POL CRUISE REPORT NUMBER 27

RRS CHARLES DARWIN CRUISE 110

OCEAN MARGIN EXCHANGE (OMEX II-II)

Leg A: Lisbon to Vigo

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HUTHNANCE, J.M. 1998

Cruise Report *RRS CHARLES DARWIN* 110, 23 December 1997 to 5 January 1998. Ocean Margin Exchange (OMEX II-II).

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ABSTRACT

RRS *Charles Darwin* cruise 110 was one of several planned at intervals of six months or less for the EU MAST project Ocean Margin Exchange (OMEX II-II) focusing on the NW Iberian continental shelf and slope. Aims are to construct and understand the cycles of carbon and associated elements. This involves the transfer of organic carbon, nutrients and other trace elements which may be rapidly deposited to the sediments and buried, and physical processes affecting lateral and vertical transport.

Leg A carried out sea-bed work, mooring deployment and attempted recovery, and systematic mapping of water properties. Five sets of multi-cores were obtained, one short Kasten core, and associated sea-bed photographs with a bed-hop camera at three sites. There was extensive sampling with a Shipek grab over the Spanish shelf sector. Mooring work primarily amounted to deployment of STABLE. An ADCP mooring intended for redeployment was not found. A current meter line mooring was located but not recovered or replaced. Underway recording included monitoring by ship-borne ADCP, of the non-toxic supply for near-surface temperature, salinity, transmittance and fluorescence, and of PAR. 39 CTD profiles and (in poorer conditions) 60 XBT profiles were obtained. With the CTD were transmittance (´ 2), optical backscatter, fluorescence and dissolved oxygen; also irradiance on some profiles. Water bottle samples were taken for salinity (only). 22 plankton net hauls were taken. There was some bias towards the shelf and slope rather than deep-water locations. The cruise was adversely affected by poor conditions: mooring work or coring were only possible on three days out of 12 in the working area; CTD profiling less than half of the time.

ACKNOWLEDGEMENT. The scientific party extends warm thanks to the Master, R. Bourne, officers and crew of RRS *Charles Darwin* for their help and co-operation during the cruise, and to RVS for its support, all willingly given and making the scientific work possible.

KEYWORDS

IBERIAN MARGIN ATLNEIBE OMEX
HYDROGRAPHY MOORINGS SAMPLING CORES
CONTINENTAL SHELVES CONTINENTAL SLOPE EXCHANGE

CONTENTS

		Page No.
1.	OBJECTIVES	7
2.	SUMMARY	8
3.	PERSONNEL ON BOARD	9
4.	NARRATIVE	10
5.	TECHNICAL REPORTS	15
5.1	Multi-coring	15
5.2	Kasten coring	15
5.3	Bed-hop camera	15
5.4	Shipek grab	15
5.5	ADCP mooring	15
5.6	Current meter line mooring	16
5.7	STABLE	16
5.8	Ship-borne ADCP	16
5.9	Underway recording	17
5.10	CTD	17
5.11	XBT	17
5.12	Satellite imagery	18
5.13	Particles	18
5.14	Plankton net	18
5.15	Ship systems	18
5.16	Computing	19
6.	CONCLUSIONS	20
TABLES		
1	Grab samples	21
2	Cores	24
3	Camera stations	24
4	Moorings	24
5	Net hauls	25
6	CTD casts	26
7	XBT casts	27
FIGURES		
1	Track plots	29
2	Coring, grab, camera and mooring locations	31
3	Plankton net haul locations	32
4	XBT, CTD and water sampling stations	33

1. OBJECTIVES

Overall OMEX objectives are to construct and understand the cycle of carbon and associated elements along the Iberian coast, dominated by variable upwelling processes. This involves the transfer of organic carbon, nutrients and other trace elements which may be rapidly deposited to the sediments and buried, and the study of physical processes affecting horizontal and vertical transport.

Specific Objectives for *RRS Charles Darwin* Cruise 110 Leg A were:

Leg A1

A1.1 Recover Galway current meter mooring and ADCP (ADCP at about about 160m water depth near 42º41'N and current meter "string" at about 700m water depth near 42º40'N).

A1.2 Redeploy current meter mooring.

A1.3 Deploy STABLE near 42º40'N at a depth suggested by slope and stratification as likely for enhanced internal waves (probably between 160 and 200 m depth).

A1.4 Bed-hop camera, especially in association with coring.

A1.5 a) Kasten coring b) Multi-coring (with subsamples for other partners). The objective was to get Kasten cores on six designated sites. Good cores from the Douro/Ave and Minho muddy deposits and from the Galician shelf, as well as from the upper slope, would complement data already obtained from this shelf in past years, hopefully enabling clarification of problems related to the genesis, accumulation history and present behaviour of these deposits. Sampling of muddy deposits would enable knowledge of the variability of sediment transfer from land to shelf, relating it to climate variability as well as to human activities in the river basins. Sampling on the upper slope enables study of sediment transfer from the shelf to deeper zones. Later sampling on Vigo seamount, Valle Inclan depression and abyssal plain would help in knowing the fate of these sediments.

Sampling on the Portuguese and Galician margin would help the comparison between a margin with good sediment supply (Portuguese) and a margin with almost no supply (the Galician rias are mainly sediment traps at present).

These will enable study of temporal as well as spatial variability.

For undisturbed samples, multicores were wanted in some locations.

Objectives were six stations for coring with Kasten corer and / or multi-corer for complementary studies of the sedimentary sequences (sets), sedimentary figures (erosional and depositional evidence) by X Ray radiography and numerisation of images from a core retained at each station for University of Bordeaux. Also spectro gamma analyses were to be intercalibrated with other partners involved.

One tube from each location on 41º48'N was to be retained for CFR.

A1.6 Shipek grab samples - as many as possible, to improve the sedimentological map from the Galician and Minho shelf.

A1.7 CTDs and water samples as required in association with the above and at reference

stations as time allowed. (Top priority "reference" stations are at 42º09'N, 42º40'N, 43ºN at water depths 100, 200, 1000, 2000 m; also at 42º09'N in the ria mouth and "oceanic" 100 km offshore.)

A1.8 Continuous ADCP and non-toxic supply: monitoring, bi-hourly sampling.

A1.9 Systematic coverage with XBTs to fill in the CTD grid.

A1.10 Plankton net hauls repeating stations occupied on CD105 (summer 1997).

Leg A2
A2.1 Redeploy ADCP mooring in same location

A2.2 Kasten coring and multi-coring (with subsamples for other partners) - as A1.5 with the addition of multi-cores near 42º40'N, 200m and the shallower sediment trap mooring for CFR.

A2.3 Shipek grab samples, see A1.6.

A2.4 CTDs as required in association with the above and at reference stations as time allows, see A1.7, with samples for particle analysis at selected stations.

A2.5 Continuous ADCP and non-toxic supply: monitoring, bi-hourly sampling.

A2.6 XBTs as A1.9 and plankton net hauls as A1.10.

2 SUMMARY

Five sets of multi-cores were obtained, one short Kasten core, and associated sea-bed photographs with a bed-hop camera at three sites partially meeting objectives A1.4,5. There was extensive sampling with a Shipek grab over the Spanish shelf sector (A1.6).

STABLE was deployed (A1.3) but the ADCP intended for redeployment (A2.1) was not found; the current meter mooring was located but not recovered (A1.2) nor replaced (A1.1).

Underway recording included monitoring by ship-borne ADCP, of the non-toxic supply for near-surface temperature, salinity, transmittance and fluorescence, and of PAR (A1.8).

39 CTD profiles were obtained, only partially fulfilling A1.7. In poorer conditions 60 XBT profiles were obtained (A1.9). With the CTD were transmittance (x 2), optical backscatter, fluorescence and dissolved oxygen; also irradiance on some profiles. Water bottles were taken for salinity (only). 22 plankton net hauls were taken (A1.10). There was some bias towards the shelf and slope rather than deep-water locations.

The cruise was adversely affected by poor conditions: mooring work or coring were only possible on three days out of 12 in the working area; CTD profiling less than half of the time.

3. PERSONNEL ON BOARD

(noting if Leg A1 or A2 only)

Scientists

J.M.	Huthnance (PS)	POL
J.D.	Humphery	POL
S.C.	Kwong	POL (A1)
J.	Xing	POL (A1)
J.	Holt	POL (A2)
P.	Axe	POL (A2)
M.	White	UCG
T.	Furey	UCG
A.C.	Garcia	UAlg
P.M.	Pedro	UAlg
S.	Schmidt	CFR (A2)
R.A.	Phipps	RVS
S.	Mitchell	RVS (TLO)
D.R.	Turner	RVS
J.R.	Benson	RVS
P.A.	Duncan	RVS
P.	Howarth	RVS

Officers and crew

R.A.	Bourne	Master
R.A.	Warner	C/O
P.T.	Oldfield	2nd Officer
J.C.	Holmes	3rd Officer
A.P.	Adams	Chief Eng.
B.J.	McDonald	2nd Engineer
J.R.	Crosbie	3rd Engineer
P.G.	Parker	Elec. Engineer
J.G.	Baker	Radio Officer
M.	Trevaskis	CPO (Deck)
M.A.	Harrison	Seaman PO
T.R.	Edwards	Seaman
J.R.	Perkins	Seaman
G.	Cooper	Seaman
D.G.	Buffery	Seaman
A.	Healy	Motorman
R.	Bell	SCM
C.K.	Perry	Chef
A.S.	Duncan	M/Steward
W.J.	Link	Steward
S.E.	Carter	Steward

4. NARRATIVE

(All times GMT). See Figure 1 for general area map and cruise tracks.

23/12/97 (Julian Day 357). RRS *Charles Darwin* left the Lisbon quayside (Santa Apolonia) at 1140. Depth recording had begun at 1100, ADCP recording began at 1200 and the thermosalinograph from the non-toxic supply at 1540. Muster drill was held at 1615. This was all *en route* to the first coring site near 41º20'N, 90º0'W.

24/12/97 (Julian Day 358). Position "W90" was reached at 0455 and a CTD station carried out (0455-0510) followed by a Shipek grab sample revealing mud (0540-0550). This gave confidence for a Kasten core (0625-0635; about 75 cm core in the 1 m barrel) followed by a multi-corer deployment (0735-0745) giving 15-30 cm cores. After regaining position, the POL bed-hop camera was deployed for an estimated 25 photographs of the bottom while drifting northwards about 1 mile (0850-0950). Course was made westwards in worsening conditions which caused an XBT to be carried out *in lieu* of a CTD at "W130" (1150-1200) before investigating the next prospective coring site "W300". After overshooting and regaining the desired depth, a CTD station (1340-1410) was followed by two attempts with the Shipek grab (1430-1445, 1455-1515) but with only a small sample of fine sand in the first case and none in the second. After a further CTD station at nominally 1000m depth (1730-1810) during which it was difficult to hold station, a sequence of XBTs was started with "W2000" (2025-2030).

25/12/97 (Julian Day 359). The XBT sequence was continued in winds up to gale force and considerable swell at U2000 (0055), T2000 (0310), S2000 (0450), R2000 (0650), Q2000 (0855). Thus progress was made towards the mooring and other coring sites, should the weather permit such work. However, conditions continued to be unsuitable for moorings or coring owing to the combination of wind and waves, and XBTs were continued at P2000 (1110), O2000 (1300) and N2300 (1440). During this time, Christmas Day was marked by three sittings of Christmas lunch with all "trimmings"; scientists, officers and crew being served together. At N2300, alignment of the wind and waves allowed a CTD station (1455-1620). Continuing eastwards along this northernmost OMEX "N" line, a CTD cast was carried out at N1600 (1700-1800) and at N220 (1900-1920) followed by two sampling attempts with the Shipek grab (1925-1940; 1940-1955); very little sample was obtained either time. Two small Shipek grab samples were obtained at N170 (2040-2050; 2055-2105). At N100, a CTD profile was obtained (2145-2235) but only after a wave had caused the cable to jump out of a sheath, the Shipek grab recovered a small amount of sand (2240-2250) and a full sample of mud (2255-2305) and a UCG plankton net haul was carried out (2310-2320).

26/12/97 (Julian Day 360). On reaching the next OMEX "O" line at O100, an XBT profile was obtained (0215, showing mixing to the bottom but cooler surface water) and two attempts at Shipek grab samples were made (0220-0225; 0230-0235) - a small sample of sand was obtained. At O140, the grab recovered sandy mud and worms (0335-0345). Operations at O175 were delayed by bad weather; then an XBT cast (0610) was followed by two attempts at Shipek grab sampling (0630-0635; 0650-0655) - the second recovered a good sample of mud. At O1000 there were problems establishing signal connections with the XBT, so a net haul was carried out first (0855-0900); a successful XBT profile was then obtained (0915).

Course was made to the "P" line at moderate speed in continuing heavy swell. An XBT cast at P1000 (1235) was followed by successful acoustic contact with the release on the 700m current meter line mooring (range 2518m). An XBT cast at P200 (1320) was followed by Shipek grab sampling (1330-1345; 1350-1405; 1415-1430) - after two attempts with no recovered sample the third recovered sand. Attempts to make acoustic contact with the "trawler-proof" ADCP in 160m on the P line were unsuccessful. At P130 the Shipek grab recovered mud (1615-1625). In slightly eased conditions a CTD profile was obtained at P100 (1735-1745) but this proved that conditions remained marginal with much swinging of the frame before recovery on to the deck. A wave washed over the starboard deck during the subsequent Shipek grab deployment (1750-1800) which recovered a good sample. To avoid taking the westerly weather on the starboard deck, course was made to the outer end of the next "Q" line. An XBT cast at Q2000 (2245) commenced the eastward line.

27/12/97 (Julian Day 361). The Q line was continued with XBTs at Q1000 (0045), Q600 (0115) and Q130 (0210) where a Shipek grab sample was also obtained (0215-0225). At Q100, an XBT (0305) was followed by two attempts at Shipek grab sampling (0310-0320; 0320-0325) yielding yellow coral the second time. The next "R" line was started at the inshore end (R100) with winds down to force 3-4 but still 3-4m swell amplitude. An XBT (0450) and Shipek grab sample (0455-0505) were taken, and likewise an XBT (0630) and Shipek grab sample (0635-0645) at R150. Improved conditions at R200 permitted a CTD (0730-0755) followed by two attempts at Shipek grab sampling (0800-0820; 0820-0835; the first proved not to have been triggered, probably through a large wire angle and consequent lack of contact with the bottom). A plankton net haul was also carried out (0840-0845). The wind was forecast to increase again later; it was decided that the next few hours might afford the best opportunity to deploy STABLE, despite the continuing swell; course was made back to the P line. Thanks to good preparation with plenty of constraining lines, STABLE was deployed smoothly near P200 (1110-1120) and the acoustics were contacted satisfactorily on the bed (as a rehearsal for recovery by RVS staff). A CTD was carried out nearby (1205-1220) confirming continued stratification in just 172m water depth. An attempt was then made to recover the UCG current meter line mooring in an estimated 686m depth. The release was contacted and set to release (1300) but even at 1415 still appeared to be in position on the bottom; in fact the closest approach gave 628m range from ship position 42º40'10.5"N 09º34'21.8"N suggesting ~ 1 cable up-slope displacement to NNE from the *a priori* estimate. As the release command had been tried many times, it appeared that either lack of buoyancy or some hindrance to release prevented the rig rising. The release was closed again to leave the rig for possible dragging another day.

During the search for the mooring a sharp coast-parallel front was noticed. The underway thermosalinograph also showed marked changes between cooler fresher (<150, <34psu) and warmer saltier (~15.80C, ~36psu) surface waters.

An acoustic search for the ADCP was then started (1510), concluding at 1715 without success after interrogation in good conditions from several directions including directly above the expected (deployment) position. Another front marked by a thin line of foam was noted here. As conditions remained good except for the large but long-period swell, course was made towards intended coring positions on line "S". A CTD station at S300 (2030-2050) was followed by two attempts with the Shipek grab (2100-2110; 2115-2135) showing muddy sand. In view of this the following multi-corer deployment (2150-2210) used only eight tubes, to minimise the number at risk if penetration was poor. In fact, eight good cores of sandy mud were recovered. RRS *Charles Darwin* then proceeded to the other planned coring site S90.

28/12/97 (Julian Day 362). At S90, a Shipek grab sample was taken (0040-0045) followed by the multi-corer (0055-0105) and CTD (0125-0135). At S130, a CTD (0225-0235) was followed by a Shipek grab sample (0245-0255) and similarly at S150 a CTD (0340-0355) preceded a Shipek grab sample (0400-0410). A CTD cast was carried out at S600 (0620-0640). In deteriorating conditions with a fresh south-easterly wind, only an XBT was possible at S1000 (0725). While the prospects for grappling were unclear and progress northwards was the easier option, the "R" line was completed with XBTs at R1000 (0840) and R600 (0930). It became apparent that the possibility of grappling was remote, and progress to the south-west was thought possible, so course was made towards the outer end of the "T" line where there was most outstanding work. Winds to 40 knots and rather confused seas delayed progress but conditions improved to permit an XBT at T2100 (1935-1940), a CTD (2050-2200) and plankton net haul (2205-2210) at T2000, and a CTD (2300-2400) and plankton net haul (2400-2405) at T1600.

29/12/97 (Julian Day 363). The T line was continued inshore in good conditions with a CTD station at T1000 (0100-0140) and at T600 (0230-0315); a plankton net haul (0400-0410), Shipek grab sample (0415-0430) and CTD (0440-0450) at T200; a CTD (0525-0535) and two Shipek grab samples (0545-0600; 0600-0610) at T150; a Shipek grab sample (0720-0730) and CTD (0740-0750) at T100 near the coast. The conditions then appeared possible for grappling, but the weather forecast was marginal and there were four hours' steaming to the S700 mooring site. It was decided to consolidate with work on the southern sections rather than risk a fruitless excursion, bearing in mind the possibility of further chances in the next week. RRS *Charles Darwin* therefore steamed southwards to the "U" line.

At the inshore position U100 a CTD station (0910-0920) was followed by a Shipek grab sample (0920-0930) and plankton net haul (0935-0945). The CTD (1020-1030) at U110 was followed by a Shipek grab sample (1035-1045), multi-coring (1100-1110), two attempts at Kasten cores which both gave only a small disturbed sample as the corer tilted over (1145-1200, 1215-1225) and bottom photography with the bed-hop camera (1240-1320). At U120, a CTD profile (1350-1405) and Shipek grab sample (1405-1415) were obtained.

In order to avoid any need for a southward excursion on leg A2, it was then decided to visit the remaining coring site on the "W" line. Accurate positioning at W300, just below a corner in the rim of a canyon, turned out to be critical to the depth and to the character of sediment recovered. A Shipek grab sample (1720-1740) yielded sand; a second after repositioning yielded mud (1815-1835). Kasten coring (1845-1905) yielded a short sandy sample. After the first multi-corer attempt did not trigger (1940-1955), the second attempt closed tubes containing only water (1955-2010). The ship returned to its original position for a third attempt but again drifted into shallower water during multi-corer deployment to give small sandy cores (2040-2055). A bed-hop camera sequence was begun in deeper water; on this occasion the drift maintained and even increased the water depth (2110-2215). Thus operations at W300 concluded and course was made for the remainder of the U line.

30/12/97 (Julian Day 364). At U1000 a plankton net haul (0210-0220) and CTD profile (0230-0320) were obtained, and a CTD profile at U600 (0400-0430). Then it was time for RRS *Charles Darwin* to steam for the planned port call in Vigo, concluding leg A1 at 1000 (the thermosalinograph stopped logging at 0845; the ship-borne ADCP continued running). After two scientists left and three joined the ship, and some other quayside business, RRS *Charles Darwin* left Vigo at 1400 bound for the P line with most high-priority work outstanding. The

thermosalinograph was started again at 1550. *En route*, a CTD was carried out at R100 (1605-1615), a Shipek grab sample taken at Qs100 (1710-1720) and a CTD at Q100 (1815-1820). An intended intermediate grab station was omitted due to too much traffic, and the "P50" inshore location was found to be unsuitable for a CTD due to rock pinnacles. Hence RRS *Charles Darwin* proceeded to P100 where a CTD station (2030-2040) was followed by a failed attempt to lower the plankton net (2045-2050; filled with air and then insufficiently weighted). Here (2050-2055) and at the following stations around the ADCP site, unsuccessful attempts were made to contact the ADCP release. At P115 the plankton net was lowered successfully (2130-2140) followed by the Shipek grab (2145-2155). An attempt to deploy the CTD at P130 was abandoned after difficulty controlling its swinging when raised from the deck; an XBT was launched instead (2255).

31/12/97 (Julian Day 365). Through the night, gusty winds and then heavy swell prevented CTDs or any coring. A Shipek grab sample was taken at P150 (0005-0020); a plankton net haul at P200 (0115-0125); an XBT profile at P700 (0230-0240); a plankton net haul at P1000 (0320-0325); XBT profiles near the inner sediment trap mooring IM2 (0425-0435), at P2000 (0625-0635) and near the outer sediment trap mooring IM3 and P2250 (0830-0835); here a plankton net haul was also taken (0840-0850). As CTDs were not likely soon to further explore deep water properties, it was decided to end the P line here, run with the weather to the adjacent Q line and work inshore for more grab sampling until conditions allowed coring or mooring work. At Q2200 in heavy swell, three XBTs failed just after entering the water (1005-1025; the last appeared to have parted in the sea); it was decided to curtail XBT attempts at this station and carry out a plankton net haul (1030-1035). In continuing heavy swell, there were again three XBT failures at Q2000 and attempts were curtailed (1145-1200; a short profile had been obtained on leg A1). An XBT was launched successfully (1300) at Q1500 followed by a plankton net haul (1305-1315). An XBT profile was obtained at Q1000 (1400-1405) and at Q600 (1425-1430) followed by a plankton net haul (1430-1440). At Q300, a plankton net haul (1505-1510) was followed by two attempts with the Shipek grab (1515-1530, 1535-1555) and an XBT profile (1600-1605). An XBT profile (1650) and plankton net haul (1700-1710) were obtained at Q136. A line of Shipek grab stations was then followed at 42035¢N between the P and Q lines, at Ps100 (1830-1840), Ps105 (four attempts from 1910 to 1950), Ps130 (two attempts from 2035 to 2055) and Ps200 (two attempts from 2145 to 2215). The ADCP was also sought acoustically without success (2220). By now the wind had moderated but a heavy swell continued. Course was made to another intermediate line "Os" of Shipek grab stations at 42º45'N.

01/01/98 (Julian Day 1). At Os300 the grab was recovered empty three times (0020 to 0110) but samples were recovered at Os150 (0155-0205) and Os130 (0245-0255). Two attempts at Os90 both returned an empty grab (0335-0355). As the sea became calmer despite the continuing large long swell, the "O" line was worked. CTD stations were carried out, without water bottles owing to the swell, at O100 (0510-0520), O140 (0605-0615) and O175 (0715-0725) where a plankton net haul was also taken (0730-0740). A plankton net haul (0835-0840) and CTD profile (0845-0920) were obtained at O600. During a CTD profile at O1000 (0940-1030; with bottles) roll and changes of depth over the steep slope were substantial as the ship manoeuvred in wind crossing the swell. O2000 was carried out a mile to the east of the intended position owing to traffic, with a CTD (1130-1245) and plankton net haul (1250-1300). RRS *Charles Darwin* then proceeded to the high-priority "N" line, and hove to for the plankton net deployment at N2300 (1415-1425) showing that the increasing cross-wind and swell prevented CTD deployment. An XBT profile

was obtained (1430-1435). After a plankton net haul (1505-1510) at N1600, an XBT profile was obtained there (1515-1525) and at N600 (1600-1605), N220 (1700), N170 (1735) and N100 (1815). (A net haul at N220 was terminated with a decision for no more net hauls during the cruise). As poor conditions continued, the pattern of intermediate Shipek grab stations was maintained with a line "Ns" along 42º55'N. Three attempts were made without success at Ns120 (1920-1945); only small samples were recovered at Ns170 (2050-2150; there was a delay here for repair of damage to the grab against the hull during the second recovery) and at Ns200 (2305-2345).

02/01/98 (Julian Day 2). Course was made for another intermediate line "Qs" of Shipek grab stations along 42055¢N. The first of these was worked (Os300; 0410-0455) with a small sample at the second attempt. By this time it appeared that the ship movement was adversely affecting the ability to grab samples. With continuing strong winds across the persistent high swell, all further work on deck was called off and RRS *Charles Darwin* hove to. As the wind moderated and became better aligned with the swell, station keeping was attempted at 0900 and at 1120 allowed a Shipek grab attempt at Qs200 (1120-1135). However, the grab was empty and work on the ship's engines delayed further attempts until 1335 when two further grabs also returned empty (1335-1405). The grab at Qs150 produced a sample at the second attempt (1445-1505). A sequence of stations was then worked along line R, RRS *Charles Darwin* having to tack between stations owing to continued heavy swell. XBTs were launched at R200 (1605), R600 (1920), R1000 (2040-2045 after some delay establishing connections and with wire breakage), R1500 (2210-2215) and R2000.

03/01/98 (Julian Day 3). On completing the R2000 XBT (0035-0055), the S line was worked with XBTs at S2000 (0225-0240), S1000 (0335-0345), S600 (0410-0415), S300 (0510-0515), S150 (0620-0625), S130 (0715-0720) and S90 (0755-0800). Continuing heavy swell prevented an intended grab station at S300, and intended lines of grab stations at 42º15'N and 42º05'N were also postponed. With gales forecast, RRS *Charles Darwin* steamed away from the coast to begin another XBT sequence at T150 (1320). XBTs were also launched at T200 (1425) and T600 (1545). In decreasing winds, a CTD was then carried out at T1000 (1625-1705) followed by a successful test of the UCG replacement mooring release (1710-1800), a CTD at T1600 (1850-2000) and a CTD at T2000 (2115-2240). Gales were forecast so that it was necessary to keep away from the coast and the best option appeared to be to head north for the P line with the highest priority work outstanding.

04/01/98 (Julian Day 4). Increasing south-westerly winds across the north-westerly swell soon forced RRS *Charles Darwin* to heave to. Some moderation of wind raised the prospect of grab sampling, but not CTDs, and course was made to an intermediate line "Rs" of stations at 42º15'N with Shipek grab sampling attempts at Rs230 (1330-1430; four attempts), Rs200 (1515-1550; three attempts), Rs150 (1635-1710; three attempts), Rs130 (1755-1835; four attempts) and Rs100 (1925-1950; two attempts). Course was then made to the outer end of another intermediate line "Ss" of stations, at reduced speed in continuing heavy swell.

05/01/98 (Julian Day 5). Shipek grab sampling was attempted at Ss210 (0025-0105; three attempts), Ss150 (0140-0210; three attempts), Ss140 (0255-0330; three attempts), and Ss130 (0405-0445; three attempts). Then it was time to proceed to Vigo; the non-toxic supply and thermosalinograph were stopped at 0824; Vigo was reached at 0930 (ADCP still running).

5. TECHNICAL REPORTS

5.1 Multi-coring (Carla Garcia and Paulo Pedro)

Five stations of multi-cores were undertaken using the multi-corer from RVS SOC. The tubes obtained were divided as follows: three to the University of the Algarve and one to the University of Bordeaux. Except for one of the cores that was immediately sectioned into 1cm slices and frozen for amino-acid studies, the others were stored in the cold room at 50C. Locations of multi-corer sampling are given in table 2.

5.2 Kasten coring (Carla Garcia and Paulo Pedro)

The Kasten corer used for sampling belonged to RVS SOC. The only successful station was W90, where a 77 cm core was obtained. On board it was described and subsampled. The procedure was as follows. The core was cut at the middle into two equal parts. Half of the core was stored in the cold room at 50ºC, for X-ray analyses of internal structures (to be done by Prof. Jouanneau of the University of Bordeaux). The other half was sampled in the following way: a small amount, for humidity calculations from each cm down to 20 cm and below that each 5 cm until the end of the core (Prof. Jouanneau, Univ. Bordeaux). For the aminoacids (Paulo Pedro, Univ. of the Algarve) and for granulometric and compositional studies of the sedimentary column (Carla Garcia, Univ. of the Algarve) samples were taken each 5 cm. The location of the Kasten core site is given in table 2.

5.3 Bed-hop camera (John Humphery)

The POL 35m bed-hopping camera was used to photograph the sea bed at three locations during CD110. These locations had been chosen as multi-corer sites; the films were taken as soon as coring activities finished. The sites are shown in table 3. Sea-bed exposures were curtailed at the W300 site because severe ship motion prevented the satisfactory reception of the pinger signals which indicated contact with the sea bed.

It had been hoped to use the camera more often, particularly at the STABLE site. However, a heavy swell, at times reaching 8m approximately, precluded over-side activities for much of the cruise, especially those involving heavy coring equipment. Nevertheless, when it was used, the camera equipment appears to have functioned correctly. No attempt was made to process films on board.

5.4 Shipek grab (Carla Garcia and Paulo Pedro)

Several Shipek samples were collected during leg A. The Shipek grab belonged to RVS SOC. The collected samples were stored in plastic boxes for future compositional and granulometric analysis, in order to identify the origin of the sediments deposited in this shelf, and compare them with the actual supply. In some stations it was necessary to repeat the sampling because the grab came empty or without enough material for the analyses. In several places, due to inappropriate sea conditions, it was not possible to collect any sample even after three attempts. The Shipek grab samples are listed in table 1.

5.5 ADCP mooring (Martin White)

This mooring was laid at 42º40.94'N, 9º28.58'W in June and the release interrogated a week later with a positive contact made at that time from a position of 42º41'N, 9º28.6'W (with a range of 153m). Upon arrival at that position on leg A1, no contact was established with the command

release after several attempts. The following day a search was carried out with the acoustic transducer, starting a mile south of the deployment position in a direction along the slope contours, with acoustic checks every 0.3nm to a position 1nm to the north of the deployment site. The deeper water region to the west of the site was checked with no contact made. Subsequently, checks were made every time a station was made within 5 miles of the deployment site, with no success. It appears that either the release has failed or the mounting has taking one or more knocks from trawling gear such that the release has been damaged. (It was subsequently learned that the ADCP had been recovered by a Spanish trawler just prior to the cruise).

5.6 Current meter line mooring (700m sub-surface moorin; Martin White)

Recovery

The C/R release S/N 164 was interrogated at a position 42º40'00"N, 9º36'11"W with a positive contact made at a range of 2581m, consistent with the cut away position during deployment in June. The following day at the site the C/R was asked to release the anchor weight and contact was made at a range of 727m. In time, however, it became apparent that the mooring was not coming to the surface when the ship moved away from the site (following a floating object observed some distance on the ship's port side). Closest contact was made at 42º40'10.5"N, 9º34'21.8"W (at a range of 628m), about 0.15nm to the north east of the cut away deployment site. The mooring may have been moved by fishing activity and it appears that either a) the release mechanism is jammed or the mooring is being held down by damaged wire/instruments, or b) the mooring has too little buoyancy remaining to surface. Persistently bad weather and sea conditions prevented dragging operations so this option was postponed until leg B.

Deployment

Weather and sea conditions were not good enough during either of leg A1 or A2, so that the deployment of the replacement 700m mooring was postponed until leg B. The position of the new mooring will be slightly deeper, between 750 and 800m water depth, with the main sub-surface buoy located at a greater depth than for the previous mooring.

5.7 STABLE (Sediment Transport and Boundary Layer Equipment; John Humphery)

The pop-up benthic-landing instrument package called STABLE was deployed in 202m water, position 42º40'41"N, 09º30'30"W at 1117 GMT on 27th December 1997. This large instrument, standing approximately 2.5 m high and weighing 1.7 tonnes in air, neasures near-bed turbulent phenomena and associated sediment resuspension using electromagnetic current meters, a pressure sensor and acoustic backscatter sensors. Mean transport phenomena and near-bed shear are measured using a rotor stack and a vane. Four simple settlement tubes collect falling particles; other sensors measure average water depth, heading, pitch, roll and temperature.

The ballast feet, weighing approximately 145kg each, are jettisoned by an acoustic command from the mother ship at the time for recovery. This command would be sent by a volunteer from RVS during a suitable weather "window" near the end of leg B. The apparatus should then return to the surface for recovery in the usual way.

5.8 Ship-borne ADCP (Martin White)

The ship-mounted ADCP was set to record at 10-minute intervals and with a bin depth of 4m in the vertical. No problems were encountered with the operation of the instrument.

5.9 Underway recording (Paul Howarth)

Surface sampling system

This system comprises a thermosalingraph, light meters, transmissometer and fluorometer. The data from the various sensors is collected approximately every two seconds and averaged over thirty seconds before being logged by the computing system. The system was run continuously throughout leg A with a break of a few hours while docking at Vigo for the start of leg A2.

The only problem that occurred was failure of the starboard light meter during the first day. Due to the bad weather conditions, the faulty sensor could not be inspected until docking at Vigo prior to leg A2. The fault was traced to a defective interface unit, which was replaced. Unfortunately some set-up information from SOC was still needed to operate the new unit and due to the New Year holidays and weekend break, this information was not available.

Chernikeeff log and Simrad echo sounder

The Chernikeef log was used continuously throughout leg A without any problems. The Simrad EA 500 echo sounder was used continuously without any problems for depths greater than its minimum range of approximately 50m.

5.10 CTD (Paul Howarth)

In total 39 CTD casts were made on this leg of the cruise. This number was limited to periods when weather conditions and sea state allowed the safe handling of the CTD frame on deck. In addition to the CTD itself, the following sensors were available:

1) Transmissometer 1 2) Transmissometer 2 3) Fluorometer
4) Light Back-scatter sensor 5) Altimeter
6) Up-welling irradiance sensor 7) Down-welling irradiance sensor

For the first three casts, sensors 1 to 6 were connected and then sensor 6 was replaced by sensor 7. On the first cast, sensor 4 was not functioning. This was traced to fault with a connecting cable which was replaced and subsequently there were no further problems.

Throughout this leg of the cruise, the altimeter failed to function correctly. After carrying out tests on deck and making adjustments after each cast, the unit was still found to be defective. This meant that the maximum depth to which the CTD could be deployed had to be determined from the 10kHz pinger traces on the ship's EA 500 echo sounder.

In order to collect water samples, a tone-fire rosette pylon was used on the CTD frame. On leg A1 the pylon failed to function properly and not all the fire commands resulted in a rosette bottle closing. However, only one small sample was required on most casts (for a salinity check) and this was obtained from one of several firing attempts.

5.11 XBT (Jeff Benson)

A total of 60 XBTs were dropped over the course of Leg A1 and Leg A2. The drops were of two probe types, T-5 for 760 metres to 1830 metres of depth, and T-7 for less than 760 metres. Of these 60 drops, 8 were partial profiles with problems attributed to probe malfunction, such as the wire breaking prior to bottom depth being reached, but were included among the successful drops. Six launches not included in the total number of drops were attributed to failures of sea-state, operator error, software errors, and/or hardware problems associated with the two different launchers used. The successful launches were conducted as an alternative to CTD stations when

weather and sea-state dictated that performing a CTD cast was not possible. A listing of the successful XBT launches and relevant details is attached (table 7).

5.12 Satellite imagery (John Huthnance)
Clouds prevailed, so that the only relevant image was obtained eight days before the cruise. It showed SST 14-15ºC close to the coast and the "Navidad" condition offshore with SST about 180C; a broad (~ 100 km) band of warmer waters advected apparently from the south along the slope as far as Cape Finisterre. It is worth noting that during the cruise the corresponding SST was about 16ºC.

5.13 Particles (Sabine Schmidt and Jean-Louis Reyss, CFR, Gif sur Yvette)
The objective was to collect at least three cores by using multicorer: in particular one near each trap mooring line, and an another in coastal waters, always on the P line. Such sampling would permit to complete cores previously sampled during CD105 and PE109 in order to determine bioturbation rate coefficients (*via* radionuclides). Moreover it would allow comparison of sedimentary inventories of radionuclides with fluxes measured from trap samples. No coring activity was possible during the leg A2.

5.14 Plankton net (Martin White)
Vertical hauls in the upper 100 m of the water column with a 40 micron mesh phytoplankton net were made at several sites throughout the study area. These samples will be used to identify qualitatively the composition of phytoplankton species in the region with emphasis on warm water indicator species. Several stations were repeats of June stations to investigate possible seasonal variability in certain species. The station positions are given in table 5 and plotted in figure 3.

5.15 Ship systems (Simon Mitchell)
This section covers the items of scientific equipment not covered in other parts of this report.

Scientific winches
The following winches were employed during leg A:
- double-barrel traction and storage winch (to deploy STABLE)
- 20T coring winch (for multi-core and Kasten core)
- Rexroth handling winch (for Kasten core)
- hydrographic winch (for Shipek grab and bed-hop camera)
- 10T conducting winch (for CTD).

In general the winches performed without failure in accordance with the requirements of the scientific programme, notwithstanding the limitations imposed by sea state. Problems arose with the winch control displays in the main laboratory and starboard gantry. Fortunately, these were an inconvenience only to the RVS technicians and did not hamper scientific operations or compromise safety.

Non-toxic and ultra-pure water
The non-toxic supply operated without significant interruption throughout leg A, while the ultra-pure water system remained unused but on standby.

Freezer and refrigeration
These performed without fault providing storage and +50 and -20ºC.

Containerised laboratories
These remained unused and on standby during leg A.

5.16 Computing (Paul Duncan)
The ship is fitted with an RVS ABC Computer system, and also an E-mail computer. Both systems are described below:

- Mk I Level A computers are used to log the Ship's gyro.
- Mk II Level A computers are used to log Ashtech GG-24 (GPS + GLONASS), Decca Mk 53G, Trimble 4000 (GPS), Chernikeeff two component ship's log, Simrad EA-500 echo sounder, Tonefire CTD bottle firing system, and Neil Brown Mk IIIB CTD system.
- The RVS-developed surface logging package outputs data in SMP (Ship Message Protocol) and so does not require a Level A system.
- All these systems are logged by a Mk II Level B system, and immediately logged to two mirrored disk drives, and then to 150MB cartridge tape. When one tape is finished, logging is automatically switched to the other tape drive. All the data received by the Level B are concentrated and then sent in one stream over the Ship's network to the Level C.
- The Level C system consists of a Sun SPARCstation IPC with a 150MB QIC drive for initialising and reading Level B tapes, and an external 2.7GB disk for storing the Level C software and cruise data.
- In addition to data from the Level B system, the Level C also takes data directly from the shipborne ADCP system. The one problem with these data is that they are dependent on the accuracy of the PC clock. All Level A computers take a clock signal from the scientific master clock to time-stamp their data before passing them on to the Level B.
- As well as *darwin1*, the main Level C system, there are three other Sun workstations on the ship (this does not include the swath bathymetry system in the plot).
- *darwin2* is another SPARCstation IPC, and has identical hardware to *darwin1*.
- *darwin3* is a SPARCstation 20 with about 8GB of disk space. It can be used when extra processing power is needed. It is also the place where E-mail and personal directories reside.
- *darwin4* is a SPARCstation 1 which lives in the plot and handles the transfer of E-mail between RRS Charles Darwin and the *sea* system at Southampton Oceanography Centre.

During Leg A, there was only one major problem, which was when the Level B system crashed. The Level C system detected this and sounded the alarm in the main lab. Approximately three minutes of data were lost.

Two types of plot were produced for each CTD cast. Charts were produced showing positions of CTD casts, XBTs, grabs, cores and camera deployments. Bottle data were produced for selected CTD casts.

6. CONCLUSIONS

Oceanographic conditions

The upper mixed layer varied from about 70 to 120m depth, and was bounded below by a pycnocline that existed in all water of depth 150m or more. The data tended to suggest some deepening during the cruise. There was just a hint of reduced mixed-layer depth over the mid-slope (600m and 1000m stations) suggesting some erosion by increased mixing below the mixed layer. Transmittance was less and fluorescence was enhanced in the mixed layer, suggesting continuing production.

Near the coast there was usually a plume of fresher, cooler water with lower transmittance and higher fluorescence. Exceptionally, on one "O" line this extended out to the 1000m station (1/1/1998). More often, the signal remained in deeper water as a slight salinity deficit throughout the depth of the mixed layer compared with the salinity just beneath.

The usual (Mediterranean water) salinity maxima were apparent between 900 and 1200 m; one profile (T2000) had two distinct maxima, at 930 and 1200 m. Below that, dissolved oxygen increased to 2000m indicating Labrador water.

Transmittance was usually reduced and optical backscatter increased near the bottom.

Operations

The cruise was adversely affected by poor weather and especially swell from a near continuous succession of storms over the Atlantic further north. The period from Christmas Eve 1997 to the first week of January 1998 was remarkable for the persistence of intense low pressure around Iceland and high pressure south of the Azores. Winds were therefore very strong in the whole northern North Atlantic. Hence the working area suffered very heavy swell from a spread of directions not usually aligned with the local winds. This combination often prevented RRS *Charles Darwin* from acting as a stable platform while keeping on station, although locally generated conditions were not often a problem.

Little time was formally lost, but the range of scientific measurements possible was severely reduced by the conditions. Mooring work or coring were only possible on three days out of 12 in the working area (not at all on leg A2). Even CTD profiles, often with a minimum of bottles, were restricted to just over half of the time in the working area on leg A1, and only 25 hours on leg A2. Hence grab sampling, XBTs, plankton net hauls and continuing underway recording were the only possible activities for a majority the time, and covered the area well.

The deployment of STABLE proceeded smoothly despite quite large amplitude swell; swinging was prevented by careful preparation with remotely-hauled constraining lines.

One particular attempt at coring near a corner of the steep upper rim of a canyon exposed the difficulty of sufficiently precise positioning in varying wind and drift when the target area is small - scale O(100m) at 300m depth in this case.

The finding of pinnacles at "P50" (which will have to be omitted from future cruise plans) illustrates a few residual problems of uncertain bathymetry in the area of the OMEX grid.

Table 1. Grab samples (Julian Day no., depth in m, G - retained Shipek grab sample; latitude and longitude in degrees, minutes, seconds)

Name	Time	Day	Latitude N	Longitude W	depth	Comments
W90G	0544	358	41 21 20	08 59 52	88	mud
W300G	1437	358	41 20 34	09 08 43	281	small sample of fine sand
W300	1507	358	41 20 42	09 08 53	297	no sample
N220	1930	359	43 00 27	09 30 54	201	very little sample
N220G	1945	359	43 00 38	09 30 54	201	little; fine grey/black sand
N170	2045	359	43 00 12	09 27 21	163	little; black sand and finer
N170G	2100	359	43 00 30	09 27 17	161	little; dark sand and mud
N100	2250	359	43 01 20	09 24 45	138	little; mostly dark sand
N100G	2305	359	43 01 37	09 25 01	141	sandy mud
O100	0220	360	42 50 20	09 19 30	126	too little sample
O100G	0235	360	42 50 30	09 19 45	126	muddy sand
O140G	0340	360	42 50 02	09 24 00	142	sandy mud and worms
O175	0635	360	42 50 00	09 30 00	177	small sample
O175G	0655	360	42 50 18	09 30 08	179	muddy sand
P200	1340	360	42 39 50	09 30 10	210	no sample
P200	1355	360	42 39 55	09 30 18	216	no sample
P200G	1425	360	42 40 05	09 29 58	194	fine sand
P130G	1620	360	42 40 00	09 22 19	131	muddy sand
P100G	1755	360	42 39 55	09 12 57	101	sandy mud, some shell
Q130G	0220	361	42 29 52	09 16 54	140	muddy sand
Q100	0315	361	42 29 57	09 10 44	79	rock?
Q100G	0325	361	42 29 57	09 10 43	80	yellow coral
R100G	0500	361	42 20 09	09 00 34	96	muddy sand with shell
R150G	0640	361	42 20 13	09 12 18	151	muddy sand
R200	0810	361	42 20 37	09 17 00	232	not triggered
R200G	0825	361	42 20 44	09 17 20	240	small sample; muddy sand
S300	2105	361	42 09 12	09 18 32	213	small sample; sand
S300	2120	361	42 09 22	09 18 21	213	small sample; sand & mud
S90G	0045	362	42 09 08	08 57 22	92	sandy mud
S130G	0250	362	42 09 09	09 02 53	132	mud
S150G	0405	362	42 09 05	09 08 21	146	muddy sand
T200G	0425	363	42 00 08	09 16 52	161	muddy sand
T150	0550	363	42 00 23	09 13 45	147	small sample; muddy sand
T150G	0605	363	42 00 28	09 13 42	146	fine sand
T100G	0725	363	41 59 57	09 00 03	100	sandy mud

U100G	0925	363	41 47 54	09 01 12	92	sandy mud, starfish limb
U110G	1040	363	41 47 58	09 05 56	112	sandy mud with shells
U120G	1410	363	41 48 08	09 09 04	118	muddy sand
W300G	1730	363	41 20 46	09 08 45	204	fine sand
W300G	1820	363	41 20 28	09 09 01	333	sandy mud
Qs100G	1715	364	42 24 36	09 05 06	112	mud; good for coring?
P115G	2150	364	42 39 46	09 16 35	113	mud; good for coring?
P150G	0010	365	42 39 51	09 25 51	146	sandy mud
Q300	1525	365	42 30 01	09 23 18	287	small sample, fine sand
Q300G	1545	365	42 29 58	09 23 16	289	small sample, fine sand
Ps100G	1840	365	42 34 47	09 10 49	96	coarse sand
Ps105	1915	365	42 34 56	09 14 54	105	empty
Ps105	1925	365	42 34 54	09 15 00	106	empty
Ps105	1935	365	42 34 52	09 15 08	107	small sample
Ps105G	1945	365	42 34 53	09 15 13	104	fine sand
Ps130	2040	365	42 34 49	09 19 57	127	almost empty
Ps130G	2050	365	42 34 40	09 19 57	127	muddy sand
Ps200	2150	365	42 34 49	09 24 51	242	small sample of sand
Ps200G	2210	365	42 34 43	09 24 53	255	muddy sand
Os300	0030	001	42 45 06	09 33 14	305	empty
Os300	0045	001	42 45 07	09 33 16	305	empty
Os300	0100	001	42 45 11	09 33 11	305	empty
Os150G	0200	001	42 44 54	09 27 11	152	muddy fine sand
Os130G	0250	001	42 44 57	09 21 00	136	muddy fine sand
Os90	0340	001	42 44 56	09 15 00	88	empty
Os90	0350	001	42 44 56	09 14 57	89	empty (rock)
Ns120	1925	001	42 54 51	09 21 28	121	empty
Ns120	1935	001	42 54 54	09 21 22	124	empty
Ns120	1940	001	42 54 43	09 22 05	123	empty
Ns170G	2055	001	42 55 00	09 26 43	171	poor sample
Ns170	2110	001	42 54 53	09 26 35	170	grab damaged
Ns170	2140	001	42 54 15	09 26 03	165	poor; added to first; sand
Ns200	2310	001	42 55 02	09 31 45	203	poor sample, sand
Ns200	2325	001	42 55 00	09 31 29	198	poor sample, sand
Ns200G	2340	001	42 54 51	09 31 15	195	small sample, muddy sand

Qs300	0425	002	42 24 55	09 22 54	377	no sample
Qs300G	0445	002	42 24 52	09 22 56	379	small sample, sand
Qs200	1130	002	42 24 54	09 17 36	208	empty
Qs200	1340	002	42 25 01	09 18 04	224	empty
Qs200	1355	002	42 25 00	09 18 17	231	empty
Qs150	1450	002	42 24 59	09 13 00	148	empty
Qs150G	1500	002	42 25 02	09 13 04	147	muddy sand
Rs230	1340	004	42 14 56	09 20 09	235	empty
Rs230	1355	004	42 14 56	09 20 21	238	empty
Rs230	1410	004	42 14 54	09 20 24	235	upside-down; empty
Rs230G	1425	004	42 14 51	09 20 15	242	small sample
Rs200	1520	004	42 14 58	09 15 11	192	upside-down; empty
Rs200	1535	004	42 14 56	09 15 19	196	empty
Rs200	1545	004	42 14 55	09 15 29	196	empty
Rs150G	1640	004	42 14 56	09 10 14	147	small sample
Rs150G	1655	004	42 14 55	09 10 26	148	small sample
Rs150	1705	004	42 14 56	09 10 42	153	no sample
Rs130G	1800	004	42 15 08	09 05 11	132	small sample
Rs130G	1815	004	42 15 09	09 05 11	132	small sample
Rs130	1820	004	42 15 12	09 05 09	138	empty
Rs130	1830	004	42 15 13	09 05 10	132	empty
Rs100	1930	004	42 15 15	09 00 19	107	empty
Rs100G	1945	004	42 15 23	09 00 17	110	copious mud
Ss210	0035	005	42 04 57	09 19 57	212	empty
Ss210	0045	005	42 04 54	09 19 53	207	empty
Ss210	0100	005	42 04 50	09 19 50	210	empty
Ss150	0145	005	42 04 56	09 14 57	162	empty
Ss150	0155	005	42 04 52	09 14 50	165	empty
Ss150	0205	005	42 04 45	09 14 46	163	empty
Ss140G	0300	005	42 05 03	09 09 42	146	small sample
Ss140	0310	005	42 05 02	09 09 38	147	empty
Ss140	0320	005	42 04 59	09 09 38	146	empty
Ss130G	0410	005	42 05 03	09 04 51	133	small sample
Ss130G	0430	005	42 05 04	09 04 37	133	small sample
Ss130	0440	005	42 05 05	09 04 22	131	no sample

Table 2. Cores (Julian Day no., depth in m; K - Kasten core, M - multicore;
latitude and longitude in degrees, minutes, seconds)

Name	Time	Day	Latitude N	Longitude W	depth	Comments
W90K	0628	358	41 21 37	08 59 53	87	77 cm (in 1 m barrel)
W90M	0737	358	41 22 58	08 59 35	86	15-30 cm cores, 4 kept
S300M	2200	361	42 09 39	09 18 05	213	30-33cm; sandy mud; 4 kept
S90M	0100	362	42 09 05	08 57 20	92	~ 30 cm; sandy mud; 4 kept
U110M	1105	363	41 47 50	09 05 48	112	30-33cm; sandy mud; 4 kept
U110(K)	1150	363	41 47 45	09 05 42	112	small disturbed sample; tipped;mud+sand,shell
U110(K)	1220	363	41 47 38	09 05 26	111	similar poor sample again
W300(K)	1855	363	41 20 33	09 08 51	305	poor sandy sample
W300(M)	1945	363	41 20 43	09 08 42	197	did not trigger
W300(M)	2000	363	41 20 43	09 08 42	208	only water samples
W300M	2045	363	41 20 04	09 08 52	183	10-15 cm sand

Table 3. Bed-hop camera stations

Name	Time	Day	Latitude N	Longitude W	depth	Comments
W90	0850-0950	358	41 22 13-76	08 59 44-57	86	25 frames, some rapid
U110	1240-1320	363	41 47 58-66	09 05 48-55	113	22 frames
W300	2110-2215	363	41 20 16-21	09 09 06-11	360	19 frames, pinger faded

Table 4. Moorings

Name	Time	Day	Latitude N	Longitude W	depth	Comments
STABLE	1117	361	42 40 41	09 30 30	202	deployment; time released
P700	1300	361				release time, not recovered
	1415	361	42 40 10.5	09 34 21.8	628	ship position, closest range
ADCP			42 40 54	09 28 35	156	when deployed, /6/1997
	1715	361				main search abandoned (trawled, 17/12/97)

Table 5. Net hauls (down to 100m unless otherwise stated)

No, Name	Time	Day	Latitude N	Longitude W	depth	Comments
1 N100	2315	359	43 01 52	09 25 15	142	net torn, small sample vol.
2 O1000	0900	360	42 49 39	09 38 14	843	
3 R200	0840	361	42 20 42	09 17 22	240	
4 T2000	2205	362	41 59 34	09 40 14	1967	
5 T1600	0005	363	42 00 14	09 33 16	1660	
6 T200	0410	363	42 00 05	09 16 56	161	to 80m wire
7 U100	0940	363	41 47 48	09 01 12	93	to 80m wire
8 U1000	0215	364	41 47 58	09 25 54	978	
- P100	2045	364	42 40 13	09 12 33	100	air-filled, could not lower
9 P115	2140	364	42 39 53	09 16 47	113	added weight; to 95m wire
10 P200	0125	365	42 40 02	09 29 56	194	net badly torn
11 P1000	0325	365	42 39 52	09 36 10	975	with repaired net
12 P2250	0850	365	42 37 53	10 00 04	2174	
13 Q2200	1035	365	42 30 08	09 49 55	2218	
14 Q1500	1315	365	42 30 04	09 32 08	1420	
15 Q600	1435	365	42 30 00	09 25 38	1040	
16 Q300	1510	365	42 30 00	09 23 22	290	
17 Q136	1705	365	42 29 52	09 16 38	138	lost some pot water
18 O175	0735	001	42 49 51	09 29 42	174	
19 O600	0840	001	42 50 05	09 35 52	612	
20 O2000	1255	001	42 50 22	09 43 19	1520	
21 N2300	1420	001	42 59 51	09 42 52	2250	
22 N1600	1510	001	43 00 04	09 39 02	1498	

Table 6. CTD casts (samples for salinity only unless otherwise stated)

No, Name	Time	Day	Latitude N	Longitude W	depth	Comments
6 W90	0500	358	41 20 27	09 00 07	86	
7 W300	1400	358	41 20 26	09 08 55	305	
8 W1000	1750	358	41 20 09	09 13 37	905	to 831m only
9 N2300	1540	359	43 00 39	09 42 46	2310	
10 N1600	1725	359	43 00 21	09 38 48	1417	to 1405m
11 N220	1910	359	43 00 19	09 30 55	205	to 160m; some bad data
12 N100	2225	359	43 00 58	09 24 34	130	to 116m; long hold at ~30m
13 P100	1740	360	42 39 55	09 12 50	100	to 91m
14 R200	0740	361	42 20 26	09 16 35	224	to 215m
15 P200	1210	361	42 40 34	09 29 36	172	to 165m
16 S300	2040	361	42 08 58	09 18 45	215	to 208m
17 S90	0130	362	42 09 03	08 57 26	92	
18 S130	0230	362	42 09 09	09 02 55	130	
19 S150	0345	362	42 09 08	09 08 24	147	
20 S600	0630	362	42 09 10	09 25 57	480	to 450m; steep slope
21 T2000	2100	362	41 59 44	09 40 24	1972	to 1960m
22 T1600	2330	362	42 00 01	09 33 06	1662	to ~1647m
23 T1000	0120	363	42 00 10	09 26 44	983	to 980m (wire)
24 T600	0250	363	42 00 07	09 22 57	545	to 545m (wire)
25 T200	0445	363	42 00 08	09 16 44	161	to 150m (wire)
26 T150	0530	363	42 00 15	09 13 44	146	to 138m (wire)
27 T100	0745	363	42 00 02	09 00 07	101	
28 U100	0915	363	41 47 52	09 01 08	92	to 80m
29 U110	1025	363	41 48 00	09 06 00	112	to 108m
30 U120	1355	363	41 48 06	09 08 56	118	
31 U1000	0250	364	41 48 06	09 25 48	960	
32 U600	0410	364	41 47 52	09 22 00	660	to 620m
33 R100	1610	364	42 20 07	08 59 53	93	to 80m
34 Q100	1815	364	42 29 48	09 10 57	83	
35 P100	2035	364	42 40 12	09 12 32	100	to 95m
36 O100	0515	001	42 49 48	09 19 11	126	no bottles
37 O140	0610	001	42 49 55	09 23 42	142	no bottles
38 O175	0720	001	42 49 51	09 29 48	174	no bottles
39 O600	0900	001	42 50 14	09 36 00	634	no bottles; to 615m (wire)
40 O1000	1000	001	42 50 07	09 37 50	1040	to 1000m (wire)
41 O2000	1200	001	42 50 14	09 43 56	1620	to 1600m (wire)
42 T1000	1640	003	42 00 10	09 26 40	980	
43 T1600	1910	003	42 00 07	09 33 02	1661	
44 T2000	2130	003	42 00 01	09 40 40	1994	to 2005m (wire) ~ 7m ab.

Table 7. XBT casts

Name	Time	Day	Latitude N	Longitude W	depth	Comments
W130	1155	358	41 20 25	09 06 59	135	
W2000	2030	358	41 20 10	09 25 16	1902	wire cut at 1150m
U2000	0100	359	41 48 02	09 32 41	2022	
T2000	0310	359	42 00 00	09 40 26	1900	
S2000	0500	359	42 08 52	09 39 19	1994	
R2000	0650	359	42 19 51	09 46 22	1997	
Q2000	0855	359	42 30 32	09 39 40	2005	
P2000	1110	359	42 39 51	09 50 35	1965	wire broke at 600m
O2000	1300	359	42 50 20	09 45 49	2037	some bad data below 800m
N2300	1440	359	43 00 09	09 42 54	2322	
O100	0215	360	42 50 13	09 19 22	126	mixed except surface cooler
O175	0610	360	40 50 00	09 30 00	177	
O1000	0915	360	42 49 32	09 38 18	835	second of two
P1000	1235	360	42 40 00	09 36 12	976	
P200	1320	360	42 40 04	09 30 10	203	
Q2000	2245	360	42 30 05	09 39 45	1997	down to about 750m
Q1000	0045	361	42 30 07	09 26 19	1054	
Q600	0115	361	42 29 58	09 25 35	700	
Q130	0210	361	42 29 55	09 16 53	139	
Q100	0305	361	42 29 58	09 10 46	80	
R100	0450	361	42 20 08	09 00 27	95	
R150	0630	361	42 20 09	09 12 10	151	
S1000	0725	362	42 09 08	09 27 58	1008	
R1000	0840	362	42 20 21	09 30 00	950	
R600	0930	362	42 20 10	09 27 10	550	
T2100	1935	362	42 00 02	09 50 07	2113	down to about 1820m
P130	2255	364	42 39 36	09 21 40	128	
P700	0235	365	42 39 57	09 33 57	656	2nd attempt; 1st XBT faulty
IM2	0430	365	42 38 54	09 41 09	1434	
P2000	0630	365	42 39 46	09 50 32	1960	
P2250	0830	365	42 37 56	09 59 58	2170	
Q2200	1015	365	42 30 06	09 49 48	2212	no record: wire broke (´3)
Q2000	1150	365	42 30 00	09 39 46	2000	no record: wire broke (´3)
Q1500	1300	365	42 29 59	09 31 57	1546	
Q1000	1400	365	42 29 57	09 26 14	480	irregular topography
Q600	1425	365	42 29 58	09 25 38	980	irregular topography
Q300	1600	365	42 29 57	09 23 19	289	
Q136	1650	365	42 30 03	09 16 35	140	

N2300	1435	001	42 59 46	09 42 53	2160	
N1600	1520	001	43 00 03	09 38 57	1500	
N600	1605	001	43 00 06	09 34 55	1201	
N220	1700	001	42 59 55	09 31 02	219	
N170	1735	001	42 59 54	09 27 26	166	
N100	1815	001	43 00 04	09 24 00	128	
R200	1605	002	42 20 09	09 16 58	231	
R600	1920	002	42 20 00	09 27 15	587	
R1000	2040	002	42 20 30	09 30 02	972	3rd attempt
R1500	2210	002	42 19 45	09 37 21	1450	
R2000	0050	003	42 19 51	09 46 15	1998	2nd attempt; 1st broke
S2000	0230	003	42 08 56	09 38 52	1962	
S1000	0340	003	42 08 58	09 27 49	1040	
S600	0410	003	42 08 58	09 26 04	531	
S300	0510	003	42 09 00	09 18 53	219	
S150	0625	003	42 09 03	09 08 29	146	
S130	0720	003	42 08 53	09 03 05	130	
S90	0800	003	42 09 01	08 57 38	95	
T150	1320	003	41 59 58	09 13 39	144	
T200	1425	003	42 00 00	09 16 55	168	broke at 100m
T600	1545	003	42 00 01	09 23 55	848	

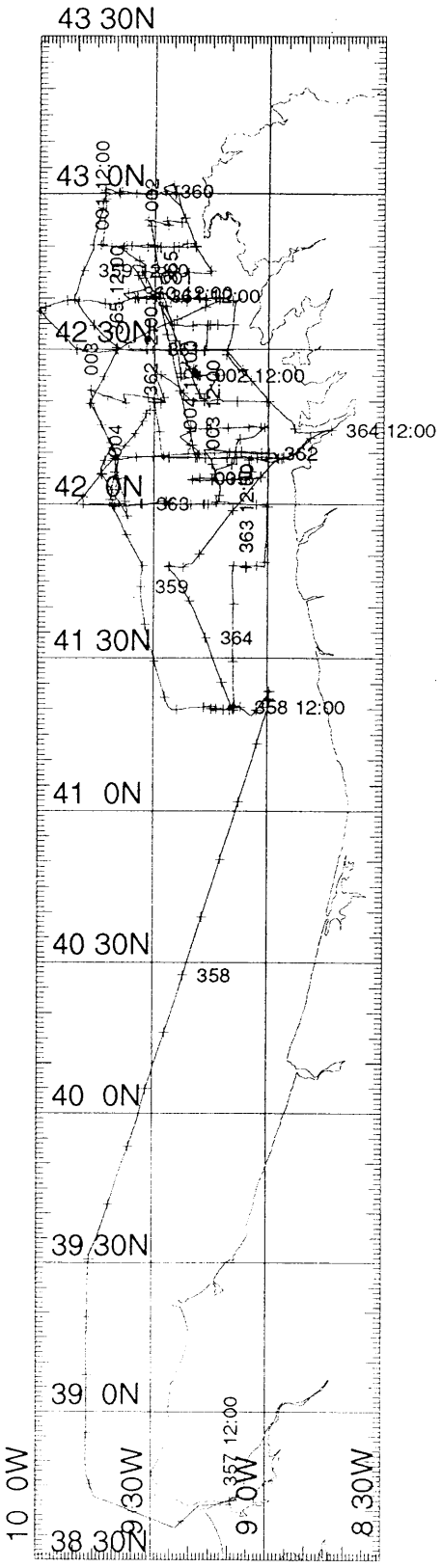

Figure 1 (a) Overall track plot.

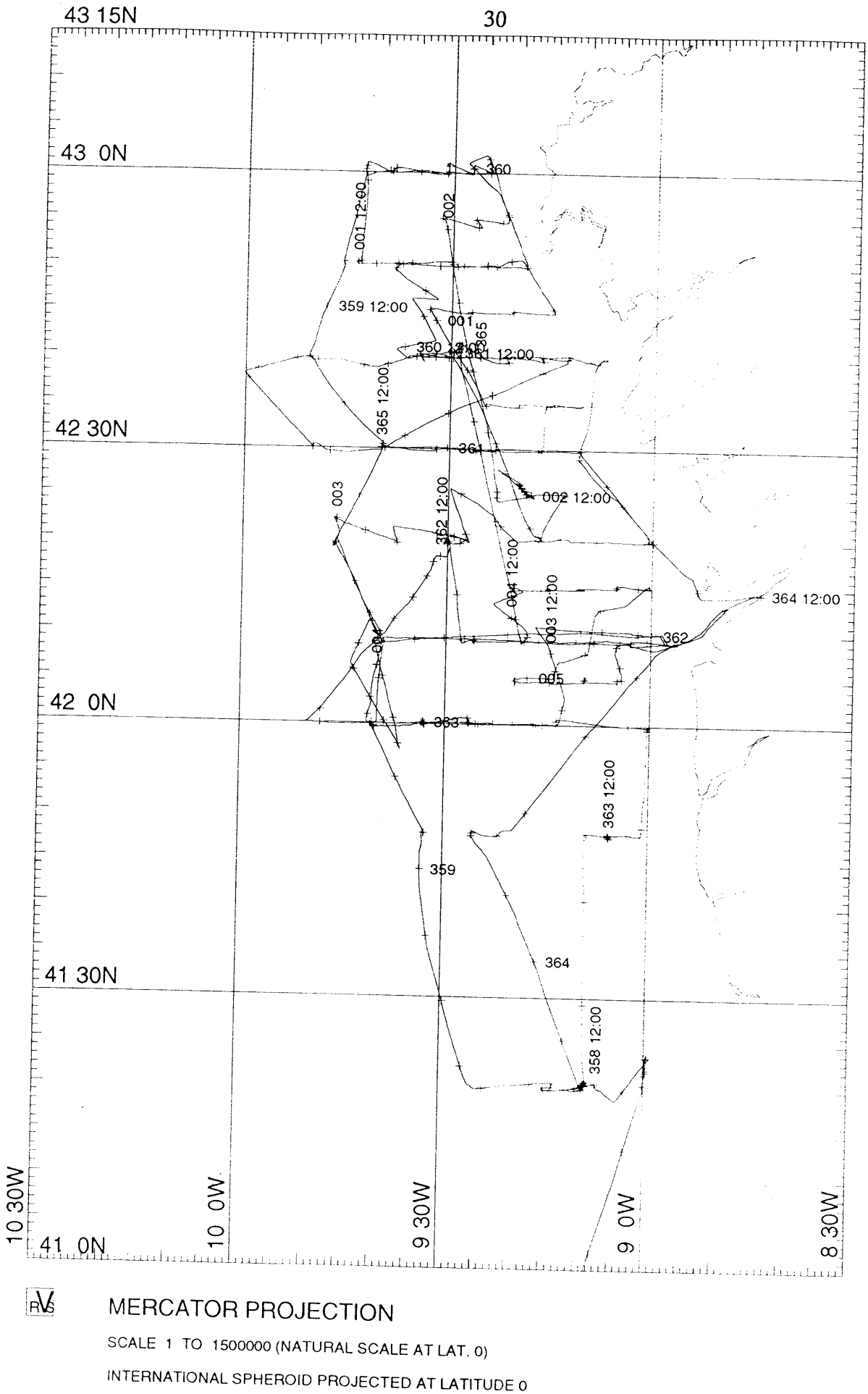

Figure 1 (b) Track plot in working area.

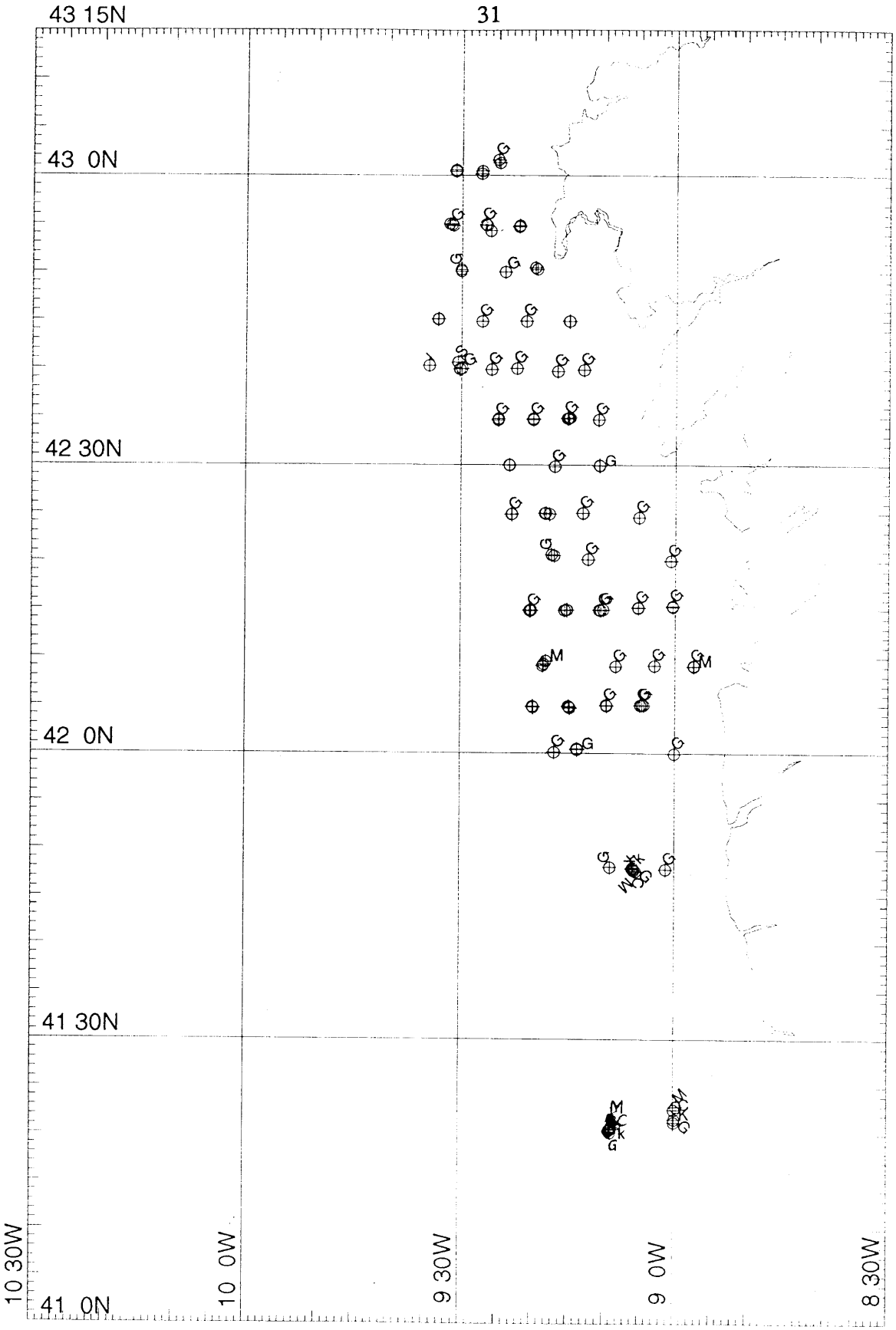

Figure 2 Coring, grab, camera and mooring locations.
| - line mooring; S - STABLE; M - multi-core; K - Kasten core; C - camera; G - grab. Lower case letters - unsuccessful, not labelled for grab samples.

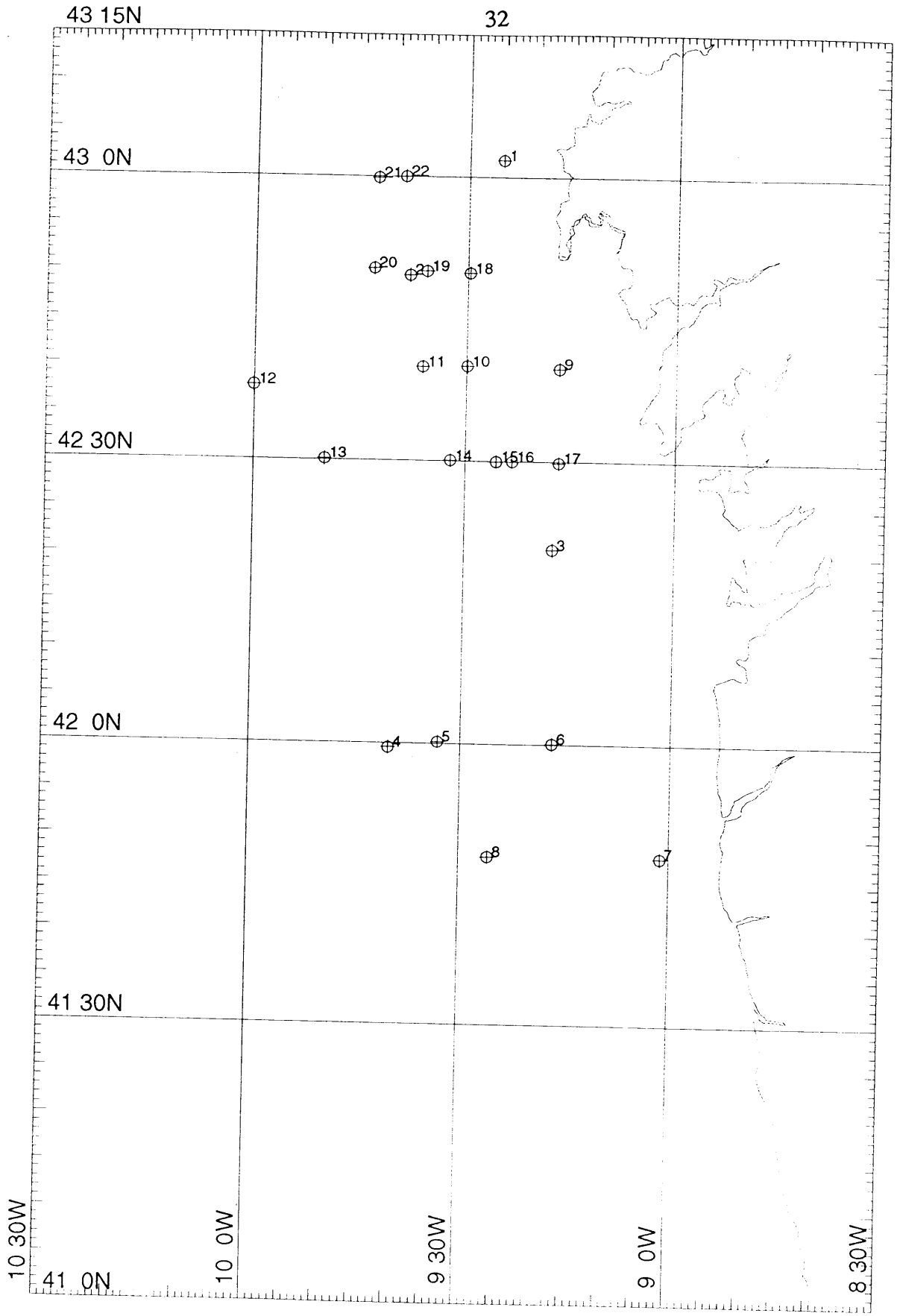

Figure 3 Plankton net haul locations.

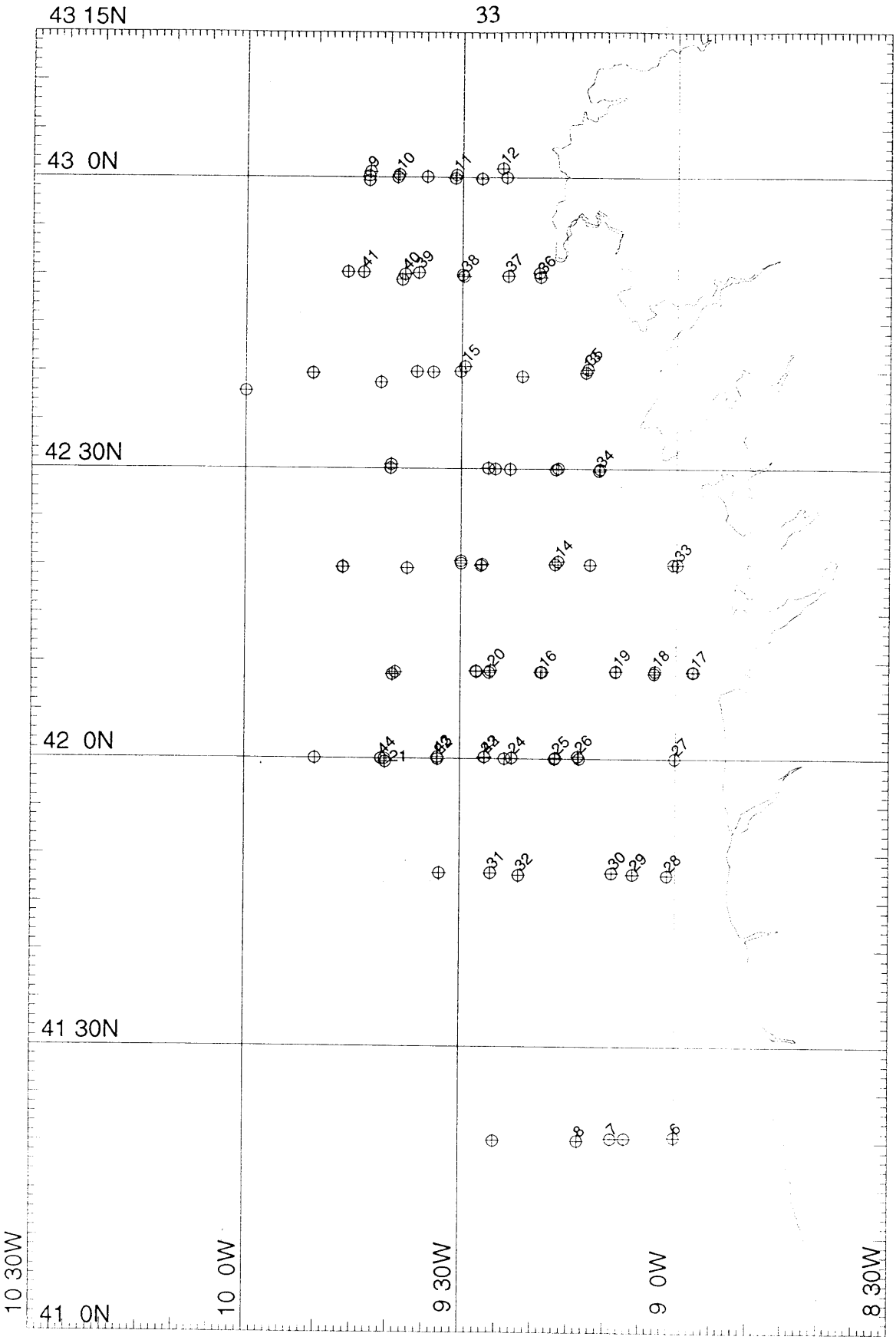

Figure 4 XBT, CTD and water sampling stations: numbers show CTDs; otherwise XBTs.