**MINISTRY OF AGRICULTURE, FISHERIES AND FOOD**
**FISHERIES LABORATORY, LOWESTOFT, SUFFOLK**

**1995 RESEARCH VESSEL PROGRAMME**
(PROVISIONAL: Not to be quoted without prior reference to the author)

**REPORT: RV CIROLANA: CRUISE 10**

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| **STAFF:** | K S Leonard (SIC) | parts a, b, c and d |
| | M B Lovett | part a |
| | D McCubbin | parts a, b, c and d |
| | P Blowers | parts a and b |
| | R Bonfield | parts a, b, and c |
| | T Brooks | parts a, c and d |
| | I T McMeekan | parts a, b, c and d |
| | R Busby (Westlakes) | part a |
| | O Condren (UC Dublin) | part a |
| | C McMahon (UC Dublin) | part a |
| | B Taylor | parts b, c and d |
| | J M Rees | parts b and c |
| | T A Bailey | parts b and c |
| | J W Read | part b |
| | A J Poole | part b |
| | A K Young | part b |
| | D C Denoon | part b |
| | L N Greenwood | part d |
| | P Ayres | part d |

**DURATION:**

Part a: Left Lowestoft 2145h, 24 November 1995
Docked Workington 2130h, 4 December 1995
(Mid-cruise break)
Part b: Left Workington 1200h, 6 December 1995
Searider changeover Whitehaven, 1200h, 12 December 1995
Part c: 12 - 19 December
Docked Lowestoft 1900h, 19 December 1995
Part d: Left Lowestoft 1830h, 20 December 1995
Docked Lowestoft 0800h, 22 December 1995
(All times are Greenwich Mean Time)

**LOCALITY:** Celtic Sea, Irish Sea, Western Isles, NE Atlantic Ocean, North Sea

**AIMS:**

1. To collect and process surface/bottom seawater and sediments from UK coastal waters for the analysis of Tc, Cs, and transuranic radionuclides as part of the post EARP survey (AE0114A, Westlakes, UCD).

2. To determine colloidal distributions from desorption of actinides from particulate material (AE0114A, AE0118A).

3. To assess the feasibility of concentrating radionuclides on microcolumns for the rapid determination of $^{239}Pu$ and $^{240}Pu$ in environmental samples by ICP MS (AE0114A, U Sheffield).

4. To determine the effect of trawling on the remobilisation of surface sediments, via radiochemical and geochemical sampling (AE0118A).

5. To recover, service and redeploy minipod and current meters in the N E Irish Sea. (AE0298F).

6. To collect surface/bottom NE Atlantic seawater samples for the analysis of fallout Tc, Cs and Sr (AE0114A).

7. To collect live Plaice from Smiths Knoll and thus enable laboratory experiments to be carried out to evaluate radiation effects on reproduction (AE0116A).

**NARRATIVE:**

RV CIROLANA sailed from Lowestoft at approximately 2145h on 24 November 1995 and, after essential adjustments to the ship's compass were completed, collection of surface water samples commenced. Samples collected were processed for a range of artificial radionuclide analyses (Cs, Tc, Sr, Co, Am, Pu(IV) and Pu(V)).The locations and cruise track of artificial radionuclide sampling from UK coastal waters (excluding the Irish Sea ) are given in Figure 1. Despite poor weather, steady progress was made during passage through the English Channel and CIROLANA arrived off the Scilly Isles on the afternoon 26 November. Good progress was made, with favourable weather, for the collection of surface water samples (and 1 bottom water) in the Celtic Sea during 26 - 27 November.

The ship then proceeded through the St George's Channel and continued surface and bottom water sampling for artificial radionuclides, and commenced sediment grabs, in the Irish Sea and North Channel. The locations and cruise track of artificial radionuclide sampling in the Irish Sea are given in Figure 2. This work was successfully carried out during the period 27 November - 2 December. Excellent progress was made during this part of the cruise, whilst the schedule was timed to allow the chemical processing to be satisfactorily completed between stations. One site (off the Sellafield pipeline) was revisited on two occasions to collect surface water samples, for the determination of the size distribution of desorbed colloidal species of Am and Pu(IV) from particulate in low salinity waters (by ultrafiltration), and to assess the feasibility of concentrating radionuclides on microcolumns for the rapid determination of $^{239}Pu$ and $^{240}Pu$ in environmental samples by ICP MS. During the period 2 - 4 December CIROLANA carried out two CTD anchor stations (off Sellafield and St Bees), collecting surface and bottom waters for the determination of Tc and Cs radionuclides to closely examine the immediate dilution behaviour of these radionuclides upon discharge. Before docking, a visual inspection of the status of current meters was carried out, indicating that one of the guard buoys was missing.

With the work programme successfully completed (for part a), CIROLANA docked at Workington on the evening tide of 4 December for the mid-cruise break. The following day an exchange of scientists and gear took place. CIROLANA departed from Workington on the morning tide on 6 December. For the remainder of the day, two (of six) current meters (Q and T) were recovered, serviced and redeployed in the N E Irish Sea. The positions of the current meter moorings are given in Figure 3. Unfortunately, during the recovery of current meter Q, the recovery wire became attached to the bow thruster. The searider was launched and the recovery wire was cut, thereby freeing the guard buoy. Although the bow thruster could still be housed, some reduction in performance was apparent. Arrangements were made for divers to carry out an inspection on the following day. On the morning of 7 December Sidescan tows were carried out, scanning on a line (Figure 3) to be trawled later by a fishing vessel. During the afternoon, inspection of the bow thruster took place by divers from Whitehaven. The recovery wire was released from the propeller blades, and the use of the bow thruster was fully restored. More consideration must be given in future as to how current meters are deployed, so that the ship carrying out the recovery (CIROLANA or CORYSTES) can achieve recovery most easily.

At 1830h on 7 December, CIROLANA commenced a 24 hour CTD anchor station (TH50, Figure 3), prior to trawling, deploying the rosette every hour to obtain baseline salinity, suspended load and hydrographic data for surface and bottom waters. At low, mid and high tides, additional large volume surface and bottom waters were collected for the analysis of Th, Pu, Am, and Cs, and three surface subsamples were taken from a NIOZ core. Having competed the last CTD station at 1830h on the 8 December, it was then necessary to deploy a guard buoy to replace one missing mooring and hence restore three markers around the tetrapod and quadrapod (Figure 3). At 0830h on 9 December, CIROLANA commenced recovery of current meter S (Figure 3). After successfully completing its service and redeployment, inspection of current meter R was carried out. It was considered unwise to attempt recovery of current meter R because of the proximity of a minipod and prevailing sea conditions, which prevented an easy approach to the meter. Therefore current meter R was not serviced but had sufficient data storage space before it is finally recovered on a forthcoming cruise. Current meter U was successfully recovered, serviced and redeployed shortly afterwards. During the afternoon a minipod was recovered from a position midway between current meter mooring S and V (Figure 3), and data was retrieved. Attempts to find the current meter at position V, including the use of a grapple run across the ground line in both directions, were unsuccessful. CIROLANA anchored at site TH50 (Figure 3) during the early evening and the minipod was redeployed in a position close to the CTD anchor station (Figure 3).

At 0730h on 10 December, a CTD anchor station commenced to determine the influence of trawling on the remobilisation of surface sediments. The CTD sampling strategy was similar to that carried out a few days earlier. At 0745h, a rendezvous between the fishing vessel KINLOCH and CIROLANA took place and the fishing skipper, L. Shillings, was transferred to KINLOCH to supervise the position of the trawling tows, along a line to the north of the tetrapod and minipod (Figure 3). Trawling commenced shortly afterwards and continued for approximately 5 hours. At 1340h L. Shillings returned to CIROLANA via the searider. The excellent support of the fishing skipper, provided during this part of the scientific programme, is greatly appreciated. The hourly CTD sampling continued for 30 hours, the last station being completed at 1330h (high tide) on 11 December. Shortly after, the minipod close to the anchor

station was retrieved and thereafter Sidescan tows were completed, scanning the line trawled by the fishing vessel KINLOCH. During the evening, a further visit to the site off the Sellafield pipeline was made to collect surface water samples for ultrafiltration experiments and to obtain a NIOZ core. On the morning of 12 December the minipod was redeployed to its original position to complete the work programme for aims 4 and 5. The combination of current meter work and the trawling experiment was most successful, undoubtedly due to the cooperation and support of the ship's officers and crew.

Prior to recommencing the artificial radionuclide sampling programme (Figure 1), an exchange of scientific staff took place off Whitehaven by searider. CIROLANA then proceeded to the North Channel. During the 13 -14 December a grid of CTD sampling stations was completed in the Malin area and through to the Western Isles. With favourable weather conditions, it was possible to complete a transect of CTD stations in the NE Atlantic Ocean on 15 - 16 December. The remainder of the scheduled water sampling stations were visited en route (North Scottish Coast), through the Pentland Firth and including a grid in the North Sea as indicated on Figure 1. CIROLANA docked at Lowestoft at 1900h on 19 December to unload the portalab, to load fishing gear and exchange scientists. A 24 hour changeover was taken to unload as much scientific gear as possible before the Christmas break and to provide the opportunity to load gear for CIROLANA 1/96.

CIROLANA departed from Lowestoft on the morning tide of 20 December and proceeded to Smith's Knoll and commenced trawling for plaice. 17 trawls (30 - 45 minutes duration) were carried out. CIROLANA finally docked at Lowestoft on the 22 December.

We express our thanks to the Master, the ship's officers and crew for their continued support and high standard of service. We also record our gratitude to the galley staff for providing excellent catering and a superb Christmas lunch.

**RESULTS:**

**Aim 1 .** Samples of 50 - 250 litres of surface seawater were collected from 90 locations around the UK coast (including 42 stations in the Irish Sea) and passed through ion exchange columns to extract $^{99}$Tc and Cs radionuclides. At 43 sites, 50 litres surface seawater samples were collected, filtered and acidified for $^{90}$Sr analysis. A further 12 surface samples were collected and processed by UC Dublin for $^{90}$Sr analysis. Samples of 50 or 100 litres of surface seawater, collected from 24 locations (including 16 stations in the Irish Sea), were subjected to preliminary chemical separation procedures to isolate $^{241}$Am, and the higher and lower oxidation states of plutonium. $^{238}$Pu/$^{239,240}$Pu, $^{241}$Pu/$^{239,240}$Pu and $^{240}$Pu/$^{239}$Pu ratios were examined at 8 stations by UC Dublin. At 11 sites (Irish Sea), 50 litres surface seawater samples were collected and $^{60}$Co was extracted by co-precipitation methods. Further radiochemical purification and radiometric assay will take place at the Lowestoft laboratory. The primary purpose of this survey is to establish elevated concentrations (Irish Sea, North Channel and North Sea) for key radionuclides from the BNF Enhanced Actinide Removal Plant (EARP). Ten CTD stations, at anchor (two sites), were worked to collect and process surface and bottom waters for the determination of Tc and Cs radionuclides. In

addition, surface and bottom (500 and 50 litres, respectively) water samples, and surface sediment (Day Grabs) were collected at 9 selected sites for $^{99}Tc$ assay, for analysis by Westlakes Research Institute. Particulate material was removed to determine $^{99}Tc$ $K_d$ values.

**Aim 2.** The stability of radiocolloids associated with Irish Sea particulate material was evaluated (in duplicate experiments) by diluting whole surface seawater (off the Sellafield pipeline ) into large volumes of deionized water prior to fractionation by ultrafiltration. Samples were fractionated using 0.45µm membrane filters and 100k and 3k Dalton (hollow fibre) ultrafilters. Aliquots (totals, permeates and retentates ) were taken for transuranic and oxidation state determinations with initial chemical separations being carried out on ship. The actinide colloid distribution was also determined using 1k Dalton (cross flow cartridges) ultrafilters at 3 different ionic strengths.

**Aim 3.** Duplicate samples of surface seawater (50 litres) were taken at two sites in the Irish Sea to compare the assay of $^{239,240}Pu$ by $\alpha$ spectrometry including conventional methods of chemical preparation, with the rapid determination of $^{239}Pu$ and $^{240}Pu$ by ICP MS using microcollumns.

**Aim 4.** Sidescan tows, along the trawl lines (in both directions), were achieved prior to and post the fishing of the KINLOCH. A CTD anchor station of 24 hours was carried out (prior trawling), and in addition to hydrodynamic data, salinity and suspended load samples were taken every hour from surface and bottom waters. At high, mid and low tides, 100, 50 and 25 litre samples were taken for Th, Cs and Pu analyses, respectively. Initial chemical separations were completed. Following the trawling of KINLOCH and the anchor station was repeated but for an extended duration (30 hours). A sample of Nephrops(15 kg-wet), caught by the charter was retained for Tc analysis.

**Aim 5.** Four of the six current meters (Q, T, S and U) were successfully recovered, serviced and redeployed to their original positions. Current meter R was inspected, but it was decided not to attempt recovery and redeployment at this time because of the proximity of a minipod. Current meter V is missing. Another minipod was successfully recovered, serviced and redeployed for the trawling experiment (Aim 4)and then redeployed to its original position. Retrieved current meter and minipod data will be worked up at the Lowestoft laboratory.

**Aim 6.** Samples of 50 - 200 litres of surface and bottom (CTD) seawater were collected from 6 locations on a transect in the NE Atlantic Ocean and passed through ion exchange columns to extract $^{99}Tc$ and Cs radionuclides. Similar samples (25 - 50 litres) were collected, filtered and acidified for $^{90}Sr$ analysis. The purpose of this work is to accurately determine fallout concentrations and thereby be able to estimate more accurately the transport of the Sellafield signal in Northern waters. Duplicate samples of surface seawater were collected on behalf of SURRC to carry out an intercomparison exercise with DFR for the low level analysis of $^{137}Cs$. Initial findings of the hydrographic data for this transect are given in Figure 4.

**Aim 7.** A total of 70 plaice were successfully landed and returned to the laboratory. Ideally, a total of 200 live fish was required to carry out experiments to evaluate radiation effects on reproduction.

K S Leonard
14 February 1996

**SEEN IN DRAFT:**

M J W (Captain)
L S (Fishing Skipper)

**INITIALLED:** JP

**DISTRIBUTION:**

Basic List +
K S Leonard (SIC)
M B Lovett
D McCubbin
P Blowers
R Bonfield
T Brooks
I T McMeekan
R Busby (Westlakes)
O Condren (UC Dublin)
C McMahon (UC Dublin)
J M Rees
J W Read
A J Poole
A K Young
D C Denoon
T A Bailey
B Taylor
P Ayres
L N Greenwood

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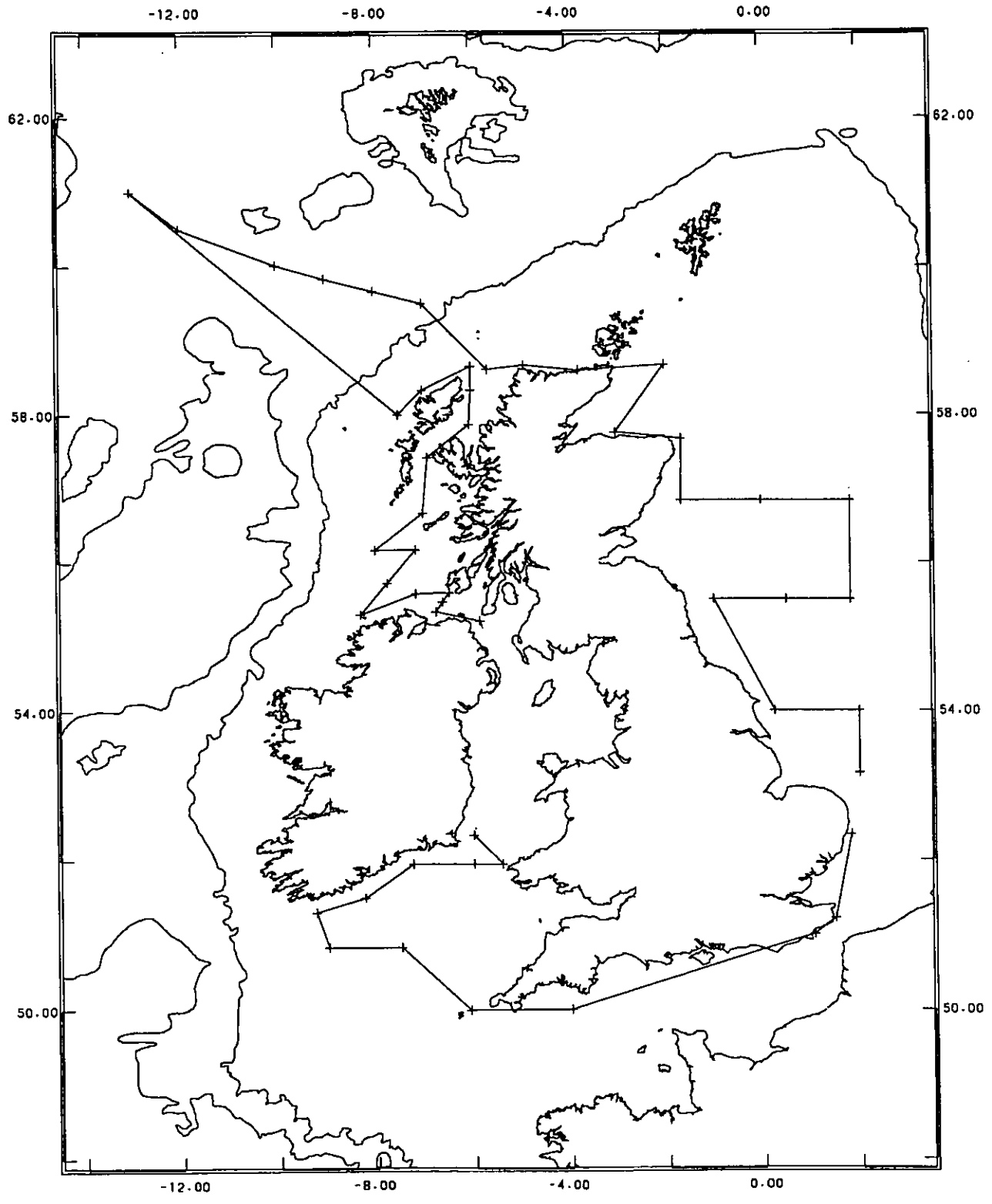
Figure 1. Artificial Radionuclide Sampling Stations - (excluding Irish Sea)



Cirolana 10/95 Figure 2. Artificial Radionuclide Sampling Stations - (Irish Sea)

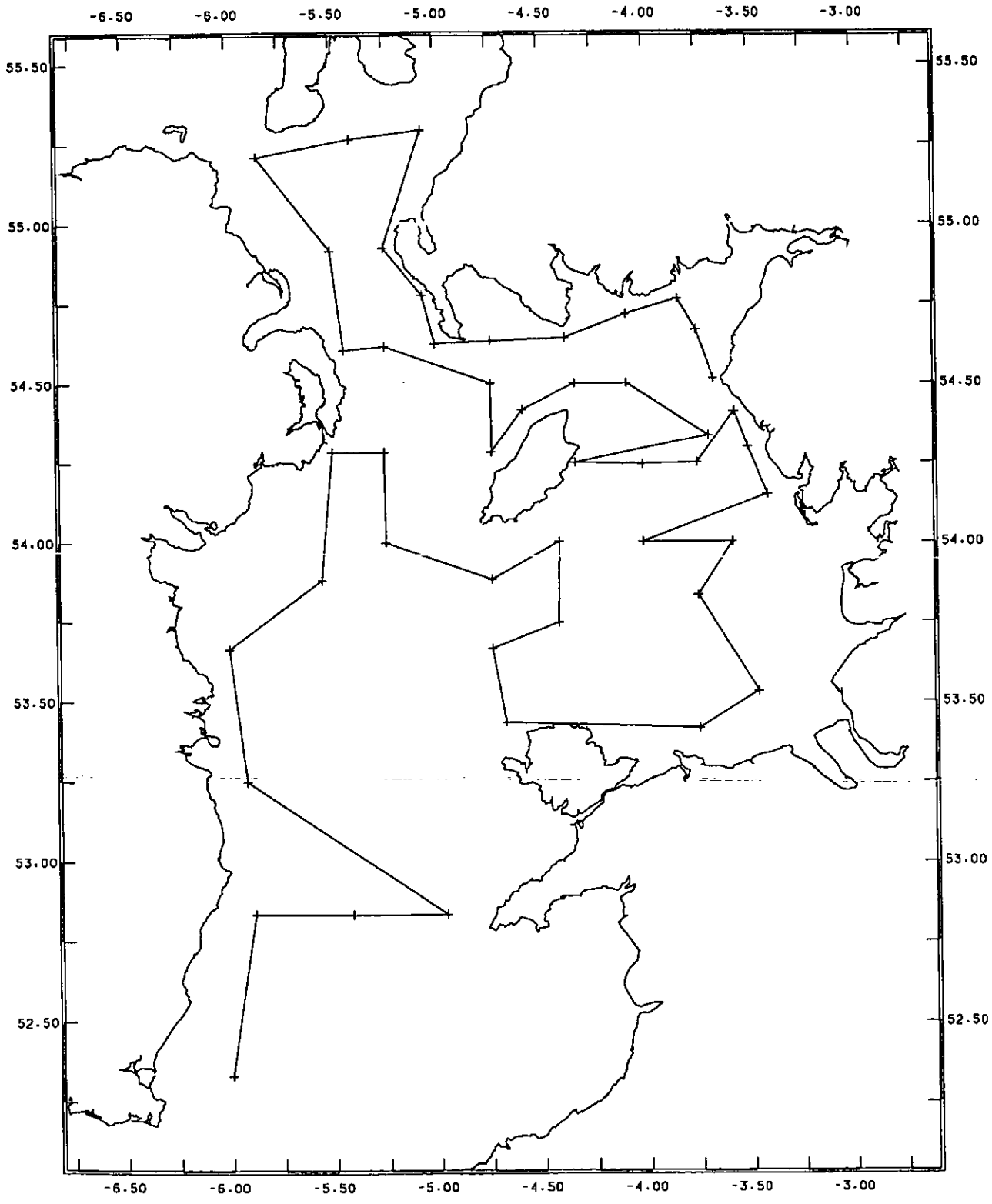


Figure 3. Current Meters, Minipod and Trawling Experiment Positions in the N.E. Irish Sea

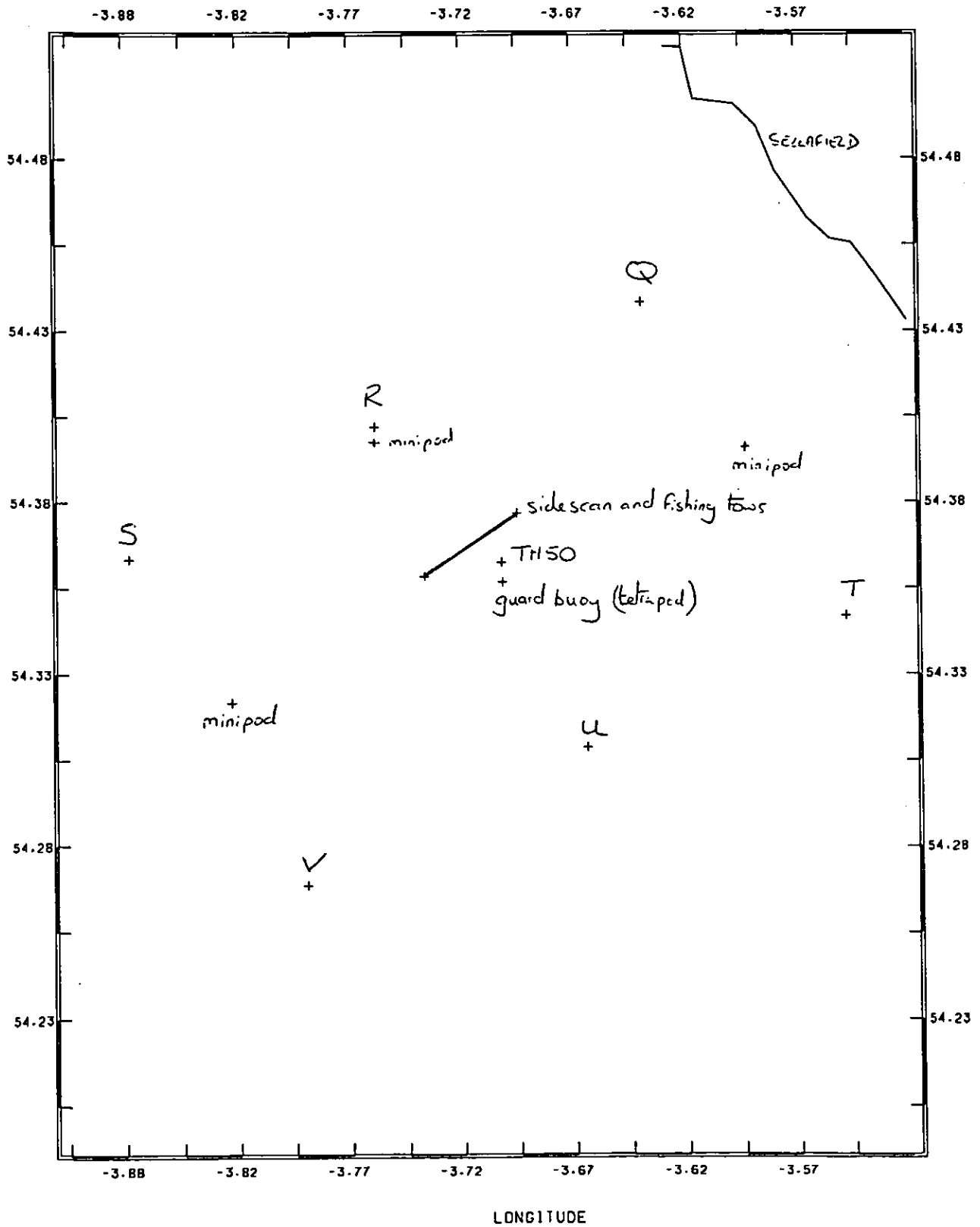


Figure 4. Hydrographic data for NE Atlantic Ocean transect

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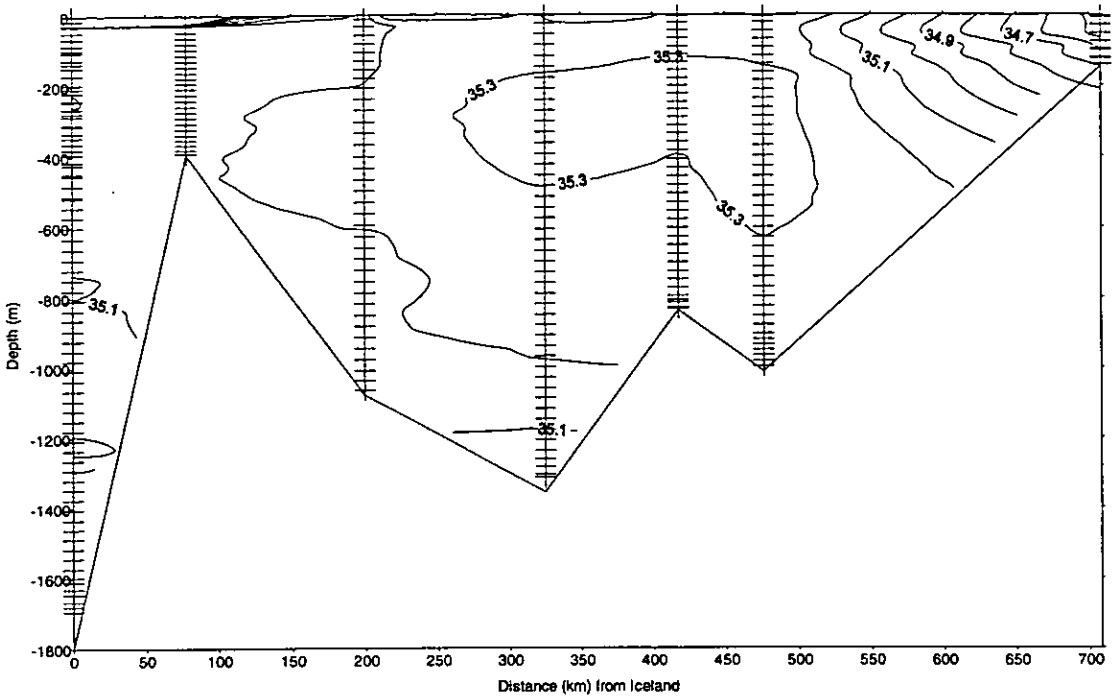


Ciro 10/95 Iceland - Scotland Section - Temperature