

**DUNSTAFFNAGE MARINE LABORATORY**  
**and the**  
**SCOTTISH ASSOCIATION FOR MARINE SCIENCE**  
**OBAN, ARGYLL, SCOTLAND**

**Rockall Channel time-series**  
**LOIS Shelf-Edge Study pilot programme**  
**EC MAST 2 PROFILE project**

**CRUISE REPORT**

**RRS CHALLENGER**

**CRUISE 110/1994**

**10 - 20 March 1994**

**DML, P.O. Box No. 3, OBAN, ARGYLL, PA34 4AD, SCOTLAND**

## **R.R.S. CHALLENGER, Cruise 110 / 1994**

**Duration:** 0945h 10 March - 1030h 20 March 1994  
All times GMT

**Locality:** Outer Firth of Clyde, Scottish continental shelf and Rockall Channel.

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### **Aims:**

- 1) To work the CTD stations of the Anton Dohrn Seamount section, between the shelf-edge and Rockall to continue the Rockall Trough time-series as a UK contribution to WOCE Goal 2.
- 2) To recover and redeploy a temperature-salinity recorder and thermistor chain at station M of the Anton Dohrn Section.
- 3) To service the DML current meter mooring in the Tiree Passage.
- 4) To sample benthos at the SAMS Permanent Station (54°30'N, 12°16'W) and at station M using the epibenthic sled and the Agassiz trawl.
- 5) To collect a suite of physical, nutrient and biological profiles and samples at the shelf-edge west of Barra as part of the LOIS pilot studies and to attempt box-coring if time and weather permit.
- 6) To work the shelf-edge - Sound of Mull CTD section, with nutrient and chlorophyll sampling.
- 7) To work the PROFILE sampling stations around the Arran deep, as time permits.
- 8) To collect clean oceanic water for the Culture Collection.

## Narrative:

Scientific staff joined "Challenger" at Campbeltown at 0945h **10 March**. After loading equipment and completing repairs to the Decca plotting system, the ship sailed at 1458h in force 6 westerly winds. In view of forecasts of westerly gales for the following three days, it was decided to begin work in sheltered waters, with the Clyde stations. After rigging gear and remedying a meter wheel problem, station CS 13, off Campbeltown Loch, was begun at 1715h, and CTD and water sampling stations were continued northwards through Kilbrannan Sound until 2348h, when the ship hove-to in force 8 winds. Work recommenced at 0800h **11 March** with stations in Loch Fyne, and continued throughout the day in Bute Sound, the Clyde entrance and around the Arran Deep in strong squally winds. The grid of stations was completed on the Outer Plateau at 0632h **12 March**, and with further forecasts of continuing westerly gales, the ship steamed via the Sound of Islay to the Sound of Mull to stand by in the vicinity of the Tiree Passage mooring in hopes of a lull in the weather between depressions.

During **13 March** "Challenger" remained in the Sound of Mull in winds which gusted to 65kt, anchoring for a period in Scallastle Bay. At 0848h **14 March** the weather had moderated sufficiently for course to be set for the Tiree Passage mooring. This was reached at 1112h and recovery began in force 7 westerly winds at 1336h and was complete by 1416h. A replacement mooring was laid between 1627 and 1632h and the ship returned to the western entrance to the Sound of Mull to begin CTD and water bottle stations on the section westwards to the shelf-edge. The first of these stations, 1G, began at 1739h and work continued overnight and the following morning across the Sea of the Hebrides in deteriorating weather until 1330h **15 March**, when the ship hove-to on the position of station 15G. Westerly gales continued during the following 24hrs, with vicious snow and hail squalls in which the wind gusted to 65kt, and with further gales forecast, it was decided at 1318h **16 March** to make for the shelter of the Outer Hebrides. Barra Head was rounded at 1847h and the ship dodged off South Uist overnight.

Opportunity was taken on the morning of **17 March** to take an Agassiz trawl haul off Skye between 0942 and 1034h. Winds, although still squally and westerly, had decreased generally to forces 6-7, and courses were set to resume work along the section. Station 15G was begun at 1809h, but the cable joint of the CTD wire became broken and had to be remade. The fluorometer had also become faulty and was removed, the station being finally completed at 2004h. Overnight and throughout **18 March** CTD and water bottle sampling continued westwards in rather marginal weather conditions. At 1800h contact was made with the release of the temperature and salinity recorder mooring laid on 7 September 1993, but in view of the rough sea and swell state it was agreed to leave recovery until cruise 112 in May.

The eastern half of the Anton Dohrn Seamount section was completed at station J at 0720h 19 March, by which time it was necessary to begin the return eastwards. It had been the intention to work three stations at intermediate positions between stations O to R, but sea and swell had increased by the time water bottle sampling was complete at P1 at 1424h, so scientific work was terminated and "Challenger" headed for the Sound of Mull, where the ship was hove-to during the early hours of 20 March. Subsequently courses were set for Oban, where the ship berthed at the North Pier to discharge staff and gear at 1030h, sailing again for Barry at 1300h.

**General results:** (see also individual topic reports below)

**Aim 1)** The eastern half of the Anton Dohrn Seamount CTD section (stations J to R) was worked between 2316h 17 March and 0720h 19 March. Figures 2a-d show the preliminary property distributions from the Sea-Bird CTD. The profiles suggested that the strong westerly gales and low air temperatures were currently maintaining mixing to depths of 300 to 600m, but towards the seamount at stations M to K a colder homogeneous layer with even higher oxygen content existed beneath this upper layer and extended down to depths slightly greater than 900m (see Figures 2d and 3). This would seem to be either the signal of deep mixing somewhat earlier in the winter, or of water advected from a region of the Rockall Channel with shallower depths or colder air temperatures. A likely source is the circulation around the crest of seamount itself, where increased heat-loss to the atmosphere is possible because the depth limits overturning to about 550 to 700m.

**Aim 2)** The Sea-Cat temperature-salinity recorder and thermistor chain mooring was found to be in position and the acoustic release responded at a range of 3.5km. Because of the rough sea and swell conditions, which would have made it difficult to sight the mooring on the surface and would have increased the danger of damage to some of the buoyancy spheres, it was decided to leave the mooring in place for recovery in May.

**Aim 3)** The Tíree Passage current meter mooring was serviced on 14 March. The mooring had been interfered with since deployment on 10 September 1993 and the snap shackle of the meter wire had been attached to the spar buoy chain close to the spar buoy anchor. However, all equipment apart from the pick-up line was recovered, and on first examination the current meter records appear to be useable. Details of the replacement mooring, laid in soundings of 46m with two current meters at 10 and 20m from the sea-bed, are given in Figure 4.

**Aim 4)** The continuing westerly gales gave no opportunity to visit the SAMS permanent benthos site west of Ireland, or to obtain epibenthic sled or Agassiz trawl samples at station M. An Agassiz haul was obtained south of Neist Point, Skye on 17 March to collect decapods to investigate their adaptation to varying light levels, and a report is given below.

**Aim 5)** The generally poor weather left no time for detailed shelf-edge sections or for box-coring. However, water bottle sampling was carried out across the shelf/slope/deep-water region in the course of working the Anton Dohrn Seamount section.

**Aim 6)** 13 water bottle sampling stations were worked across the shelf on the standard section from the Sound of Mull to the shelf-edge west of Barra during 14 - 17 March. Uncorrected sections from the CTD stations are shown in Figure 5a-4e. Details of the samples taken are given below in the individual reports. 5-minute position, temperature and chlorophyll values were logged from a fluorometer run in a deck tank fed continuously by the ship's non-toxic supply and calibrated from samples taken at each station. Chlorophyll profiles were taken with a fluorometer mounted upon the CTD at stations out to 15G, where it failed.

**Aim 7)** The basic PROFILE station grid of 25 CTD and water bottle stations in the Clyde Sea area was worked at the beginning of the cruise during 10 - 12 March. In the prevailing windy conditions, water over the Great Plateau was well mixed, with water of temperature 6.2°C and salinity close to 33.6 psu which was descending into the Arran Deep.

**Aim 8)** Clean oceanic seawater was collected from the vicinity of Anton Dohrn Seamount for the Culture Collection on 19 March.

## **Individual topic reports**

### **1) Nutrient sampling**

Nutrient measurements were carried out on water samples taken at 22 stations between Rockall and the Sound of Mull, including the LOIS Shelf-Edge Study (SES) area, and at 18 stations in the Clyde Sea area.

Analyses were made of nitrate (plus nitrite), phosphate, silicate and ammonium using the Autoanalyser. No major problems were encountered and full coverage was obtained.

B.E. Grantham

### **2) Visual function and adaptation in decapods**

It was hoped that the biological sampling planned for this cruise would provide samples of reptantian decapods from depths comparable to the domain of mesopelagic natantians. Unfortunately the weather prevented trawling at station M. However, a short Agassiz tow (20 min. at 138m) in the Sea of the Hebrides provided some useful and interesting specimens. The most abundant decapods in the haul were *Calocaris macandrea* (237), *Plesionika heterocarpus* (25) and *Nephrops norvegicus* (21). Other animals caught were *Crangon allmani* (2, one berried), *Pasiphea* sp. (2), *Goneplax* sp. (2) and *Macropipus holsatus* (1).

The eyes of *P. heterocarpus* and *Pasiphea sp.* were videod along dorso-ventral and antero-posterior axes under coaxial illumination. After image analysis this will provide information on their sensitivity to incident light from varying directions. All specimens were fixed in formal saline, Kamovsky's solution or 5% gluteraldehyde in decapod ringer. The eyes of *P. heterocarpus*, *C. allmani*, *Pasiphea sp.* and *C. macandrea* will be observed under an interference microscope and sectioned for light and electron microscope examination. The crabs *M. holsatus* and *Goneplax sp.* will provide useful material for Dr. E. Gaten (Leicester). The *N. norvegicus* may be used by M. Belchier (Leicester) who is looking at age pigments (lipofuscin) in the brains of commercially exploited decapods.

Magnus Johnson (Leicester University and IOS)

### Acknowledgements

We thank Captain Plumley, his officers and crew for helping us to make the maximum scientific use of indifferent weather. Persistence in our attempts to work over deep water were well rewarded by obtaining the observations of unusually deep mixing during this winter.

D.J. Ellett

8 April 1994

**Table 1. RRS "Challenger" Cruise 110/1994 : Station List**  
(Times and positions refer to start of CTD lowerings where taken)

Date 1994	Start GMT	Stn.	Lat. N. ° ' "	Long. W. ° ' "	Sdg. (m)	CTD Dip no.	w/bs	Notes	
Firth of Clyde stations									
10 Mar	1715	CS13	55 25.9	05 29.0	60	001	4	-	-
	1857	CS12	55 30.1	05 26.2	87	002	6	-	-
	1942	CSE	55 34.6	05 25.3	111	003	6	-	-
	2116	CS11	55 40.3	05 25.1	120	004	6	-	-
	2204	CS10	55 42.6	05 20.0	123	005	6	-	-
	2334	CS9	55 46.0	05 15.6	128	006	6	-	-
11 Mar	0812	LF2	55 50.7	05 20.0	179	007	-	-	-
	0900	LF3	55 53.4	05 22.9	178	008	7	-	-
	1140	CS8	55 42.0	05 09.1	166	009	7	-	-
	1308	CE2	55 46.7	04 58.8	89	010	5	-	-
	1410	AB35	55 49.5	04 58.8	68	011	-	-	-
	1535	AD1	55 39.7	04 56.5	78	012	-	-	-
	1612	CS7	55 38.3	05 01.9	164	013	7	-	-
	1757	CS6	55 31.8	04 59.3	112	014	6	-	-
	1837	AD2	55 31.1	04 53.0	81	015	-	-	-
	1939	CS5	55 26.6	05 01.3	116	016	6	-	-
	2035	AD4	55 25.3	04 56.9	71	017	-	-	-
	2113	AD5	55 23.9	04 51.7	60	018	-	-	-
	2229	CS4	55 21.8	05 04.6	65	019	5	-	-
	12 Mar	0025	CS14	55 22.5	05 18.9	57	020	5	-
0128		CS3	55 17.9	05 11.2	53	021	4	-	-
0250		CS2	55 13.7	05 15.5	52	022	4	-	-
0345		CS1	55 09.5	05 22.4	69	023	5	-	-
0531		CS15	55 17.0	05 27.8	44	024	4	-	-
0613		CS16	55 14.6	05 33.2	79	025	5	-	-
Tiree Passage current meter mooring									
14 Mar	1336	Y	56 37.5	06 24.2	45	previous mooring recovered			
	1629	Y	56 37.6	06 24.2	46	current meter anchor laid			
	1632	Y	56 37.7	06 24.2	44	spar buoy anchor laid			
Sound of Mull - shelf-edge section									
14 Mar	1804	1G	56 40.2	06 08.3	81	026	5+2Cs	-	-
	1850	2G	56 41.1	06 17.0	45	027	4+2Cs	-	-
	1936	3G	56 42.6	06 22.3	-	surface salinity sample only			
	2023	4G	56 44.0	06 26.7	83	028	5	-	-
	2118	5G	56 44.0	06 36.0	-	surface salinity sample only			
	2202	6G	56 44.0	06 45.0	50	029	4	-	-
	2351	7G	56 43.8	07 00.2	145	030	7	-	-
	15 Mar	0046	8G	56 44.0	07 10.1	-	surface salinity sample only		
0130		9G	56 44.0	07 20.1	161	031	7	-	-
0316		10G	56 44.0	07 29.8	215	032	8	-	-
0450		11G	56 43.8	07 39.7	71	033	5	-	-
0639		12G	56 45.7	07 50.7	-	surface salinity sample only			
0803		13G	56 46.9	08 00.2	126	034	7	-	-

w/bs = no. of water bottles

2Cs = 2 large-volume samples for radiocaesium

**Table 1 (continued). RRS "Challenger" Cruise 110/1994 : Station List**  
(Times and positions refer to start of CTD lowerings where taken)

Date 1994	Start GMT	Stn.	Lat. N. ° ' "	Long. W. ° ' "	Sdg. (m)	CTD Dip no.	w/bs	Notes	
Sound of Mull - shelf-edge section (continued)									
15 Mar	0927	14G	56 48.2	08 10.0	-			surface salinity	sample only
	1047	T	56 50.2	08 20.0	137	035	7	-	-
Ship hove-to for weather									
16 Mar	1000	-	56 52.4	08 56.4	-			surface salinity	sample only
	1145	-	56 52.5	09 01.4	-			surface salinity	sample only
	1315	-	56 52.4	09 06.5	-			surface salinity	sample only
	1500	-	56 49.1	08 38.6	-			surface salinity	sample only
	1630	-	56 47.0	08 13.0	-			surface salinity	sample only
Agassiz trawl off Skye									
17 Mar	0942	AZ1	57 09.1	06 49.1	-			Agassiz trawl	shot
	1034	AZ1	57 10.0	06 52.1	-			Agassiz trawl	hauled
Sound of Mull - shelf-edge section resumed									
17 Mar	1923	15G	56 52.8	08 30.2	131	036	7	-	-
	2151	S	56 56.9	08 46.8	132	037	7	-	-
	2316	16G	57 00.0	08 59.8	138	038	6	-	-
Anton Dohrn Seamount section									
18 Mar	0123	Q	57 02.8	09 13.3	358	039	6	-	-
	0300	P	57 06.0	09 25.1	1425	040	7	-	-
	0916	O	57 09.0	09 42.2	1959	041	8	-	-
	1322	N	57 14.0	10 03.1	2120	042	7	-	-
	1931	M	57 17.0	10 25.2	2244	043	7	-	-
	2340	L	57 22.9	10 39.9	2138	044	8	-	-
19 Mar	0423	K	57 23.7	10 52.3	791	045	7	-	-
	0616	J	57 26.9	11 05.1	592	046	6	-	-
	1312	P1	57 07.4	09 33.5	900	-	6	-	-

w/bs = no. of water bottles



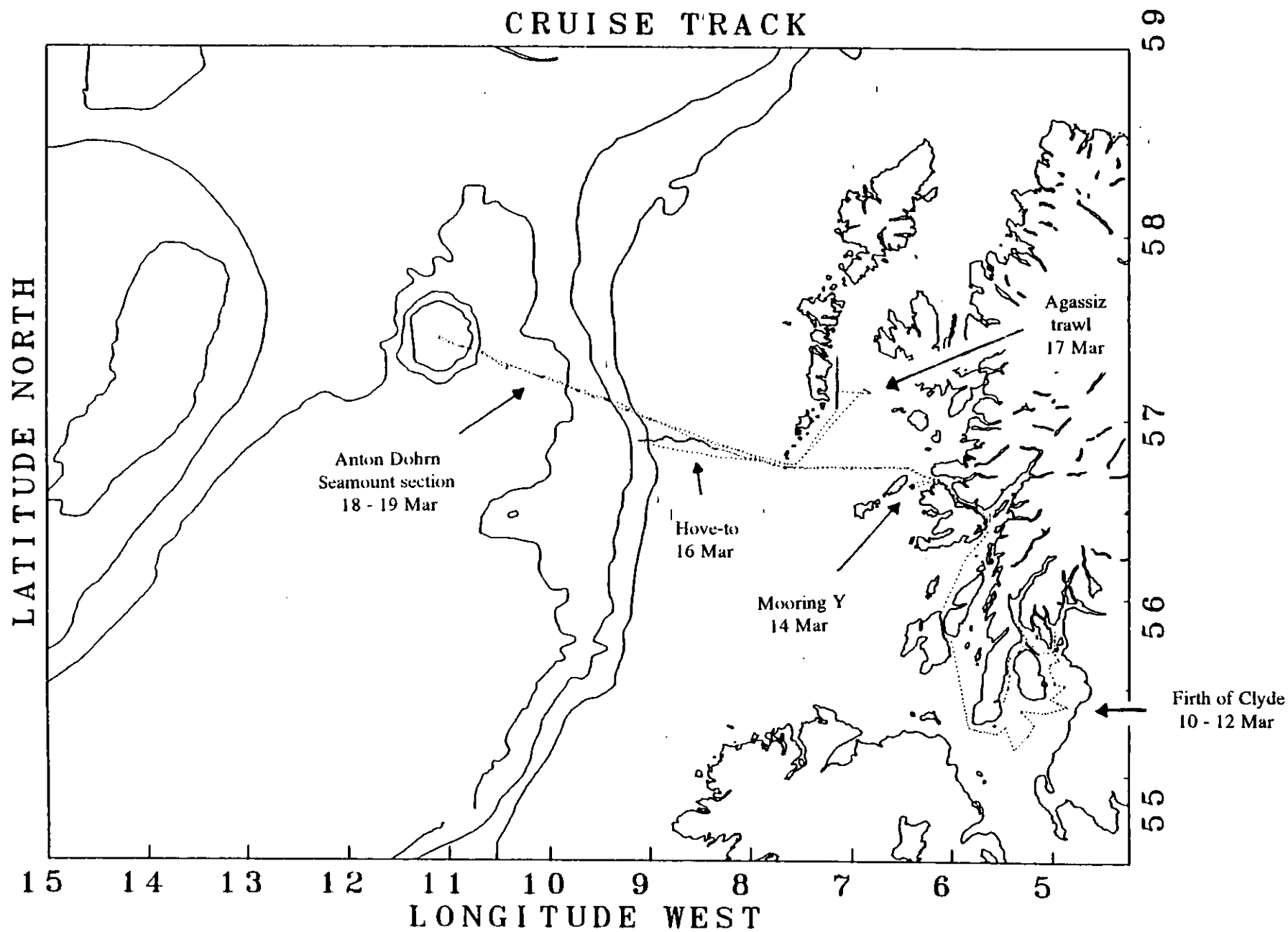


Figure 1. RRS "Challenger", Cruise 110/1994. Ship's track, 10 - 20 March 1994.

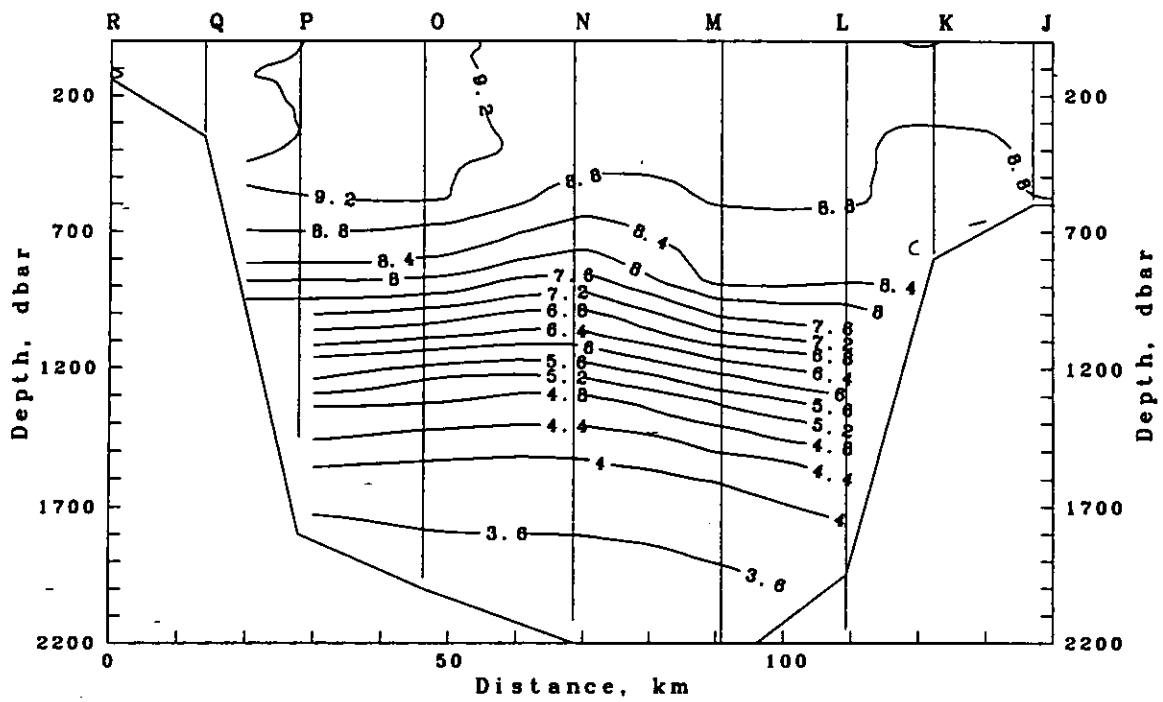


Figure 2a. Anton Dohrn Seamount section, 17 - 19 March 1994. Temperature ( $^{\circ}\text{C}$ ).

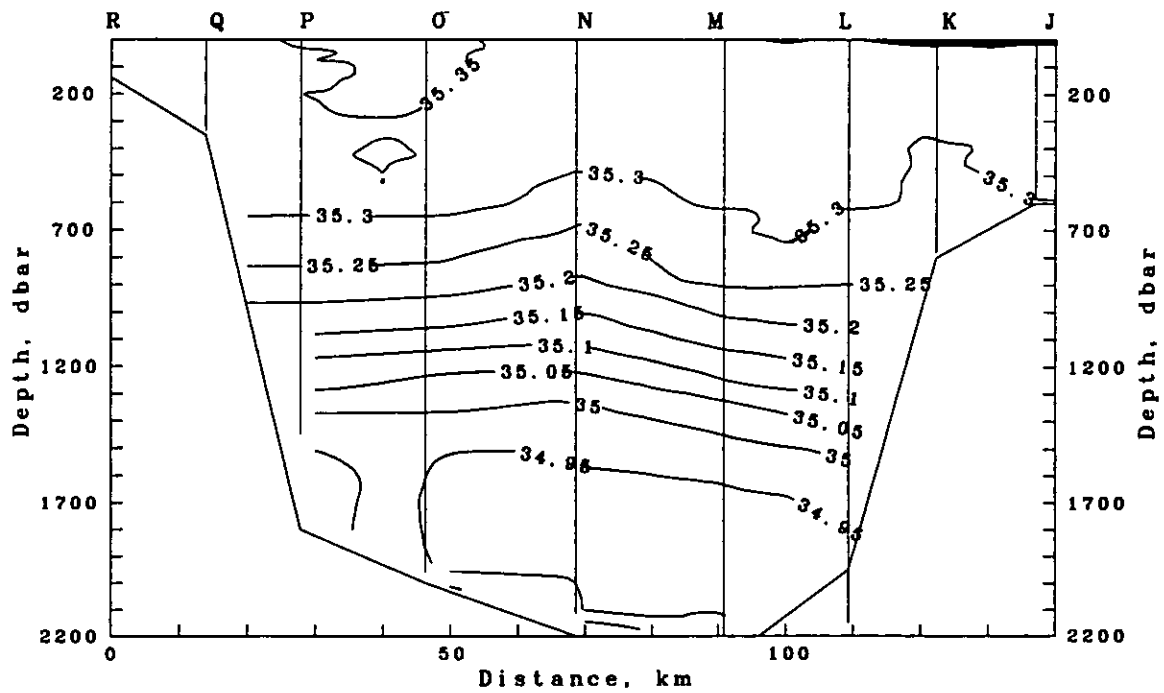


Figure 2b. Anton Dohrn Seamount section, 17 - 19 March 1994. Salinity (psu).

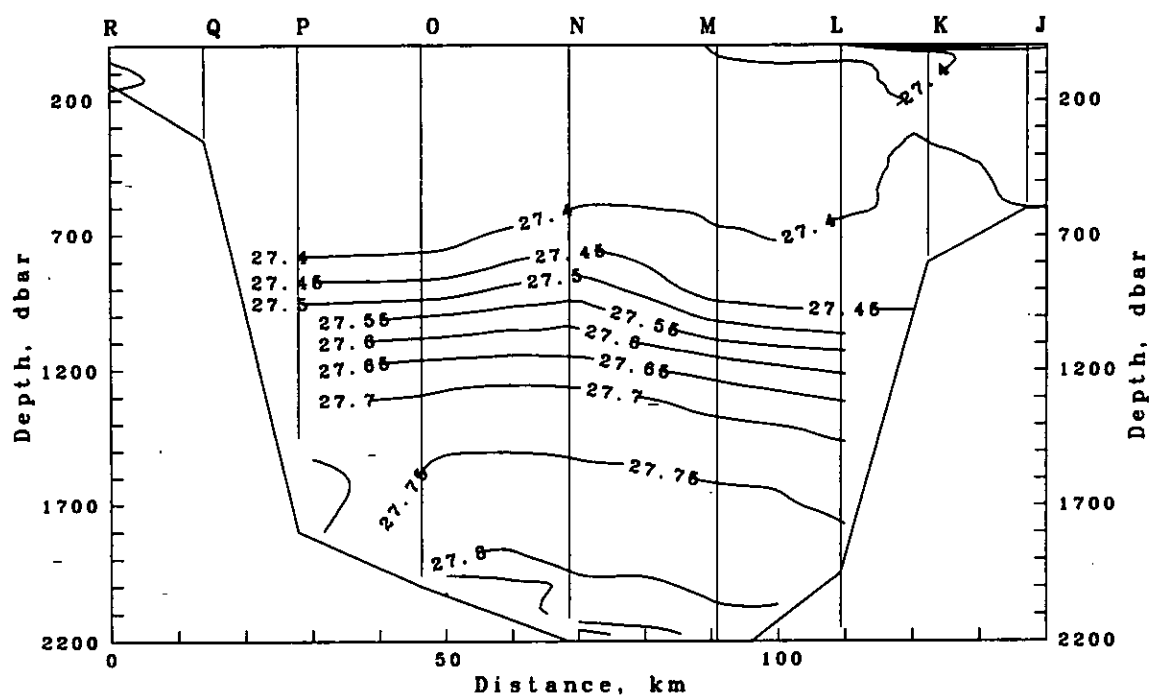


Figure 2c. Anton Dohrn Seamount section, 17 - 19 March 1994. Density ( $\sigma_t$ ).

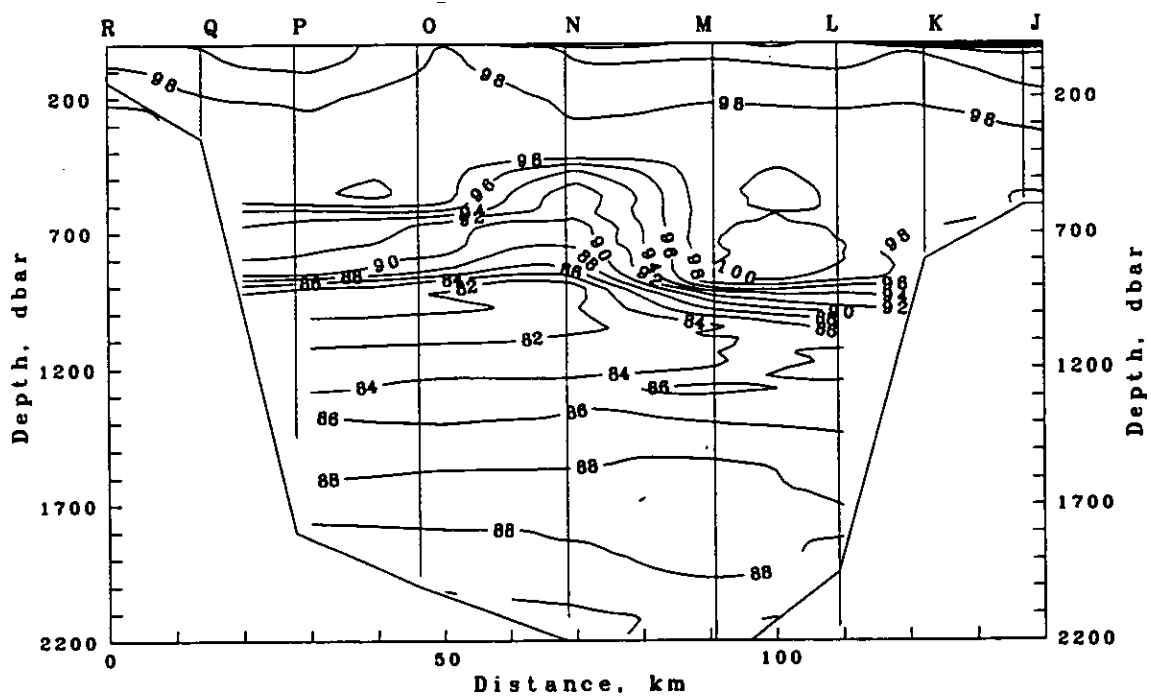


Figure 2d. Anton Dohrn Seamount section, 17 - 19 March 1994. Oxygen saturation (%).

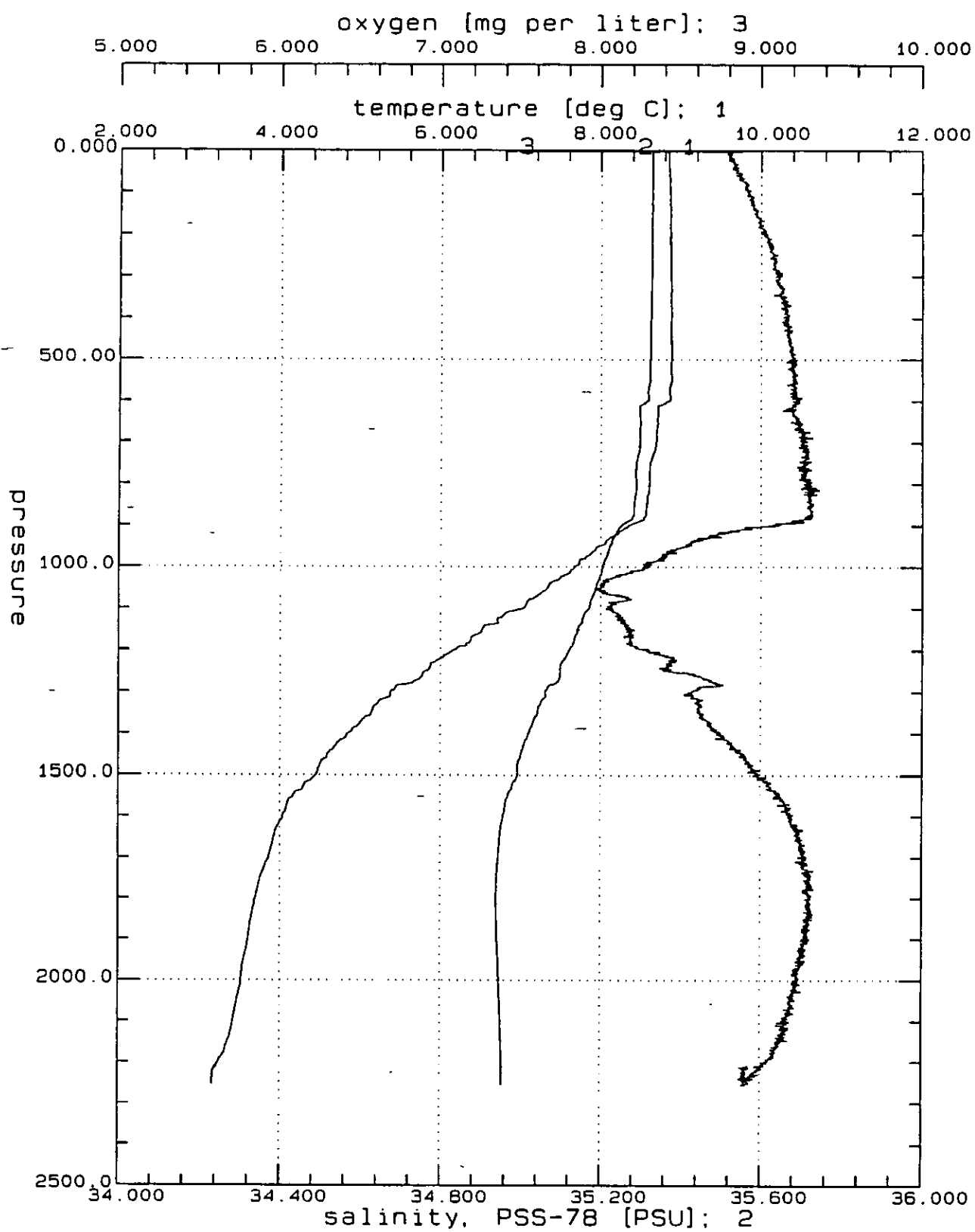


Figure 3. CTD temperature, salinity and oxygen profiles,  
Station M, 18 March 1994.

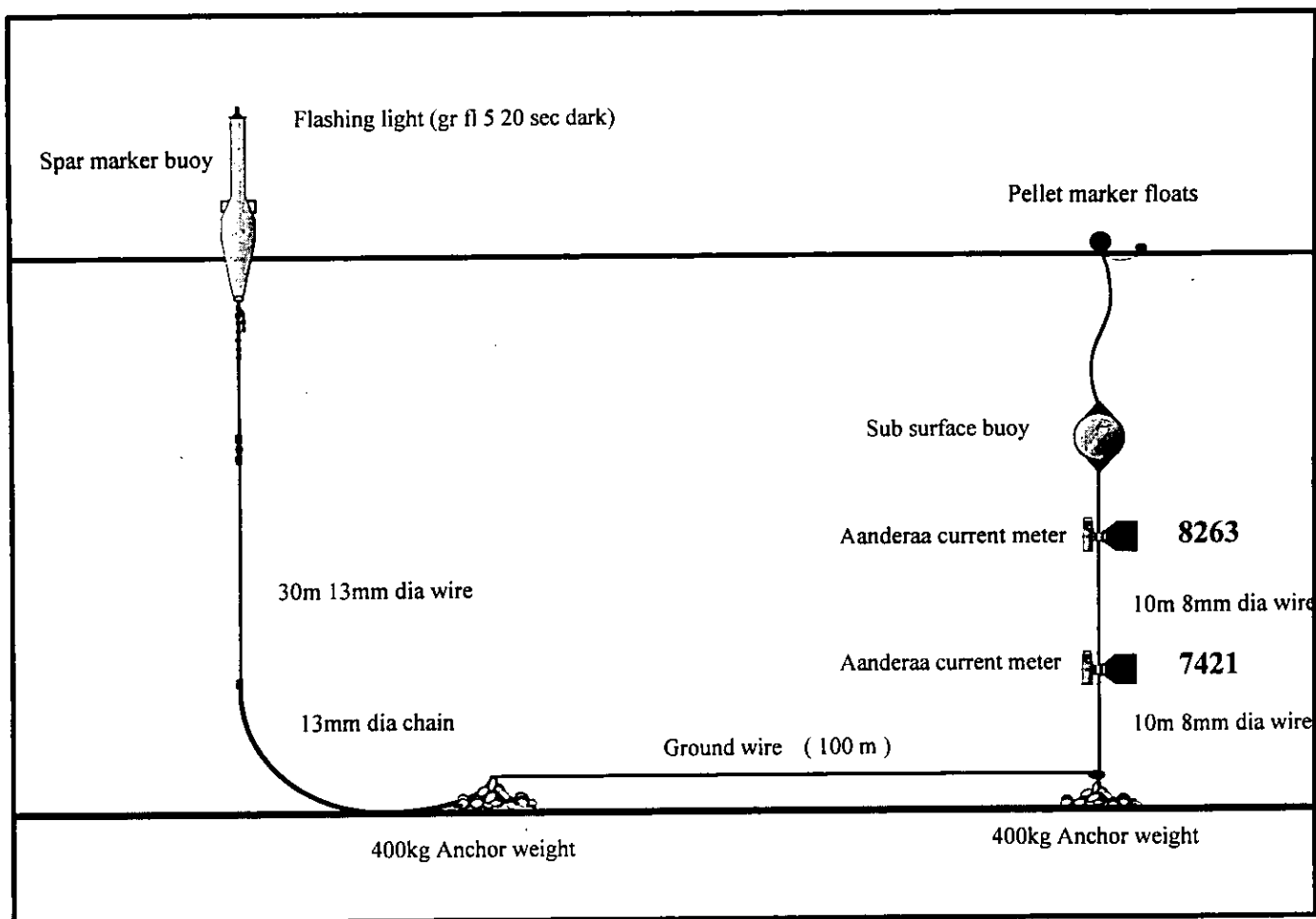


Figure 4. Diagram of mooring Y, laid in the Tiree Passage 14 March 1994.

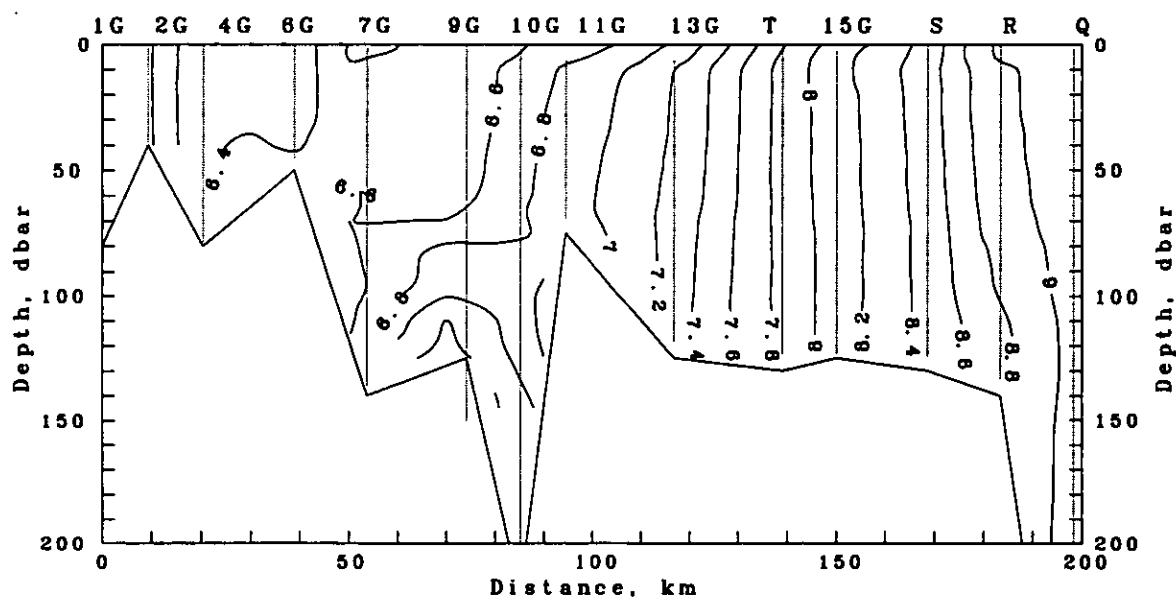


Figure 5a. Sound of Mull - shelf-edge section, 14 -17 March 1994.  
Temperature (°C).

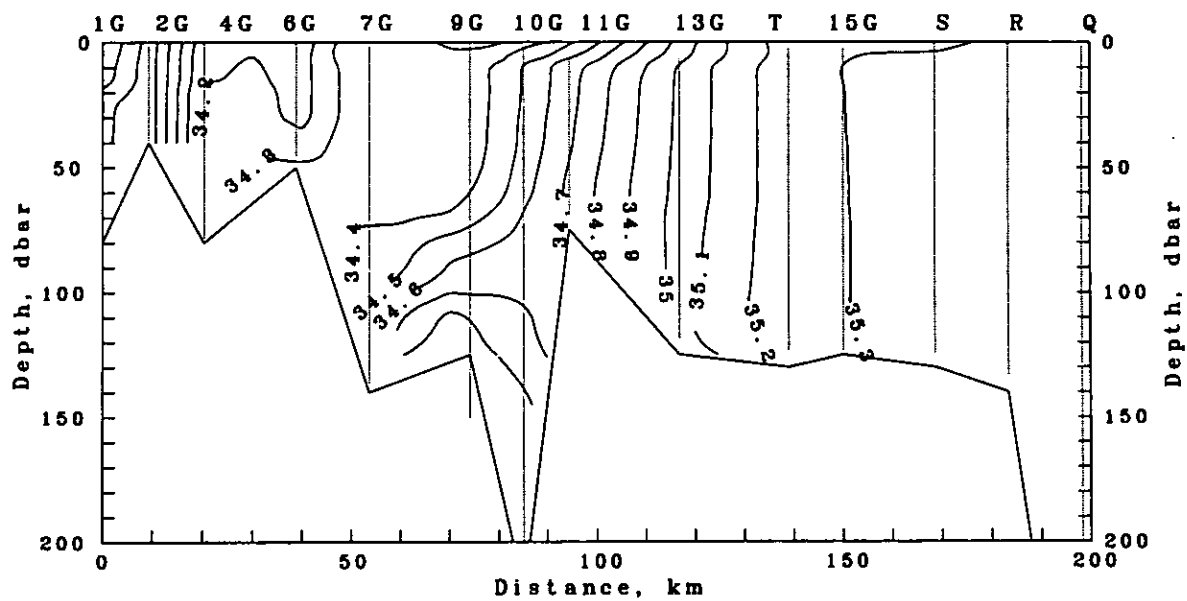


Figure 5b. Sound of Mull - shelf-edge section, 14 -17 March 1994.  
Salinity (psu).

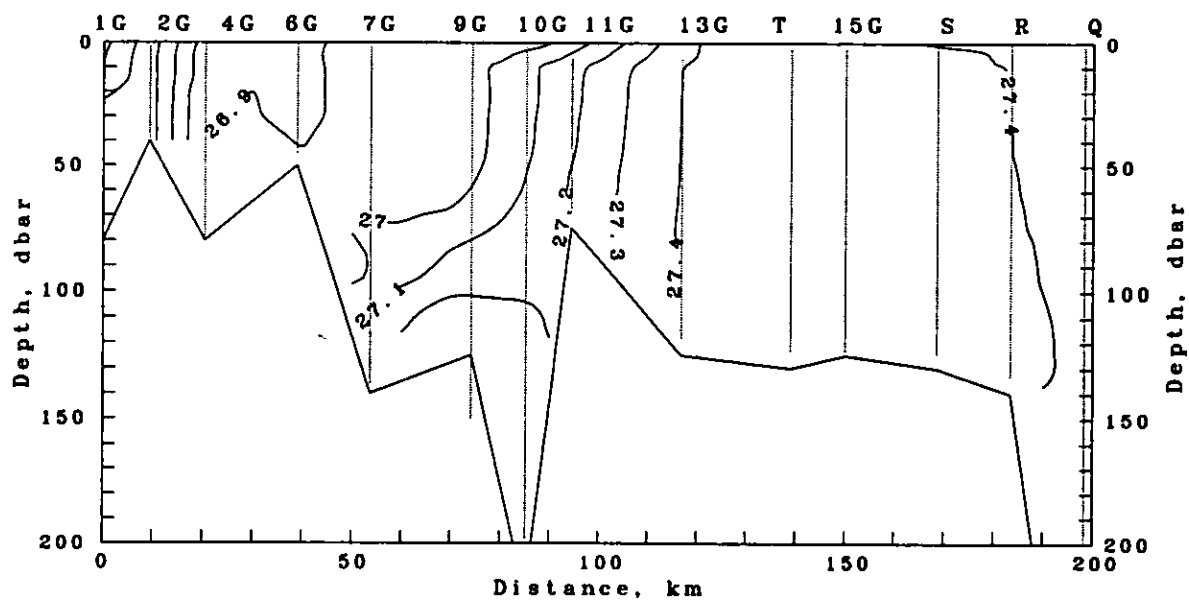


Figure 5c. Sound of Mull - shelf-edge section, 14 -17 March 1994.  
Density (sigma-t).

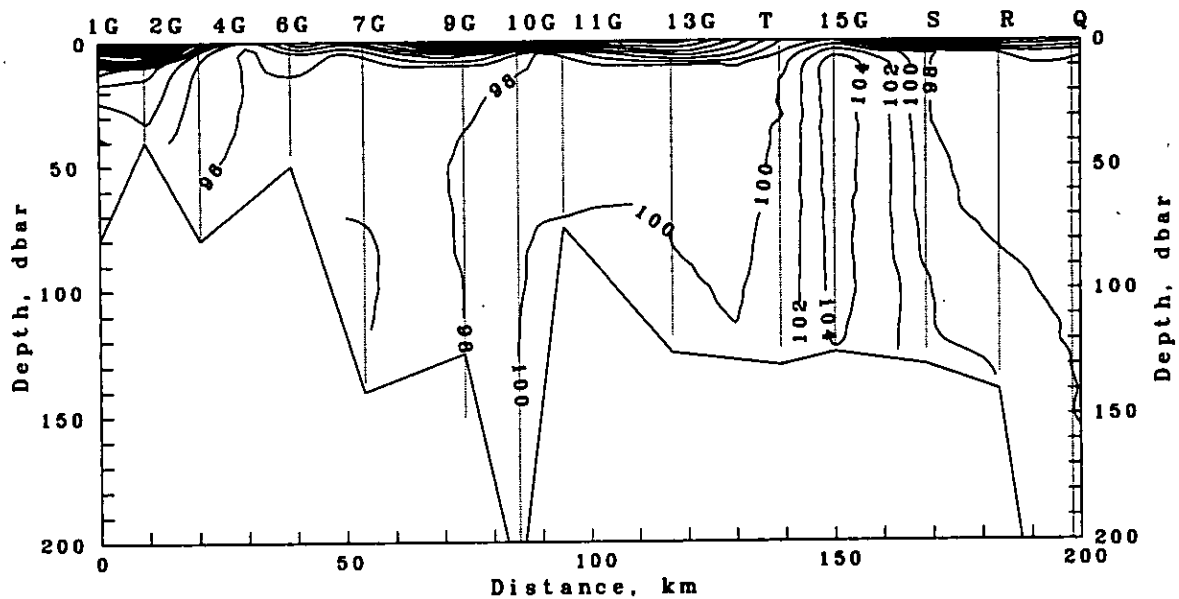


Figure 5d. Sound of Mull - shelf-edge section, 14 -17 March 1994.  
Oxygen saturation (%).

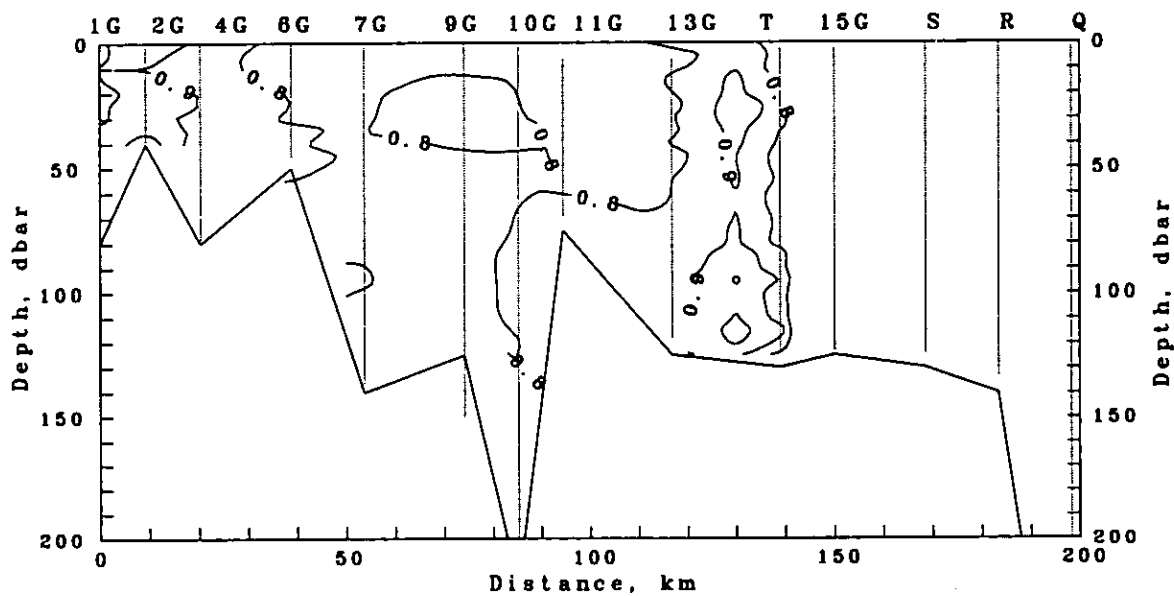


Figure 5e. Sound of Mull - shelf-edge section, 14 -17 March 1994.  
Fluorescence (fluorimeter voltage).