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# A reexamination of stratification processes in Ides Cove, N.Y. with reference to sediment geochemistry

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A reexamination of stratification processes in Ides Cove, N.Y.  
with reference to sediment geochemistry

A Thesis

resented to the Faculty of the Department of Biological Sciences  
of the State University of New York College at Brockport  
in Partial Fulfillment for the Degree of  
Master of Science

by

George Joseph Pesacreta

June 1981

THESIS DEFENSE

FOR

George Pascret  
Master's Degree Candidate

VED      NOT APPROVED

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## Abstract

Ides Cove is a small, relatively deep, isolated body of water off Irondequoit Bay of Lake Ontario, Irondequoit, N.Y. In 1970-71, the cove was meromictic with meromixis being attributed to the heavy application of deicing salts in the cove's watershed. Application of deicing salts to roads in the Town of Irondequoit has steadily declined from 31,230 metric tons in 1970-71 to 3,981 tons in 1979-80. Salt concentrations in surface waters of the cove have decreased since 1970. Complete mixing of the water column was observed during the winter of 1979-80 suggesting the town's "sensible salt use policy" has been a success. However,  $\text{Cl}^-$  concentrations and conductivity in the hypolimnion have remained high due primarily to the saline discharge of groundwater streams (mean annual  $\text{Cl}^- = 303 \text{ mg/l}$ ). The discharge of saline groundwater streams into the cove will affect mixing periods with autumnal and vernal turnover probably being replaced by a winter mixing period.

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## INTRODUCTION

Ides Cove ( $43^{\circ} 12' N - 32^{\circ} 30' W$ ), located within the eastern limits of the Town of Irondequoit, Monroe County, New York, is a small, deep ( $2m = 8.7m$ ) body of water (Fig. 1) adjacent to Irondequoit Bay of Lake Ontario. The cove is wind-protected from the north, west and south by a forested encarpment (~50m high) which rises from the shores of the cove with a slope greater than 30%. On the east the cove is also protected from extensive wave action in Irondequoit Bay by a submerged sill (1 m below the surface) (Fig. 1). Three "streams", two surfacing at the base of the surrounding hills and a third (#2 in Fig. 1) draining a well previously studied by Bubeck (1972), enter the cove.

Bubeck (1972) observed Ides Cove to be highly eutrophic and meromictic in 1970. The meromixis was thought to be due to ectogenic (i.e. deicing salt), biogenic factors and basin morphometry. As a result of the work of Bubeck and associates (1971, 1972) and the general realization that increased salt usage to maintain the "bare pavement" policy of the town was having a detrimental effect on water quality of wells and lakes, the use of deicing salt has decreased in the Town of Irondequoit. This investigation pursued possible effects of the decrease in use of deicing road salts on meromixis in Ides Cove.



## MATERIALS and METHODS

### Routine Sampling

Water chemistry samples and physical measurements were taken at preselected depths every week during the autumn and spring and every 2 weeks during the summer and winter (1979-80) at the deepest point of the cove with a 2-liter PVC Van Dorn sampler (Fig. 1). Dissolved oxygen was determined by the azide modification of the Winkler method, alkalinity by potentiometric titration to pH 4.7,  $\text{Cl}^-$  by the mercuric nitrate procedure and  $\text{Cl}^-$  electrode, total dissolved solids with a Myron dissolved solids meter,  $\text{SO}_4^{--}$  by the turbidimetric method,  $\text{Na}^+$  and  $\text{Ca}^{++}$  concentrations with a Perkin Elmer Model 303 atomic absorption spectrophotometer (pretreatment of water samples by acidification with 1 ml concentrated nitric acid/100 ml sample and autoclave at 121°C for 1 hr) electrical conductivity at 25°C with a Thomas Model 275 linear conductance/resistance meter and pH with a Beckman Expandomatic SS-2 pH meter by standard procedures (American Public Health Association 1978). A Whitney thermometer calibrated ( $\pm 0.1^\circ\text{C}$ ) with a precision thermometer gave temperature measurements while a Secchi disk provided transparency data.

Concurrent with cove measurements, temperature, water chemistry samples and stream flow measurements were also made for each of the three ground water streams. The

extremely low flow rates (combined flow =  $\sim 26 \text{ m}^3/\text{day}$ ) of these "streams" and the well-defined channels allowed flow rates to be obtained by the use of a stopwatch and calibrated bucket.

#### Dye Tracing Studies

The movement of stream water into Ides Cove was observed in April by adding 3g of Rhodamine-B (Judd 1969) to stream #3 water and allowing it to enter the cove. Background fluorescence and fluorescence in the water column after addition of dye were determined at 1-m intervals at three locations every 5 hr with a Turner Model 111 Fluorometer (Fig. 1).

#### Core Studies

In February 1980 a continuous sediment core (84cm long, 6.4cm wide) was obtained at the deepest area of Ides Cove with a gravity corer. The core was sealed with rubber stoppers and returned to the laboratory for extrusion, sectioning and freezing into 2.0-cm intervals near the top and to 5.0 to 6.0-cm intervals towards the bottom.

Geochronology of the sediments was determined by  $^{137}\text{Cs}$  dating by M. Wahlen (1980).

Interstitial water was expressed into 125-ml polyethylene bottles through #1 Whatman filter paper (Brunskill *et al.* 1971) with a sediment squeezer at a maximum pressure of 120 psi within 45 min (Reeburgh 1967). Interstitial water samples were analyzed for  $\text{Na}^+$ ,

$K^+$ ,  $Ca^{++}$  and  $Mg^{++}$  by atomic absorption spectrophotometry and  $Cl^-$  by the mercuric nitrate procedure.

Sediment samples were dried at  $60^\circ C$  for 1 week and ashed at  $550^\circ C$  for 1 hr. Matter lost on ignition was taken as organic matter and ashed residue as mineral matter. Volumetric samples for density determinations were obtained by placing sediment into a spoon of 2-ml capacity.

Relative amounts of Na, K, Mg, Ca, Zn, Al, Fe, Si, S and Cl were measured with depth in the core by x-ray probe analysis with a Hitachi S-500 SEM equipped with an ORTEC 6250 x-ray probe attachment using the sample preparation techniques of Culver et al. (1980). Two-sided adhesive tape was substituted for colloidal gold as a coating on the SEM stubs with no resulting analytical interferences except for poorer quality SEM pictures. Each sample was counted for 200 sec at 40x magnification. At this magnification, the probe analyzed a field of  $\sim 1$  mm. Limitations of x-ray probe analysis and methodology for calculations of flux of individual elements, organic matter and mineral matter follow Culver et al. (1980).

## RESULTS and DISCUSSION

### Groundwater Streams

Stream temperatures generally followed the trend of the mean monthly air temperatures throughout the year. Oxygen concentrations were slightly less than 100% saturation with concentrations a function of temperature (Fig. 2). Concentrations of  $\text{Na}^+$ ,  $\text{Ca}^{++}$ ,  $\text{Cl}^-$  and electrical conductivity are consistently greater in the streams than in the cove (Figs. 3 & 10) throughout the year. Flow rates of these streams were relatively constant with a slight decrease during the summer (Table 1).

The flow of the salt-laden stream water into the cove was traced by addition of rhodamine-B to stream #3 (Fig. 1). After 10 hr dye was observed at 2 and 6m in the cove, apparently moving along the bottom of the cove towards the deepest point (Fig. 4). By 20 hr the salt-laden stream water with dye was observed near the bottom of the cove along the western slope of the basin. Conductivity determinations also indicated a build up of ions along the line of flow with depth.

### Interstitial Water Chemistry of the Sediments

The depletion of  $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  just below the mud-water interface indicates probable precipitation of an autigenic material (Fig. 5; Sasseville and Norton 1975). If profiles are controlled by continual mineral solution and upward diffusion, the increase in concentration

of  $\text{Ca}^{++}$  and  $\text{Mg}^{++}$  with depth below 10 cm may be expected.

The  $\text{Na}^+$  and  $\text{Cl}^-$  profiles are more difficult to interpret. The decrease in  $\text{Na}^+$  and  $\text{Cl}^-$  with depth below 10-cm may be a relict of past meromictic conditions in the cove. The downward movement of  $\text{Na}^+$  and  $\text{Cl}^-$  ions in meromictic lake sediments has been demonstrated (Judd 1969). Under conditions of meromixis in Ides Cove,  $\text{Na}^+$  and  $\text{Cl}^-$  concentrations were higher in the overlying water column (monimolimnion); thus, downward diffusion of these ions with time resulting in higher concentrations with decreasing depth in the sediment would be expected. With the recent mixing of the cove,  $\text{Na}^+$  and  $\text{Cl}^-$  concentrations in the overlying water stratum were lower than the sediments, thus a movement of  $\text{Na}^+$  and  $\text{Cl}^-$  out of the sediments into the lake. The end result is perhaps a  $\text{Na}^+$  and  $\text{Cl}^-$  profile of the type given in Fig. 5 with increasing concentrations to 10 cm and decreasing below 10 cm.

Another possible but incomplete interpretation is that the lowering of  $\text{Cl}^-$  with depth may also be attributed to an uptake of  $\text{Cl}^-$  by hydroxides found in the sediment and/or to an absorption of the  $\text{Cl}^-$  to an exchange position of a clay material (Muller 1969). This mechanism does not explain the increase in  $\text{Cl}^-$  concentrations from 0-10cm.

### Sediment Geochemistry

The activities of  $^{137}\text{Cs}$  with depth in Ides Cove is shown in Fig. 6. The sedimentation rates used below the  $^{137}\text{Cs}$  rise assumes that the sedimentation rate has remained constant and has not been corrected for sediment compaction. Therefore, sediment flux rates presented near the bottom of the core are distorted.

$^{137}\text{Cs}$  gives sedimentation rates calculated to be  $0.07 \text{ g/cm}^2/\text{yr}$  (i.e.  $0.76 \text{ cm/yr}$ ) which would generate a date of  $\sim 1870\text{AD}$  for the bottom of the core.

The major mineral elements (Na, K, Mg, Ca, Ti, Fe, Zn, Al, Si, S) show variability of their loading into the cove (Fig. 7). The elements Na, K, Ca, Fe, Al, Si, S appear to be correlated among themselves and can be traced to some known events in the watershed. For example, the high deposition rate for elements (Na, K, Ca, Fe, Al, Si) mineral and organic matter at 50-60 cm ( $\sim 1900 - 1910\text{AD}$ ) represents the period when Ides Cove was initially homesteaded (Piecych 1980). Clearcutting would be expected to cause soil erosion increase watershed runoff, increase cation ion loss and increase sediment deposition (Likens *et al.* 1977).

In the early 1950's ( $\sim 22 \text{ cm}$  depth) the steep hills just to the north of the cove were removed following the destruction of the nearby Point Pleasant Hotel. Some of the material from the hills was apparently transported into the cove and has become incorporated in the sediments. The

peaks for the elements Na, K, Mg, Ti, Al, and Si at this position in the sediments reflects the hill removal. The sediment influx rates for mineral matter during this period appears to be unaffected by the soil transport and remains unexplained (Fig. 7). S.E.M. photographs reveal that diatom assemblages are abundant throughout the core except at positions which correspond to increased allochthonous input.

The S.E.M. sediment geochemistry does not indicate which years Ides Cove was meromictic. It does however, clearly demonstrate man's intervention in the watershed.

#### Subsurface Springs

Isotherm patterns may indicate the presence of subsurface springs (Stewart 1972). In February during holomixis, temperature readings were taken every meter every 20-30m horizontally along several transects of the cove across the sill onto Irondequoit Bay (e.g., Fig. 8). Using temperature increase near the bottom to indicate subsurface flow, there was no evidence of springs. Also, mud temperatures similar to the water overlying them suggested that no subsurface springs were encountered.

#### Septic Tanks and Surface Runoff

Direct pumping of septic tanks into the cove no longer occurs. In an attempt to determine whether diffusion of sewage septic water into the cove was occurring, fecal coliforms,  $Cl^-$  concentrations and electrical

conductivity were monitored along the shoreline of the cove. No fecal coliforms were observed and no areas of increased conductivity or  $\text{Cl}^-$  concentrations were detected (Hunt 1980). Seepage from septic tanks is probably occurring but at levels too low to be detected.

Concentration of cation and anions, flow rates and duration of flow from surface runoff and storm drainage runoff were determined on 20 March and 29 March 1980. Measurable surface runoff was observed along the boat launch area near stream #3 (Fig. 1). Conductivity for the storm drainage and surface runoff were relatively high (range =  $786 - 1176 \mu\text{mhos/cm}^3$ ). However, flow rates were exceedingly low (range =  $0.7 - 9.0 \text{ l/min}$ ) and of only a few hours duration. Only after prolonged storm periods is any flow detectable through the two eastern most storm drainage pipes. Runoff into the cove from salted Point Pleasant Hill Road is now prevented by an asphalt conduit which diverts runoff into Irondequoit Bay (Fig. 1).

#### Water Column Properties of Ides Cove

Hypolimnetic stratification continues through autumn reinforced by a chemically induced density layer with  $\text{Na}^+$ ,  $\text{Ca}^{++}$  and  $\text{Cl}^-$  concentrations near the mud-water interface reaching 170, 140 and 220 mg/l, respectively (Figs. 9 & 10). The reduction in oxygen concentrations during the autumn reflects the mixing of the reduced materials in the anoxic layer with surface waters.



Even though isothermal conditions were established between 24 November and 1 December near  $7.2^{\circ}\text{C}$ , the cove did not mix completely due to the salt-laden denser bottom waters (Figs. 9 & 10). Further cooling of the mixing surface waters in December below  $4^{\circ}\text{C}$  produced a cooler less dense surface layer overlying a warmer, but denser bottom layer.

Complete mixing occurred during January, 2 weeks after ice formed on the cove. In 1970 Bubeck (1972) also observed a similar circulation period under the ice, except that year the cove did not mix completely to the bottom. Since the adjacent Irondequoit Bay was ice free, interactions between the cove and bay, such as density differences of the water masses, barometric pressure differences magnifying seiches, and influx of dense, silt-laden runoff waters (Culver 1975) are possible explanations for the underice circulation. In fact, just prior to mixing, a heavy rainfall (6.6 cm) occurred.

By February, restratification, not thermally but chemically induced, was evident as ion concentrations increased and oxygen decreased near the bottom (Figs. 9 & 10). The peaks of  $\text{Na}^+$ ,  $\text{Cl}^-$  and electrical conductivity in mid-March resulted from deicing road salt entering the cove during periods of winter thaws. The increase of  $\text{Ca}^{++}$  to a peak in April and the increases in  $\text{Na}^+$ ,  $\text{Ca}^{++}$  and  $\text{Cl}^-$  concentrations in the

hypolimnion during the rest of the spring and summer are due primarily to stream discharge.

The 4.7°C thermal cell and low chemical concentrations associated with it in late March reflect the inflow of warm, chemically dilute rainwater. With ice breakup, the deep depth of the cove, the chemically induced density differences and the wind-protected location of the cove prevented complete vernal circulation. By July, the cove was anoxic at 3 m with pycnocline depth determined primarily by inputs from the groundwater streams.

## GENERAL DISCUSSION

The Ontario lowland is an east-west belt south of Lake Ontario and generally north of U.S. Highway 20. An area of saline groundwater extends from Buffalo on the west through the Rochester area to roughly Syracuse on the east. The water occurs in salt and gypsum bearing shale and sandstone of the Silurian age (Salina and Clinton group). In the central and western part of the lowland, groundwater containing unusual amounts of sulfate and chloride ions are found (Luseynski et al. 1956) (Table 3500).

Hall (1843) describes mineral springs in Monroe County including one "near the head of Irondequoit Bay" as a "brine type" belonging to the Medina sandstone formation which also outcrops along Lake Ontario near Irondequoit Bay. Leggette et al. (1935) investigated 1312 wells and springs in Monroe County and concluded that the Queenstone shale and Medina sandstone in the northern part of the county have a number of salt lenses with high  $\text{Cl}^-$  concentrations. Both the Medina sandstone and Queenstone shale underly Irondequoit Bay and Ides Cove (Grossman and Yarger 1953) suggesting that the salt lenses probably occur in the watershed of Irondequoit Bay.

Chloride concentrations in wells in the Medina sandstone range from 30-275 mg/l, in Queenstone shale from 0-1,925 and in unconsolidated glacial drift from 0-415 mg/l. Bubeck (1972), analyzed a well at the base of the escarpment

draining into stream #2 in Ides Cove and observed a high annual  $\text{Cl}^-$  concentration ( $\bar{x} = 217 \text{ mg/l}$ ). Groundwater streams emerging from the hills around Ides Cove have a mean annual  $\text{Cl}^-$  concentration of  $303 \text{ mg/l}$  (Range =  $210 - 424$ ). Concentrations of total dissolved solids (Range =  $500 - 1480 \text{ mg/l}$ ) in water from known salt lenses in unconsolidated glacial drift in Monroe County are similar to concentrations of total dissolved solids in Ides Cove's streams (Range =  $800 - 1410 \text{ mg/l}$ ) (Grossman and Yarger 1953). Also the groundwater "streams" draining into Ides Cove possess a diversity of ions, not just  $\text{Na}^+$  and  $\text{Cl}^-$  that would predominate in runoff water influenced by deicing road salt (Table 3500). Undoubtedly, the groundwater streams discharging into Ides Cove contain saline water influenced by naturally occurring salt lenses in underlying geologic formations.

The movement of the groundwater fed streams discharging into Ides Cove is density controlled plunging to the bottom of the cove and is at a minimum partially responsible for the current concentrations of salts in the hypolimnion. Calculation of maximum loading potentials (Table 2) indicates that more than enough water from the groundwater streams is present to create a hypolimnion with a concentration of  $704 \text{ mg/l Cl}^-$  (observed concentration  $157 \text{ mg/l}$  in April).

The 7 to 8.5-m stratum occupies a volume of

1760m<sup>3</sup>, while estimated flow for a 85-day period would generate nearly 3,200m<sup>3</sup> of saline water. Clearly, not all of the water entering the cove is plunging to the bottom. Dye studies indicate that a portion of the salt laden stream water is mixed and diluted with the upper water layers of the cove and undoubtedly carried over the sill into Irondequoit Bay. Although the salt lenses are probably not major contributors to the salt budget of Irondequoit Bay, they appear to have a localized effect in Ides Cove by curtailing the normal autumn and vernal turnover and by chemically stratifying the cove most of the year. Inputs from surface runoff, springs below the surface of the cove and from septic tanks appear to be negligible.

The application of deicing salt to roads in the Town of Irondequoit decreased from a high of 31,230 metric tons in the winter of 1970-71 to 3,981 tons in 1979-80 (Fig. 11). The steady decrease in use of deicing salts on roads was prompted by the town switching from a "bare pavement" to a "sensible salt use" policy (Monroe County Highway Department 1976). Also, the asphalt conduit built along Point Pleasant Hill Road diverts a portion of deicing salt runoff destined for Ides Cove into Irondequoit Bay.

The surface waters of the cove have decreased with respect to salts since 1970 (Figs. 12 and 13). In this respect, the "sensible salt use" policy has been a success. The hypolimnetic Cl<sup>-</sup> and electrical conductivity

values since 1970, however, have remained high due primarily to the saline discharge of the groundwater streams. However, even in the bottom waters of Ides Cove,  $\text{Cl}^-$  concentrations and electrical conductivity have decreased from 1970 to 1979. This is due to the decrease in deicing salt application and to an equilibrium of  $\text{Cl}^-$  concentrations reached between Irondequoit Bay and Ides Cove. The lower  $\text{Cl}^-$  concentration in Irondequoit Bay and hence the decrease in  $\text{Cl}^-$  in the cove's surface water are due to horizontal transport into the Bay allowing  $\text{Cl}^-$  flux from the deeper waters of the cove each time mixing occurs. The bottom waters of the cove lose  $\text{Cl}^-$  to the point of equilibrium with the  $\text{Cl}^-$  input. The total mass of  $\text{Cl}^-$  in the cove has been decreasing as the use of deicing salts has decreased. This decrease has weakened the chemical component of meromixis. Also, October hypolimnetic temperatures are warming each year (Fig. 12) indicating the thermal component of meromixis as well as the chemical component, has also been weakening. This suggests that the stability of the cove is decreasing.

In fact, the first reported mixing of the cove completely to the bottom occurred during the winter of 1979-80. Nevertheless, even with the decrease in application of deicing salts to roads within the watershed, the input of naturally occurring saline stream water into the cove will continue to affect stability of the cove and

create a "partial meromixis" with the autumn and vernal turnover probably being replaced by a winter mixing period.

### Modeling

It has recently been suggested that Ides Cove be utilized as a "model" for lake reclamation efforts to improve water quality in Irondequoit Bay. Before such an experiment is undertaken, the feasibility and necessity of such a study should be considered.

Irondequoit Bay and Ides Cove have inherent differences which precludes comparing events observed in the cove with the bay. The bay and cove share a similar epilimnion (2m depth) but below this depth their aqueous geochemistry differs.

The cove receives inputs from groundwater-fed streams which enhance establishment of a saline, anoxic hypolimnion with low pH for extended periods of the year. The cove's hypolimnion exhibits greater concentrations of salts than those found in the bay. The low pH values of the cove would be expected to mediate nutrient and metal transport between the sediments and the overlying water column. The effect of the streams upon the cove must be considered when comparing the two basins. Also, the cove's basin morphometry (relatively deep depth with small surface and fetch areas) is different from the bay. The bay has extensive, open, shallow areas which would enhance sediment resuspension due to wind-generated waves.

Any attempt to use sediment sealers or dredging in these

shallow areas may cause particulate and nutrient remobilization and resuspension into the water column. Consider that ~50% of the Bay's sediments lie within a depth of 3m of the surface (Bubeck 1972, Fig. 12); If flyash was applied in shallow areas resuspension due to wind and wave action may introduce heavy metal contamination in the water column.

The cove is a distinct system partially isolated from the larger Irondequoit Bay, having a different mechanism and period of circulation (monomictic versus dimictic). Any investigation attempting to model Irondequoit Bay with Ides Cove should realize these dissimilarities and thus limitations of the model.



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## APPENDIX A

### Suggested Studies

1. Ides Cove should be monitored to determine what mechanism(s) cause the under ice circulation. The author suggests water movement studies of interactions between the cove and Irondequoit Bay near the sill with introduction of a fluorometric dye (i.e. rhodamine-B) or a radioactive tracer (i.e.  $^{24}\text{Na}$ ) prior to the period when the cove mixes completely. Also, the watershed should be monitored for any sudden influx of materials (i.e. heavy rains), which could circulate the bottom layer.

2. The chemistry of the surfacing groundwater streams should be examined for nutrients ( $\text{PO}_4^{---}$ ,  $\text{NO}_3^-$ ,  $\text{NO}_2^-$ ,  $\text{NH}_4^+$ , Si) to determine their contribution to plant growth in the cove. It is interesting to note that most macrophytes appear in the shallows near the areas where the streams discharge into the cove.

## APPENDIX B

Comparison of Whatman #1 and Millipore .45 $\mu$  filter paper for interstitial water chemistry. Concentrations are in mg/l.

### Filter Paper

<u>Element</u>	<u>Whatman</u>	<u>Millipore</u>
Sodium	140	128
Calcium	47	33
Potassium	40	40
Magnesium	19	17

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Magnesium	19	17

- ⊙ Slope gradient > 30%
- Houses
- ⊙ 68 Schnackel Drive Well
- # Storm drains
- ⊢ Storm pipes
- Sill
- ▬ Asphalt Conduit
- ▲ Rhodamine-B introduction
- Sampling positions for dye study
- × Physico-chemical sampling position

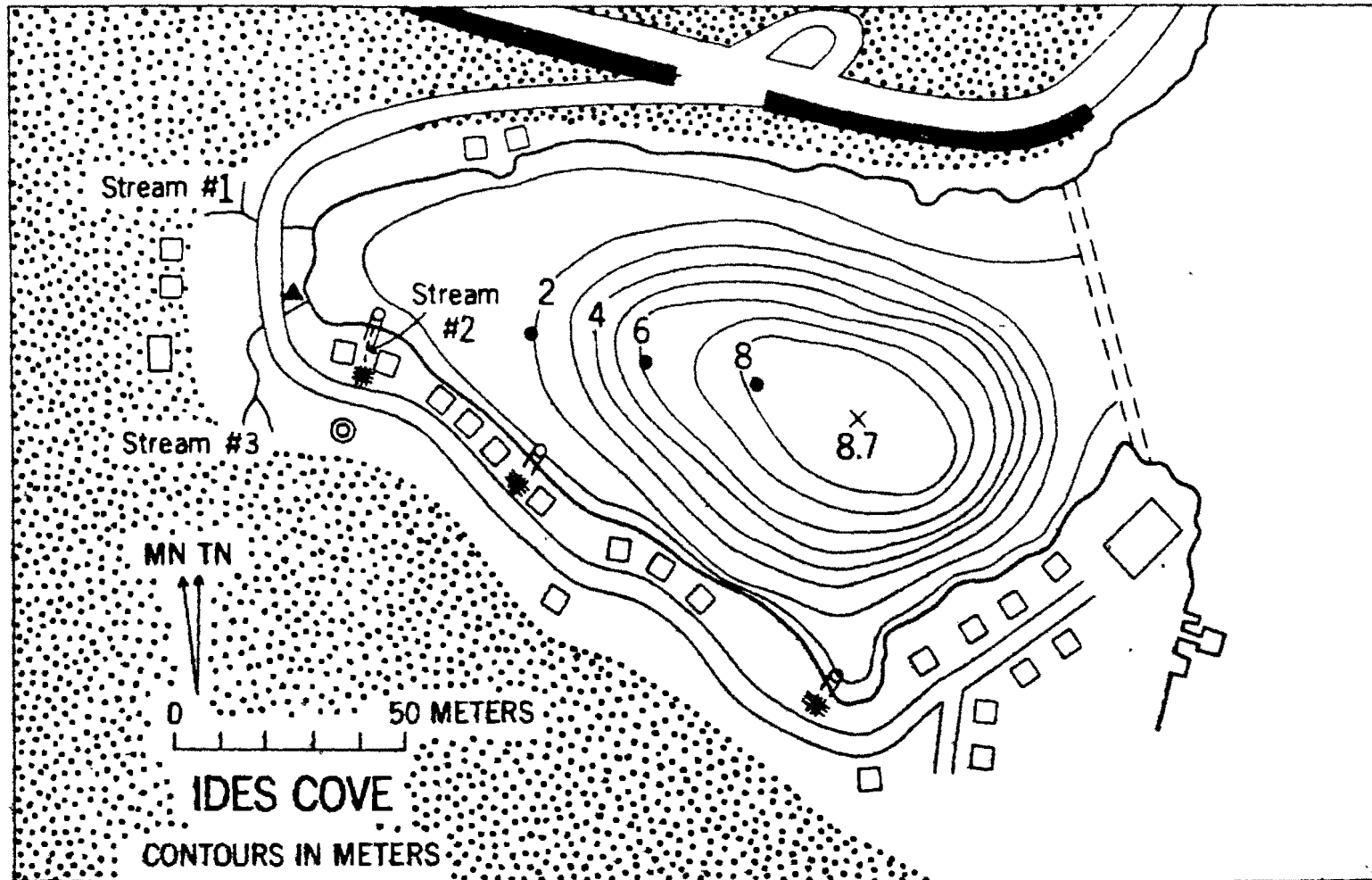


Fig. 1. Morphometric map of Ides Cove, N.Y.; modified from Bubeck (1972).

MIG/L

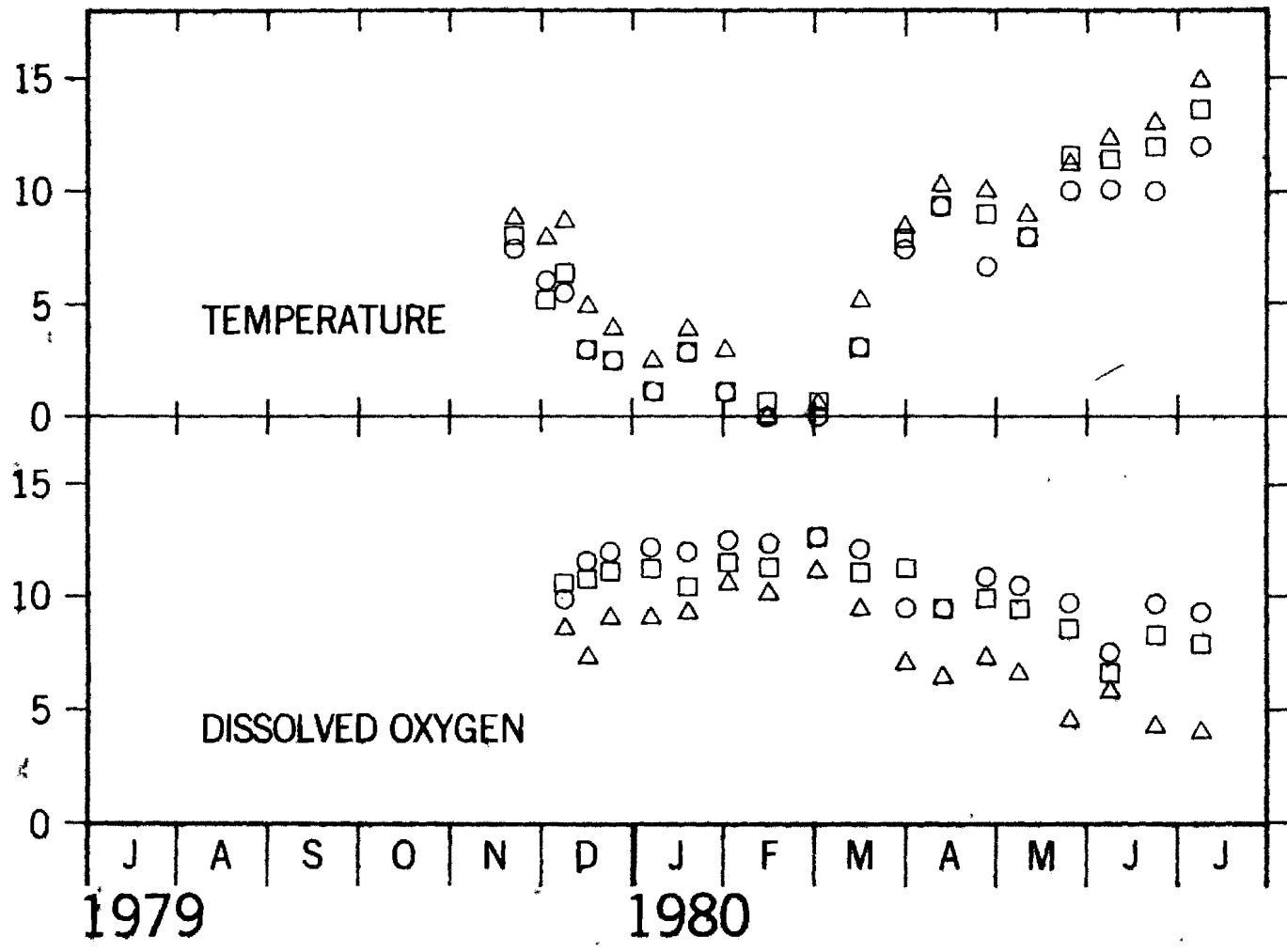


Fig. 2. Temperature and oxygen values for the groundwater streams entering Ides Cove, N.Y.; stream #1 =  $\Delta$ ; stream #2 =  $\circ$ ; stream #3 =  $\square$ .

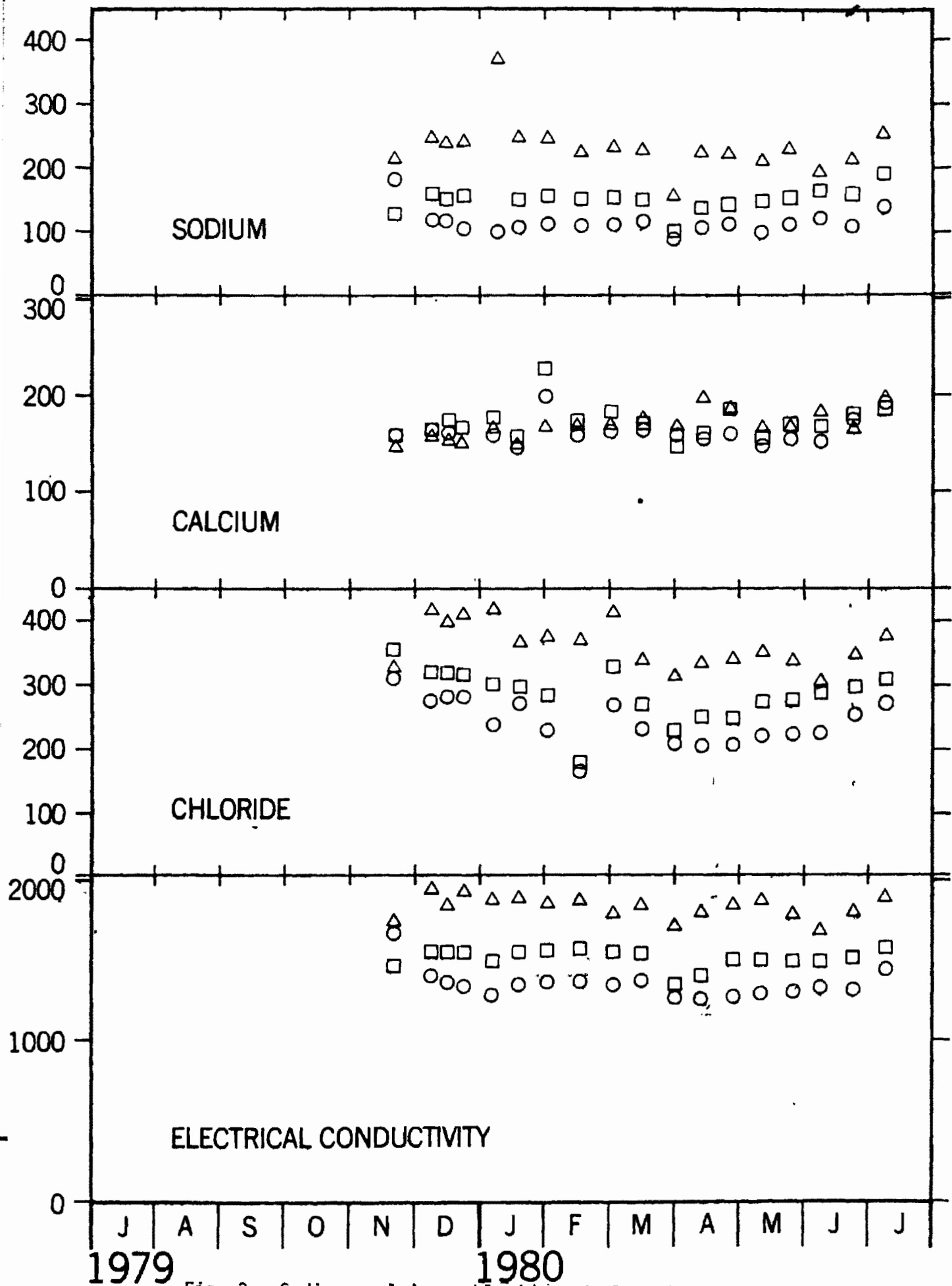


Fig. 3. Sodium, calcium, chloride and electrical conductivity values for the groundwater streams entering Ides Cove, N.Y.; stream #1 =  $\Delta$ ; stream #2 =  $\circ$ ; stream #3 =  $\square$ .



DEPTH (M)

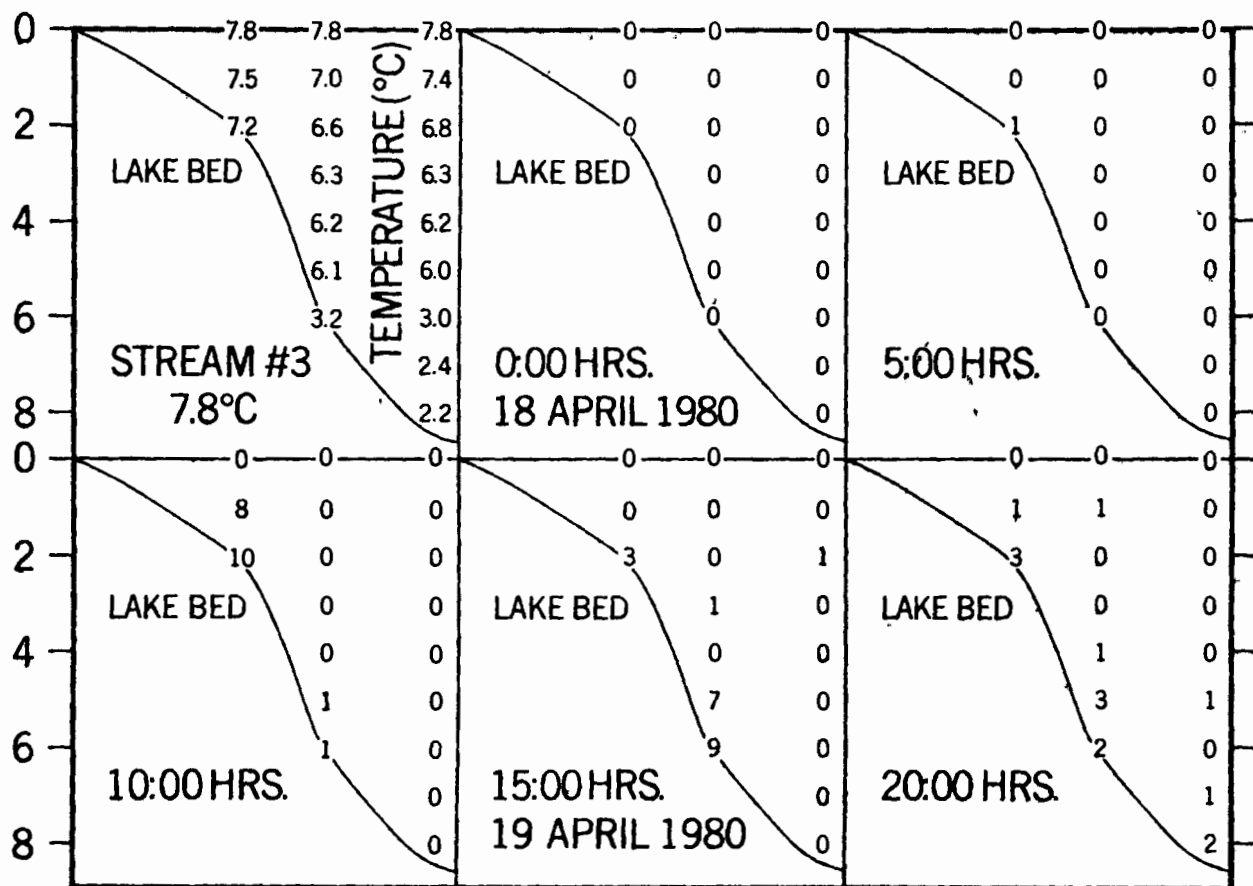


Fig. 4. Positions of the mixture of Rhodamine-B and stream #3 water 5, 10, 15, and 20 hrs after introduction from stream #3. Values are in Turner fluorometer units.

DEPTH  
CM

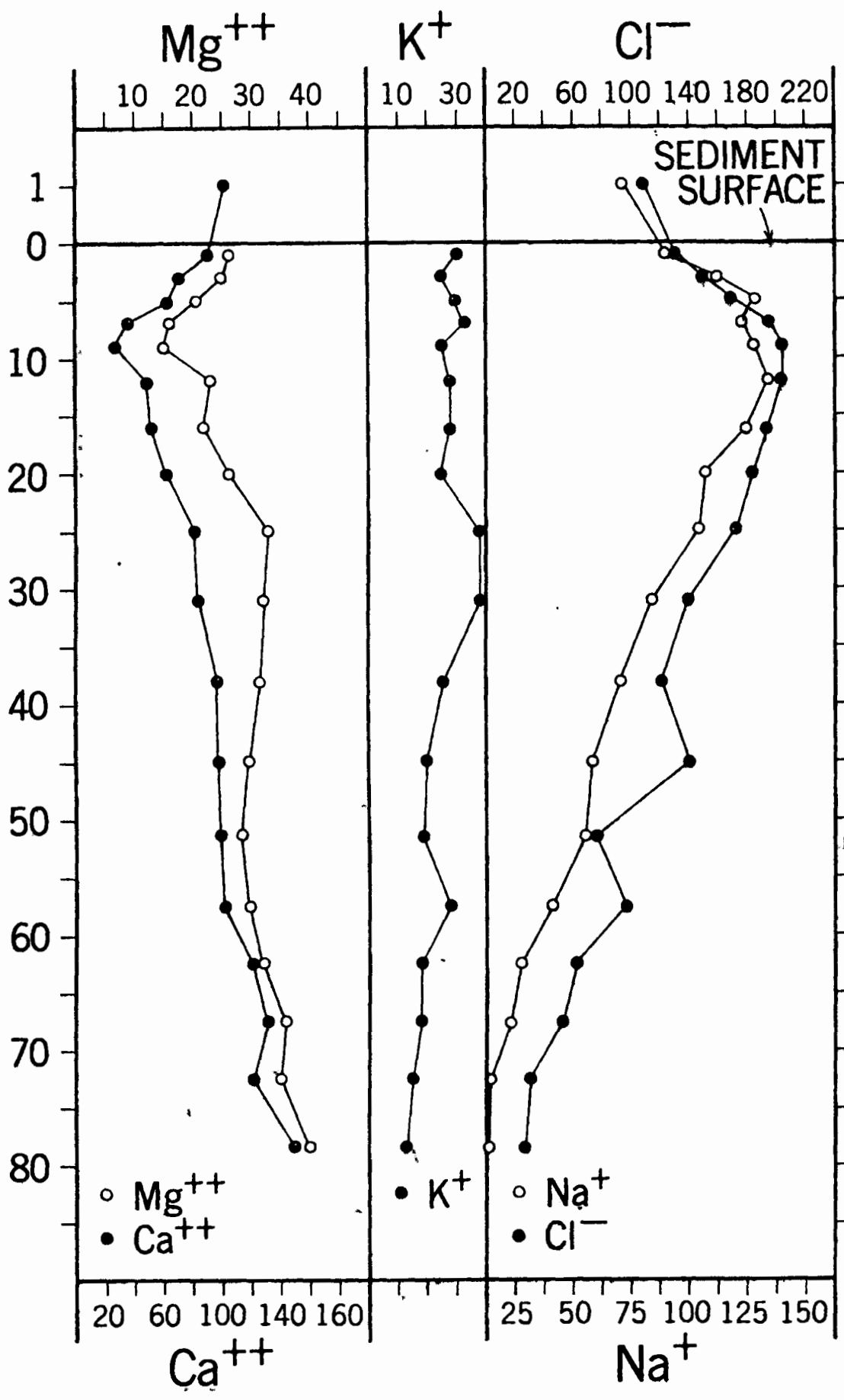


Fig. 5. Ides Cove interstitial water chemistry and lake water chemistry, 21 February 1980. Vertical bars at right of diagram indicates length of sediment core squeezed. All values in mg/l.

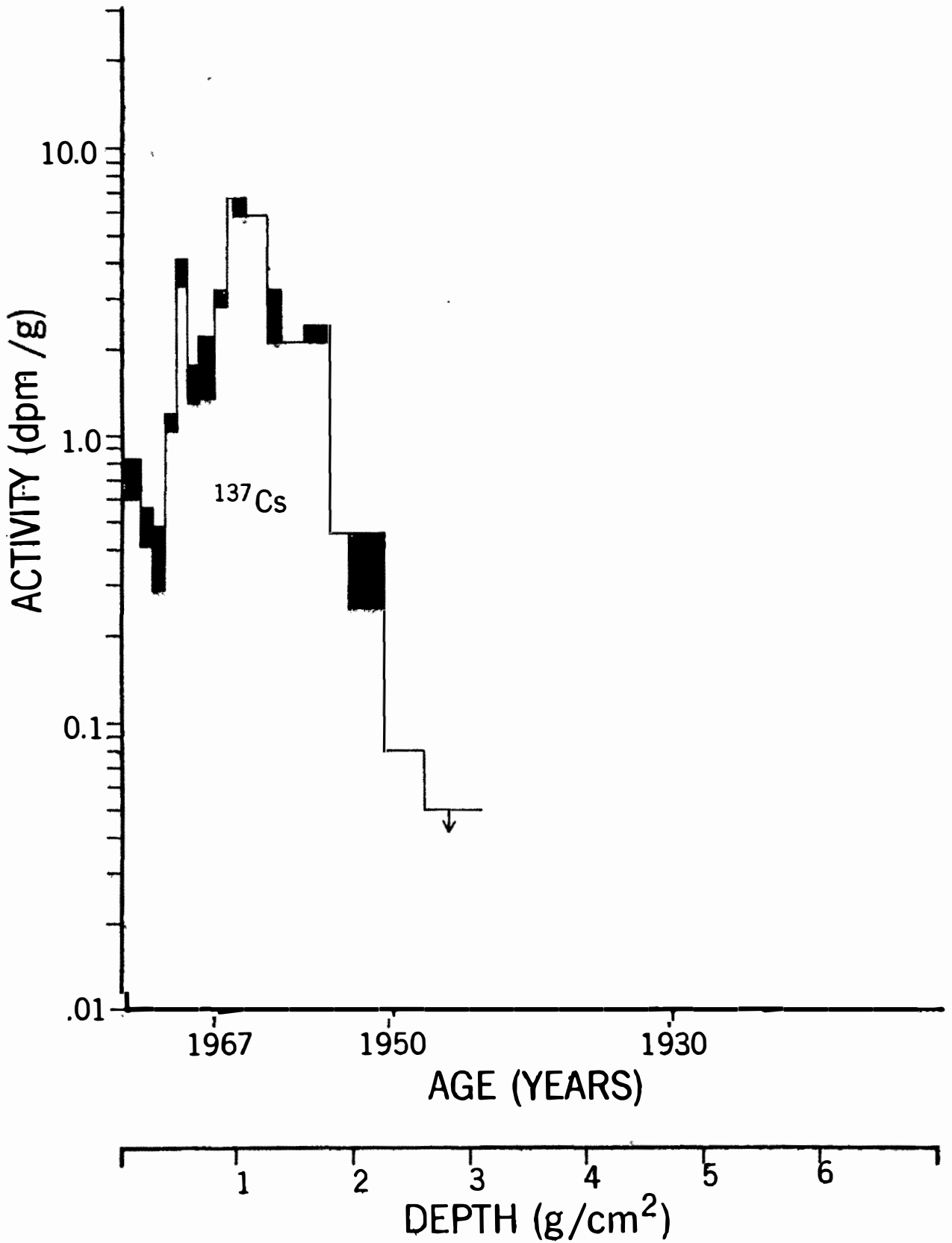


Fig. 6. <sup>137</sup>Cs activities (dpm/g) as a function of depth (gm/cm<sup>2</sup>) of age (yr) as inferred from the sedimentation rate for Ides Cove, N.Y.

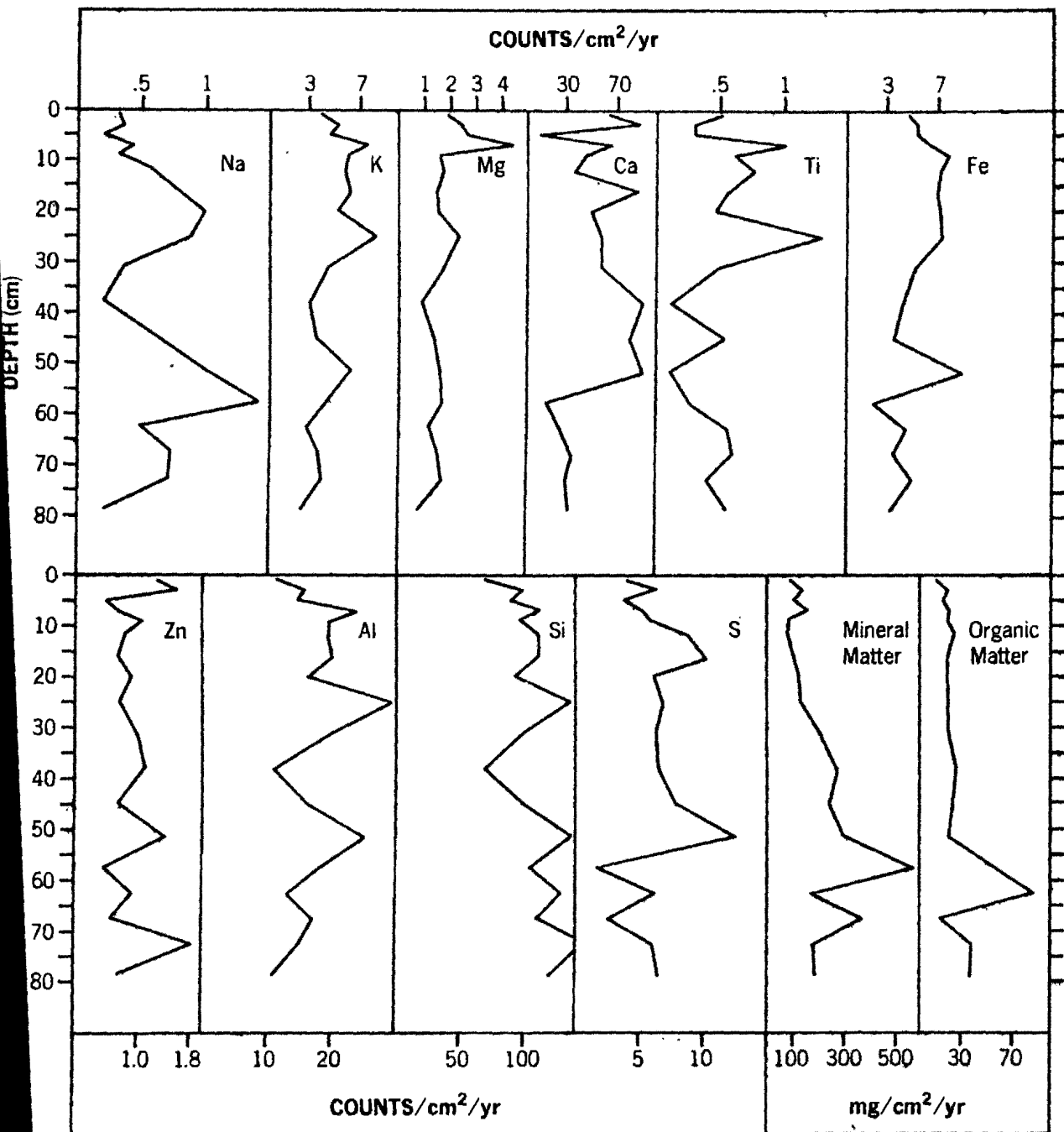


Fig. 7. Fluxes of mineral matter, organic matter and major elements to the sediments of Ides Cove, N.Y. Flux diagrams represent the deposition of material (cm<sup>2</sup>/year) to the sediments. "Counts" for each element represents the counts per second of the k<sub>alpha</sub> emission peaks.

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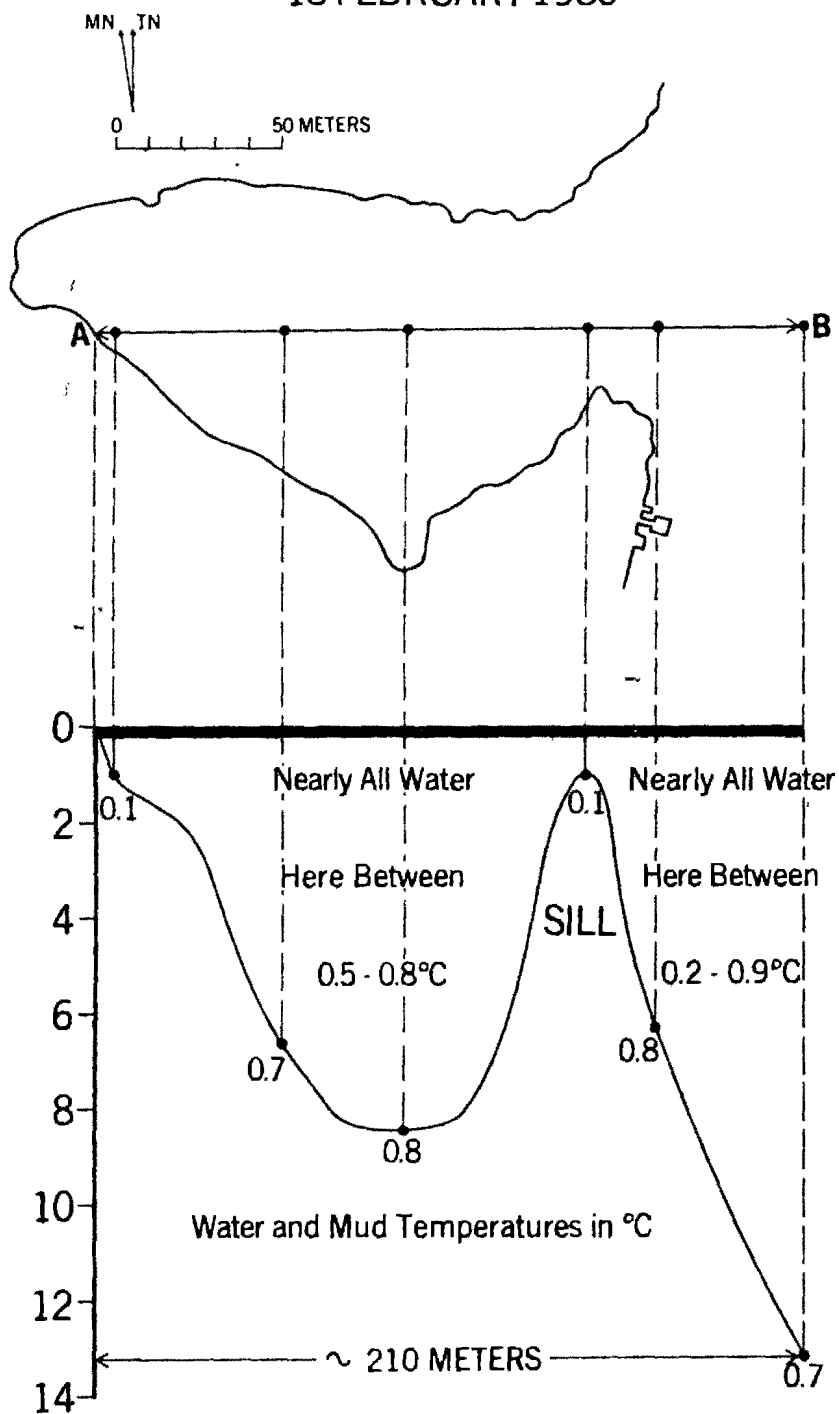


Fig. 8. Thermal transect across Ides Cove, N.Y. Note the relative uniformity of temperatures.

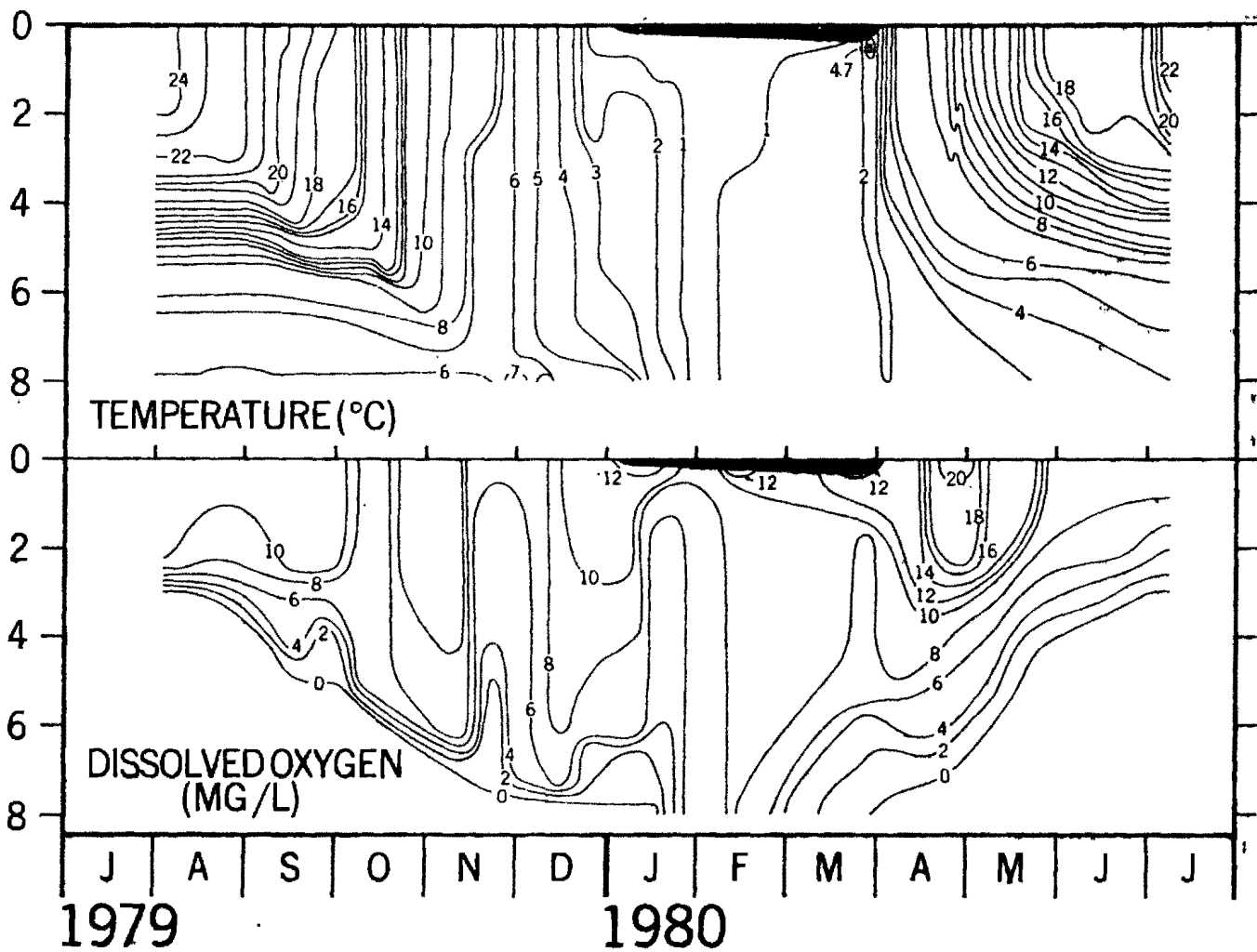


Fig. 9. Isopleths for temperature and oxygen for Ides Cove, N.Y. Ice thickness is represented by black regions.

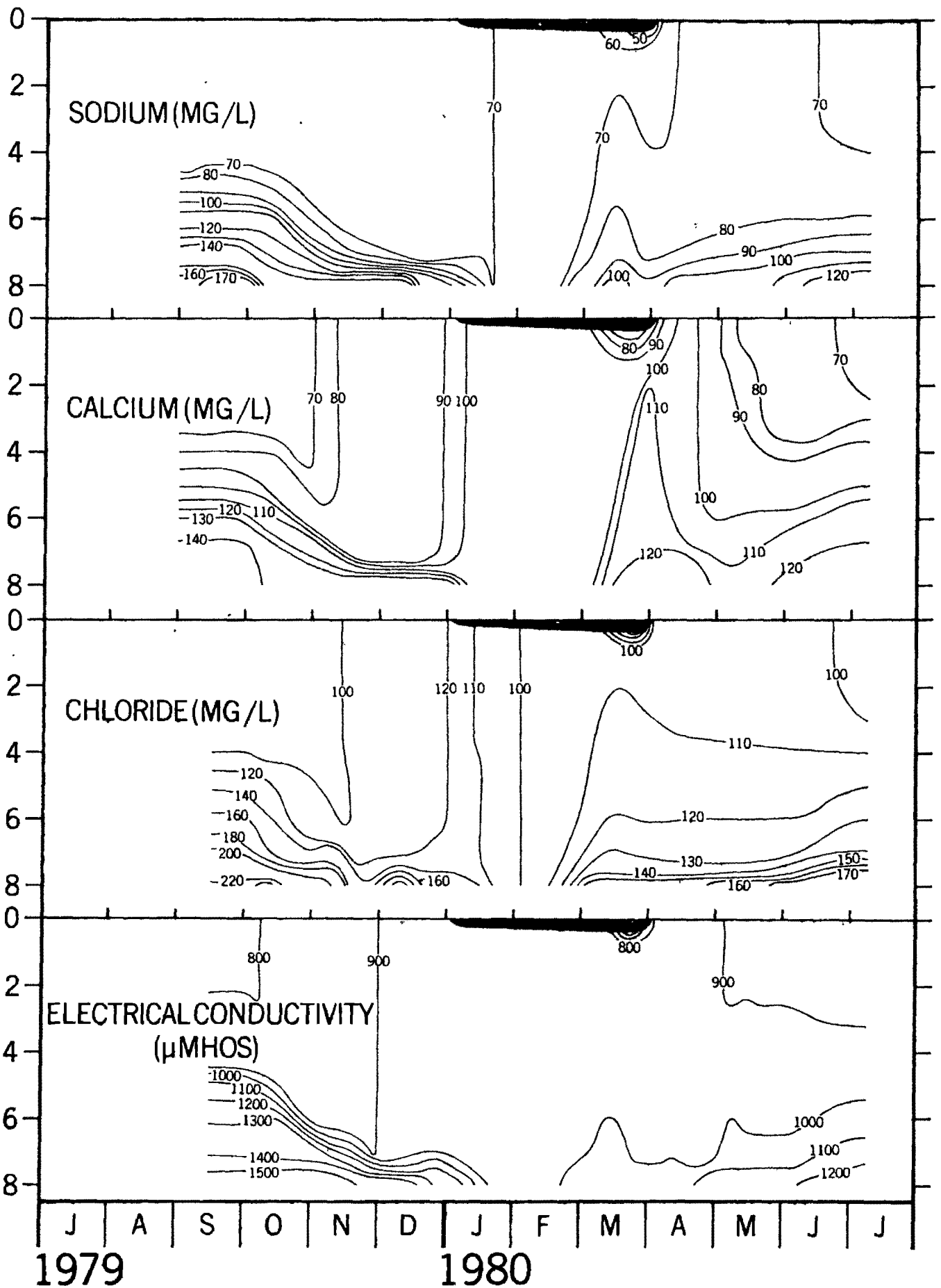


Fig.10. Isopleths for sodium, calcium, chloride and electrical conductivity for Ides Cove, N.Y.

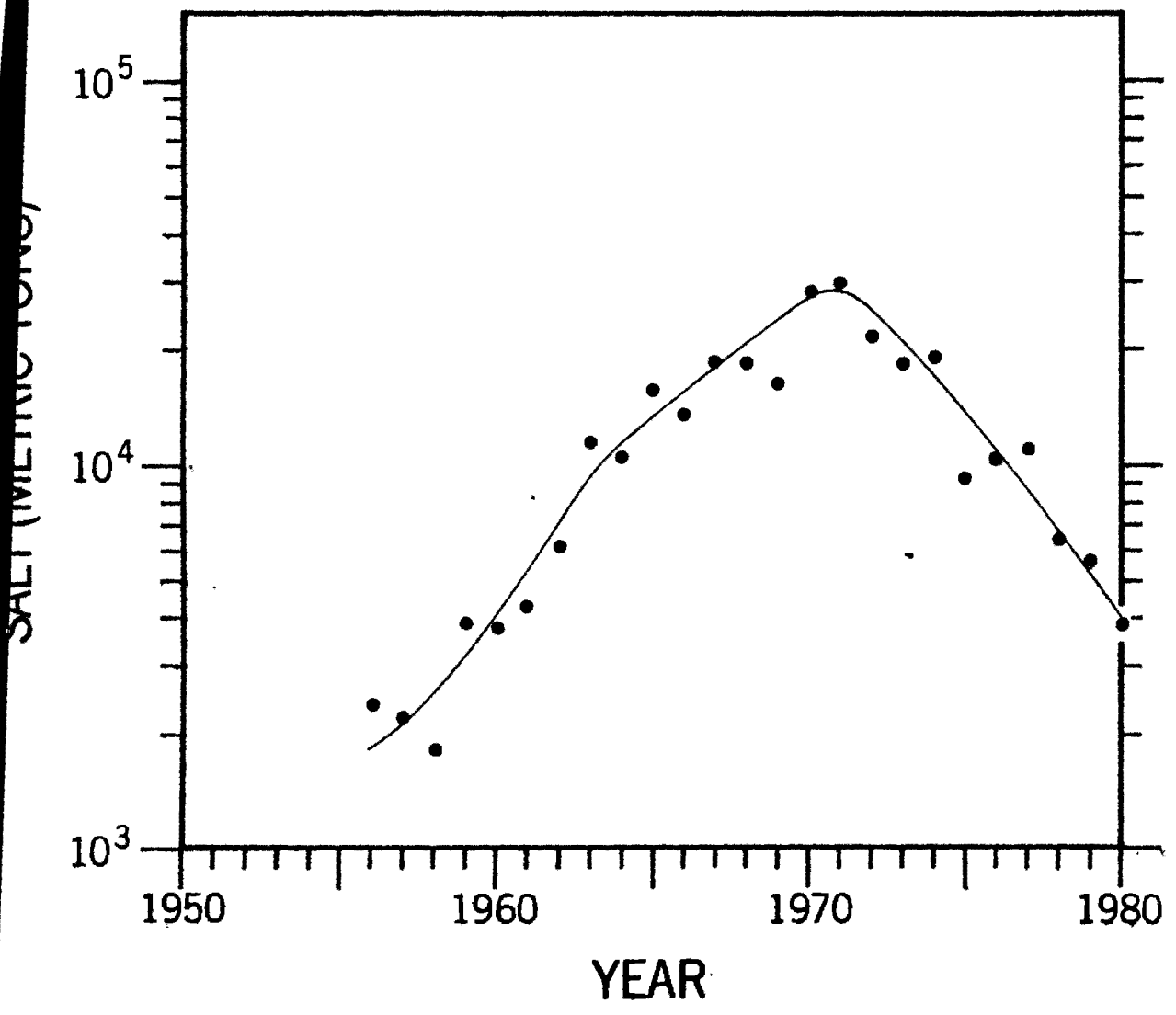


Fig. 11. Salt usage for deicing roads in Town of Irondequoit, Monroe Co., N.Y.



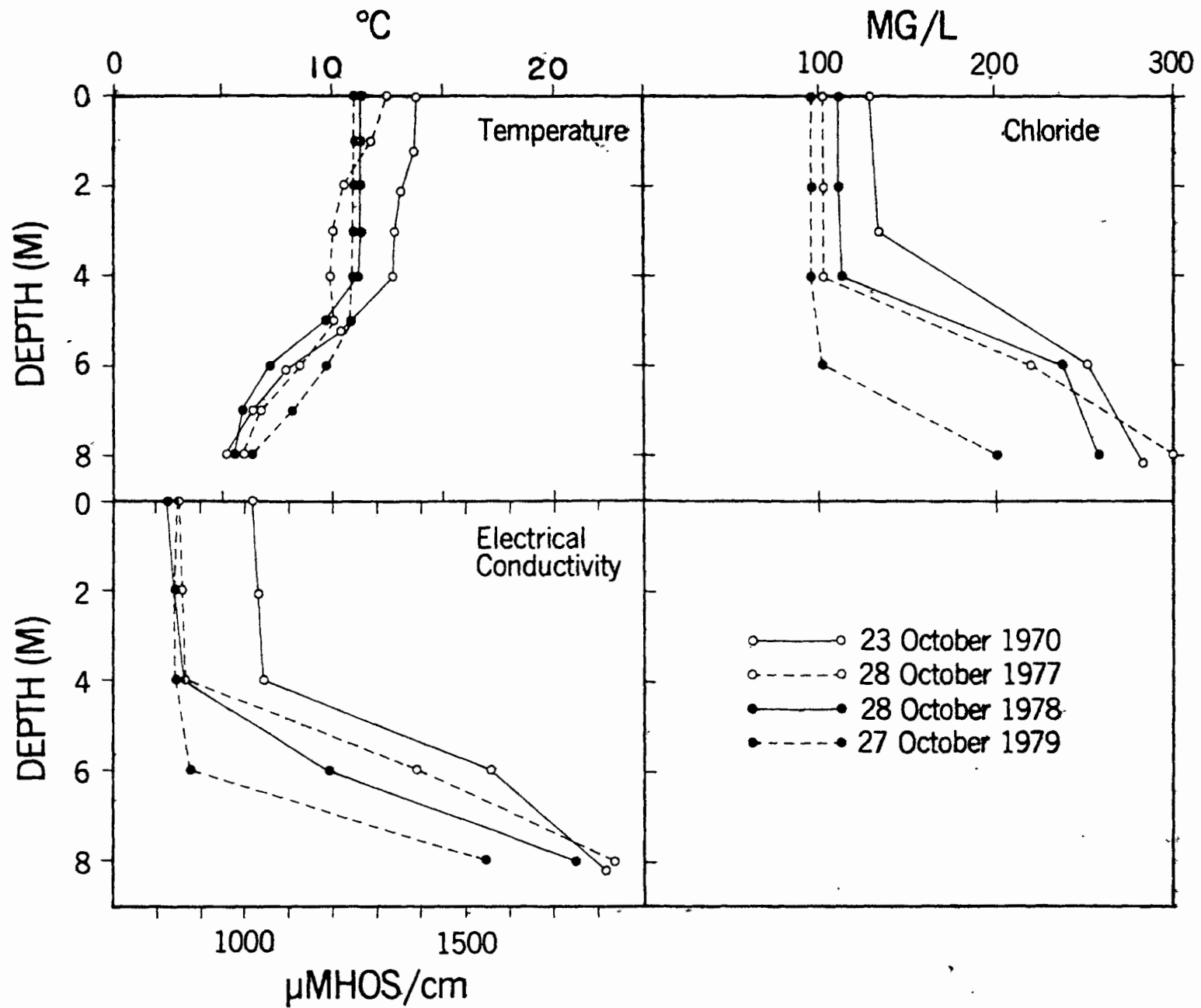


Fig. 12. Temperature, chloride and electrical conductivity profiles in October for the years 1970 and 1977-79. Data from 1970, 77 and 78 are from Bubeck (1972) and Stewart (1980).

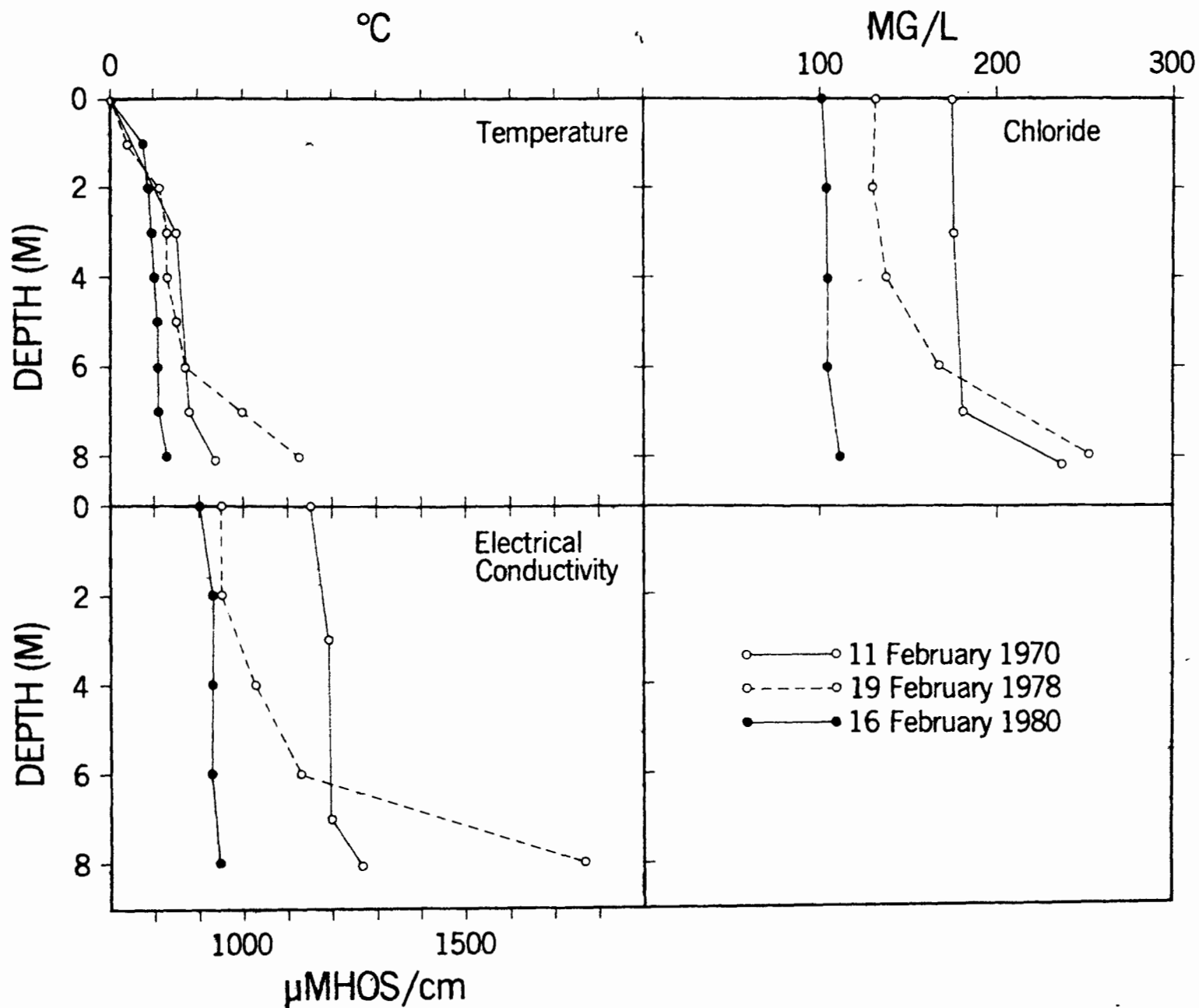


Fig. 13. Temperature, chloride and electrical conductivity profiles in February for the years 1970, 78 and 80. Data from 1970 and 78 are from Bubeck (1972) and Stewart (1980).

	STREAM #3	BUFFALO WELL*	PITTSFORD WELL*	DEICING SALT
$\text{Ca}^{++}$	51.3	34.6	84.8	0.3
$\text{Mg}^{++}$	8.3	8.4	12.8	0.0
$\text{Na}^+$	38.9	54.8	2.0	99.6
$\text{K}^+$	1.4	2.2	0.4	0.1
<hr/>				
$\text{Cl}^-$	39.3	57.0	0.1	99.0
$\text{HCO}_3^-$	41.5	33.1	12.0	0.3
$\text{SO}_4^{=}$	19.2	9.9	87.9	0.7

\* FROM LUSEYNSKI, GERAGHTY, ASSELSTINE AND GROSSMAN (1956)

Table 3500 Cation and anion composition of stream #3 into Ides Cove, deicing salt (rocksalt) and saline wells in nearby Buffalo and Pittsford, N.Y. Values are in percent composition by weight.

## Flow Rates (M<sup>3</sup>/DAY)

Stream		Winter	Spring	Summer
#1	Range	3.8—12.0	—————	—————
	$\bar{x}$	5.9	—	—
#2	Range	5.2—6.4	5.6—7.2	5.2—5.6
	$\bar{x}$	5.8	6.2	5.5
#3	Range	12.6—18.0	13.2—18.0	12.0—14.4
	$\bar{x}$	13.9	15.4	13.6

Table. I. Range and average flow rates (m<sup>3</sup>/day) of the ground-water streams draining into Ides Cove. See figure 1 for locations.

	19 Jan. 1980			12 Apr. 1980			Predicted 12 Apr. 1980		
	Na <sup>+</sup>	Ca <sup>++</sup>	Cl <sup>-</sup>	Na <sup>+</sup>	Ca <sup>++</sup>	Cl <sup>-</sup>	Na <sup>+</sup>	Ca <sup>++</sup>	Cl <sup>-</sup>
Ides Cove 7-8.5m (V=1764m <sup>3</sup> )	77	93	113	105	125	157	364	409	704

Table. 2. Observed and predicted concentrations of Na<sup>+</sup>, Ca<sup>++</sup>, and Cl<sup>-</sup> in the 7 - 8.5m strata of Ides Cove. Predictive values were calculated on the initial concentration of 19 Jan. 1980 and flow rates and concentrations of the three streams assuming all the stream water entering the 7 - 8.5m strata.