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SOME OCEANOGRAPHIC OBSERVATIONS IN THE SOUTHERN GULF OF ST. LAWRENCE SUMMER, 1965

by

B. L. BLACKFORD

FISHERIES RESEARCH BOARD OF CANADA
DARTMOUTH, N.S.

1967

ROGER DUHAMEL, F.R.S.C.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1967
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SOME OCEANOGRAPHIC OBSERVATIONS IN THE SOUTHERN GULF OF ST. LAWRENCE - SUMMER, 1965

by

B. L. BLACKFORD

ABSTRACT

Non-tidal drift was determined in the region of the Gulf of St. Lawrence just north of Prince Edward Island. Measurements were made by means of parachute drogues and by calculations of relative geostrophic flow. The geostrophic flow patterns show both clockwise and anticlockwise gyres in the layer above the thermocline. The data from the parachute drogues support these observations. The gyres were typically the order of 20 miles in diameter and were observed to move along with the flow. The inferred clockwise and anticlockwise gyres are associated with a depression and elevation respectively, of the thermocline.

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INTRODUCTION

This report contains a description and interpretation of data collected on an oceanographic cruise in a relatively small area of the Gulf of St. Lawrence during July of 1965. The main purpose of the cruise was to observe non-tidal water circulation. A similar investigation was carried out during the previous summer and the results were reported previously by the author, Blackford (1965)*. The most important result of I was the observation of moving gyres in the layers above the thermocline. Correspondingly, the primary objective of the present investigation was to attempt to observe more of these gyres. The observation technique was the same as that employed in I, but the area of observation was west of and adjacent to that of I. Figure 1 shows a map of the entire Gulf of St. Lawrence with the present area of observation shaded in.

METHOD OF OBSERVATION

CNAV "Sackville" served as an observation platform and geographic positions were determined by means of decca and radar. Non-tidal drift was determined by two independent methods, as follows:

(1) direct observation of the drift of surface buoys attached to subsurface parachute drogues,

(2) calculations of relative geostrophic flow from temperature and salinity data collected at oceanographic stations.

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* Referred to as I throughout the present report.

The details of these methods are given in I and will not be repeated here.

In all, 18 drogues were released and tracked for periods of up to eight days. Three of the surface buoys were equipped with radio transmitters.

Figures 2(a,b) show the networks of oceanographic stations which were occupied. It was originally intended to occupy the network of Fig. 2a twice, however time did not permit a complete occupation during the second run as shown in Fig. 2b. It required 79 hours to complete the first run of stations (6 to 52) shown in Fig. 2a. Thus the picture of the mass field obtained thereby is by no means an instantaneous one. This point of caution is discussed in more detail in I.

RESULTS AND DISCUSSION

A) Drift Drogue Results:

Parachutes were located at depths of 6, 20, and 45 metres: above the thermocline, just below the thermocline and near bottom, respectively. Figure 3a shows the drift tracks at 6 metres and Fig. 3b shows the drift tracks at 20 and 45 metres. The motion at 6 metres is considerably stronger than at 20 and 45 metres, thus the discussion will be limited to the upper layer only.

The drift tracks at 6 metres indicate a general southeasterly set in the region north of P.E.I. The speeds are considerably weaker than those reported in I. Buoys 13A and 14 give evidence for the existence of a clockwise gyre in the region southeast of North Pt., P.E.I.

B) Oceanographic Station Results:-

Figures 4(a,b,c) show relative dynamic height anomalies* at 0, 10 and 20 metres, respectively for the first run, i.e., stations 6-52 in Fig. 2a. These dynamic heights are referred to a depth of 30 metres which is below the average depth of the thermocline. The direction of the geostrophic flow is indicated by the arrows on the contour lines and the speed is inversely proportional to the distance between the contour lines. The speeds may be calculated by making use of the graph that appears in each figure.

The flow pattern of Figs. 4(a,b,c) consists of a general southeasterly set with several gyres superimposed on it. The agreement with the drift drogue tracks of Fig. 3a is relatively good. The clockwise gyre southwest of North Pt. suggested by the drift drogue tracks is substantiated by the geostrophic flow. In addition the geostrophic flow of Figs. 4(a,b,c) shows an anti-clockwise gyre centered between stations 32 and 33 and a clock-wise gyre centered at station 23, see Fig. 2a.

The peculiar behaviour of drogue No. 7 in Fig. 3a may be explained in terms of the anticlockwise gyre in Fig. 4a. The fact that drogue No. 10 didn't behave like No. 7 at the point where their tracks intersect may be explained by the fact that No. 7 was at this point considerably sooner than No. 10.

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* In all of the figures showing dynamic heights the dots in front of the numbers do not represent decimal points. Rather they indicate the locations of stations where oceanographic data were collected.

In the region directly north of North Pt. the dynamic heights of Fig. 4a indicate an easterly flow between stations 50 and 51 and a westerly flow between stations 51 and 52. Drift buoy No. 12 was located roughly between these regions of westerly and easterly flow and thus its very slow movement towards the west is consistent with this dynamic height observation.

Figures 5(a,b,c) show dynamic heights at 0, 10, and 20 metres, respectively for the second run, i.e., stations 53-86 in Fig. 2b. The general features of the geostrophic flow in these figures are much the same as in the first run, Figs. 4(a,b,c). The clockwise gyre southeast of North Pt. is still in evidence. The clockwise and anticlockwise gyres in the centre of the figures are still present and appear to have moved towards the southeast. The movement of the gyres would be expected on the basis of the general southeasterly set. The center of the anticlockwise gyre moved a distance of about 7 miles in about 56 hrs. giving a speed of 0.13 knots. The clockwise gyre moved about 14 miles in 91 hrs. giving a speed of 0.15 knots.

It thus appears that the drift drogue tracks and dynamic heights of the present investigation both give further support for the existence of gyres of the type reported earlier in I. In I only anticlockwise gyres were observed, however in the present case both clockwise and anticlockwise ones are reported. In I it was pointed out that an anticlockwise gyre in the surface layers causes an elevation of the thermocline at the centre of the gyre. Naturally, one would expect a clockwise gyre to have the opposite effect, i.e., to depress the thermocline. Both of these effects

are suggested in Figs. 6(a,b,c) which show the temperature contours on the 0, 10, 20 and 30 metre surfaces respectively, for stations 6-52. In Figs. 6(b,c) the regions of cold water correspond to an elevated thermocline, the temperature distribution being similar to that expected about an anticlockwise gyre. In Figs. 6(c,d) the regions of warm water correspond to a depressed thermocline as expected about a clockwise gyre. Figures 7(a,b,c,d) show similar results for the temperature contours obtained on the second run, stations 53-86.

Figures 8(a,b,c,d) and Figs. 9(a,b,c,d) show salinity contours obtained on the first and second run, respectively. As in the case of the temperature distributions these salinity distributions correspond to those that would be expected about clockwise and anticlockwise gyres, respectively.

In I it was conjectured that the gyres were formed locally. In the present study the data are by no means complete enough to indicate whether the gyres form locally or move into the region of observation from outside. However, it seems possible that the clockwise gyre situated southeast of North Pt. could be an eddy created by the land configuration of the western portion of P.E.I.

SUGGESTIONS FOR FUTURE STUDY

Several suggestions for future study were given in I. In the author's opinion these are still valid at the present time, but they will not be repeated here.

As an additional suggestion it seems that the centre of an anticlockwise gyre may be a region of increased biological

activity because such a gyre raises deep water nearer to the surface. The increased sunlight should then increase the biological activity of this deeper water. However, the water beneath the thermocline does not travel with the moving gyre so the increased biological activity would be greatest for stationary or slowly moving gyres. In any event it would be useful to collect biological data concurrently with any future study designed to observe gyres of this type.

SUMMARY

1) Non-tidal water movements were observed by the use of parachute drogues and by calculations of relative geostrophic flow. The results obtained by the two methods were in general agreement.

2) The geostrophic flow patterns determined from the mass field show both clockwise and anticlockwise gyres in the layer above the thermocline. The data from the parachute drogues support these observations. The gyres were typically the order of 20 miles in diameter and were observed to move along with the flow.

3) The clockwise gyres are associated with a depression of the thermocline while the anticlockwise gyres are associated with an elevation of the thermocline.

ACKNOWLEDGEMENT

The author wishes to extend thanks to the oceanographers who assisted in the collection of data included in this report. In addition, thanks is extended to the officers and crew of CNAV

"Sackville" for their cooperation and assistance during the field program. Thanks is extended to S.B. McHughen and T.A. Grant for preparation of diagrams.

REFERENCES

Blackford, B.L., 1965. Some oceanographic observations in the southeastern Gulf of St. Lawrence - summer, 1964. Fish. Res. Bd. Canada, MS Rept.(Oceanogr. and Limnol.) No. 185

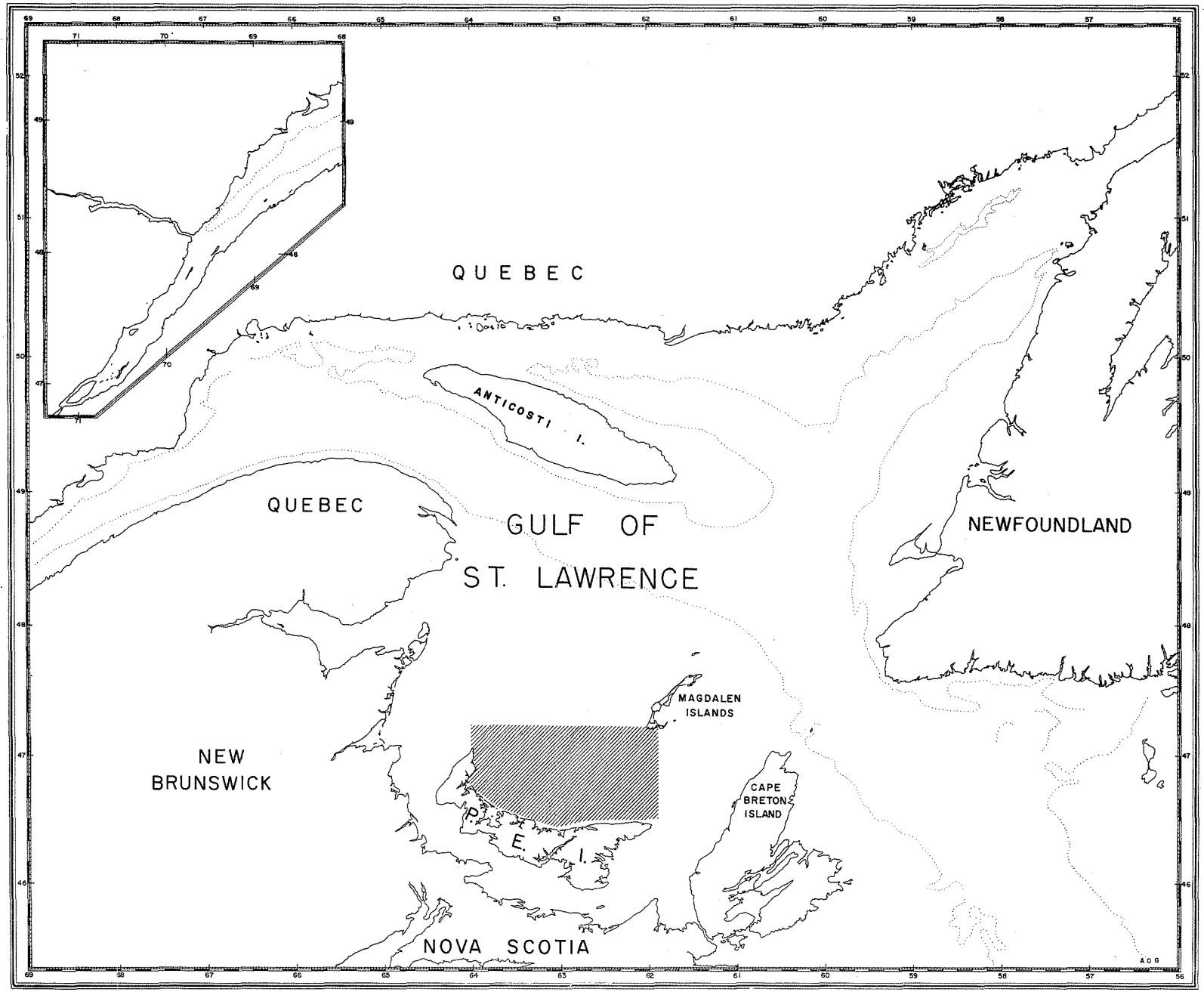

Fig. 1 Map of the Gulf of St. Lawrence with the present area of observation shaded in.

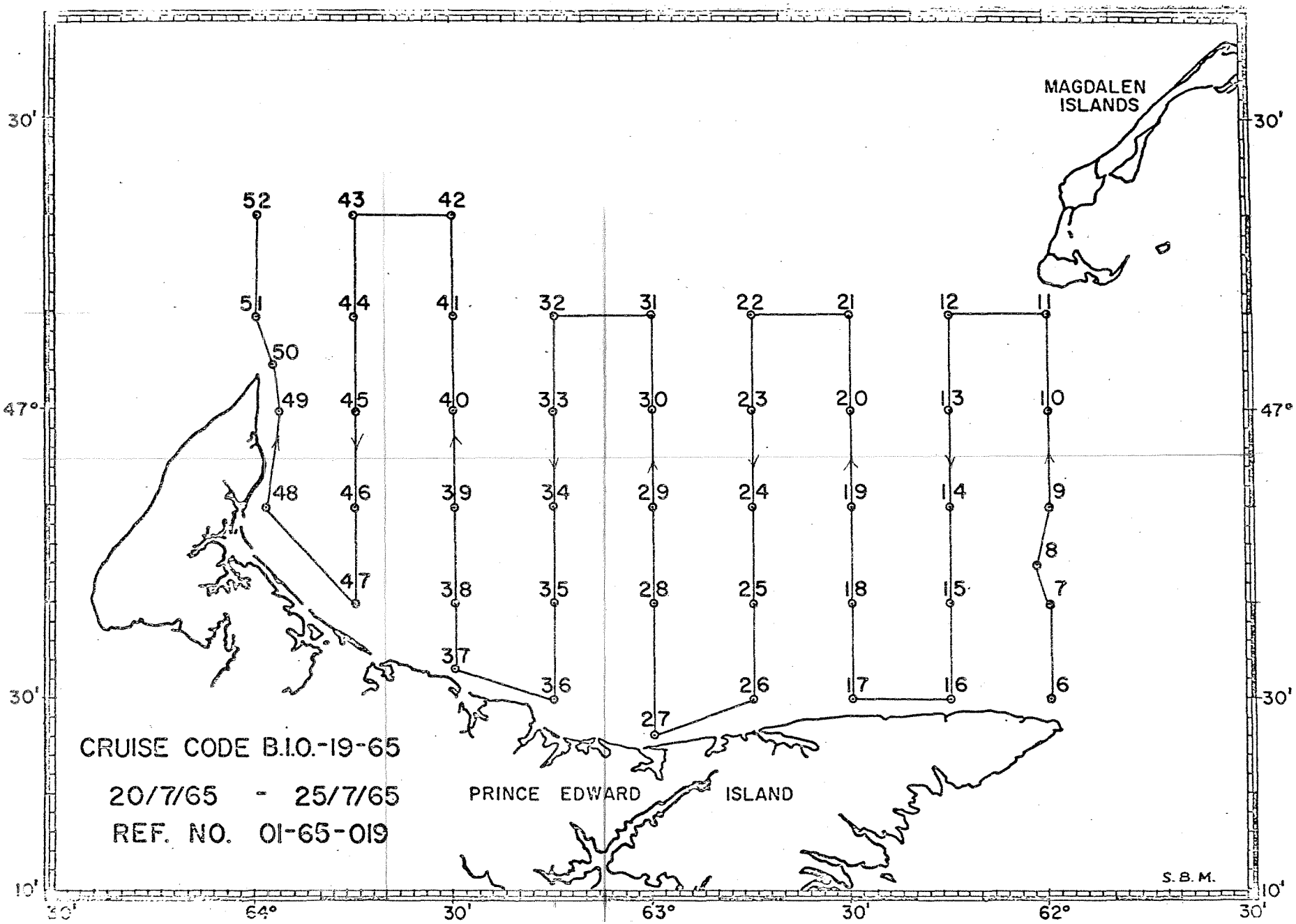

Fig. 2a Network of oceanographic stations occupied on the first run. Stations 6-52. (0500-20/7/65) to (1200-23/7/65).

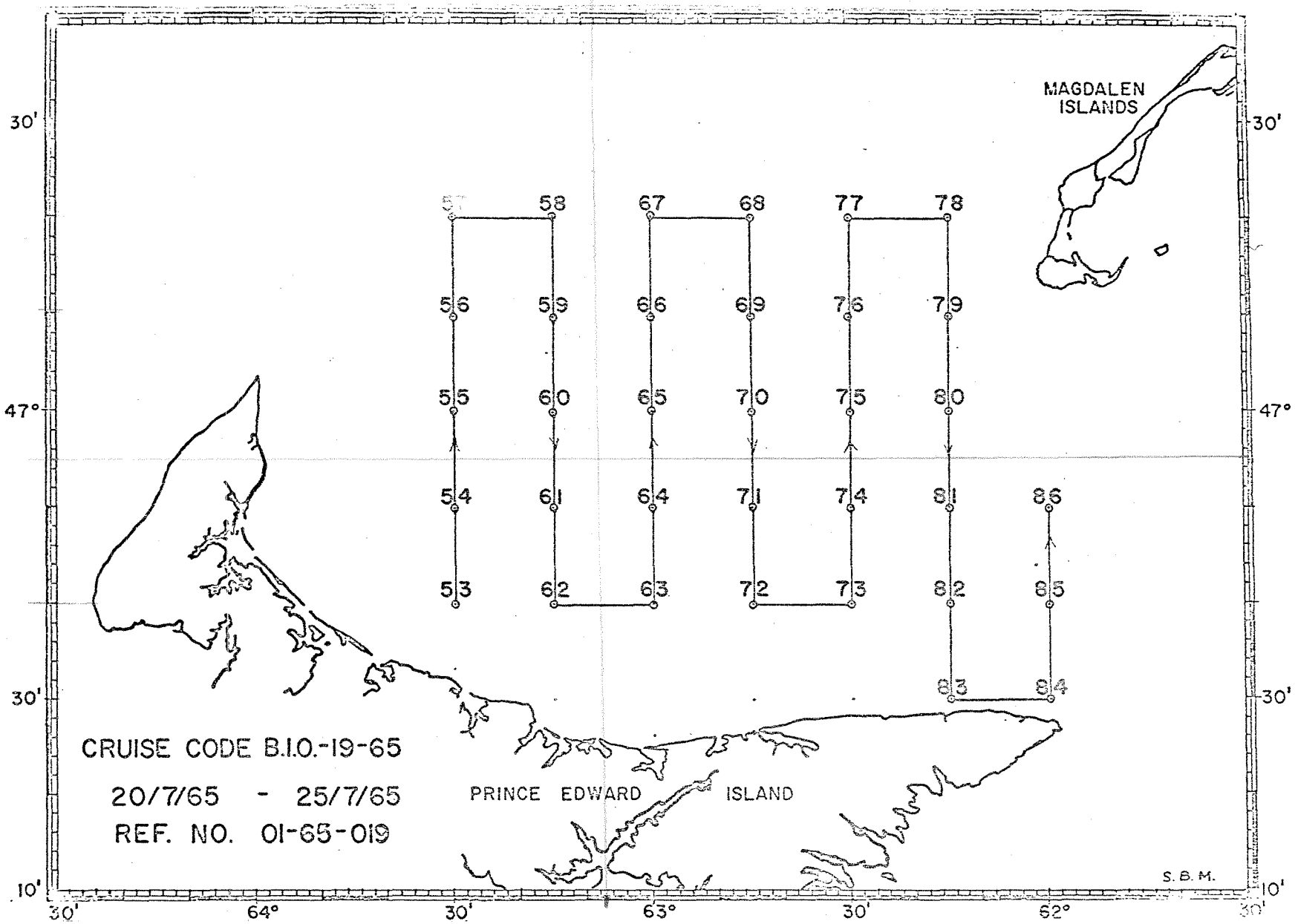

Fig. 2b Network of oceanographic stations occupied on the second run. Stations 53-86. (2000-23/7/65) to (2100-25-7-65).

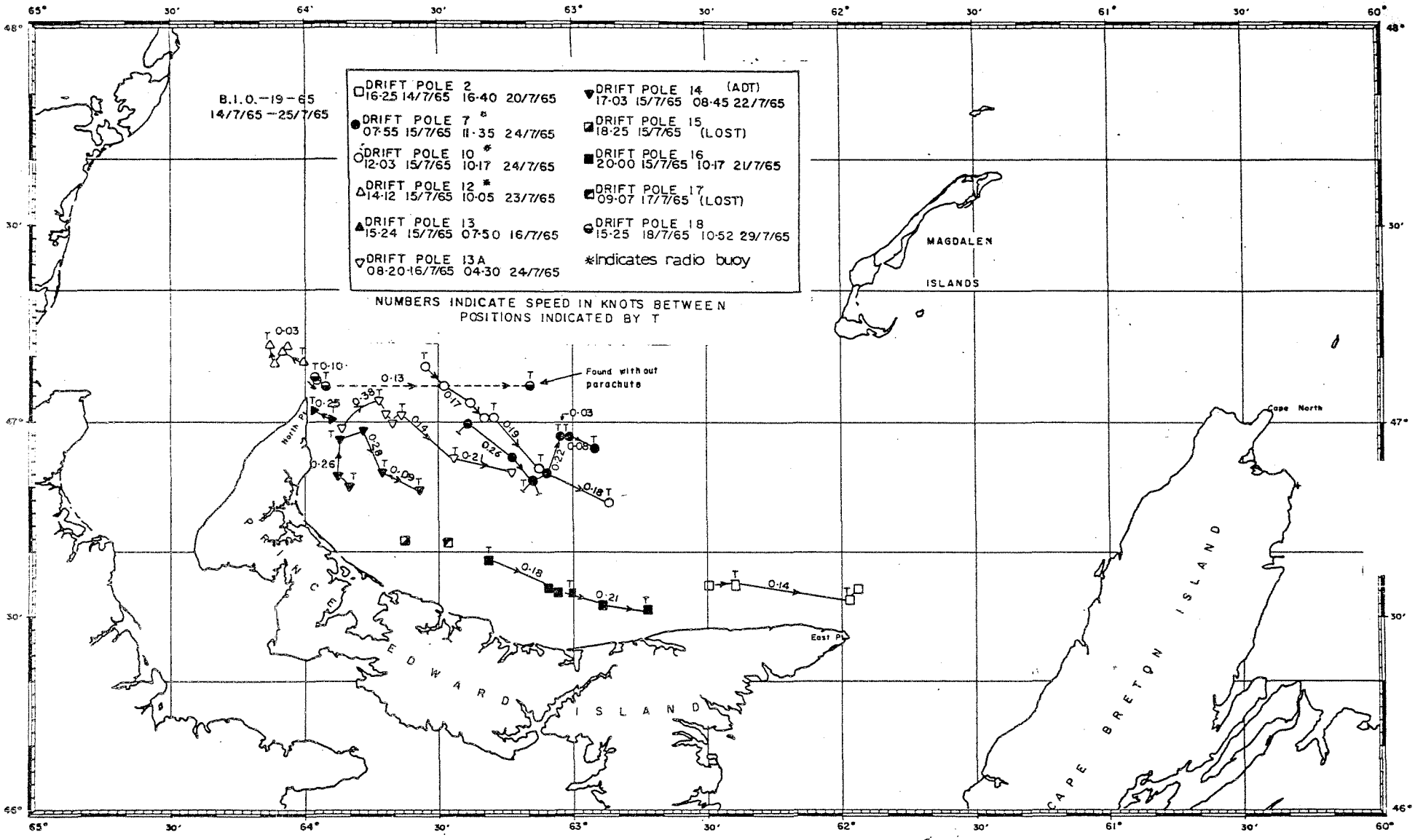

Fig. 3a Drift tracks of drogues located at a depth of 6 metres.

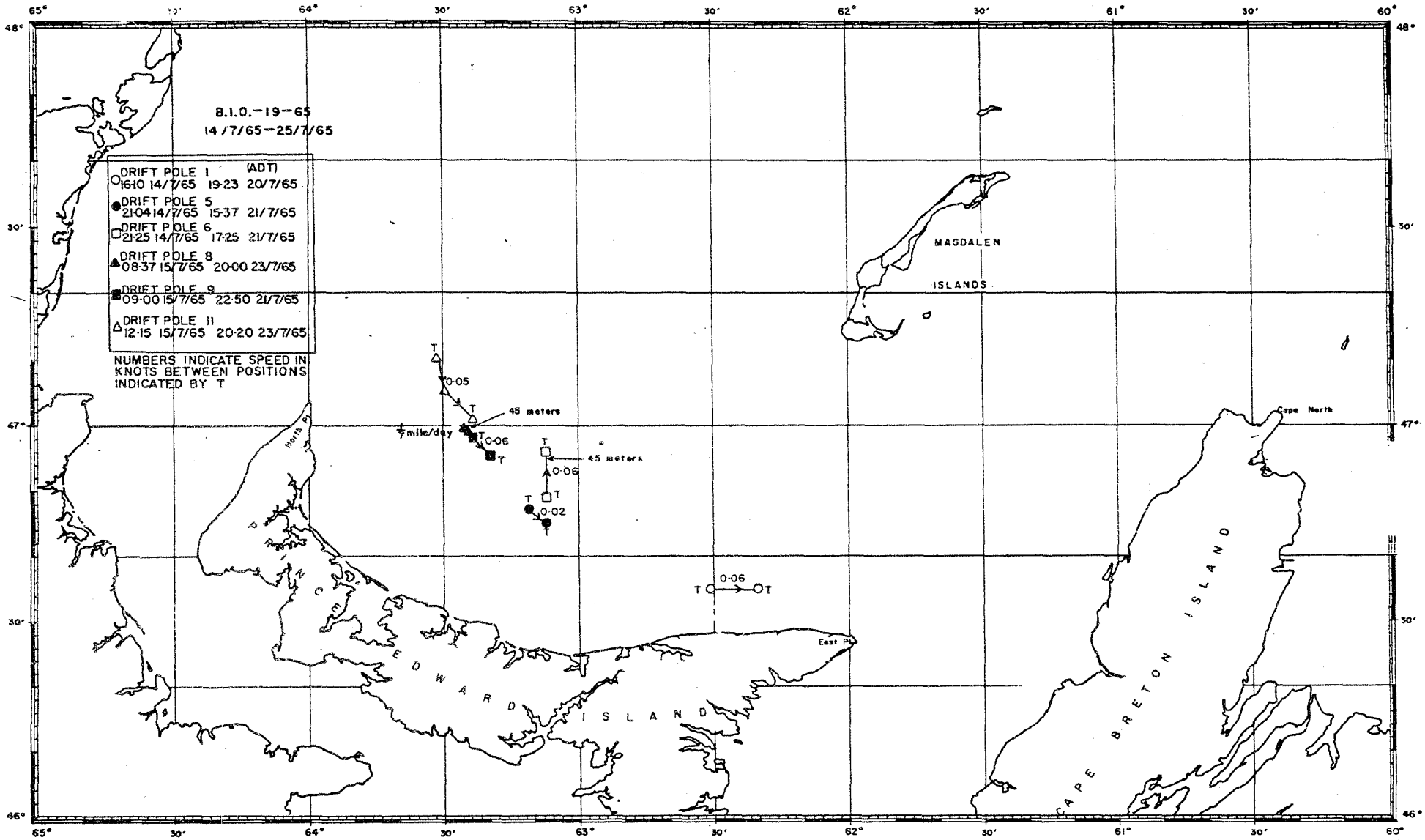

Fig. 3b Drift tracks of drogues located at depths of 20 and 45 metres.

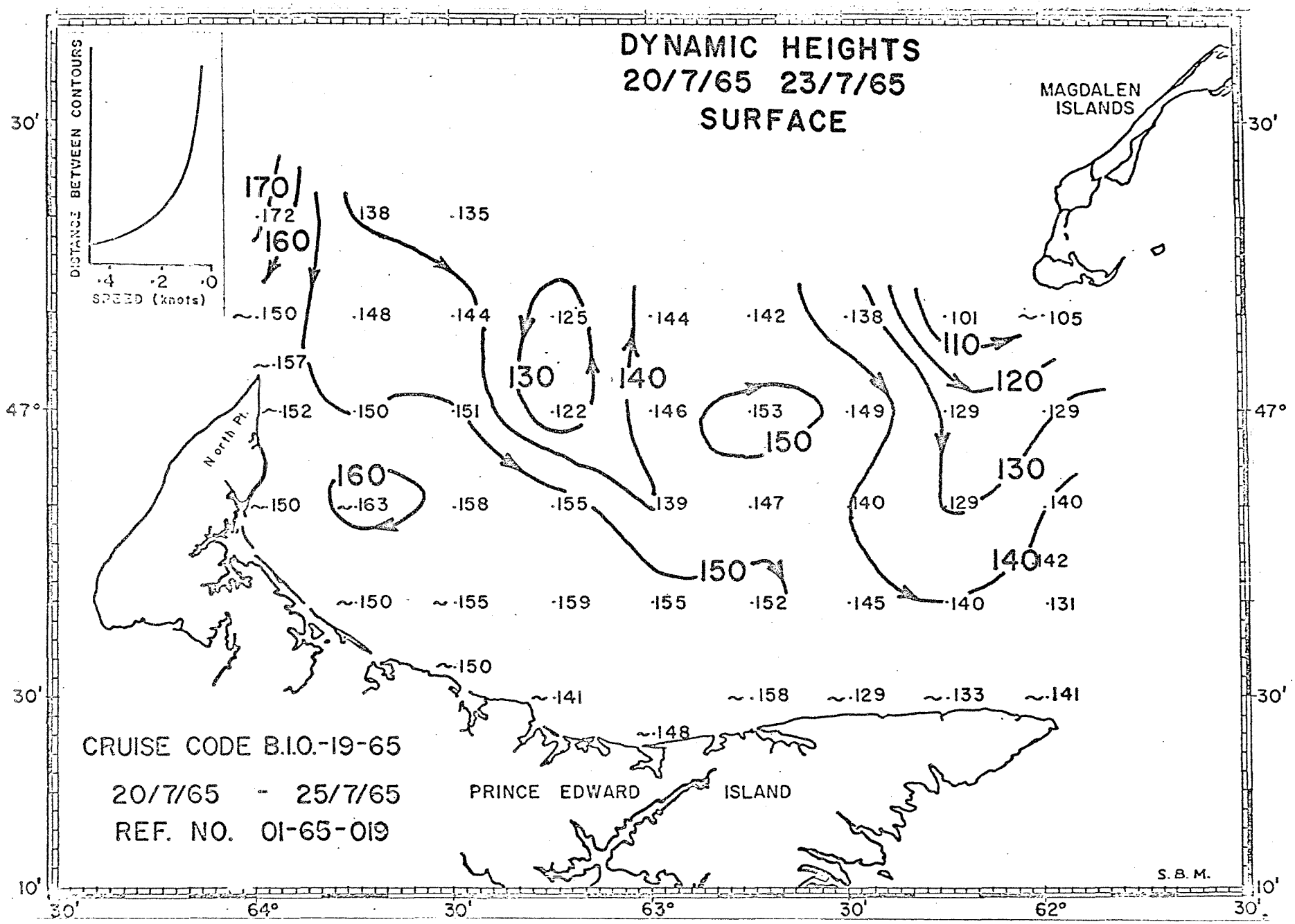

Fig. 4a Relative dynamic surface topography for stations 6-52. (dyn.mm.) Reference depth: 30 metres.

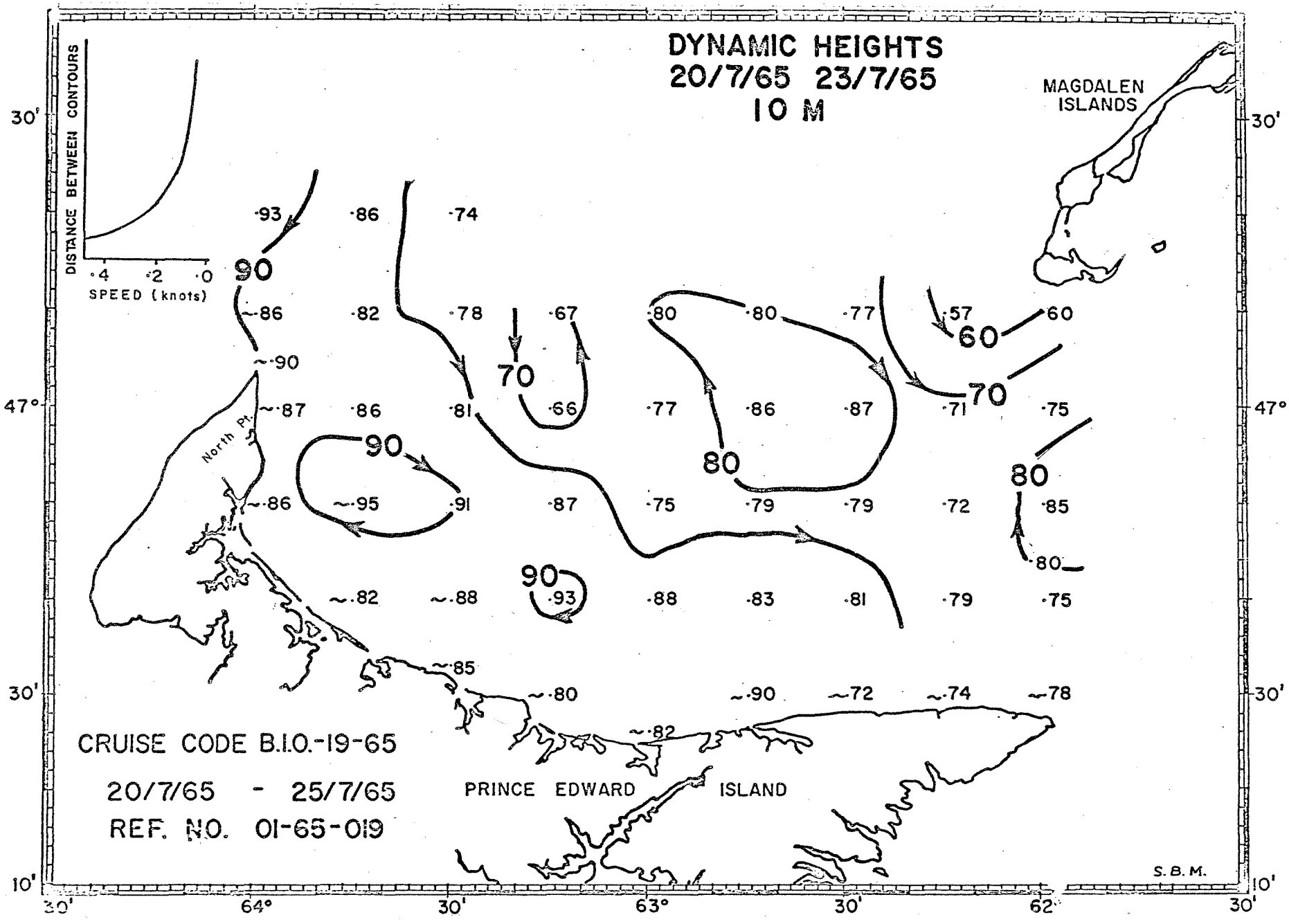

Fig. 4b Relative dynamic topography at 10 metres for stations 6-52. (dyn.mm.) Reference depth: 30 metres.

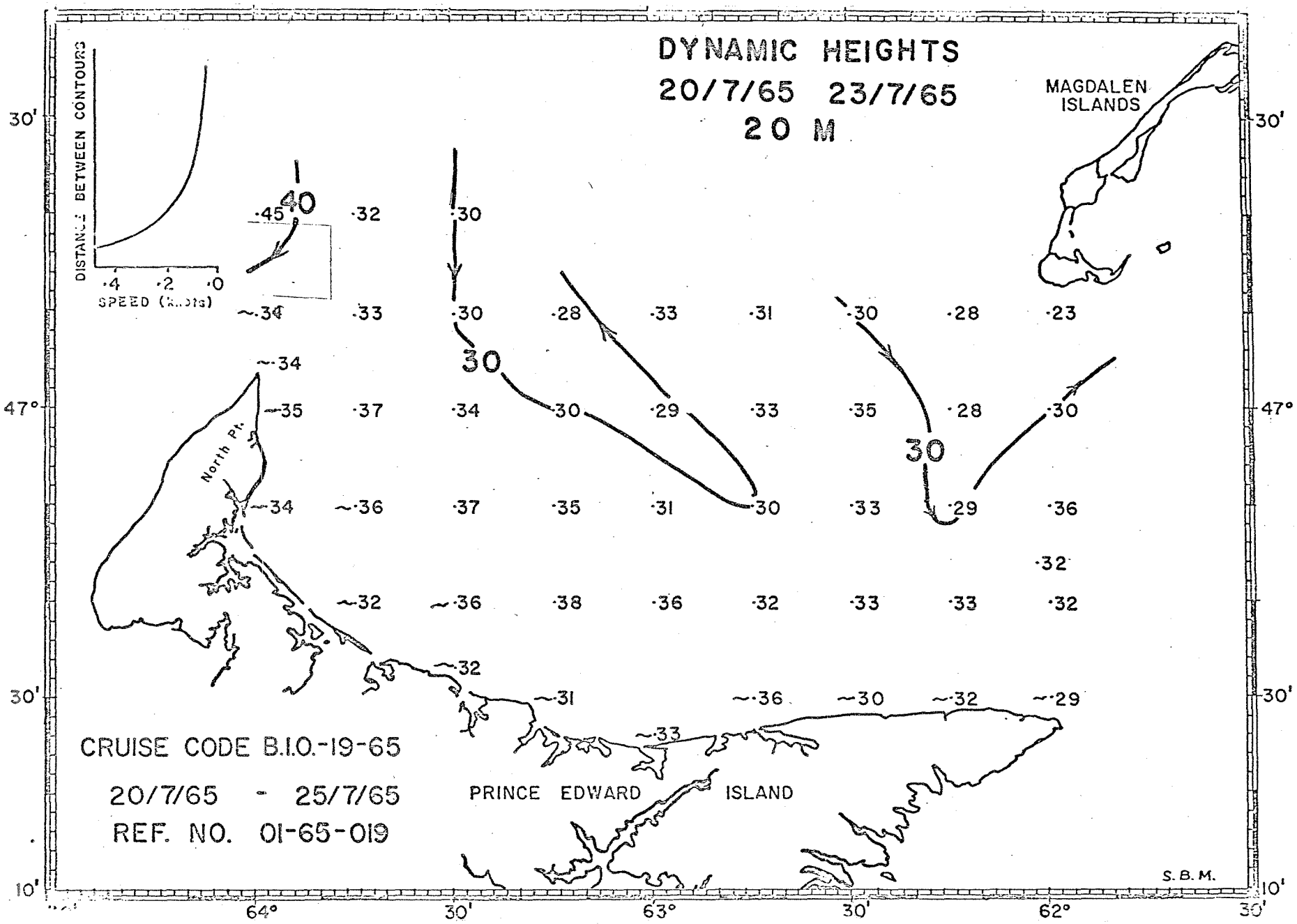

Fig. 4c Relative dynamic topography at 20 metres for stations 6-52. (dyn.mm.) Reference depth: 30 metres.

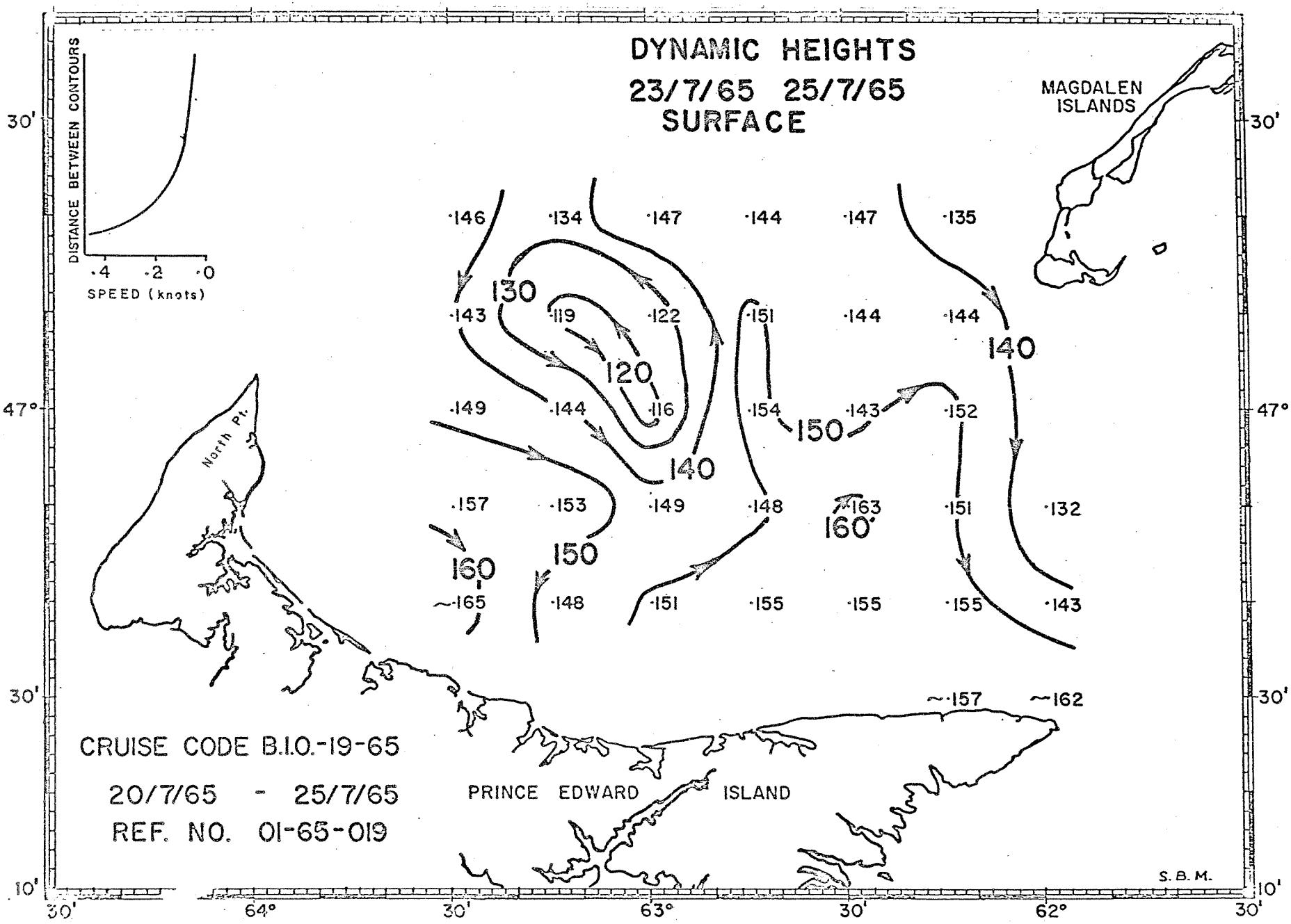

Fig. 5a Relative dynamic surface topography for stations 53-86. (dyn.mm.) Reference depth: 30 metres.

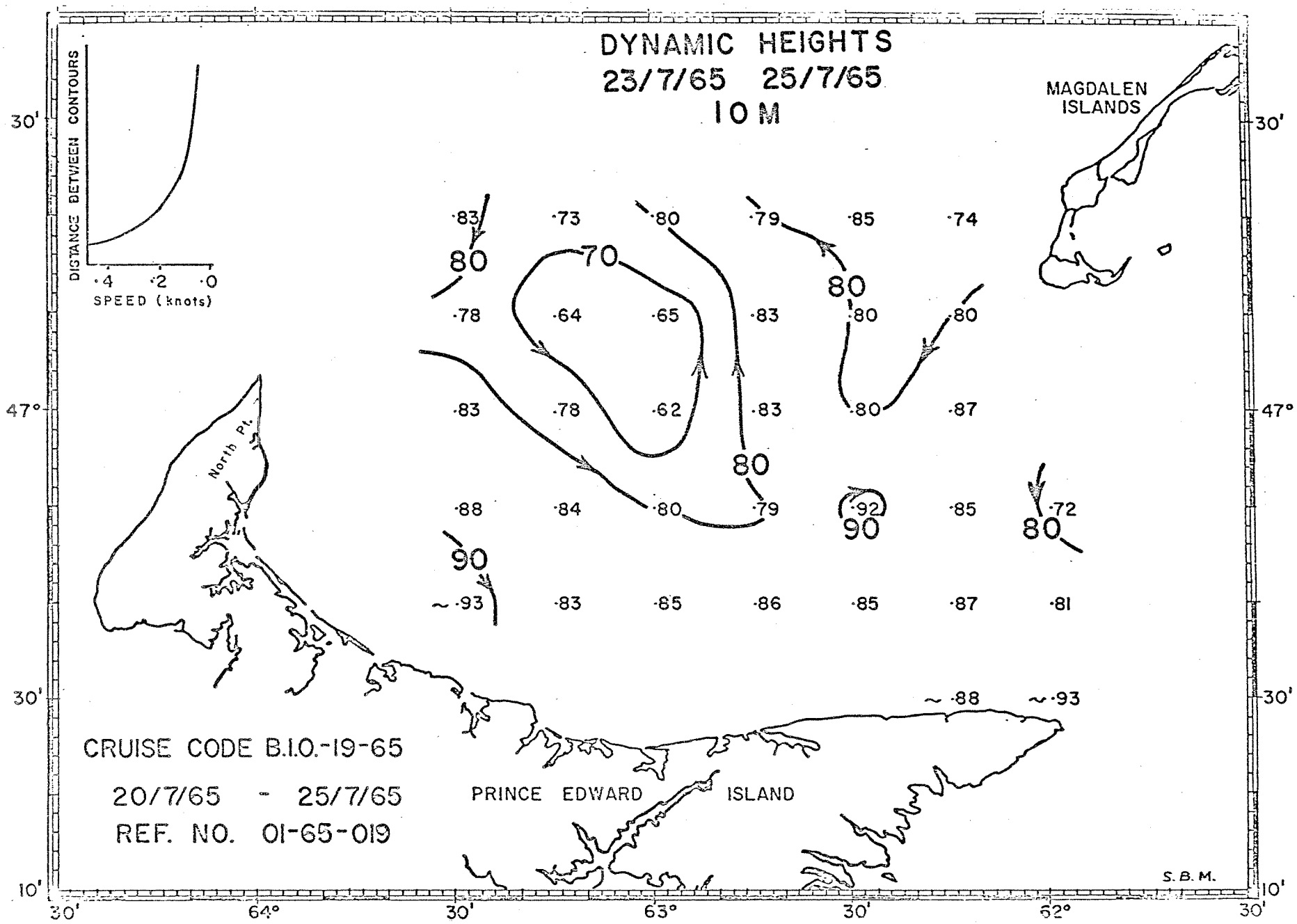

Fig. 5b Relative dynamic topography at 10 metres for stations 53-86 (dyn.mm.) Reference depth: 30 metres.

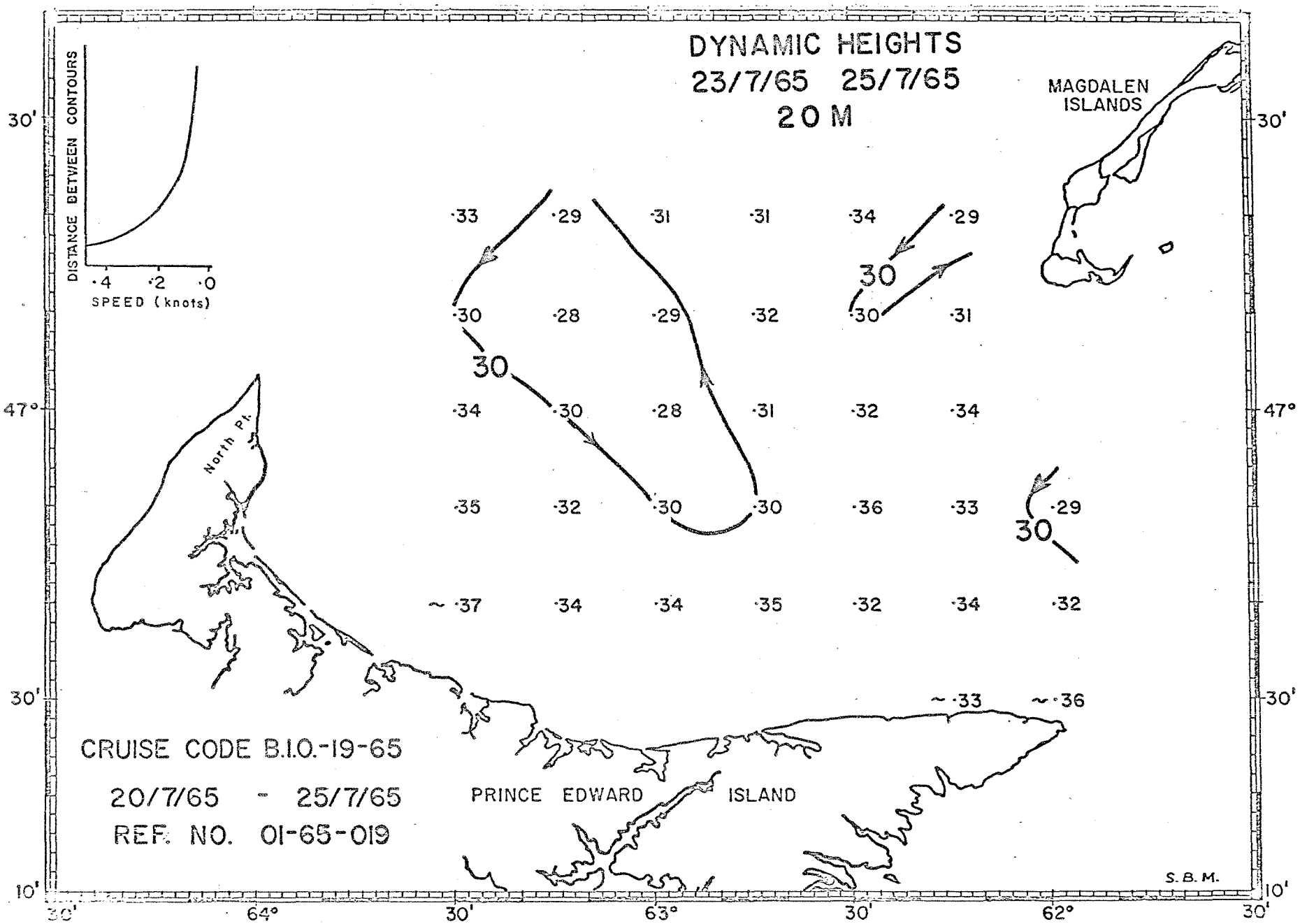

Fig. 5c Relative dynamic topography at 20 metres for stations 53-86. (dyn.mm.) Reference depth: 30 metres.

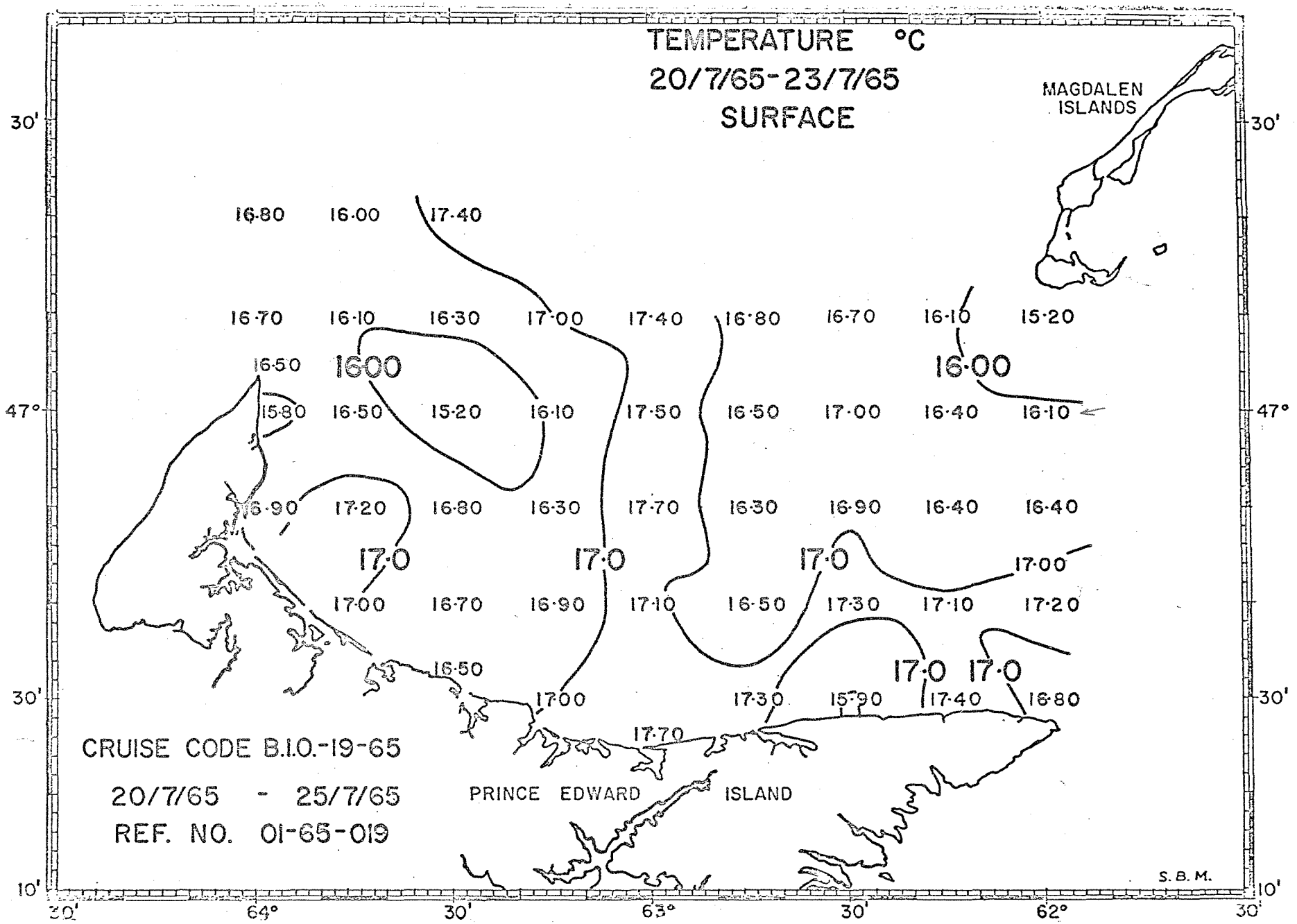

Fig. 6a Surface temperature values (Stns. 6-52).

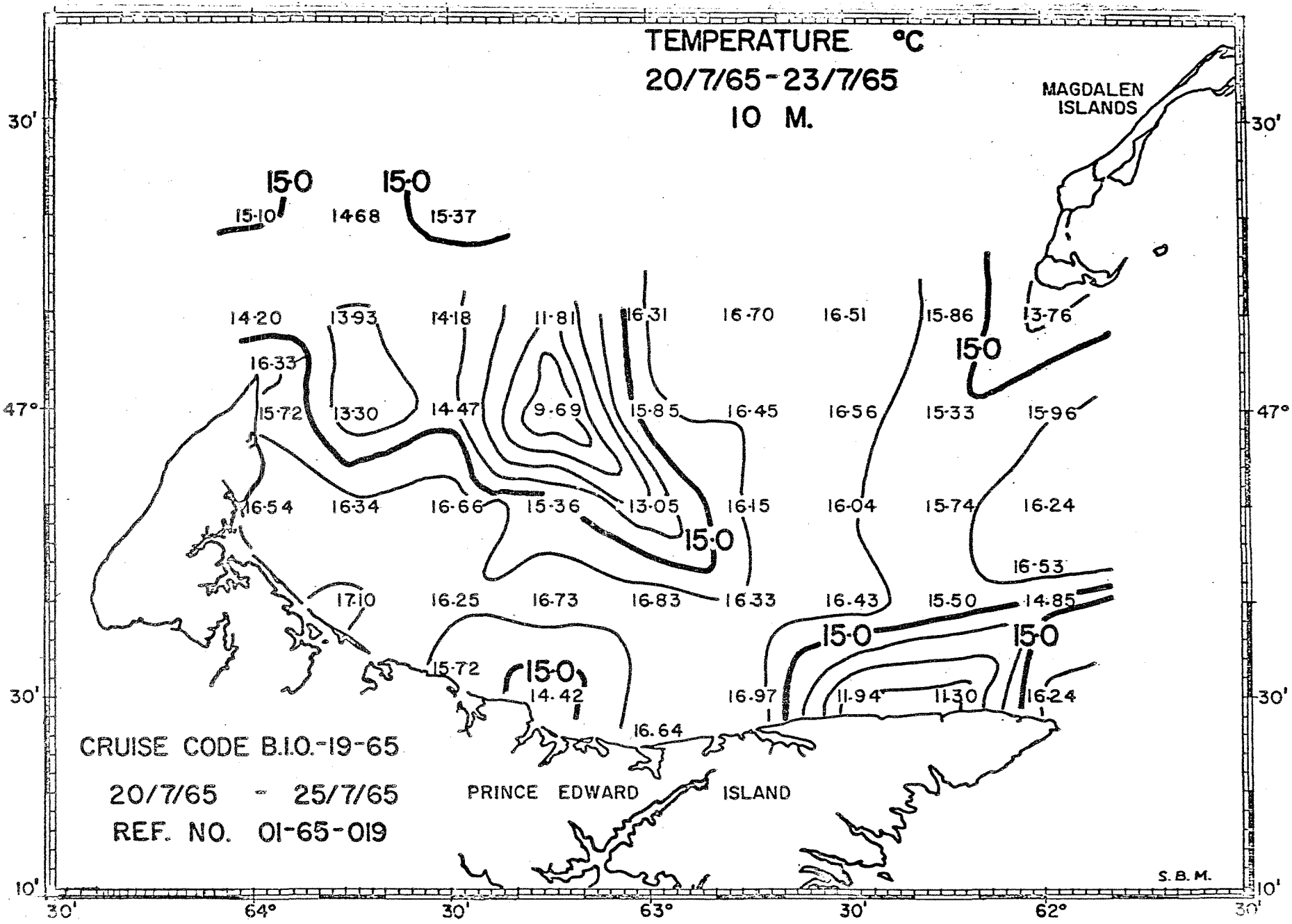

Fig. 6b Temperature values at 10 metres (Stns. 6-52).

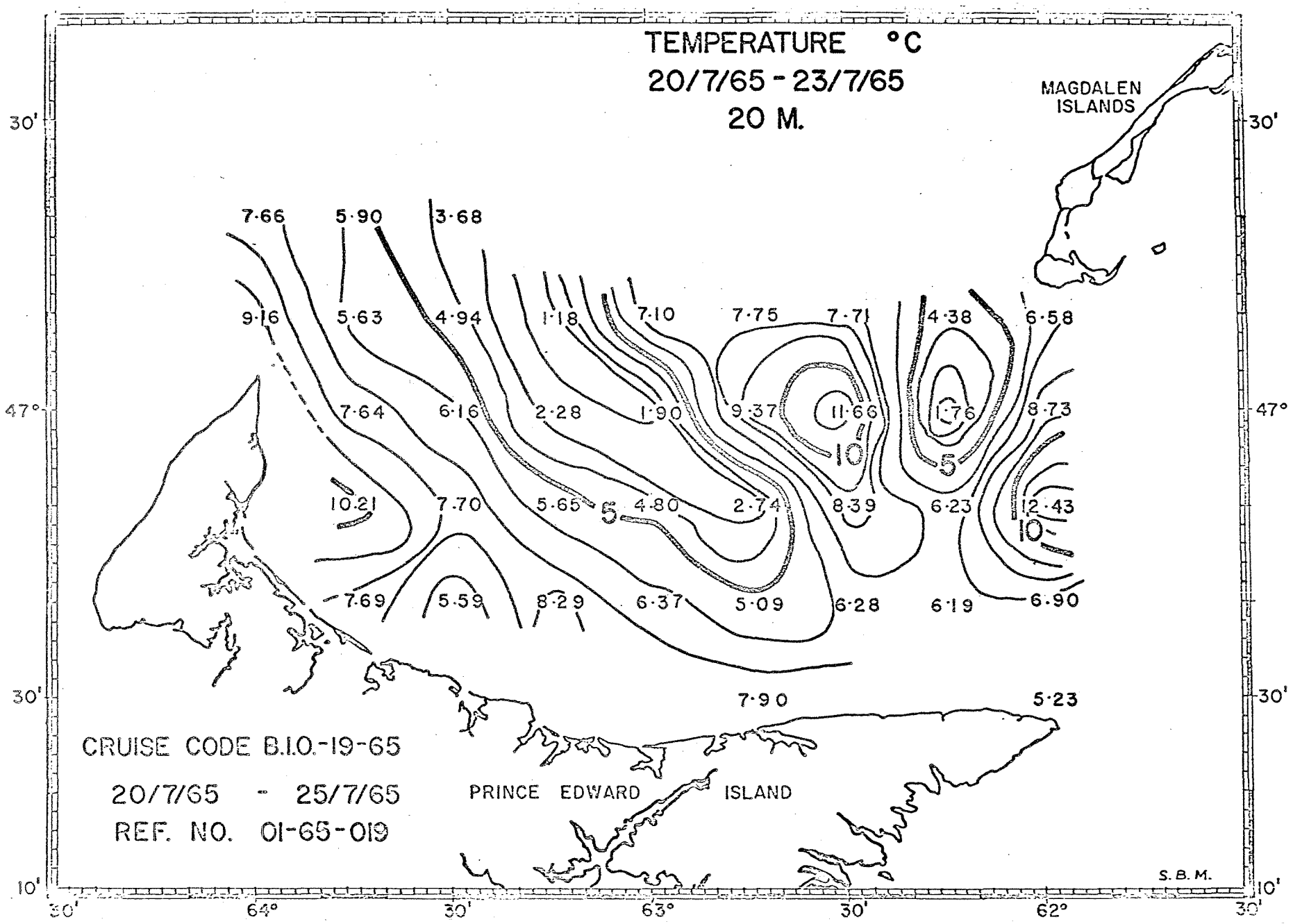

Fig. 6c Temperature values at 20 metres (Stns. 6-52).

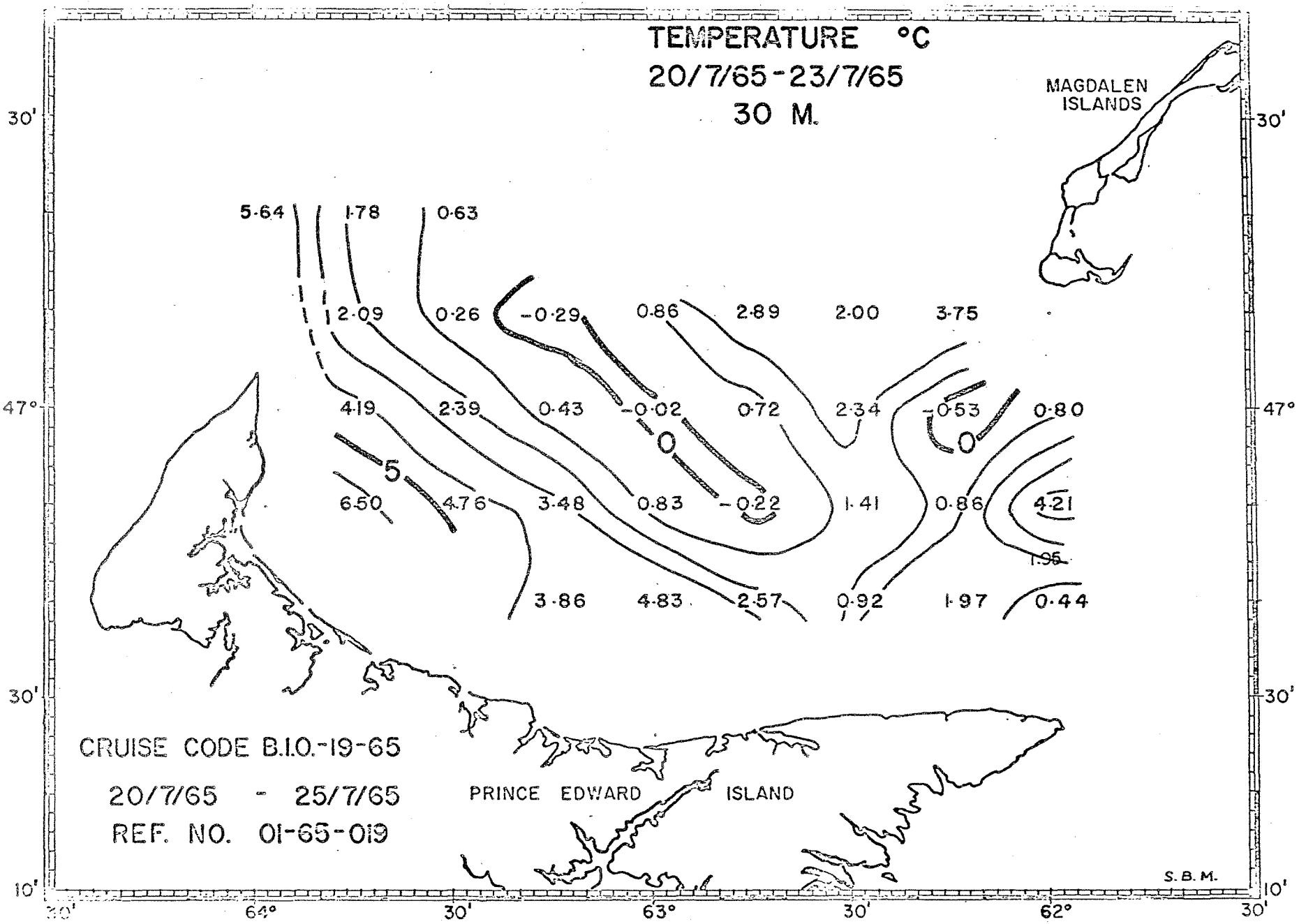

Fig. 6d Temperature values at 30 metres (Stns. 6-52).

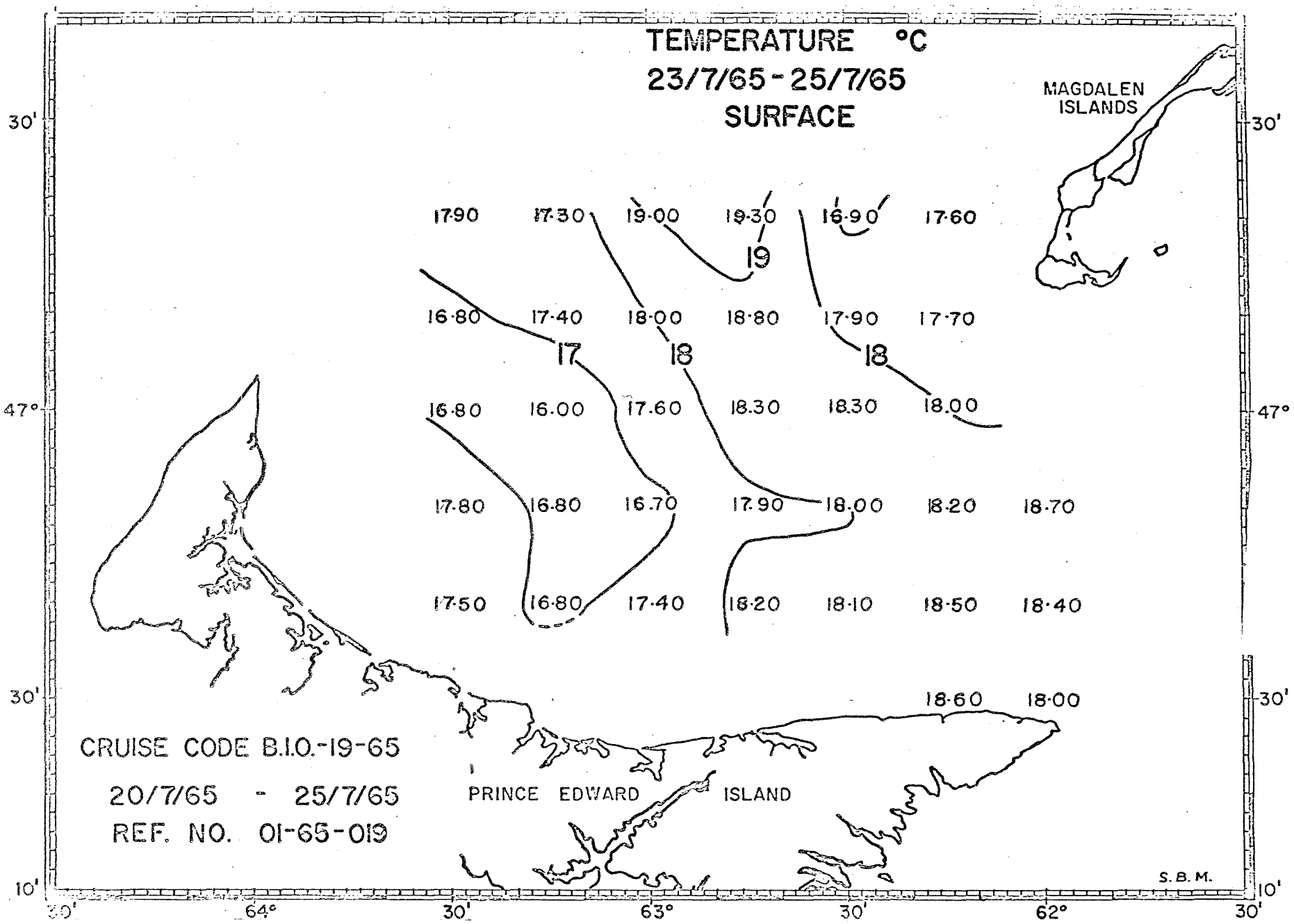

Fig. 7a Surface temperature values (Stns. 53-86).

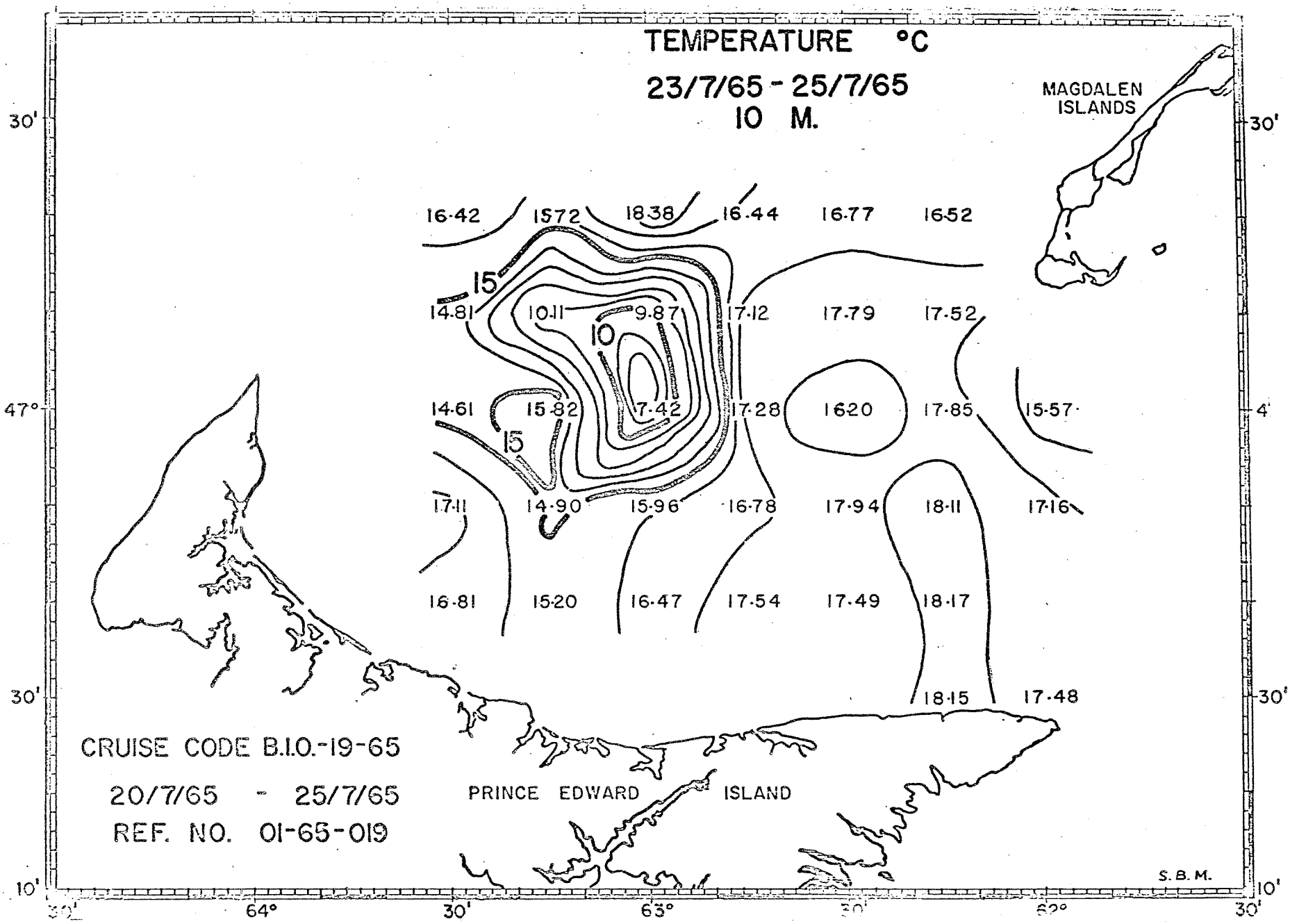

Fig. 7b Temperature values at 10 metres (Stns. 53-86).

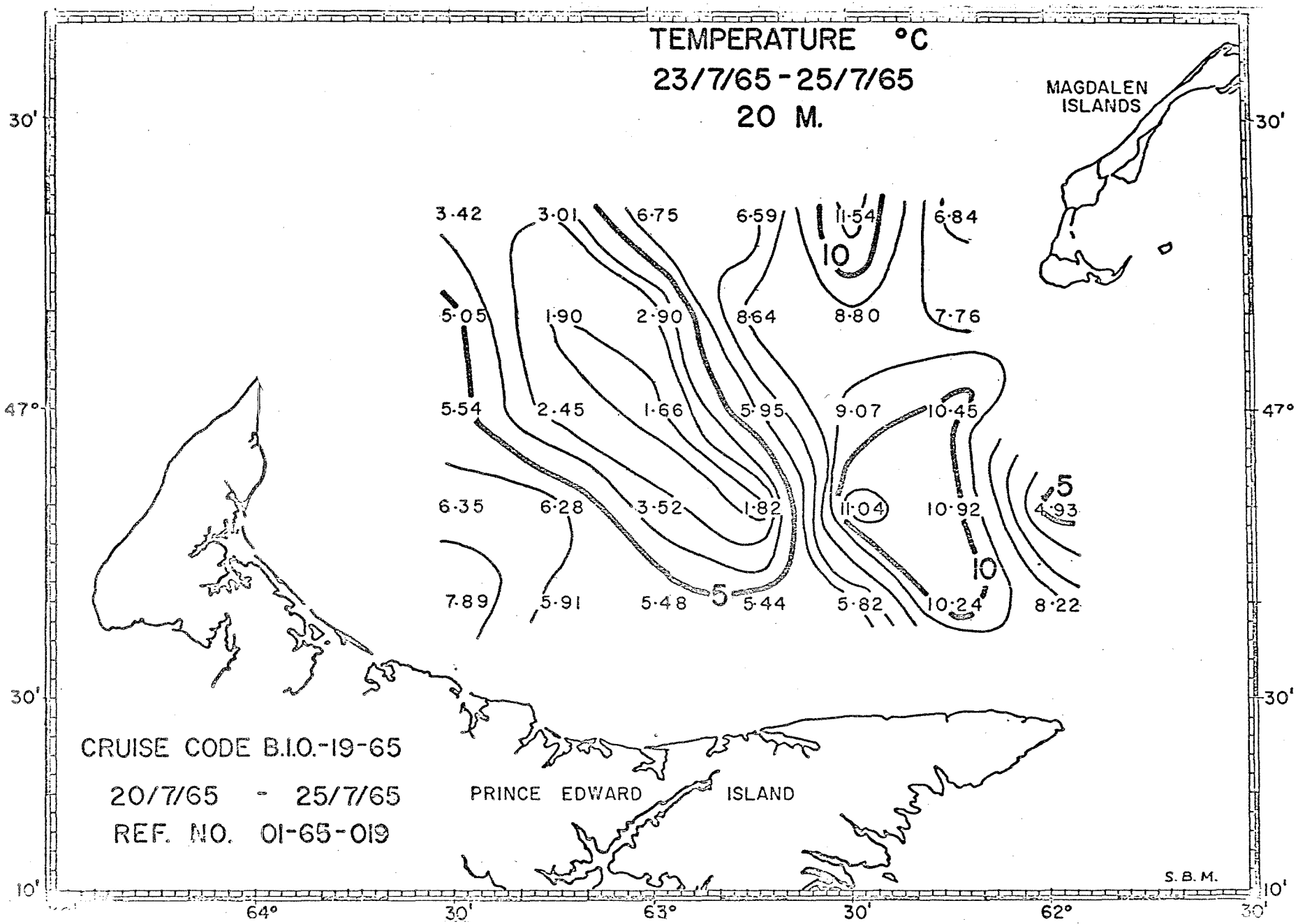

Fig. 7c Temperature values at 20 metres (Stns. 53-86).

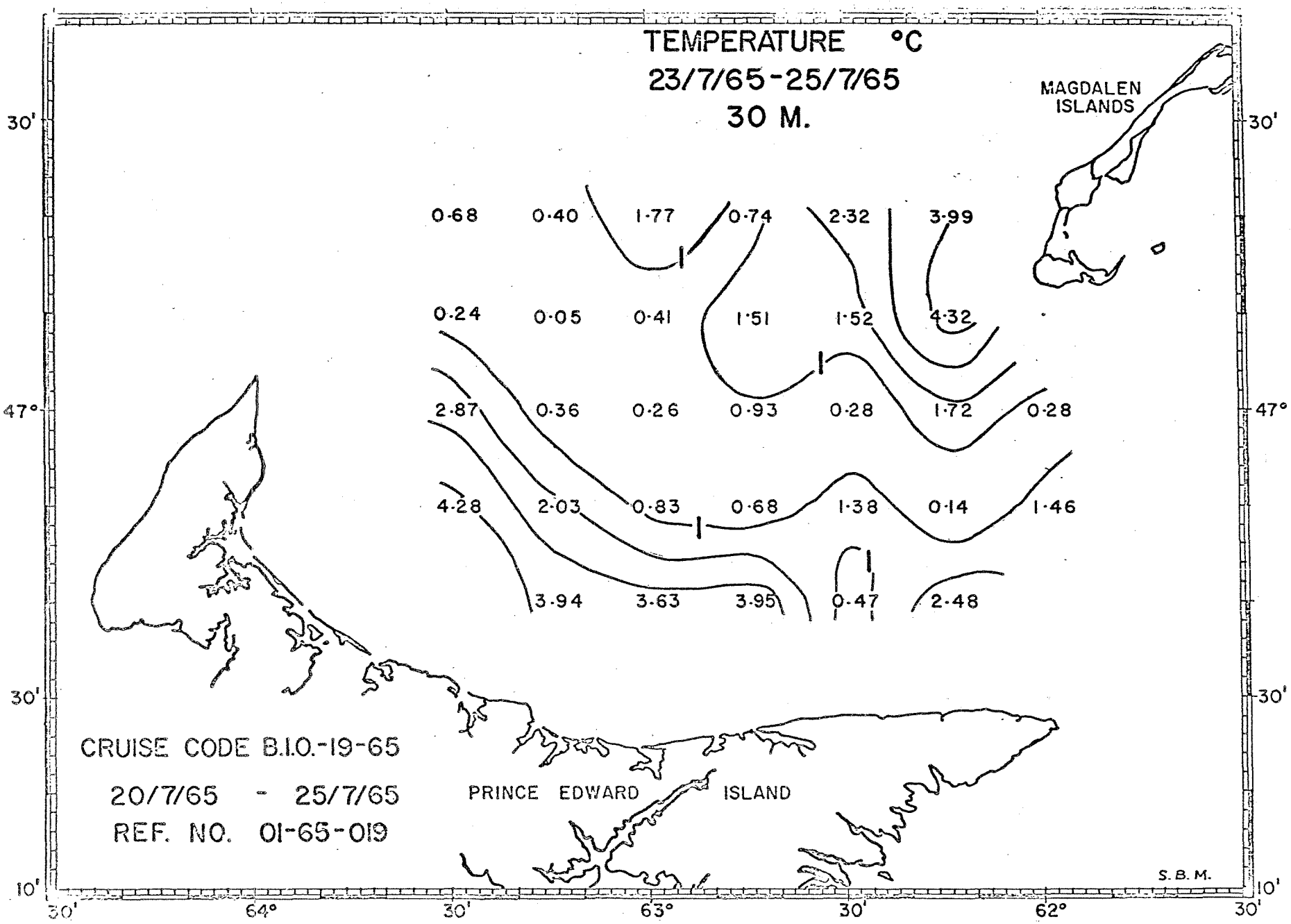

Fig. 7d Temperature values at 30 metres (Stns. 53-86).

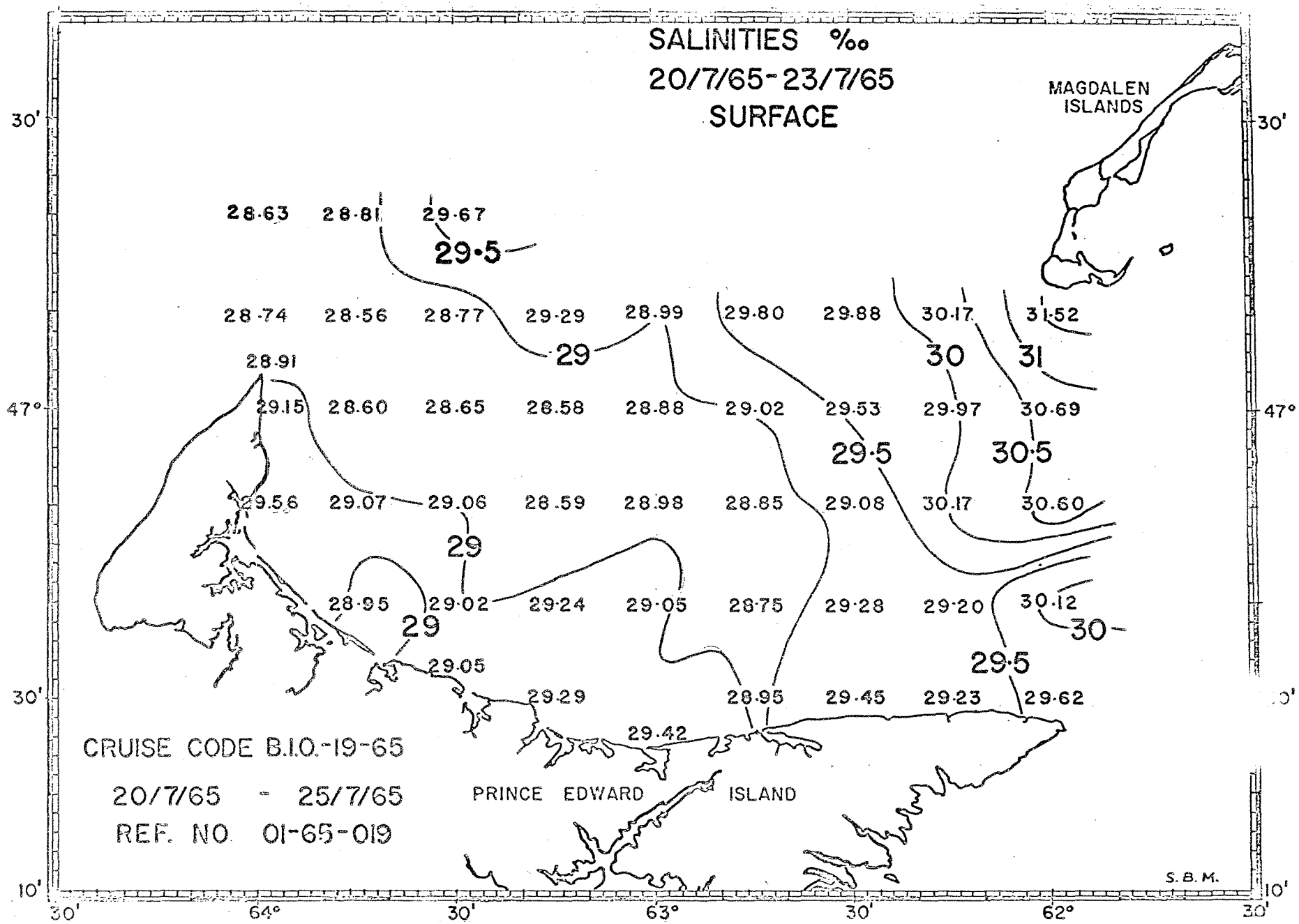

Fig. 8a Surface salinity values (Stns. 6-52).

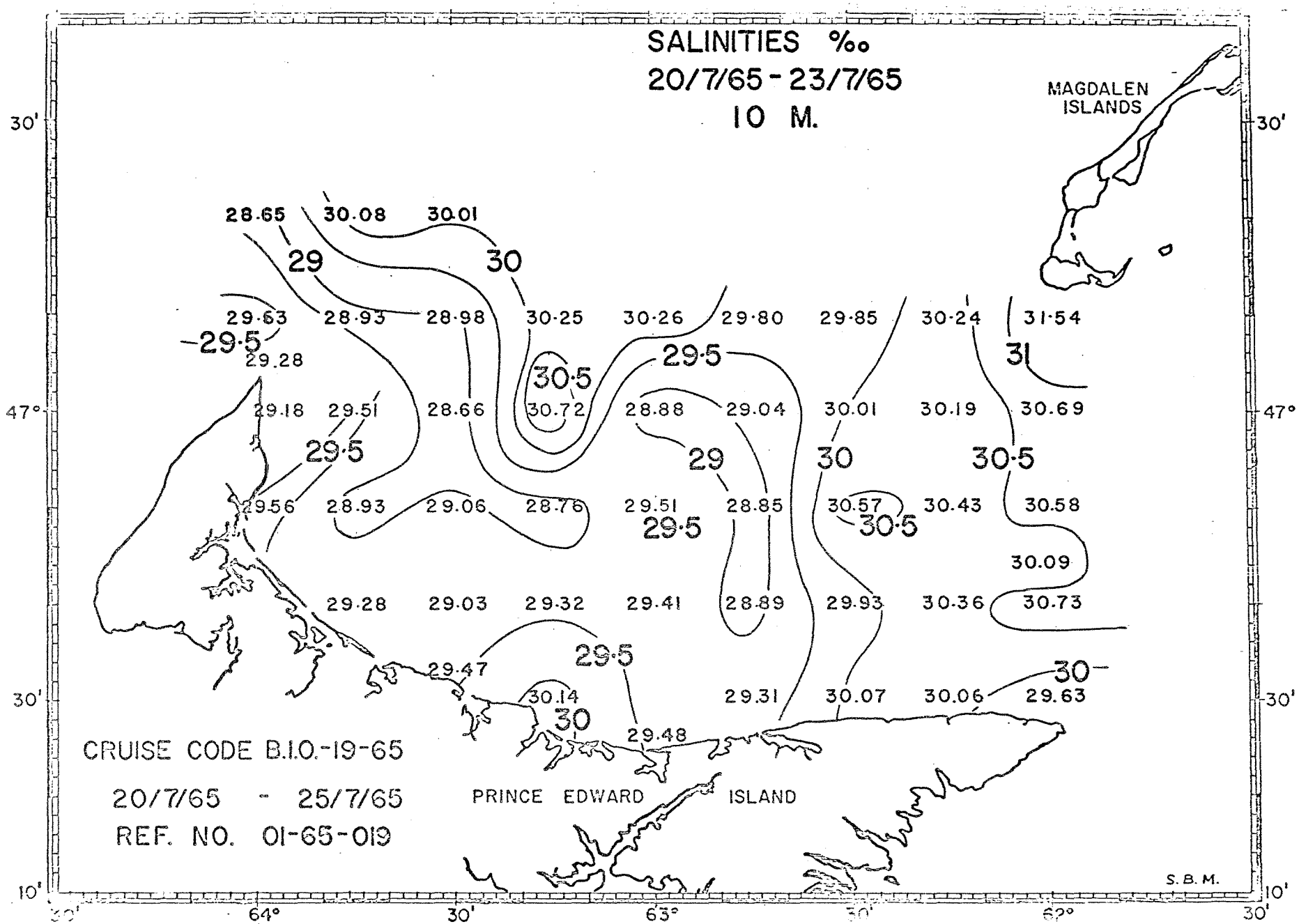

Fig. 8b Salinity values at 10 metres (Stns. 6-52).

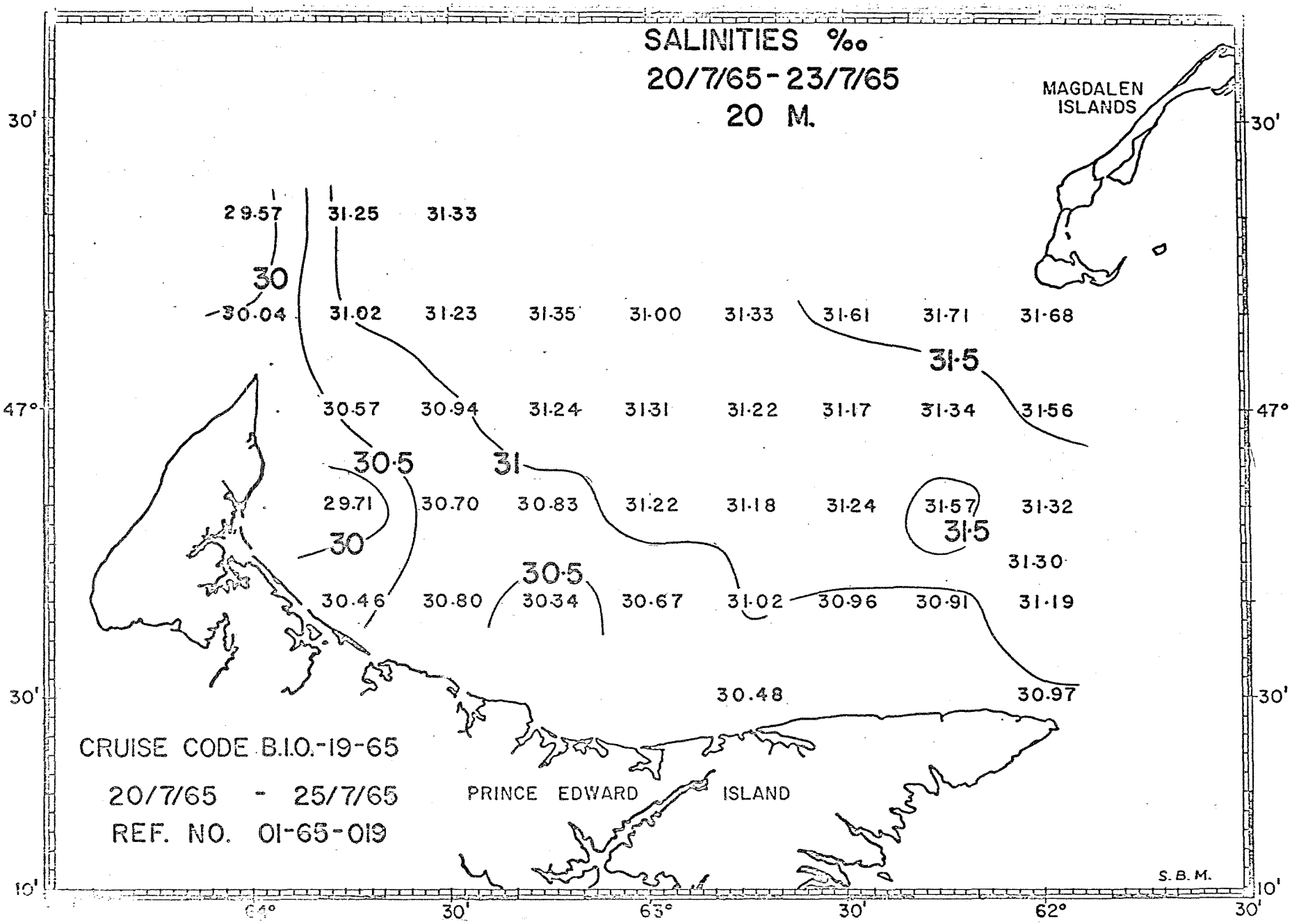

Fig. 8c Salinity values at 20 metres (Stns. 6-52).

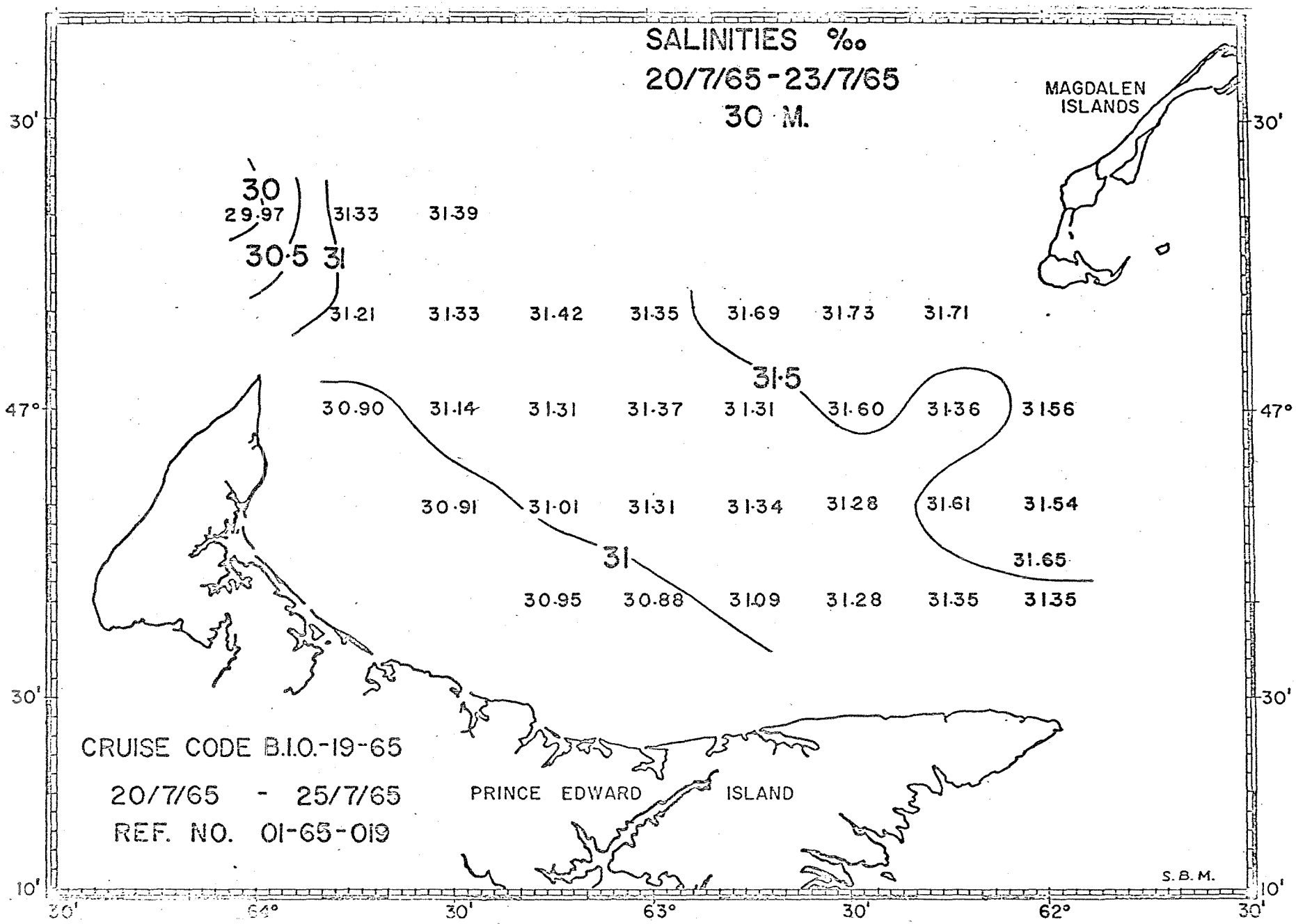

Fig. 8d Salinity values at 30 metres (Stns. 6-52).

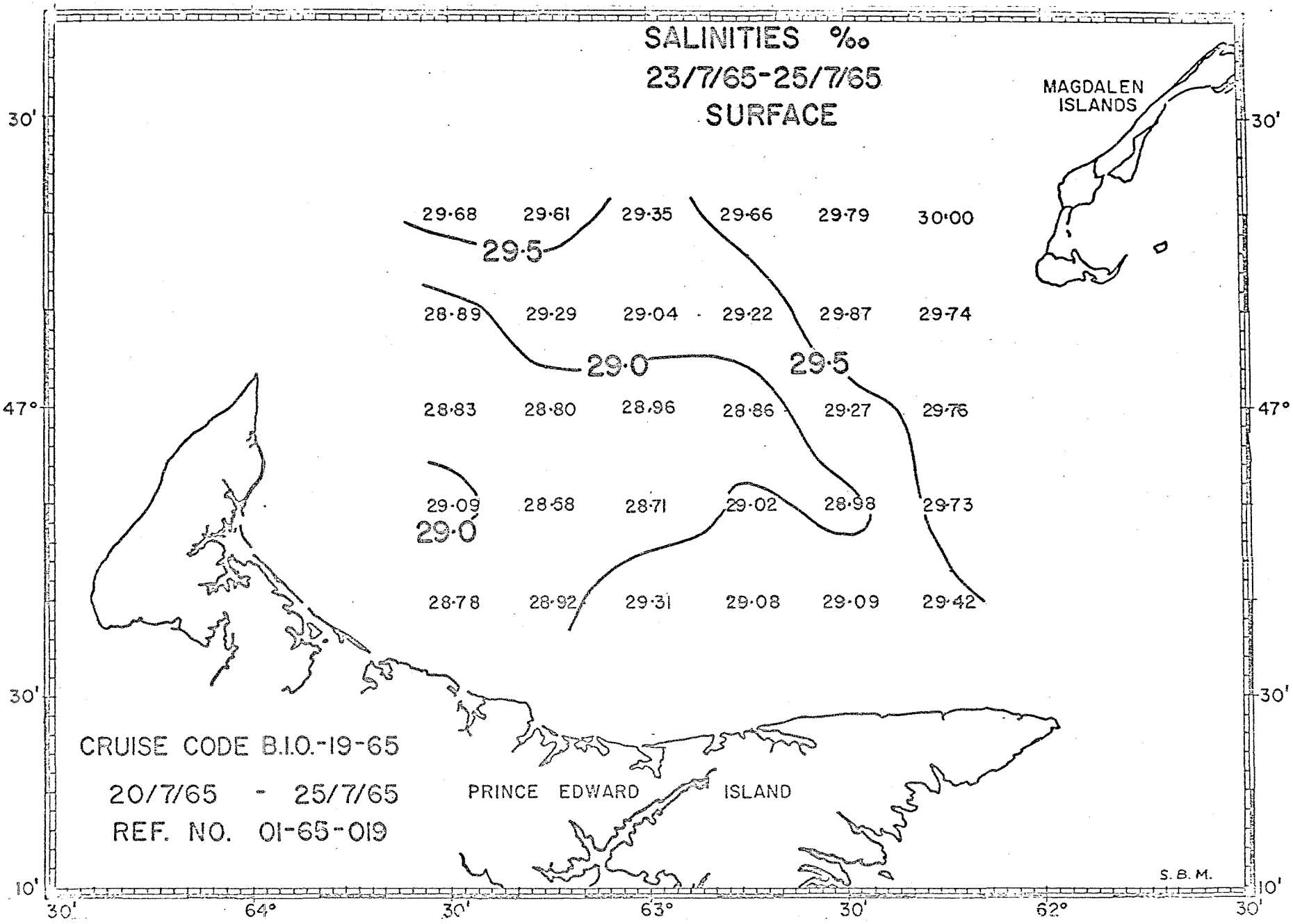

Fig. 9a Surface salinity values (Stns. 53-86).

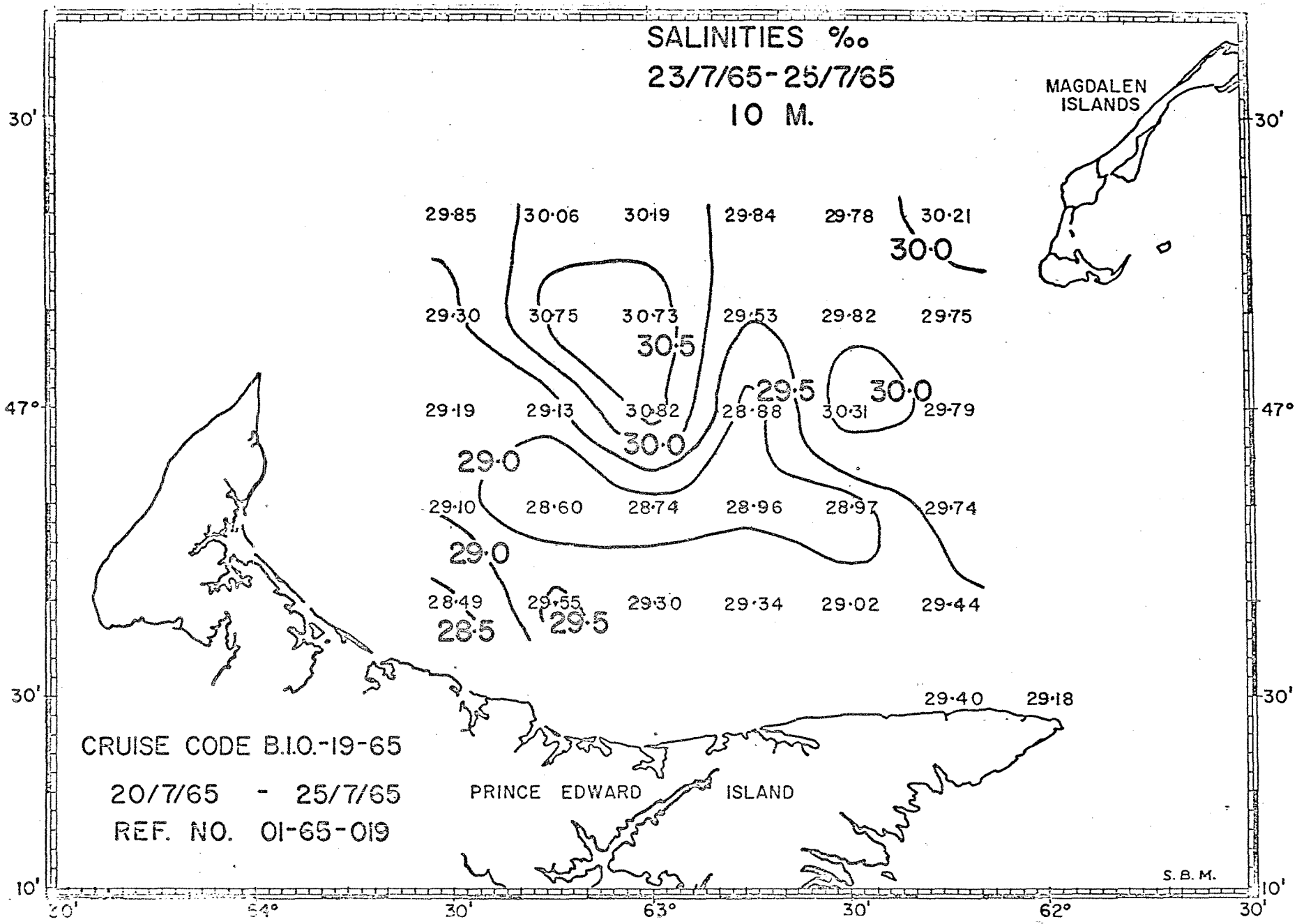

Fig. 9b Salinity values at 10 metres (Stns. 53-86).

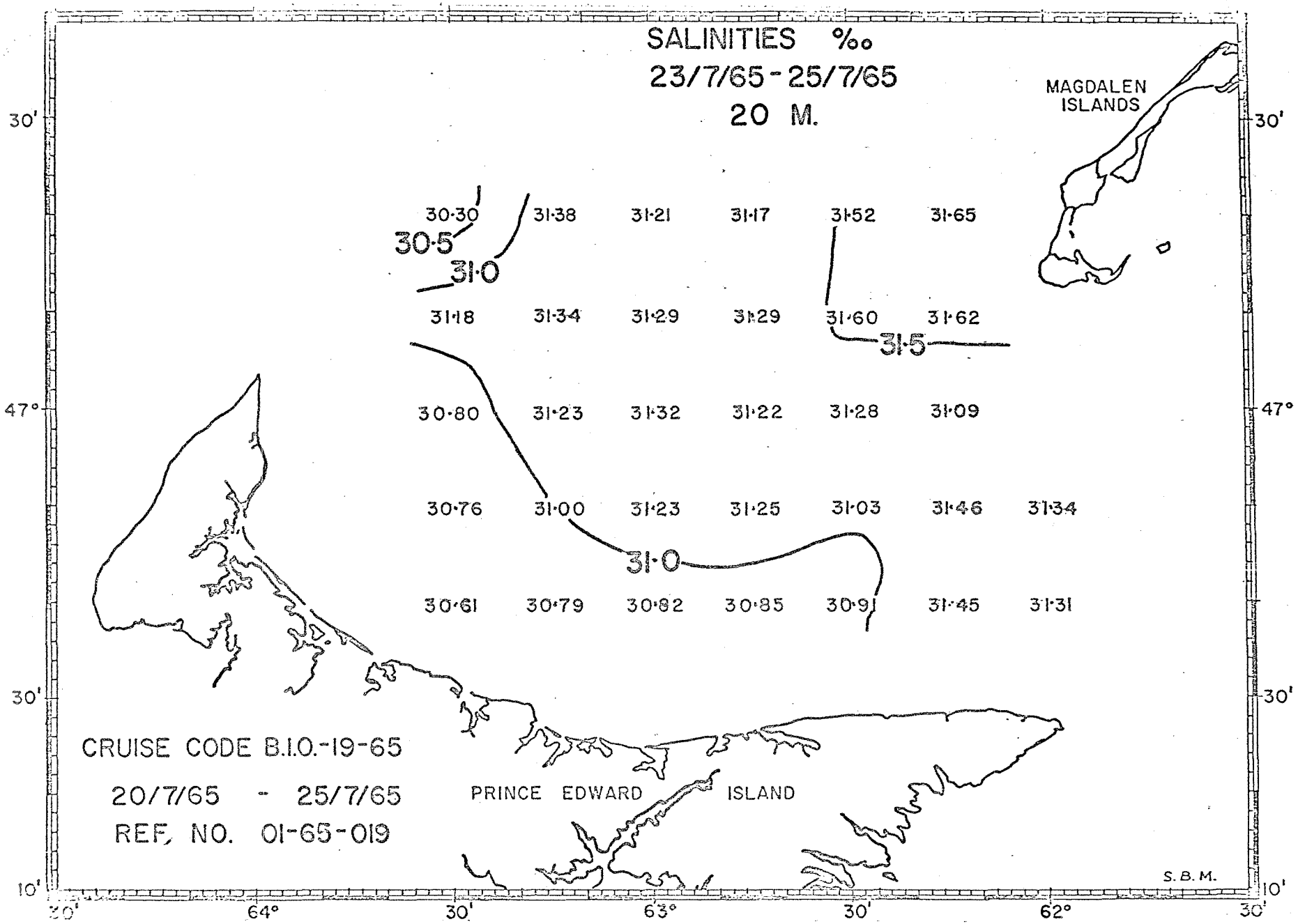

Fig. 9c Salinity values at 20 metres (Stns. 53-86).

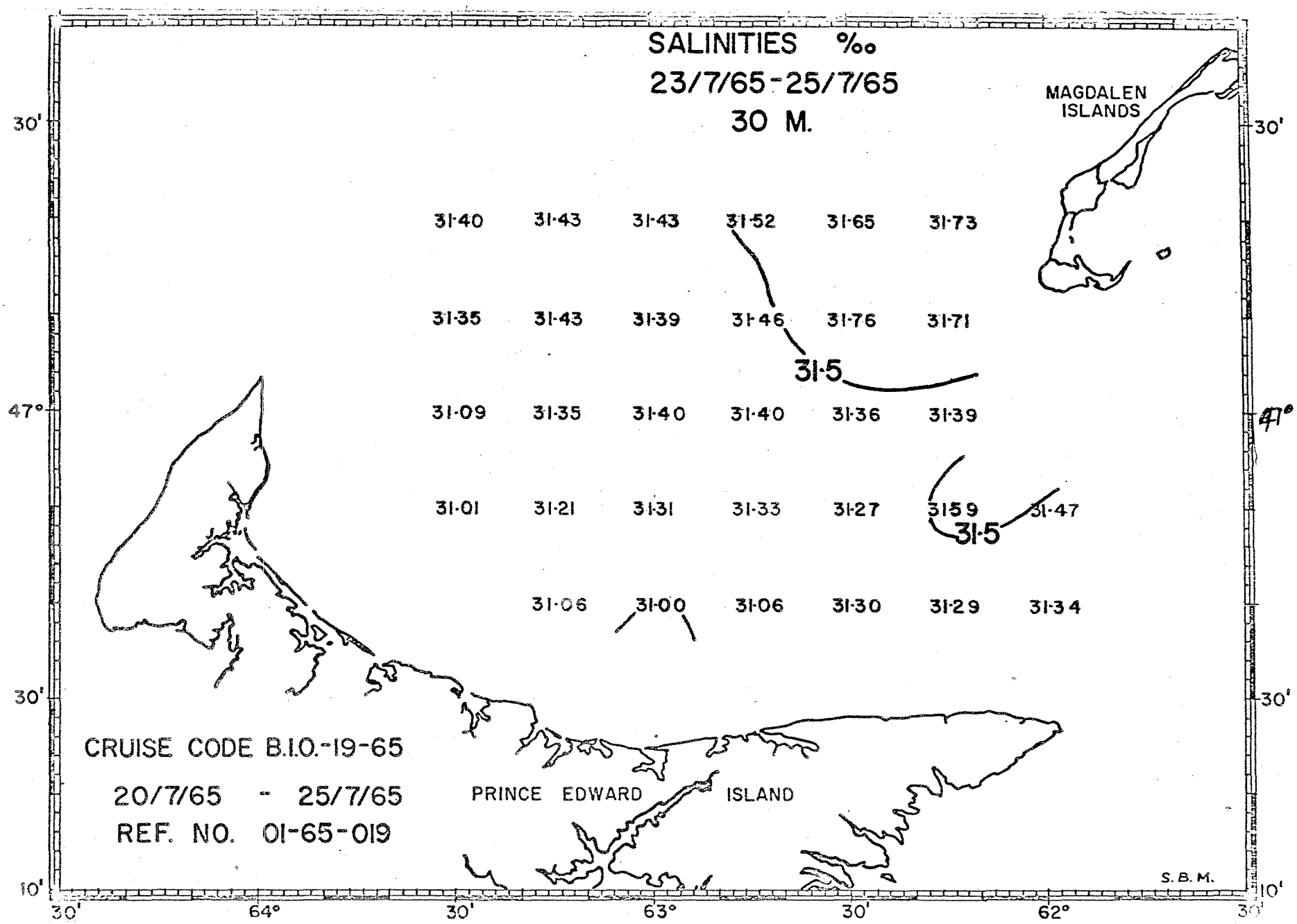

Fig. 9d Salinity values at 30 metres (Stns. 53-86).