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

1985 RESEARCH VESSEL PROGRAMME

REPORT: RV CIROLANA: CRUISE 9
(PROVISIONAL: Not to be quoted without prior reference to the author)

PART A

DURATION 25 October-11 November

STAFF

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LOCALITY: North Sea, Shetlands, Irish Sea

AIMS:

1. To undertake a survey of Np, Pu, Am, Cm and Tc radionuclides in seawater and suspended particulate matter in British coastal waters.

2. To carry out speciation studies for these same elements at selected locations.

3. To deploy the near-bed rig at two locations in the Irish Sea to measure current profiles, suspended load (by transmissometry) and sample water for radionuclide analysis.

4. To investigate the behaviour of transuranic elements in sediment porewaters at two sites in the vicinity of the Sellafield discharge and to define the bio-geochemistry of the sediments by measuring various physico-chemical parameters.

5. To set up preliminary reaction-rate incubation experiments on-board the ship using freshly collected Irish Sea sediments.

6. To collect cores for the estimation of seasonal variations in the short-time-scale migration rates in sediments using thorium/uranium disequilibria.

7. To investigate the residence-time and scavenging rates of particle-reactive radionuclides using the $^{234}Th/^{238}U$ disequilibrium in the seawater/suspended solids/sea bed system of the Irish Sea.

8. To survey the distribution of benthic organisms (especially Maxmullaria lankastri) in the muddy sediments of the north east Irish Sea during the autumn season.

NARRATIVE

CIROLANA sailed at 1800 h on 25 October and proceeded via the Shetland Islands, the Minches and North Channel to the Irish Sea. Surface seawater samples were collected, on course, at a number of locations for the analysis of transuranic and other radionuclides. Speciation measurements were made for the plutonium, americium and curium at selected stations, but gales and rough seas caused plans to sample northwest of the Orkney Islands and close inshore at Dounreay to be abandoned. CIROLANA arrived in the north eastern Irish Sea in the early hours of Wednesday 30 October. The first task in this working area was to deploy the near-bed current velocity and water sampling rig just north of St Bees Head. This deployment and the placing of three toroid marker buoys was completed by 0900 h. Recovery of this equipment was completed in good weather conditions on Sunday 3 November. Unfortunately only a third of the bottles were found to contain samples of water, and so a concerted effort was made throughout the day to identify and correct the faults. Wet weather made this task more difficult, but by the evening all systems appeared to be fuctioning oorrectly. Bad weather prevented the scheduled second deployment the following day, but this operation was successfully completed with the ship at anchor off Sellafield on the morning of Tuesday 5 November. The second and final recovery took place on Friday 8 November. This time the equipment had operated correctly and a full set of water samples was obtained. During the recovery of the toroid marker buoys the "A" frame of one broke when the buoy was being lifted from the water, and a second attempt to retrieve it had to be made.

A programme of sampling to supplement previous surveys of the distribution of benthic macrofauna in the muddy sediments of the eastern Irish Sea was carried out using five Reineck box cores per station. The sediments were seived under running water to allow the benthic organisms to be picked out and preserved for subsequent identification and counting back at the laboratory. A grid of stations was worked throughout the period 30 October to 10 November.

A similar programme of sampling for the analysis of radionuclide concentration and transuranic speciation was also undertaken during this same period. Sampling locations were chosen to coincide with the areas defined in the Irish Sea box model, and most of the northern and eastern sites were sampled.. Part B of the cruise was scheduled to pick up samples in the remaining areas.

Calm weather on 31 October and 1 November allowed a full programme of work on sediment pore-waters to be completed at a station about 1 mile west of Sellafield. On-board, chemical separations for plutonium and americium were carried out, E_h and pH measurements were made, and the concentration of nitrite and ferrous iron in the pore-waters determined. Sub-samples were retained for trace-metal and nutrient analyses back at Lowestoft. The effect that core-sectioning, in the presence of oxygen, has on the results obtained for both transuranics and the other parameters was investigated by handling one set of cores in air and one set under nitrogen in a glove box. Plans to carry out a similar full analytical programme at a second location further off-shore had to be abandoned due to unsuitable weather conditions, but a restricted programme without radionuclide analysis was completed at two other sites.

On Thursday 7 November a set of five stations from north of the Isle of Man to Sellafield were worked within a five hour period to provide a set of data for the ^{234}Th budget study. Samples of surface and bottom seawater were collected using the CTD/rosette array. This array was lowered on the same cable as used for the near-bed water sampler fed from the main cable winch via large diameter alloy pulley blocks, one on the after deck and one on the port-side derrick. Once the water samples were on board, particulate matter was filtered off and the ^{234}Th remaining in the aqueous phase separated from its parent ^{238}U by coprecipitation with ferric hydroxide followed by an ion exchange separation. To complete the budget, a core was taken at each site and these, together with the particulate matter, were retained for analysis later at the laboratory. During

this work a fault developed in the ship's bow-propeller making this manoeuvering aid no further use for the duration of the cruise.

As opportunities arose during the time spent in the Irish Sea, cores were taken for a variety of other purposes. These included samples to provide an indication of seasonal variations in the short time-scale migration rates in sediments (by measuring the $^{234}Th/^{238}U$ disequilibrium), and long cores taken with the Kaston corer to provide additional information from selected areas for the artificial radionuclide sediment budget. Cores from the mud-patch west of Sellafield were collected and used on-board in experiments to examine time-course changes in pore-water constituents and the rate of oxygen uptake.

Part A of this cruise finished on 11 November and a complete exchange of scientific staff took place at Workington with the help of the local pilot-boat. Sea conditions prevented the ship's Z-boat being used for this exchange.

RESULTS

1. Surface seawater samples were collected at 33 stations and partially processed on board for the determination of ^{238}Pu, $^{239/240}Pu$, ^{241}Am, $^{242/244}Cm$, ^{237}Np and ^{99}Tc concentrations. The separated particulate matter from each sample was retained for analysis at the laboratory and samples for $^{134/137}Cs$ and salinity determinations were collected for reference purposes. Five samples of whole seawater were collected for ^{60}Co analysis and one for $^{103/106}Ru$ analysis.

2. Oxidation state separations were carried out for plutonium americium and curium at 17 of the stations visited for surface seawater sampling.

3. The near-bed monitoring rig was successfully deployed and recovered twice. After the first deployment only 8 of the 24 flasks had filled with water but following some repairs to the electronic circuitry 23 flasks collected samples at the second deployment. The water samples were filtered and a preliminary separation of transuranic nuclides carried out on the aqueous phase. The rig also carries 5 current meters and 2 transmissometers to measure the amount of material in suspension. Data for these are collected on tape and await laboratory analysis.

4. Pore-water samples were obtained at 3 stations to provide high resolution profiles of the sediments. Handling techniques were compared by sectioning the cores in air and under nitrogen. Samples from all stations were measured on board for E_h, pH, nitrite and ferrous iron. Aliquots were preserved for later determination of total iron, manganese, silicate, phosphate, nitrate, total iodine, iodate, ammonium, alkalinity, sulphate and dissolved organic carbon. Oxidized and reduced species of plutonium and americium were separated from the pore-waters at one of the stations "Punch-in" E_h and pH profiles were measured at each station.

5. Incubation experiments were initiated on-board using material from the eastern Irish Sea mud patch to examine the rate of charge of pore-water constituents with time. An additional experiment was set up to examine oxygen uptake of intact cores.

6. Cores from two locations were obtained for the estimation of seasonal variations in the short time-scale migration rates in sediments of the eastern Irish Sea area. These were X-Rayed and then sectioned for return to the laboratory for the determination of the $^{234}Th/^{238}U$ disequilibrium.

7. A set of 5 stations from north of the Isle of Man to Sellafield was worked to investigate thr residence time and scavenging rates of particle-reactive radionuclides using the $^{234}Th/^{238}U$ disequilibrium in surface and bottom sea-water, suspended solids and the sea bed material.

8. Seventy box core samples were sieved to provide date on the distribution of benthic organisms in the muddy bottom sediments of the eastern Irish Sea. 11 stations were repeats of stations studied in 1984, the remaining 3 were new stations.

B R Harvey
2 December 1985

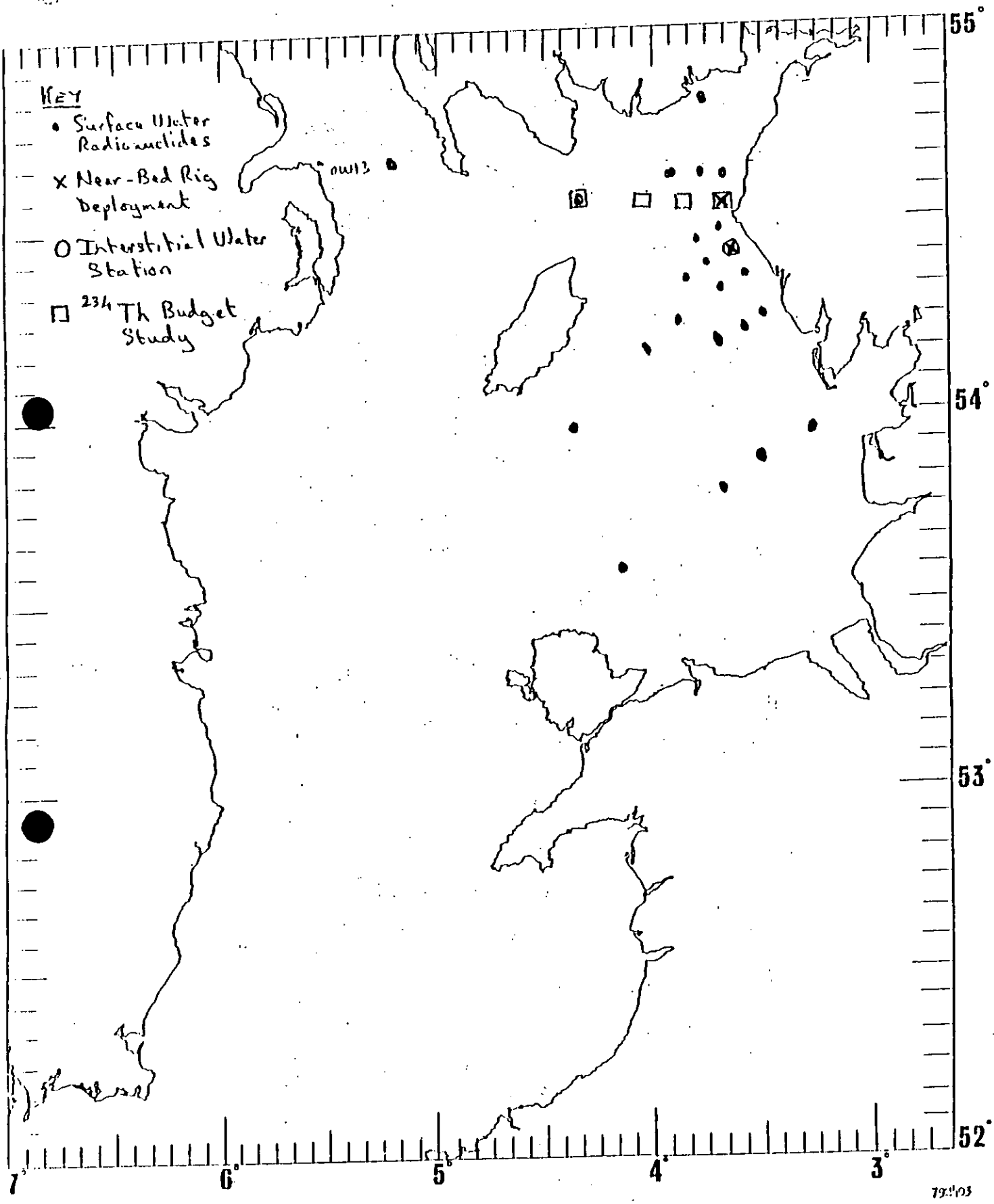
SEEN IN DRAFT: Captain M J Willcock
Fishing Skipper

INITIALLED: HWH

DISTRIBUTION:

Basic List +
B R Harvey (SIC)
M B Lovett
S J Malcolm
P J Kershaw
D J Swift
I A Huggins
D C Denoon
A K Young
L M Thurston
P Blowers

CIR 9A/85 SAMPLING LOCATIONS IN THE IRISH SEA



CTD 9A/85 OUTWARD WATER SAMPLING TRACK