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Profiling Current Meter Measurements on Board of R.V."Bjarni Saemundsson" during "OVERFLOW'73"

by
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INTRODUCTION

During the International ICES-Expedition "OVERFLOW'73 a joint Icelandic - Danish - German oceanographic survey was made in the region east and southeast of Iceland from the R.V."Bjarni Saemundsson". This survey consisted of hydrographic sections - Nansen bottles and XBT's (S.A.MALMBERG) - optical measurements (N.HØJERSLEV &al.) and Profiling Current Meter(PCM)-measurements (M.STEIN). This paper deals with some preliminary results of these PCM-data obtained on board of the Icelandic R.V."Bjarni Saemundsson" between August 19, 1973 to September 5, 1973. The location of the PCM-stations is given in fig. 1.

THE DATA

The measurements were done by means of a Profiling Current Meter of Bergen type. This PCM has a sampling intervall of 30 sec, it records temperature (T), conductivity (C), current direction (φ) and speed ($|\vec{v}|$) as a function of the hydrostatic pressure (P), which ranged between 0 and 1000 psi. The PCM descends to the seafloor by a mean sinking rate of 10 m/min, i.e. one measurement at about every five meters;

the sinking procedure was controlled by the aid of an echograph, see fig. 2.
During the PCM - measurements the ship drifted. The ship's drift was calculated from the readings of the LORAN C - navigator, which have been recorded every 5 minutes. The mean direction of the drift trajectories and their displacement between initial position and end position were used to estimate the influence of the ship's drift on the current profile measured by the PCM.

RESULTS

The results are shown in figs. 3 to 11; temperature (T), east (U) - and north (V) - component of the current are plotted as functions of depth. Salinity plots are not available because of difficulties in calibrating the rough data.
The position of the PCM - stations in detail can easily be detected by the small chart given in each profiler plot. Repetitions of measurements are indicated by dotted or dashed lines respectively.

The first measurements

Section I (stations 33, 34 and 35):
The temperature profiles of $T_{33/1}$, $T_{34/1}$ and $T_{35/1}$ are nearly of the same shape (indices refer to the different stations and number of measurement). For discussion of the results the water column is divided in three major layers:
The upper one (A), consisting of the surface mixed layer, the transition zone (B) and a homogenous zone (C).

(A) A water mass with temperatures more than 6°C and 70 m to 80 m thickness flows in a southeast direction (33/1, 34/1 and 35/1). It's mean velocities are 20 - 30 cm/sec (33/1) and 70 - 80 cm/sec (34/1) and(35/1).

(B) The transition zone reaches down to 370 m (33/1), 360 m (34/1) and 310 m (35/1). The temperature decreases from a maximum of 4°C below the surface mixed layer to 0°C or less in the different depths given above.
The general current direction in this layer is SE with the exception of 34/1, where the V - component is positive in the depth range between 120 m and 210 m. There is an increase of current speed at station 33/1 which has it's maximum in 270 m depth; the

general shape of the current profile of 34/1 and 35/1 is an increase of current velocity down to the bottom.

(C) In the homogenous layer - temperature 0°C or less - an increase of current speed was observed at station 35/1 (U: 40 cm/sec E, V: 80 - 90 cm/sec S) which represents a strong bottom current in a southeasterly direction.

Section II (stations 37, 38 and 39):

(A) On this section a thin mixed surface layer was observed. It's thickness varied between 20 m and 50 m, the temperature of this surface layer was in the range of 8°C to 10°C ($T_{37/1}$, $T_{38/1}$) and 7°C to 8.2°C ($T_{39/1}$).
The current profiles have a maximum in the top of this layer, they decrease when reaching the thermocline.

(B) Below the thin surface layer a nearly homothermal water layer with temperatures between 7°C and 8°C was found. It's vertical extension amounted to 250 m at station 37/1 and 180 m at station 38/1. A second sharp interface occurs at stations 37/1 and 38/1 respectively. It is located between 300 m and 380 m water depth. (37/1) and 180 m to 210 m depth (38/1). A third interface was observed only at station 38/1; it is the upper boundary of the cold bottom water below 400 m water depth. This step like structure is missing in the temperature profile at station 39/1. Here a rather inhomothermal upper layer is separated by a sharp interface in 150 m water depth from a homothermal layer; it's temperature ranges between 2.5°C and 4°C. As for the current distribution in this (B) - layer, station 37/1 shows a lightly increasing tendency with a maximum in the second interface; at station 38/1 there is a constant increase in both the U - and V - component. Station 39/1 is characterized by the change in the current direction at a water depth of 150 m, i.e. in the interface mentioned above. The current turns from a southwesterly direction to a southeasterly direction below the interface, increasing with depth to a maximum of V: 90 cm/sec S.

(C) The (C) - layer has only been recorded at station 38. At a depth of 410 m the temperature has dropped down to 0.5°C. In this layer the current profile has reached it's maximum value of 105 cm/sec E and 45 cm/sec N, indicating a strong flow in NE - direction.

Section III (stations 54, 56 and 58):

(A) A surface mixed layer with temperatures ranging between 10°C and 11°C was observed on section III. The vertical thickness of this layer varied from 30 m (54/1) to 20 m (56/1) and 10 m (58). The current measurements yield large gradients which have their maximum in the vicinity of the interface.

(B) The lower stratum has a vertical extension of 280 m (54/1), 310 m (56/1) and 320 m (58). The temperature in this layer is in the range of 7.5°C to 8.5°C (54/1, 56/1) and 8°C to 9°C at station 58 respectively. Another large gradient in temperature can be seen from the profile $T_{56/1}$. It is followed by a homothermal layer, having it's upper boundary at 500 m water depth. The current profiles indicate a flow with nearly constant speed, except in the thermal gradient layers, e.g. 56/1 and 58. The lowest stratum, observed at station 56/1, is accompanied by an increase in current velocity (40 cm/sec E, 50 cm/sec N).

(C) This layer is missing in section III!

Repetitions of measurements

Temperature:

There are significant changes in the different temperature profiles: At section I, for example, the mixed surface layer has been dissolved completely (second measurement). At September 4, 1974 - third measurement - the observations reveal a mixed surface layer which has been rebuilt again!
On section II the variation in the temperature profile is even much larger: The three measurements at station 37 show nearly the same profile, whereas at station 38 the second and the third measurement reveal a completely different situation in the thermal structure of the water column: The characteristic two deep interfaces of $T_{38/1}$ have disappeared; instead of this the gradient of the interface between the (A) - and the (B) - layer has been enlarged.
The repetition of PCM - measurements at section III has only been done at stations 54 and 56 respectively. The temperature profile of $T_{54/2}$ shows the steplike structure of this water column, indicated already from the first profile.

Current:

Several changes in current speed and current direction have been observed. Of major influence is the tidal effect, e.g. 34/2, 35/2 37/2 and 56/2. At station 35/2, for example, this influence can be seen very clearly:
The current runs to the northwest, with an U - component increasing with depth, whereas the first and the third PCM - measurement yield a current flowing to the southeast.

CONCLUSIONS

This paper gives a descriptive presentation of PCM - data obtained during "OVERFLOW'73" in the region east and southeast of Iceland. The conclusions of this paper can be summarized as follows:

1. The profiles show the large variations of a water column during an intervall of 15 days. From the temperature profiles of one hydrographic section (section I) the formation of a mixed surface layer can be observed as well as a heating of the entire water column.

2. Several distinct water layers have been observed which are separated by sharp interfaces ($T_{38/1}$). Some of the temperature profiles show a cold water mass in the vicinity of the sea-floor. Thus it would be worth-while to compare these PCM - measurements with the Icelandic and Danish measurements mentioned above.

ACKNOWLEDGEMENT

I would like to thank the HAFRANNSÓKNASTOFNUNIN (Marine Research Institute) Reykjavik for the opportunity to participate in that "OVERFLOW'73" - cruise of the R.V."Bjarni Saemundsson", and I appreciate the help given to me by the crew members when I performed my PCM - measurements.

Figure captions

Fig. 1 Location of the PCM - stations
Fig. 2 Echograph plots of the sinking PCM
Fig. 3 - 11 PCM-profiles of temperature and current components as a function of the hydrostatic pressure.

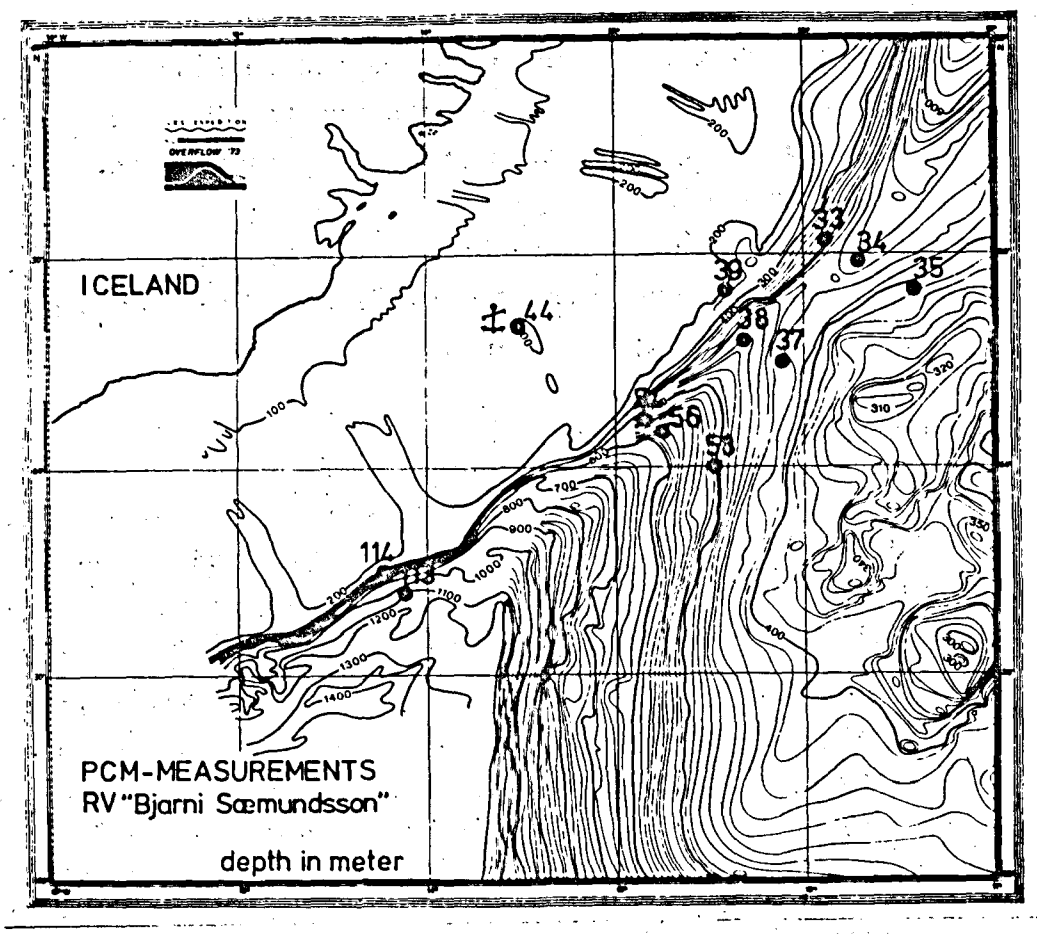


Figure 1

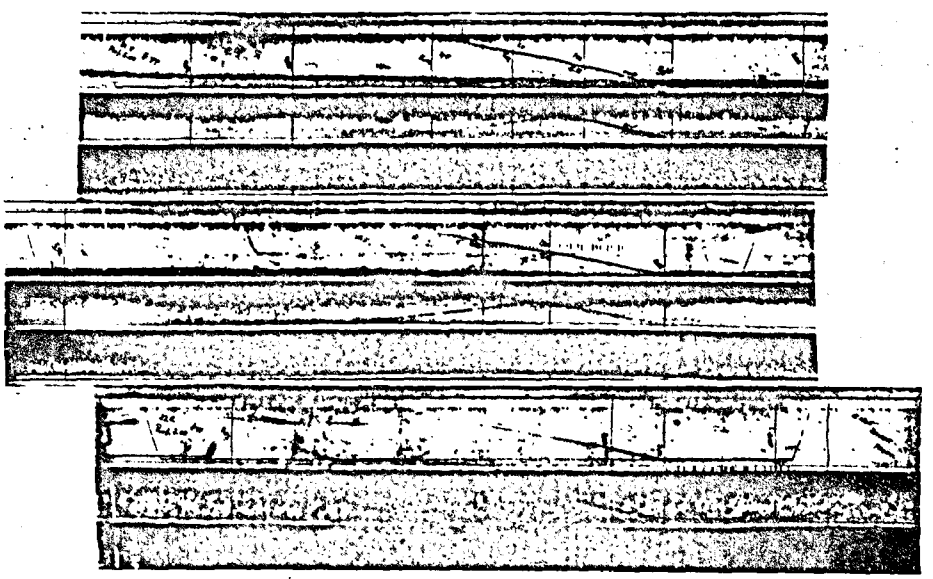
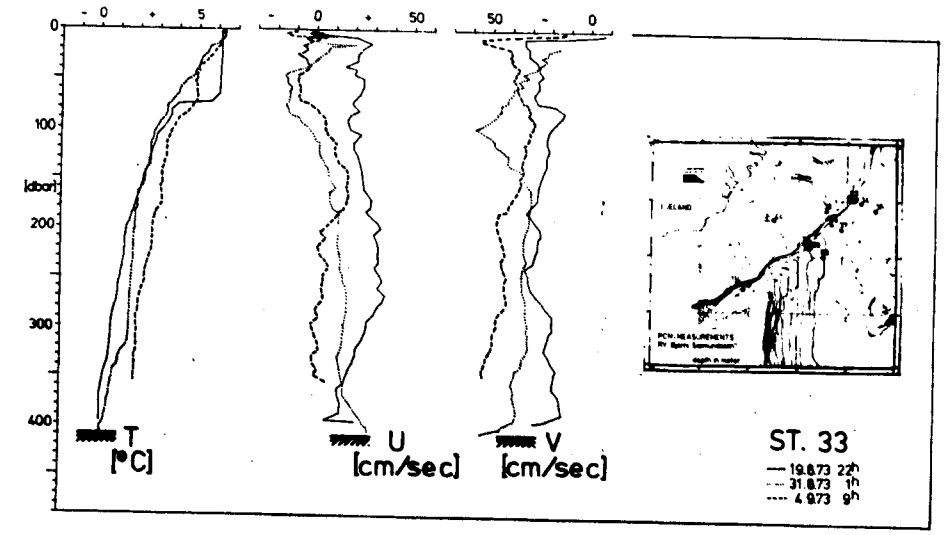


Figure 2



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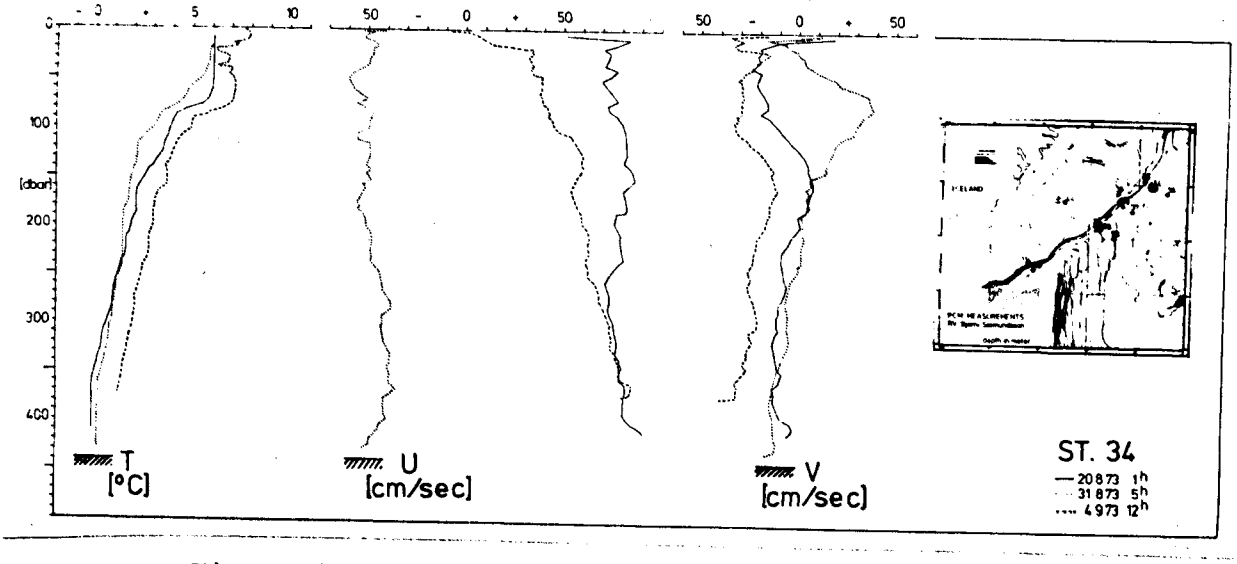
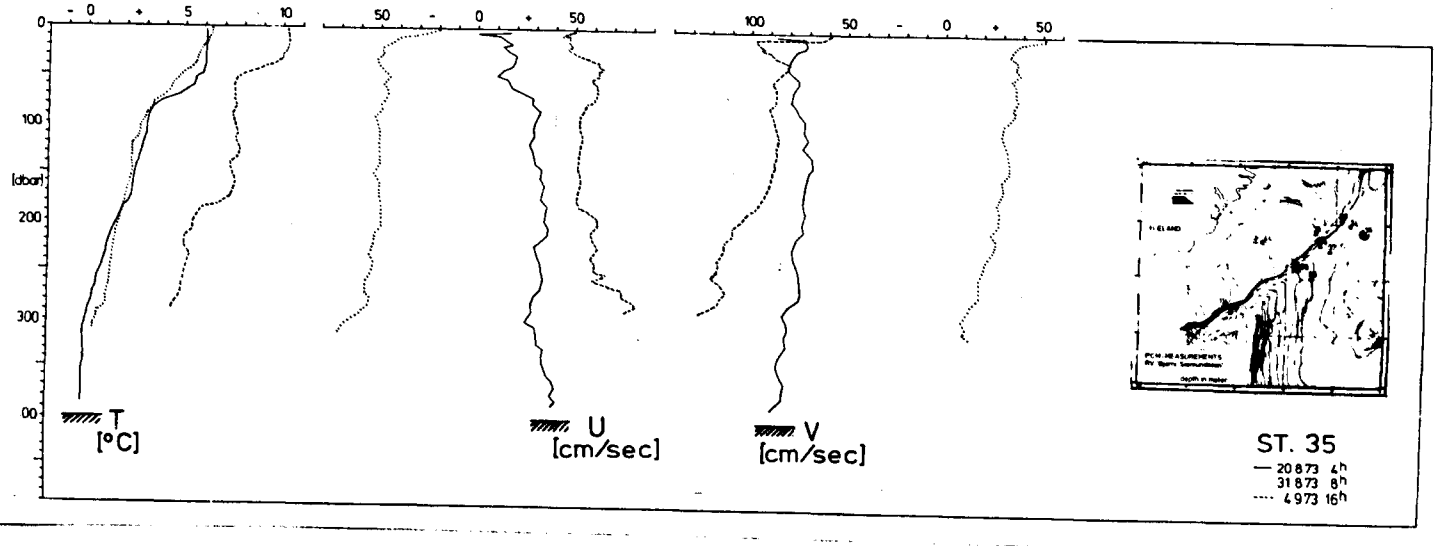


Figure 4



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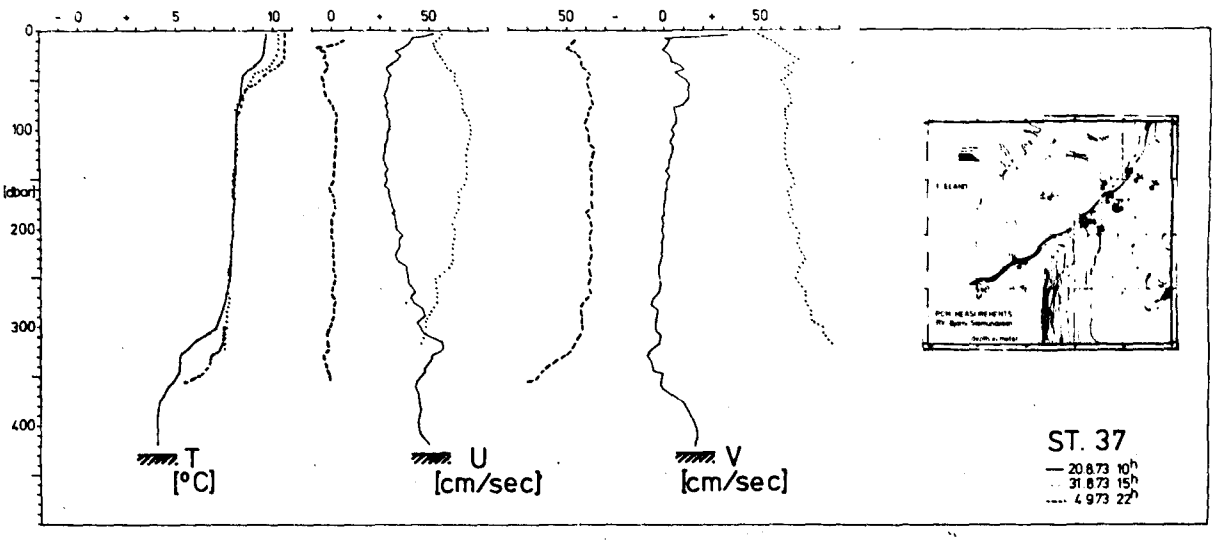

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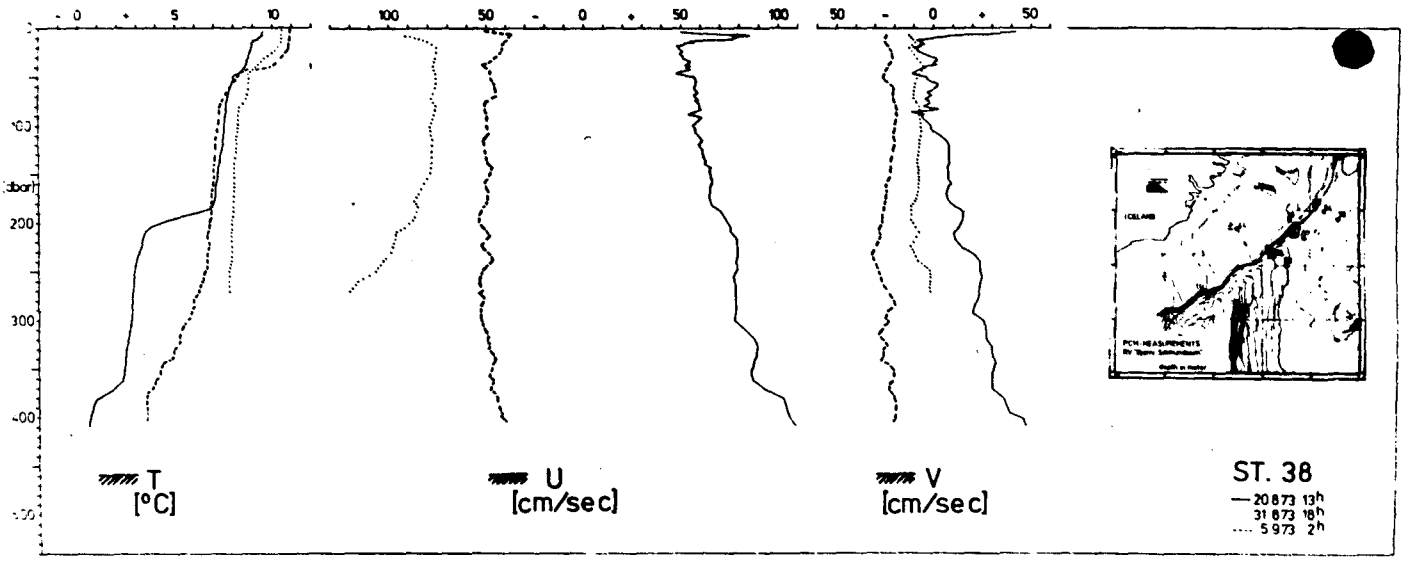

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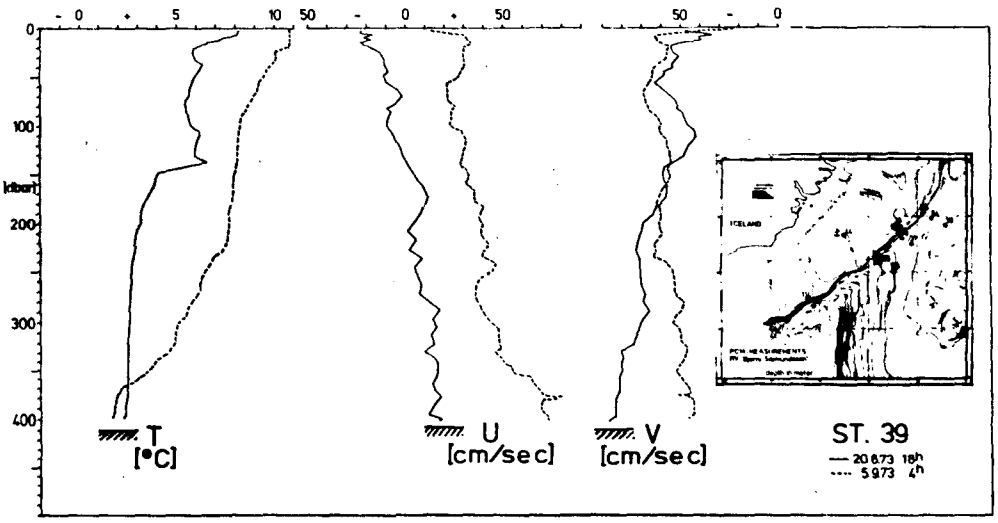

Figure 8

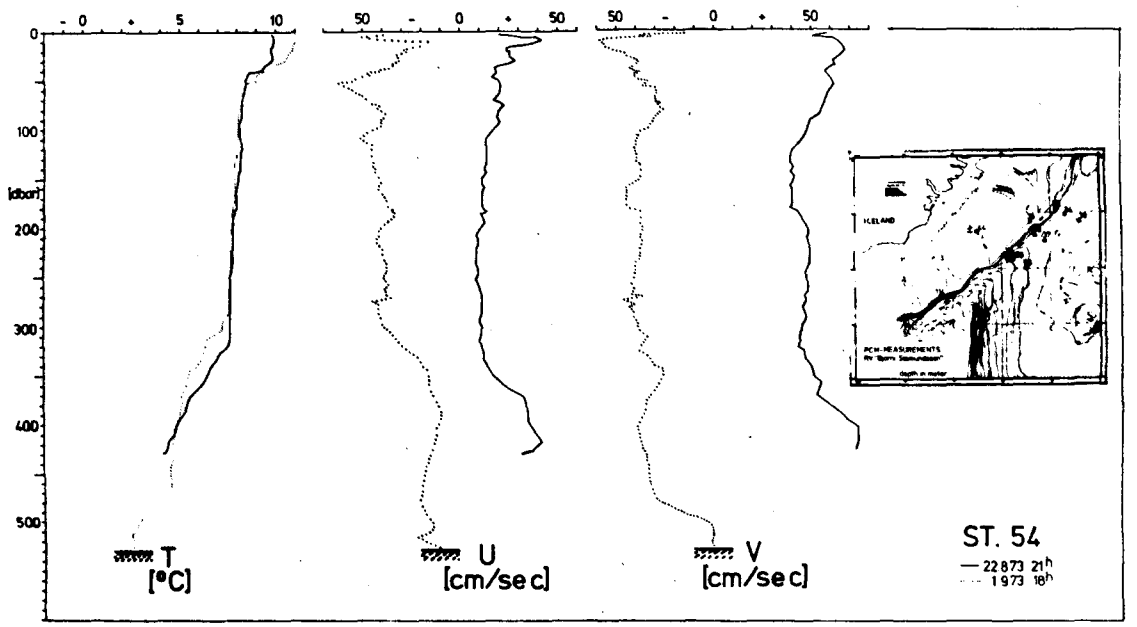

Fig. 9

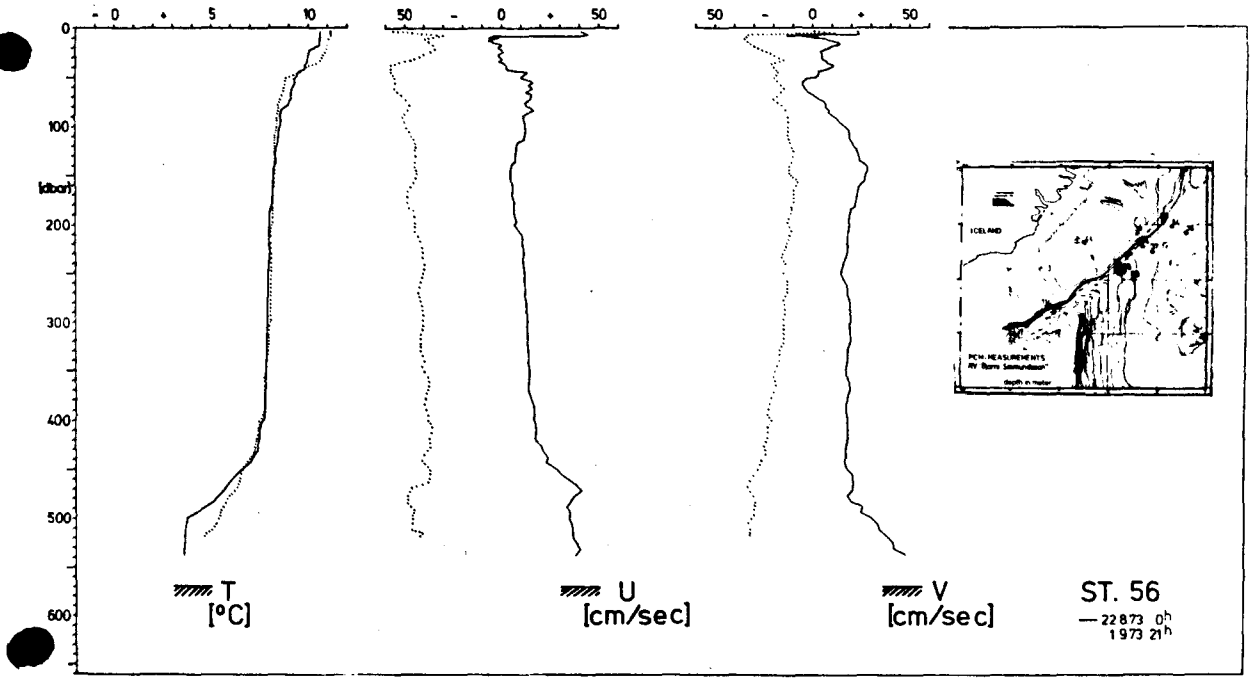

Fig. 10

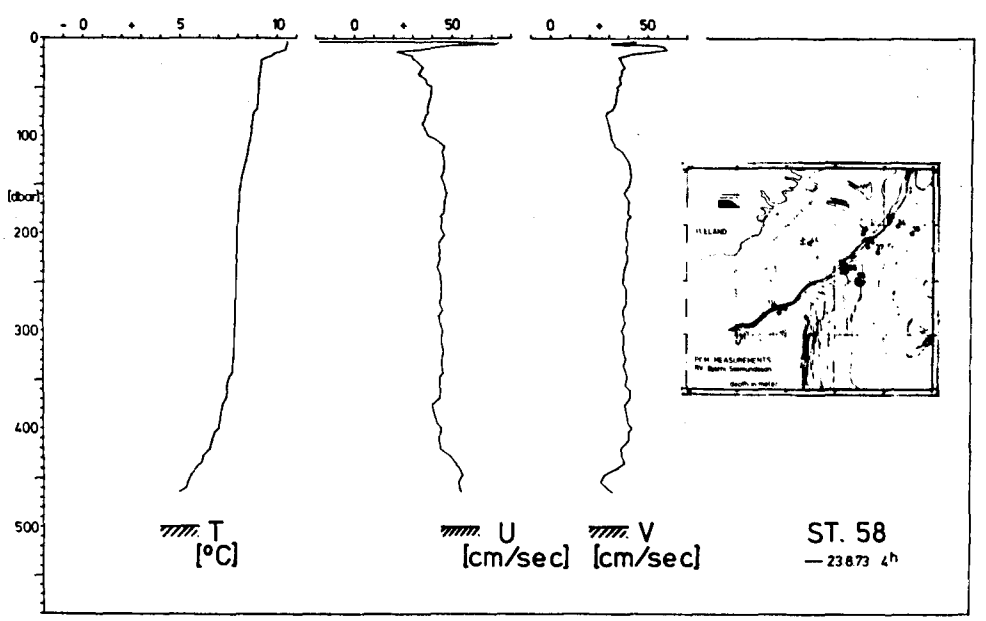

Fig. 11