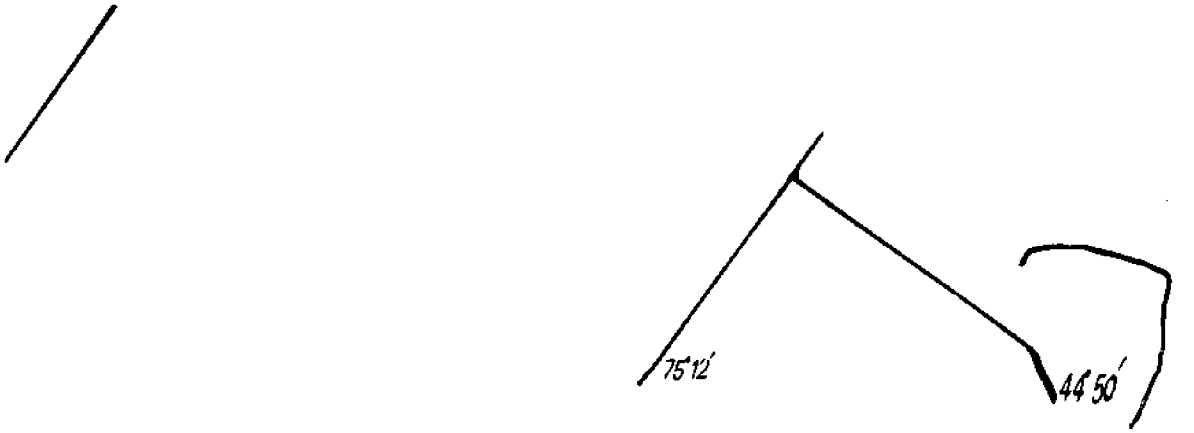
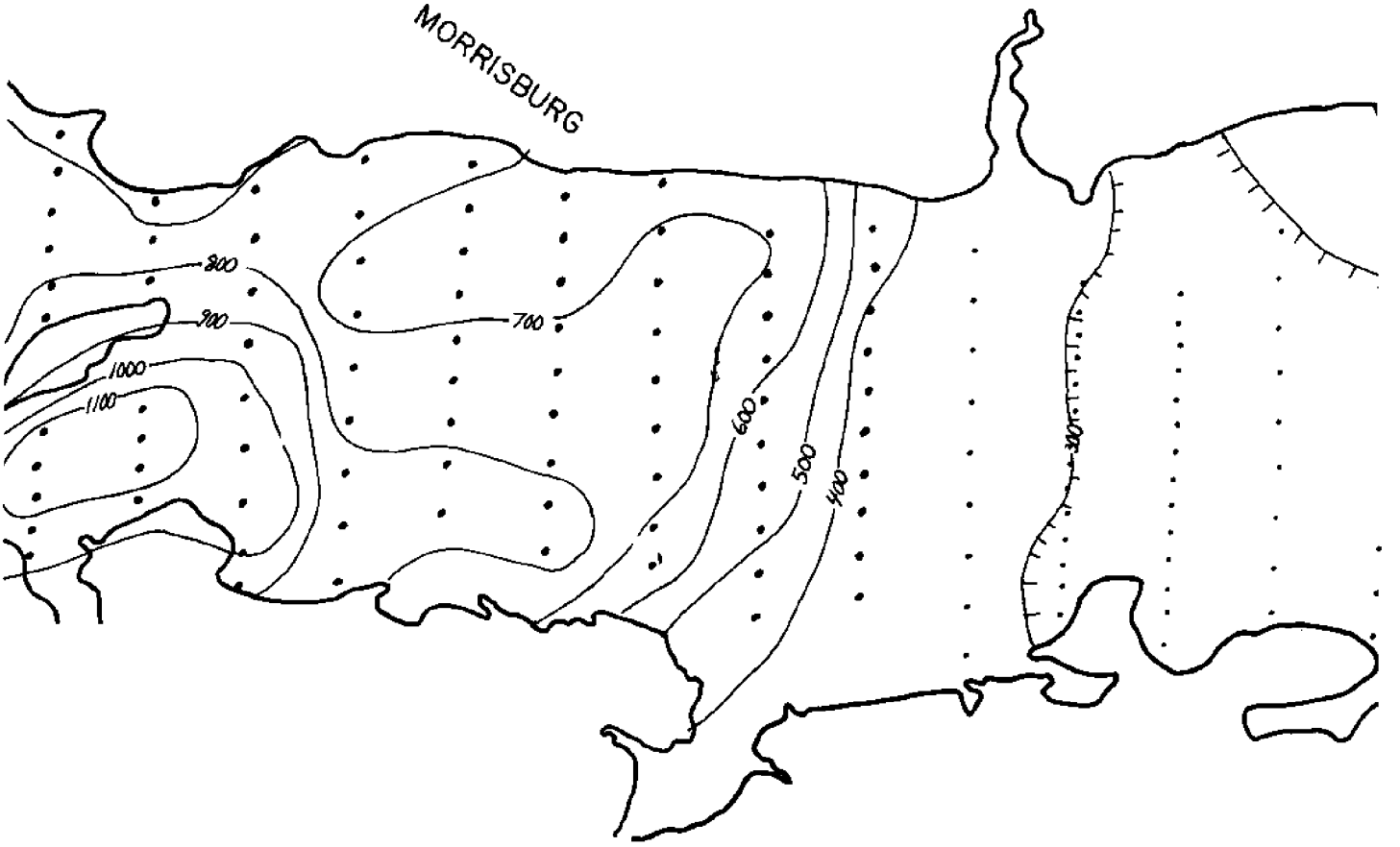
300
300
500
600
700
OGDEN
ISLAND
WADDINGTON


75°12'
44°50'

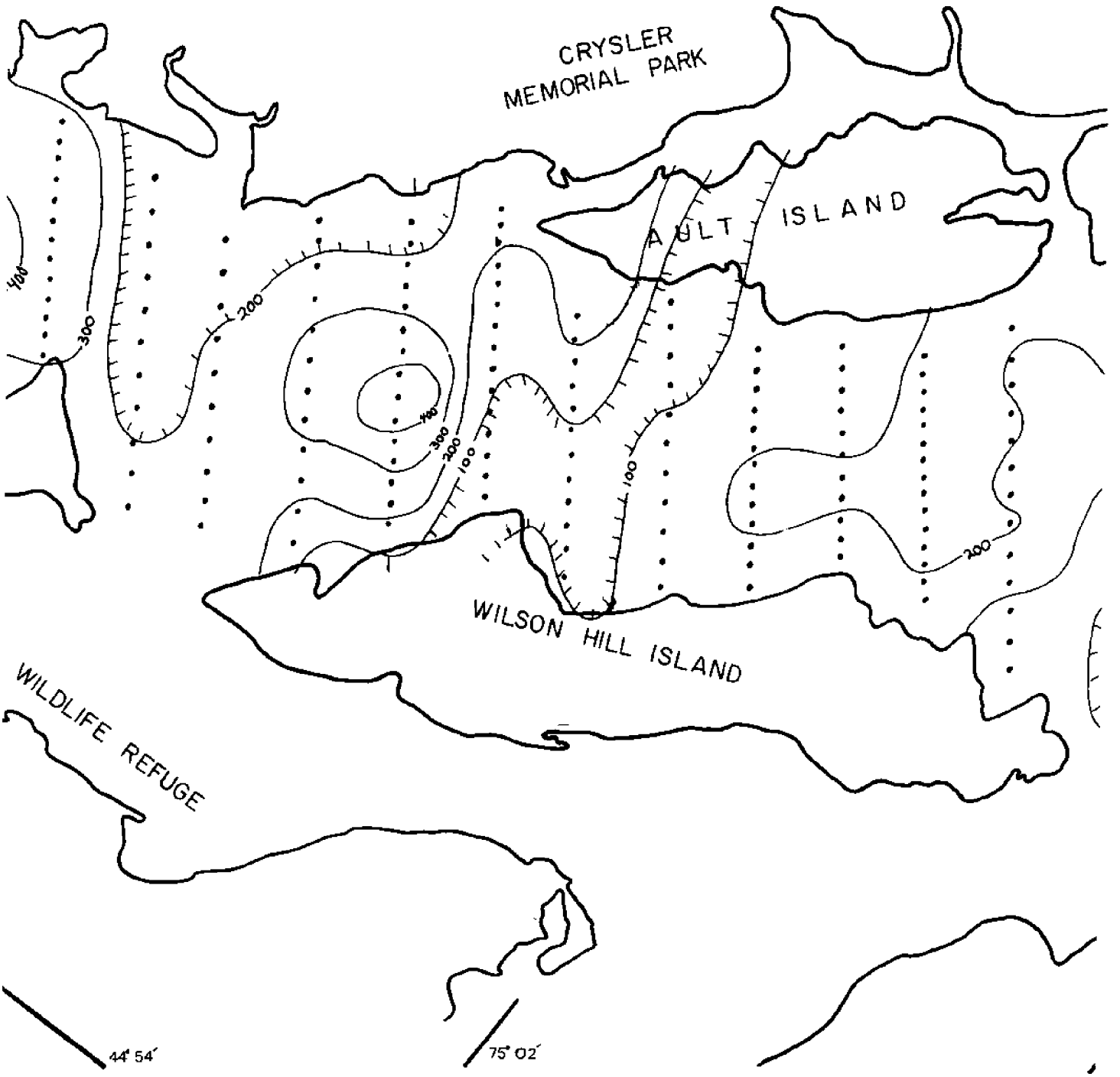


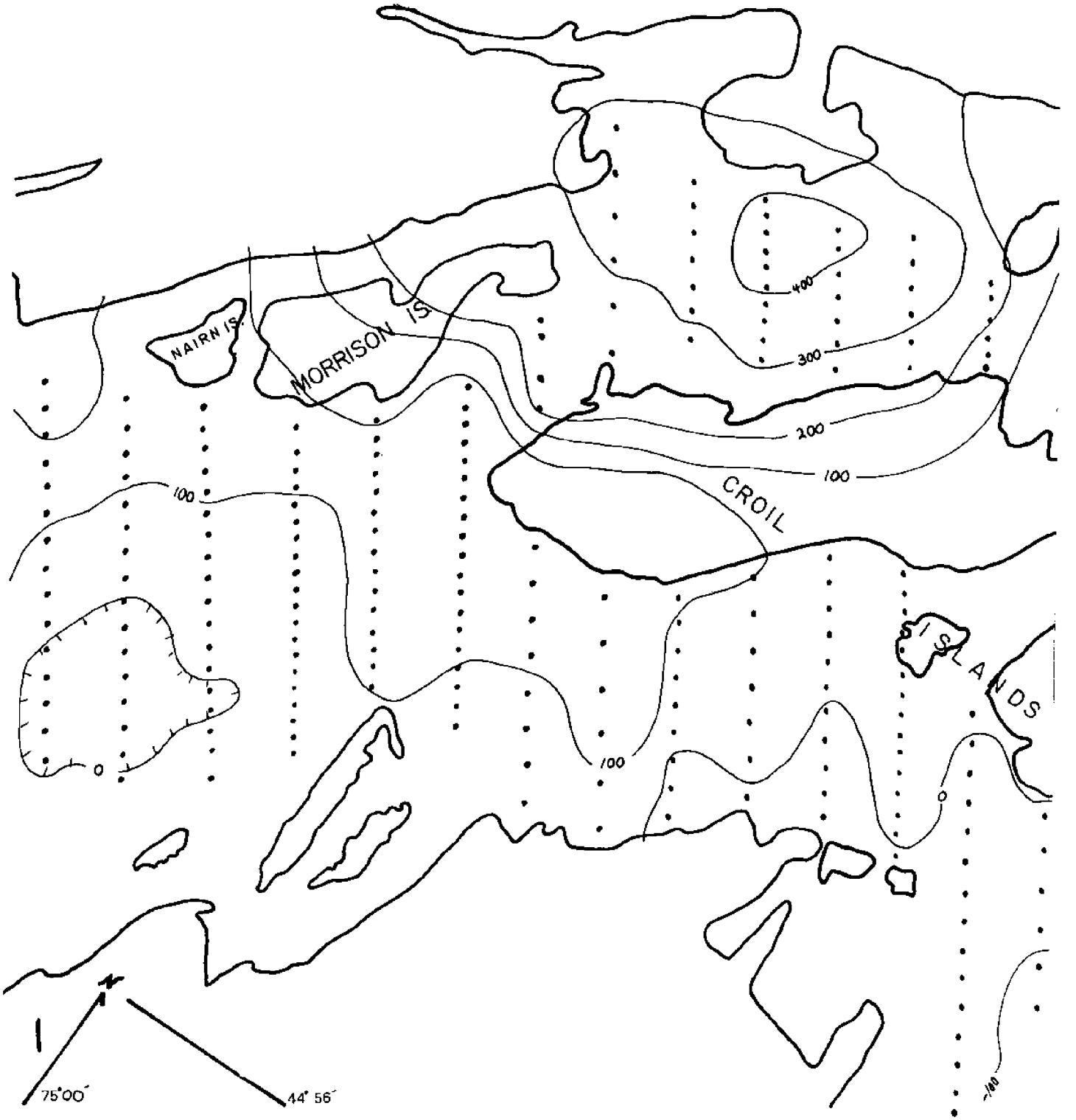
75° 10′

75° 08′

44° 52′


900
800
700
600
500
400
300
800
700
600
500
400
WILSON HILL WILD.
75° 06´
75° 04´


CRYSLER
MEMORIAL PARK
AULT ISLAND
WILSON HILL ISLAND
WILDLIFE REFUGE
400
300
200
100
300
200
100
100
200
44° 54'
75° 02'


NAIRN IS.
MORRISON IS
CROIL
ISLANDS
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200
100
100
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0
0
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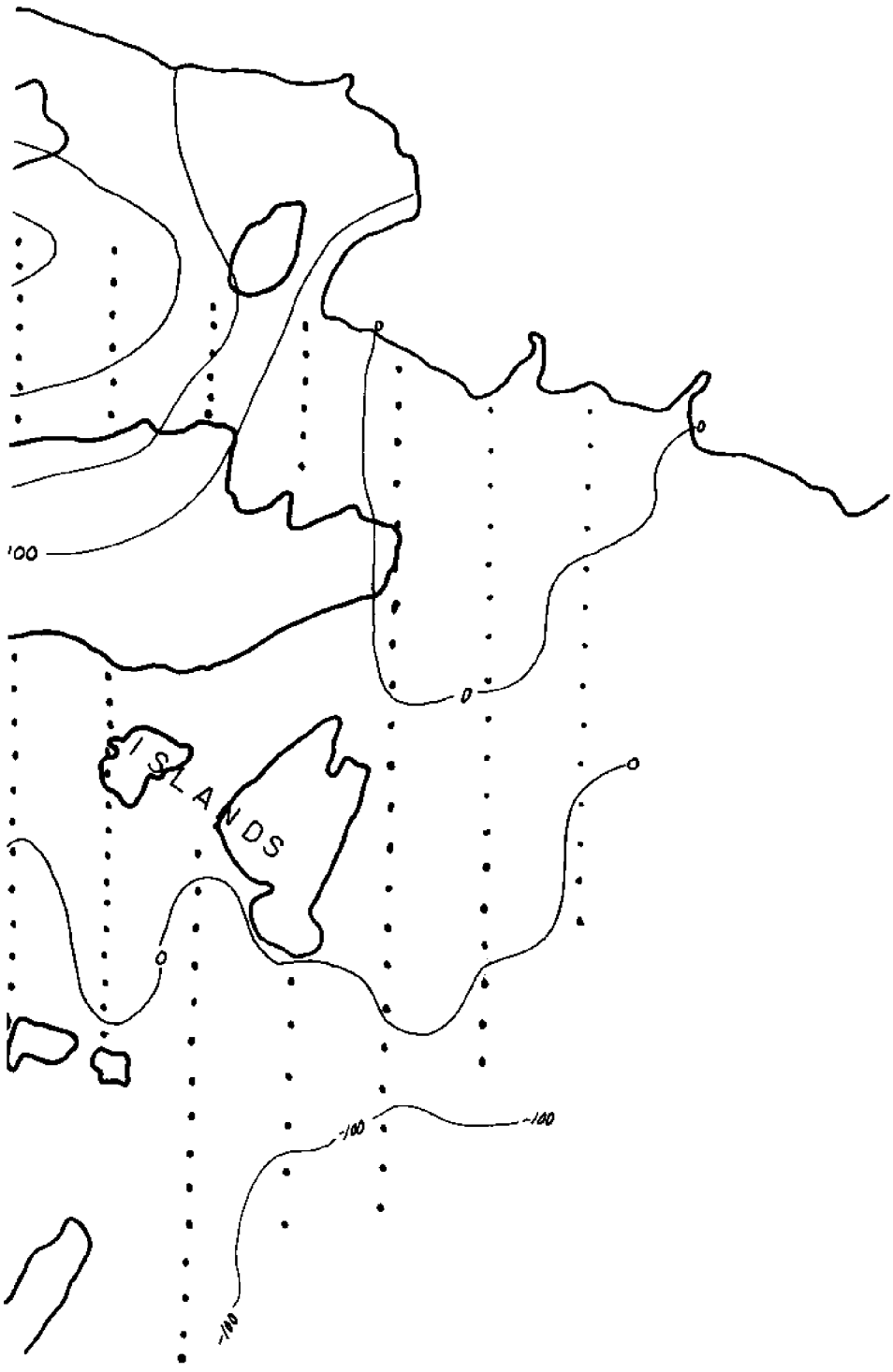
75°00'
44° 56'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ISLANDS
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