

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

**1994 RESEARCH VESSEL PROGRAMME**

(PROVISIONAL: Not to be quoted without prior reference to the author)

**REPORT : RV CIROLANA : CRUISE 12**

**DURATION :** Left Lowestoft 1915h 01 December  
Arrived Lowestoft 0930h 19 December)  
(All times are Greenwich Mean Time)

**LOCALITY :** Celtic Sea, Irish Sea, Malin, Western Isles, North Sea

<b>STAFF :</b>	K S Leonard (SIC)	
	M B Lovett	01 - 12 December
	R D Ibbett	
	D McCubbin	
	P Hackney	01 - 12 December
	R Bonfield	
	T Brooks	01 - 09 December
	I T McMeekan	
	D C Denoon	09 - 12 December
	A K Young	09 - 12 December
	H S Emerson	09 - 12 December
	P Blowers	12 - 19 December

**AIMS:**

1. To collect and process surface and bottom water from UK coastal waters for the analysis of Tc, Cs, Sb and transuranic radionuclides as part of the post Enhanced Actinide Removal Plant (EARP) survey (AE0114A, Nuclear Fission Safety Programme).
2. To conduct further studies to determine the temporal distribution and stability of actinide colloids in both surface and bottom waters using a variety of ultrafiltration techniques (AE0114A, Nuclear Fission Safety Programme).
3. To study the surface sediment and water concentrations of U, Th, Ra, Po and Pb radionuclides and nutrients in the immediate vicinity of the Marchon outfall and further offshore in the eastern Irish Sea. Part of this work is to be done in conjunction with a small charter vessel (AE0115A).
4. To collect, on behalf of IAEA, the remainder of a bulk fish sample required for world-wide distribution as an intercalibration reference sample (carried over from CIR 6/94).

## **NARRATIVE :**

RV CIROLANA sailed from Lowestoft at 1915h on 1 December 1994 and, with favourable weather, made good progress through the English Channel. On the morning of 3 December, despite deteriorating weather and strong south westerly winds, the ship commenced the collection of surface seawater samples in the South-western Approaches and Celtic Sea. Samples collected were processed for a range of artificial radionuclide analyses (Cs, Tc, Sb, Am, Pu(IV) and Pu(V)). The locations and cruise track of artificial radionuclide sampling from UK coastal waters (excluding Irish Sea) are given in Figure 1. A surface water sample was also collected at one site and ultrafiltered for the determination of the distribution and speciation of colloidal plutonium in open waters.

The ship then proceeded, in poor weather, through St George's Channel (5 December ) and continued the surface water sampling for artificial radionuclides in the Irish Sea. The locations and cruise track of artificial radionuclide sampling from the Irish Sea are given in Figure 2. At approximately 1600h on 6 December a crew member of CIROLANA embarked by sea rider from Llandudno. Thereafter water sampling was only possible for a short period because the south westerly winds developed into severe gale force. CIROLANA returned to Anglesey to shelter overnight. With marginal improvement in the weather, artificial radionuclide sampling recommenced during the following morning (7 December). Despite continuing strong south-westerly winds excellent progress was made during the period of 6 - 8 December and the majority of stations for artificial radionuclides were safely completed ahead of schedule. Large volumes of surface seawater were also collected off the Sellafield pipeline and experiments commenced, using the ultrafiltration technique, to study the stability of actinide colloids. In addition, during the afternoon of 8 December and early morning of the following day, the opportunity arose to collect the required bulk fish sample on behalf of IAEA. In all, the trawl was shot on four occasions (each tow was hauled after a period of 2 hours) in the vicinity of Sellafield.

CIROLANA arrived off Whitehaven on the afternoon 9 December and, with a short break in the persistent bad weather, it was possible to carry out the planned exchange of scientific staff by sea rider. During the remainder of the day further stations for artificial radionuclides along the south Scottish coast of the Irish Sea were carried out. On Saturday 10 December CIROLANA commenced the Marchon survey extending from the Saltom Bay area collecting both water and sediment samples for natural radionuclides (U, Th, Pb, Po and Ra) and nutrient analyses. The locations and cruise track of Marchon sampling are given in Figure 3. Weather conditions deteriorated again due to further strong south westerly winds and it was not feasible for the charter vessel (LADY EMMA) to carry out collection of samples from the inshore stations. Therefore, the planned rendezvous between the LADY EMMA and CIROLANA was initially postponed. The remainder of the offshore Marchon work programme continued and was successfully completed by the morning of 12 December. During this period the weather prohibited any work to be carried out by the LADY EMMA, and the collection of samples from the inshore Marchon stations was eventually abandoned on the morning of the 12 December. Also during the period 10 -12 December the opportunity was taken to complete the artificial radionuclide sampling in the NE Irish Sea. Prior to a further transfer of scientists, on the afternoon of 12 December by the ship's searider from Whitehaven, more large volumes of surface and bottom seawater (for further ultrafiltration experiments to study the stability of actinide colloids) and sediment cores were also collected off the Sellafield pipeline.

CIROLANA then proceeded to the Western Irish Sea to recommence the artificial radionuclide sampling. After passing through the North Channel (visiting surface water stations en route) a grid of CTD sampling stations was completed during the 13-14 December in the Malin area, collecting surface and bottom water for technetium and caesium radionuclides. The remainder of the scheduled water sampling stations was visited en route including the north Scottish coast, passage through the Pentland Firth (on 15 December) and a grid in the North Sea as indicated in figure 1. 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.

CIROLANA docked at Lowestoft at 0930h on 19 December. Throughout this cruise first class support was provided by the Master, the ship's officers and crew for which we record our gratitude.

## RESULTS :

**Aim 1 .** Samples of 50 litres x 2 surface seawater were collected from 86 locations around the UK coast (including 42 stations in the Irish Sea) and passed through ion exchange columns to extract  $^{99}\text{Tc}$  and Cs radionuclides. At 24 sites, 50 litres surface seawater samples were collected and  $^{125}\text{Sb}$  was extracted by co-precipitation methods. Samples of 50 or 100 litres of surface seawater, collected from 23 locations (including 15 stations in the Irish Sea), were subjected to preliminary chemical separation procedures to isolate  $^{241}\text{Am}$ , and the higher and lower oxidation states of plutonium. At 11 sites (Irish Sea), 50 litres surface seawater samples were collected and  $^{60}\text{Co}$  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 the baseline (North Sea) and elevated concentrations (Irish Sea and North Channel) for key radionuclides from the new BNF Enhanced Actinide Removal Plant (EARP). In addition, duplicate samples were collected at three selected sites for  $^{99}\text{Tc}$  analysis. Particulate material was removed using  $1\mu\text{m}$  Pall candles (reusable) as an alternative for  $0.45\mu\text{m}$  filter papers.

**Aim 2.** Samples of surface water and sediments for natural radionuclide, nutrient and suspended particulate matter determinations were collected by CIROLANA at a total of 60 stations extending from the Saltom Bay area. Due to the unavailability of the charter vessel (LADY EMMA), due to adverse weather, 16 inshore stations were abandoned. Preliminary separation of U, Th, Pb and Po radionuclides, and the initial filtration of water samples for Ra, took place on board. Further radiochemical purification and radiometric assay of water samples, and natural radionuclide, grain size and geochemical analysis of sediments, will take place at the Lowestoft laboratory. Nutrient samples were filtered and preserved with  $\text{HgCl}_2$ . Surface sediments were collected for natural radionuclide, grain size and geochemical analysis. This programme of work, undertaken 2.5 years after the Albright & Wilson Marchon works ceased processing phosphate ore, completes the down-run study of the environmental changes in concentrations of natural radionuclides and nutrients as a

consequence of this change. Samples have been collected prior to cessation of ore processing and on four previous occasions (at 6 monthly intervals).

**Aim 3.** Samples of surface seawater were collected at four carefully selected locations (Celtic Sea, Irish Sea (2), and off Dournreay) for the study of radiocolloids. At each site samples were fractionated using 0.45µm membrane filters and 1k Dalton or 0.5k Dalton (MWCO) ultrafilters. Aliquots (totals, permeates and retentates) were taken for transuranic and oxidation state determinations with initial chemical separations being carried out on ship. The stability of radiocolloids associated with Irish Sea particulate material was also evaluated (in duplicate experiments) by diluting whole seawater into large volumes of deionized water prior to the ultrafiltration methodology. The actinide colloid distribution was determined using both 30k Dalton (hollow fibre) and 1k Dalton (cross flow cartridges) ultrafilters. Further colloid stability experiments were undertaken using 5µm Pall candles as prefilters and thereafter ultrafiltering through 30k Dalton filters. A total of 40 Pu separations were carried out during the ultrafiltration programme. In addition, samples of surface and bottom water (2 Irish Sea stations) were collected on behalf of NLH (Agricultural University of Norway) and ultrafiltered using 10k Dalton and 1k Dalton (MWCO) ultrafilters. Two Reineck cores (one kept completely intact) were also collected for NLH. This collaborative work was carried out under the auspices of a CEC contract (Nuclear Fission Safety Programme).

**Aim 4.** A bulk sample of approximately 220 kg (wet) mixed fish was obtained from four trawls off Sellafield. This completes the work carried over from CIROLANA 6/94. In addition, blood samples were taken from 6 male plaice for the determination of sex hormone levels (AE0116A).

K S Leonard (SIC)  
19 December 1994

**SEEN IN DRAFT**

W G (Captain)  
M R (Fishing Skipper)

**INITIALLED : JEP**

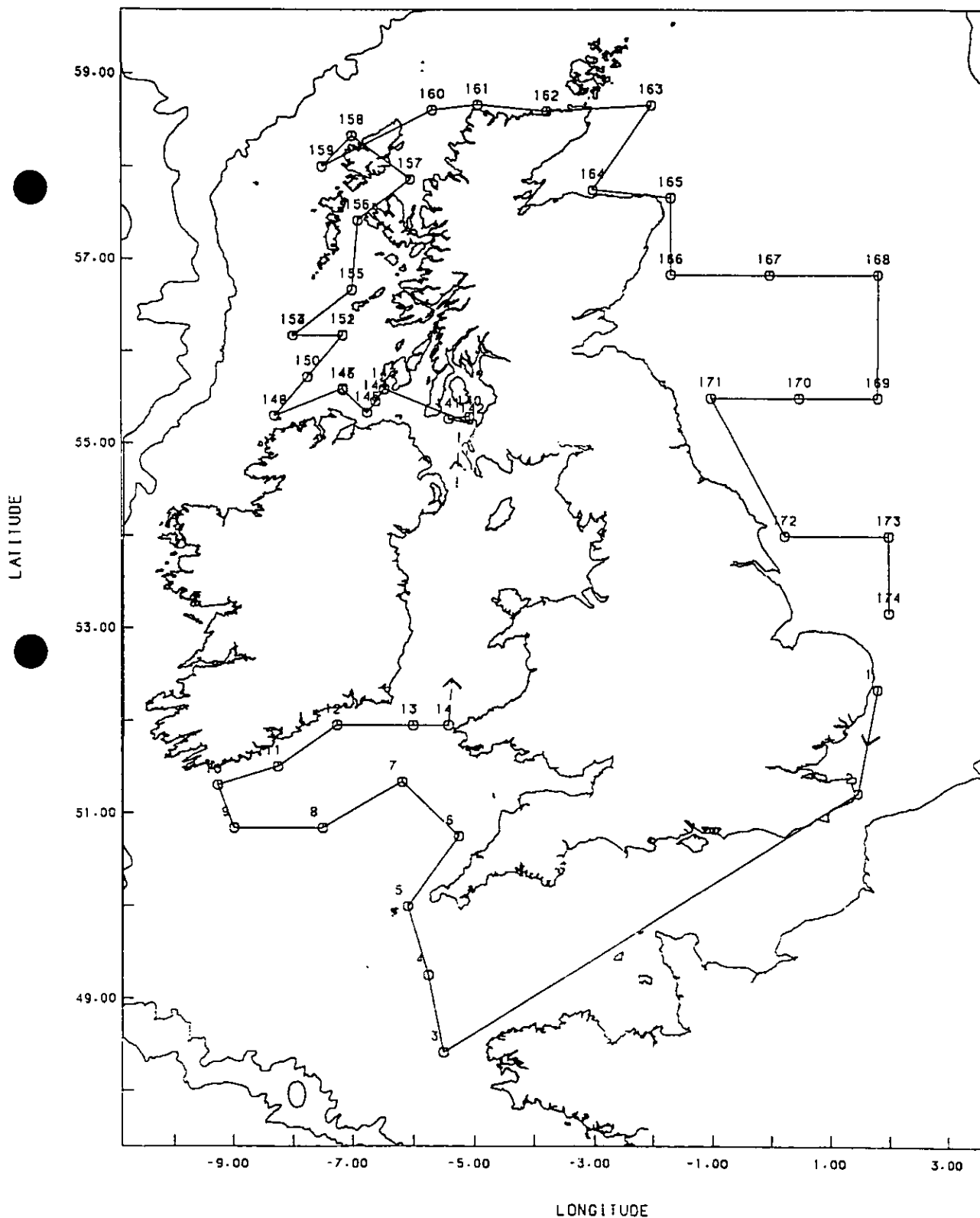
**DISTRIBUTION :**

Basic List +  
Staff on cruise

CIROCLANA 12/94

FIGURE 1 Artificial Radionuclide Sampling Stations  
(excluding Irish Sea)

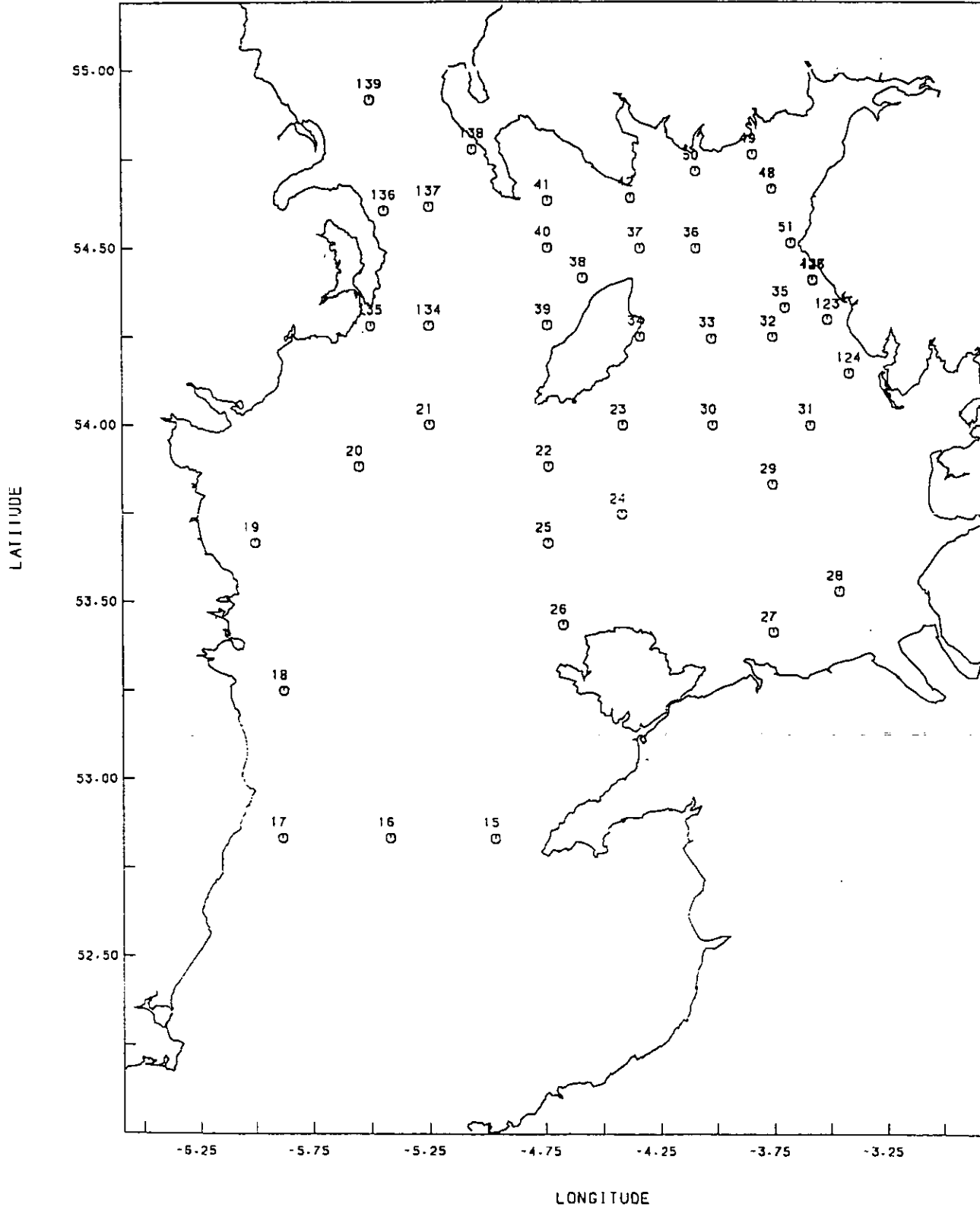
SHOWING :  
CRUISE TRACK  
STATION POSITION  
STATION NUMBER  
COASTLINE

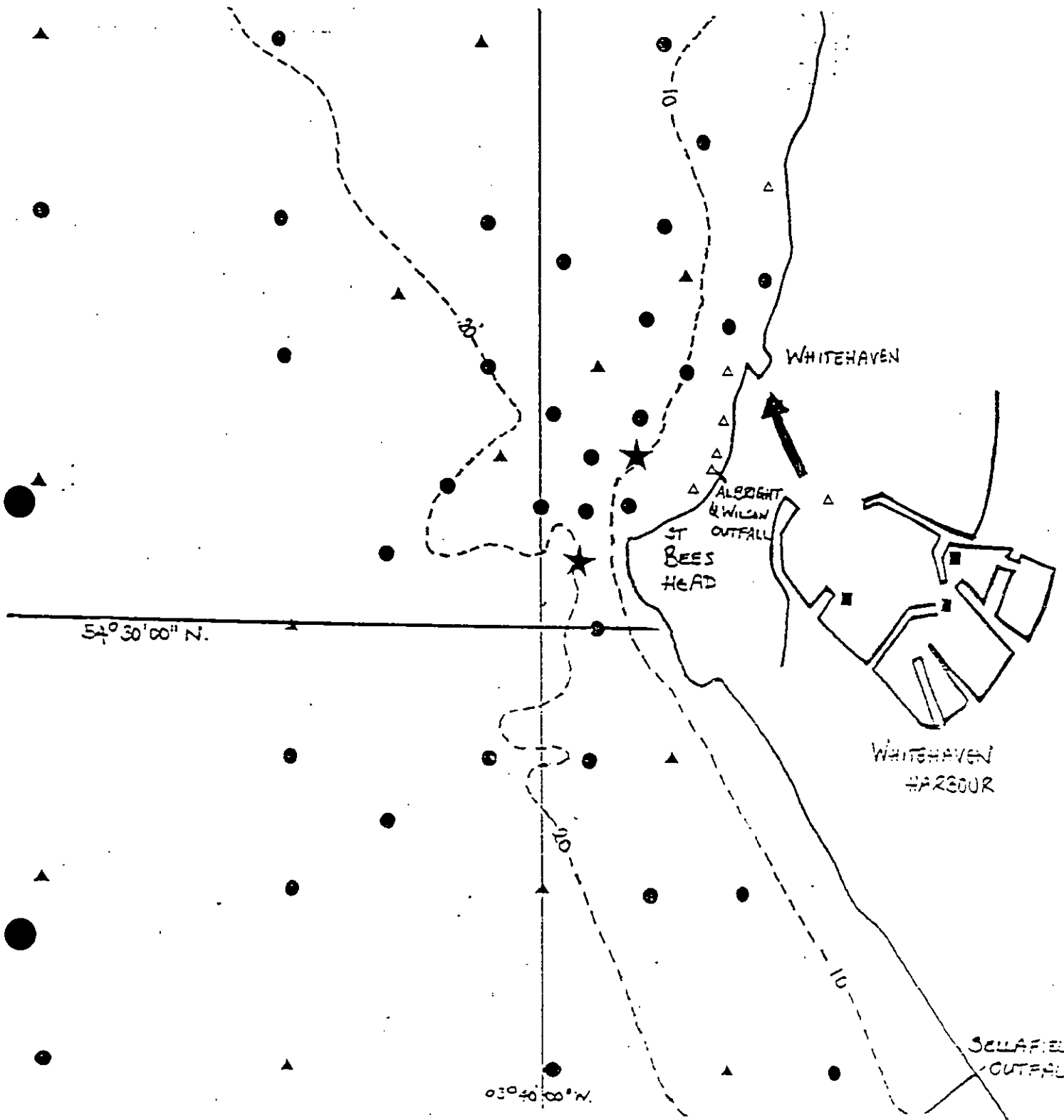


CIRCEANA 12/94

FIGURE 2. Artificial Radionuclide Sampling Stations  
(Irish Sea)

SHOWING :  
STATION POSITION  
STATION NUMBER  
COASTLINE





- ★ - Surface waters for Ra, Pb, Po, Th and U radionuclide, nutrient, suspended load and salinity analysis plus sediments for geochemical, grainsize and Ra, Pb, Po, Th and U radionuclide analysis
- - Sediment samples for geochemical, grainsize and Ra, Pb, Po, Th and U radionuclide analysis
- ▲ - Surface waters for dissolved  $^{226}\text{Ra}$  determination and nutrient, suspended load and salinity analysis and sediments for geochemical, grainsize and Ra, Pb, Po, Th and U radionuclide analysis
- △ - Surface waters for dissolved  $^{226}\text{Ra}$  determination and nutrient, suspended load and salinity analysis
- - Surface water samples for nutrient, suspended load and salinity analysis

FIGURE 3 CIROLANA 12/94 MARCHON (NATURALS) SURVEY