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

1988 RESEARCH VESSEL PROGRAMME

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

STAFF

- D S Woodhead )
- P J Kershaw )
- D C Denoon )
- A K Young ) Whole cruise
- D J Allington )
- D B Sivyer )
- K J Williams )
  
- S J Malcolm )
- M McCartney ) Part A
- R D Ibbett )
  
- D J Swift )
- R Chapman ) Part B
- M Fulcher )

DURATION Part A: 28 October-8 November  
Part B: 8 November-17 November

LOCALITY: Irish Sea

AIMS:

1. To determine the distribution and inventory of transuranic and gamma-emitting artificial radionuclides in the sediments of the Irish Sea.
2. To determine the distribution of transuranic and Cs radionuclides in filtered seawater and suspended particulates.
3. To investigate the effects of tidally-induced resuspension of sediment on the scavenging of dissolved radionuclides. An anchor station, WSW of St Bee's Head, will be occupied for 24 hours. The tetrapod (NBVR) will be deployed nearby.
4. To determine the variation of the chemical characteristics and processes, and radium concentrations, in pore waters with depth in sediment.
5. To collect sediment cores from the Solway Firth to examine the distributions of Th-234/U-238 and Pb-210/Ra-226.
6. To collect water samples for C-14 analysis at SURRC, East Kilbride, in support of a NERC/MAFF CASE studentship.
7. To extend past surveys of benthic infauna to determine the degree and extent of bioturbation.
8. To collect sediment samples to be used in laboratory studies.

## NARRATIVE

CIROLANA sailed from Lowestoft at 1045h, Friday 28 October 1988 and commenced the south-about passage to the Irish Sea. The weather was good and surface water samples were collected at 5 stations en route for transuranic and Cs radionuclide analysis. Work on the main water and sediment sampling programme started on arrival in the western Irish Sea at 0630h, Sunday 30 October and continued throughout the day on an easterly track to Liverpool Bay and then northwards towards Sellafield. Early on Monday, 31 October a number of Reineck cores were collected from a station close to the Sellafield outfall for a detailed study of the variation, with depth in the seabed, of chemical conditions and processes in sediment pore waters. Water and sediment sampling continued for the remainder of the day. This work pattern continued until the early morning of 4 November when a southeasterly gale made coring a hazardous procedure. However, water sampling and the associated radiochemistry continued. During the afternoon moderating winds and the shelter of the Isle of Man allowed sediment coring to be commenced again. Calm conditions on 5-7 November permitted the water sampling programme for transuranic and Cs radionuclide analysis to be almost completed, and the coring schedule to be recovered.

The change-over of three scientific staff was completed on the morning of 8 November off Whitehaven.

The programme of Reineck coring for the survey of distributions of benthic infauna started immediately and the NBVR was prepared for deployment. The coring work was discontinued in the afternoon due to a heavy swell. In the early morning of 9 November ten Reineck cores were obtained for the biology programme and at 1130h the first of the guard toroids was laid in position, followed closely by the second. The NBVR was deployed successfully at 1539h followed shortly by the third guard toroid. Kaston coring for the transuranic inventory survey continued for the remainder of the day.

~~Attempts to take Reineck cores early on the 10 November for the biology programme were only partially successful due to deteriorating sea conditions. These continued for the rest of the day and permitted limited sediment sampling with the Day grab for particle size analysis.~~

Sea conditions had moderated by the morning of 11 November and Reineck coring for the benthic survey continued. In anticipation of a period of relatively calm conditions CIROLANA anchored close to the NBVR at 1230h in preparation for the 25h anchor station which commenced at 1630h. This involved bi-hourly CTD sampling of surface, middle and bottom water and Day grab samples of surface sediment for Thorium analysis, salinity and suspended load. On the alternate hours CTD samples of surface, middle and bottom water were taken for suspended load and particle size analysis. This was completed at 1730h, 12 November. Because the weather conditions were forecast to continue relatively calm it was decided to make a repeat anchor station at another site adjacent to the NBVR during the 10h period 0630-1630h on 13 November. The evening was spent collecting sediment samples for the transuranic inventory study and the benthic survey.

In good weather conditions the NBVR and the guard buoys were successfully recovered on the morning of 14 November and the rest of the day was spent completing the remainder of the sampling for the water and sediment programmes and most of the sampling for the benthic survey.

CIROLANA started for home, south-about, at 2145h and after an uneventful journey, docked at Lowestoft at 0200h, on 17 November.

## RESULTS

1. Reineck or Kaston cores were collected at 73 stations in the Irish Sea and carefully sub-sampled to give material from the surface 0-5 cm, the 5cm layer at the base of the core and a bulked sample from the intervening layer. These are being returned to the laboratory for gamma- and alpha-spectrometric analysis. The new frame for deploying the Kaston corer worked well but the core recovery with the shortened barrel was less than expected with a maximum of 80 cm instead of 1m. This problem could be solved by extending the frame and increasing the barrel length to 1.60m. An alternative solution, avoiding an increase in the overall size of the corer, would be to redesign the corer shoe to give a more positive closing action when the barrel is withdrawn from the sediment.
2. Surface and bottom water has been collected at 7 stations and surface water alone at 28 stations for the analysis of transuranic and Cs radionuclides. For the transuranic nuclides the samples have been partially processed on board, including, at 14 stations, a determination of the chemical speciation.  
  
In addition 3 distilled water blanks were processed to provide controls for contamination.
3. The NBVR was successfully deployed and recovered. Analysis of the data records from the current meters, the transmissometer and the acoustic backscatter probe will take place at the laboratory. A time-lapse camera was also included in the instrumentation of the rig. Two separate anchor stations, of 25h and 10h duration, were worked in the vicinity of the NBVR to provide complementary information.
4. Sediment samples for interstitial water studies were collected at 7 sites in the NE Irish Sea. Samples were sectioned and squeezed under a nitrogen atmosphere to produce 1cm resolution profiles down to 10cm depth at these sites. At one site at the mouth of the Solway Firth the sandy nature of the sediment prevented the extraction of the pore water and it was abandoned. Eh and pH measurements were made on cores from each site by "punch-in" electrodes and the sediments were all found to be reducing below the top few cm. The interstitial water was analysed colorimetrically for Fe(2+) and Mn(2+) and showed depth profiles similar to those obtained previously. The concentrations of these two cations showed a grain size dependence with the higher values being found in the muddier sediments. The profile structure also showed variations with site and the presence of burrows. Samples were retained of interstitial water for titration alkalinity and nitrate analysis in the laboratory, and of all squeezed residues.

The oxidation rate of Mn within profiles at three sites was determined by injection of Mn-54 tracer into intact cores followed by incubation for 24h prior to extraction. The amount, and oxidation state, of Mn in oxides was partly determined by a titrimetric method on 5 cores with the procedure to be completed in the laboratory. The results so far indicate the presence of oxides in the top 6-8cm of the sediments in this area: a finding which is consistent with the mobilization of Mn observed in interstitial water. The amount, and oxidation state, of Mn in oxides were also determined on samples of suspended matter at 6 sites.

Replicate sediment samples were collected at one site to assess the local variability of profiles. Not surprisingly, the results for Fe(2+) and Mn(2+) show considerable variation; samples were retained for additional analyses at the laboratory.

Radium-226 concentration profiles were successfully measured in sediment pore waters and show a two-fold increase from the surface to a depth of 25 cm (5 cm resolution).

5. Sediment cores were collected at 3 sites at the mouth of the Solway Firth. These will be analysed for Th-234/U-238 and Pb-210/Ra-226 disequilibria to study vertical mixing in the seabed.
6. Two water samples were collected for the joint MAFF/SURRC CASE student. These samples will be analysed for C-14 to check the method and to obtain an indication of the concentrations in the various fractions in the water column.
7. Five Reineck cores were collected at random positions from 9 Decca boxes (approximate area, 1sq.km). These were sieved to obtain the benthic infauna. The organisms have been preserved for identification at the laboratory. In addition surface sediment samples have been collected with the Day grab at 5 sites to provide particle size information to complement earlier surveys.
8. Sediment samples were collected for laboratory studies of the interactions of radionuclides with particles. Three water samples were collected to determine the existence (and extent) of enhanced Ra-226 concentrations in the immediate vicinity of Whitehaven.

D S Woodhead  
24 November 1988

SEEN IN DRAFT: G Sinclair - Master  
R C Newrick - Senior Fishing Mate

INITIALLED: RJP

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