

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

1989 RESEARCH VESSEL PROGRAMME

CRUISE REPORT: RRS CHALLENGER 62B

STAFF: P J Kershaw)
 S J Malcolm)
 M McCartney) Whole cruise
 D J Allington)
 D Smith)
 R Woodhead)

 E Shreeve)
 N D Pearson) Part a
 A K Young)
 F Begg)

 D C Denoon)
 J Vives, UCD) Part b
 T Ryan, UCD)

DURATION: 6-20 December 1989; (a) 6-14, (b) 14-20

LOCATION: Irish Sea

AIMS:

1. To investigate the effects of sediment resuspension on the scavenging of dissolved radionuclides in the north-east Irish Sea. A 25-hour anchor will be worked with the NBVR deployed nearby. ACB4/6.
2. To examine the nature and rates of chemical processes in the seabed using ^{226}Ra , ultrafiltration, incubation experiments, fine resolution sampling and selective leaching. ACB3/4/8.
3. To collect water and sediment samples for ^{14}C and ^{137}Cs analysis at SURRC, East Kilbride, in support of a NERC/MAFF CASE Studentship. ACBA.
4. To study the distribution and behaviour of transuranic and gamma-emitting artificial radionuclides in the western Irish Sea in collaboration with University College, Dublin. ACB2.
5. To assess the importance of colloidal material on radionuclide scavenging using ultrafiltration and measuring the fractionation of ^{234}Th . ACB4.
6. To examine the surface properties of suspended particulates using CEC and selective leaching. ACB8.
7. To investigate the impact of the Marchon (Whitehaven) and Springfields discharges on the distribution of naturally-occurring radionuclides. ACB4.

8. To collect sediment cores for meiofaunal analysis in support of MAFF Commission AEB8.
9. To collect particulate material for analysis of Pu by Professor Kudo, NRC, Canada.
10. To collect particulate material and surface sediment for Dr Hamilton, Phoenix Research Laboratory, Devon.
11. To compare three systems for the ultrafiltration of colloidal material. ABB1.

NARRATIVE:

RRS CHALLENGER sailed from Britannia Quay, Cardiff Docks, at 1000 on Wednesday 6 December. Following compass testing and trials of the modified side gantry, a series of surface water and Day grab samples was collected, for ^{14}C and ^{137}Cs analysis, in the Bristol Channel and St Georges Channel, en route to the eastern Irish Sea (AIM 3). The NBVR was laid at 1600 on the 7th and a 22-hour anchor station commenced, in calm conditions, with hourly CTD dips (AIM 1). The NBVR was recovered at 1615 on the 8th. The upper part of the rig was damaged during the recovery operation but there was no water leakage into the electronics packages. A transect of surface water and sediment samples was run from Liverpool Bay, past the mouth of the Ribble estuary, to the Duddon estuary (AIM 7), with additional samples being taken up to the Sellafield pipeline (AIM 3).

Reineck cores were collected from PLZ and the centre of the 'mud patch' on the morning of the 9th and 10th for pore-water analysis (AIM 2) with continuing surface water and sediment samples (AIMS 3, 9). The Pu ultrafiltration experiment (AIM 11) was initiated and a set of Craib cores taken for an incubation experiment. One scientist was put ashore at Whitehaven using the ship's inflatable boat.

The transect from Sellafield to Islay commenced on the morning of the 11th and ended at 1900 on the 12th. Surface water and sediment was sampled at 10 locations to provide a comprehensive dataset of artificial and naturally-occurring radionuclide chemistry (AIMS 3, 5, 6).

Pore-water studies continued at PLZ on the 13th (AIM 2) and a transect of surface water samples was run in the vicinity of Whitehaven (AIM 7), passing close to a bulk carrier offloading phosphate ore - the Marchon site is the probable source of the observed high concentrations of some naturally-occurring radionuclides in this region.

Surface and bottom, waters Craib and Kasten cores were recovered from the centre of the 'mud patch' on the morning of the 14th (AIMS 2, 4, 8) before completing the exchange of scientists off Workington at 1215 using the pilot boat. Further water and sediment samples were collected from PLZ (AIMS 4, 8, 9) before commencing to steam westwards at 1615. This was a day ahead of schedule as a result of the exceptionally good conditions and the efficient use of time. Surface and bottom waters were sampled to the north of the Isle of Man en route.

A transect of Craib cores and surface and bottom waters was run off Ardglass, on the Irish coast, on the 15th to provide a 'control' dataset for the Marchon study (AIM 7). Kasten cores and surface and bottom waters

were taken at 3 sites in the western Irish Sea mud basin for Pu analysis (AIM 4).

Further sampling was precluded on the 16th and 17th as severe southerly gales, backing westerly, forced CHALLENGER to seek shelter around the Isle of Man, eventually anchoring in Ramsey Bay with gusts of 60 knots being recorded. Most of the samples taken require many hours of intensive chemical processing so the storm did not have a major impact on the overall programme.

Sampling of bottom sediments and surface and bottom waters in the western Irish Sea continued on the 18th and 19th (AIMS 2, 4, 9) before commencing to steam southwards. CHALLENGER docked in Barry at 1030 on 20 December 1989.

RESULTS:

1. An anchor station was worked for 22 hours in Liverpool Bay with surface, mid and bottom waters sampled hourly for suspended load and every 2 hours for $^{238}\text{U}/^{234}\text{Th}$ analysis. The NBVR was laid nearby equipped with an electro-magnetic current meter, pressure sensor and two transmissometers, logging at half-hourly intervals. Water samples were filtered and initial chemical separations undertaken. Chemical analysis will be completed in Lowestoft. The results of this study should lead to an improved understanding of contaminant scavenging by suspended particulate resulting from tidal resuspension alone.

2. Chemical processes within the seabed were examined at two sites in the eastern Irish Sea: close to the Sellafield pipeline (PLZ) and in the centre of the 'mud patch'. Reineck, Kasten and Craib corers were used to provide material for several studies. The fine-scale distribution of Pu species was assessed at PLZ. The rates of chemical reactions and fluxes across the sediment-water interface were studied using a temperature-controlled incubation experiment. The amount of colloidal Pu in pore-water was determined by ultrafiltration at 1000 Daltons (1K). The vertical distribution of ^{226}Ra was measured to provide an indication of the degree of bio-irrigation. A third site was worked in the western Irish Sea with further ^{226}Ra measurements being made. Chemical analysis will be completed in Lowestoft.

3. In order to study the aquatic discharges of ^{14}C from Sellafield, 200 l water samples were collected at 25 sites in the Irish Sea and North Channel. The samples were initially filtered through glass-fibre membranes and the dissolved inorganic carbon extracted by acidification and then transferred into 400 ml solutions of NaOH. The particulate fractions were retained for further analyses. At 4 of the sites further samples were collected for the radiocarbon analysis of the dissolved organic carbon component of the water column. At all stations 50 l samples were collected, filtered, acidified and passed through ion-exchange resins to extract Cs. These data will be used to compare and contrast the dispersion characteristics of ^{14}C and Cs. Surface sediment samples were taken at 7 stations and more detailed cores at 2 further sites. Samples were also collected in the Bristol Channel to determine the effect of ^{14}C discharges from Amersham at Cardiff. All these samples are to be returned to SURRC (East Kilbride) for analysis.

4. Surface and bottom waters were collected from 10 sites in the eastern and western Irish Sea for the determination of total Pu and Am and Pu speciation in the filtrate and particulate. Initial chemical separations were completed onboard. Kasten and Reineck cores were also collected and sub-sampled. These analyses will be performed at University College, Dublin.

5. To assess the importance of colloidal material on radionuclide scavenging, water samples were collected and filtered using both conventional and ultrafiltration techniques. Three separate samples were passed through: (a) a 0.45 μm pore-size membrane, (b) a 100K hollow-fibre membrane, (c) a 3K hollow-fibre membrane. Thorium isotopes in both permeate and retentate were then extracted by coprecipitation and purified using ion-exchange resins. This procedure was repeated at 4 sites at various distances from the coast.

6. The surface properties of suspended particulate were examined at 5 sites, using a variety of techniques. The Cation Exchange Capacity was determined and a novel method for selective chemical leaching was applied. Additional measurements will include Pu, Mn, Fe and chlorophyll in seawater, POC, and elemental analysis by XRF, at Edinburgh University.

7. Water and surface sediment samples were collected at 7 sites in near-shore waters, running from Liverpool Bay to the Duddon estuary, and are to be analysed for ^{226}Ra and isotopes of both uranium and thorium. The initial separation procedures for the analyses of uranium and thorium isotopes were carried out. The preliminary results of the ^{226}Ra analyses show a slight enhancement of dissolved ^{226}Ra in the water column near the mouth of the Ribble estuary, thus indicating an additional input, most probably from BNFL's Springfields works.

Additional samples were obtained from near St Bees Head to obtain further information on the discharges of natural radionuclides from the Albright and Wilson (Marchon) phosphate plant at Whitehaven. Water samples were collected at 4 sites, at various distances from Marchon, and are to be analysed for ^{234}U , ^{230}Th and ^{226}Ra . The initial separation of these radionuclides from the sample matrix was completed.

In order to look at the effect of water depth on the distribution of naturally-occurring radionuclides in the Irish Sea, but in a place relatively isolated from the influence of Marchon, a suite of samples was collected on the western margins of the Irish Sea off Ardglass. At 3 sites both water and sediment samples were collected and are to be analysed for ^{238}U , ^{234}U , ^{234}Th , ^{232}Th , ^{230}Th , ^{228}Th , ^{226}Ra and ^{210}Pb . Where appropriate, initial separation procedures have been applied.

8. A set of 5 Craib cores was collected at each of 3 sites in the eastern Irish Sea. The cores were sectioned and preserved in formalin for later analysis of the meiofauna by Dr Barnett (MAFF Commission AEB8).

9. Suspended particulate was filtered from a 1000 l water sample collected from close to PLZ and from a second, more remote, site in the western Irish Sea. Filtrate samples were also collected. These materials will be analysed by Professor Kudo of the NRC, Canada.

10. Sub-samples of suspended particulate and surface sediment from the eastern Irish Sea were taken for 'hot particle' analysis by Dr Hamilton of the Phoenix Research Laboratory.

11. Aliquots of a large volume (600 l) water sample collected from near PLZ were filtered (0.45 microns) and passed through 3 different ultrafiltration systems: (a) a large hollow-fibre rig; (b) a small hollow-fibre rig; and (c) a tangential-flow cell. The permeate and retentate fractions were returned to Lowestoft for Pu analysis.

P J Kershaw
Scientist-in-Charge/
Principal Scientific Officer

INITIALLED: Master PMcD
First Mate CML

CEP

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