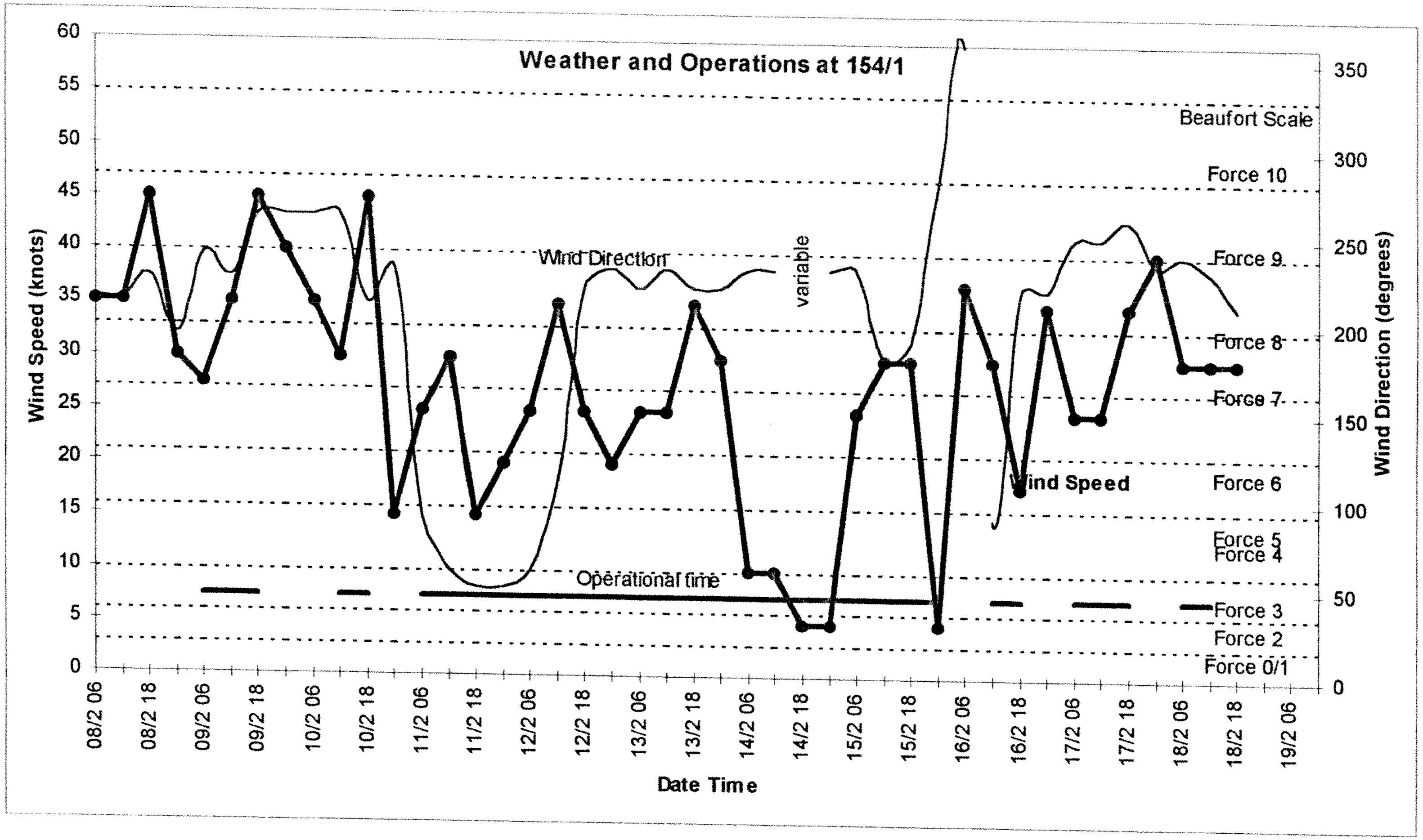


Figure 2. Weather and operations during Discovery 230C.

CENTRE FOR COASTAL AND MARINE SCIENCES
SCOTTISH ASSOCIATION FOR MARINE SCIENCE

DUNSTAFFNAGE MARINE LABORATORY

CRUISE REPORT

RRS DISCOVERY CRUISE 230C

07 FEBRUARY - 20 FEBRUARY 1998

Environmental Impact Survey on behalf of Enterprise Oil Ltd. in 17 th Round Licence Block 154/1 (58° 50' - 59° 00'N, 07° 48' - 08° 00'W)

Principal Scientist
K. J. Jones

1998

Centre for Coastal and Marine Science
Dunstaffnage Marine Laboratory
P.O. Box 3
Oban, Argyll
PA34 4AD.
U.K.

Scottish Association for Marine Science
Dunstaffnage Marine Laboratory
P.O. Box 3
Oban, Argyll
PA34 4AD.
U.K.

Tel: 01631 562244
Fax: 01703 565518
e-mail: kjj@dml.ac.uk

SAMS THE SCOTTISH ASSOCIATION FOR MARINE SCIENCE

Dunstaffnage Marine Laboratory

CONTENTS

Table 3.

Station	Discovery station No.	Depth (m)	Julian day	Date	Time	Ship's	Position	Gear	HC	HM	PS	Sediment radionuclides	Macro-benthos	Salinity	Temperature	Beam attenuation	Water column geochemistry	Status
TRIAL	13344#1	106	39	08-Feb	19:19:35	58° 28.50'	5° 57.67'	BEDHOP										OK
TRIAL	13344#2	100	39	08-Feb	21:25:00	58° 29.01'	5° 56.12'	OI CAMERA										OK
A2	13345#1	1289	40	09-Feb	16:40:00	58° 58.38'	7° 57.56'	AGASSIZ										EMPTY
A1	13346#1	1346	41	10-Feb	12:32:00	58° 59.41'	7° 58.82'	CTD						y	y	y	y	OK
A2	13347#1	1307	41	10-Feb	15:03:00	58° 58.82'	7° 57.70'	CTD										ABORTED
A2	13347#2	1328	42	11-Feb	03:18:00	58° 59.20'	7° 58.18'	CTD						y	y	y		OK
A6	13348#1	1107	42	11-Feb	06:02:00	58° 55.02'	7° 52.96'	CTD						y	y	y	y	OK
A6	13348#2	1100	42	11-Feb	08:30:00	58° 54.10'	7° 53.31'	NIOZ										EMPTY
A6	13348#3	1105	42	11-Feb	10:33:40	58° 54.41'	7° 53.06'	NIOZ					0.2 m2					OK
A8	13349#1	863	42	11-Feb	13:17:00	58° 51.53'	7° 51.26'	NIOZ										SAMPLE LOST
A8	13349#2	905	42	11-Feb	14:34:00	58° 51.45'	7° 51.35'	NIOZ										NOT FIRED
A8	13349#3	917	42	11-Feb	15:54:00	58° 51.77'	7° 51.14'	NIOZ										NOT FIRED
A8	13349#4	917	42	11-Feb	17:03:00	58° 51.45'	7° 52.15'	NIOZ					0.2 m2					OK
A9	13350#1	698	42	11-Feb	19:06:00	58° 50.18'	7° 50.20'	NIOZ										EMPTY
A9	13350#2	717	42	11-Feb	20:57:00	58° 50.53'	7° 50.36'	NIOZ					0.2 m2					OK
A2	13347#3	1312	42	11-Feb	23:38:00	58° 58.96'	7° 58.28'	NIOZ					0.2 m2					OK
A2	13347#4	1295	43	12-Feb	02:19:00	58° 58.66'	7° 57.40'	BEDHOP										OK
A9L1	13351#1	741	43	12-Feb	06:34:00	58° 50.84'	7° 50.86'	ROCK DREDGE										OK
A9L2	13352#1	801	43	12-Feb	10:31:00	58° 50.63'	7° 49.95'	ROCK DREDGE										OK
A8	13349#5	974	43	12-Feb	15:30:00	58° 51.98'	7° 49.55'	AGASSIZ										OK
A6	13348#4	1115	43	12-Feb	20:33:00	58° 54.59'	7° 53.35'	AGASSIZ										OK
A2	13347#5	1278	44	13-Feb	01:30:00	58° 58.29'	7° 58.26'	AGASSIZ										OK
A2	13347#6	1311	44	13-Feb	05:55:00	58° 58.87'	7° 57.29'	NIOZ					0.2 m2					OK
A2	13347#7	1316	44	13-Feb	08:18:00	58° 58.77'	7° 57.66'	M/C	y	y	y	y						OK
A6	13348#5	1123	44	13-Feb	10:01:00	58° 54.41'	7° 53.03'	M/C	y	y	y	y						OK
A8	13349#6	910	44	13-Feb	11:39:00	58° 51.60'	7° 51.11'	M/C	y	y	y	y						OK
A8	13349#7	885	44	13-Feb	13:11:00	58° 51.45'	7° 51.48'	BEDHOP										OK
A9	13350#3	721	44	13-Feb	15:32:38	58° 50.15'	7° 50.05'	BEDHOP										OK
A9	13350#4	704	44	13-Feb	18:17:00	58° 49.97'	7° 50.32'	NIOZ *	y	y	y	y						OK
B3	13353#1	896	44	13-Feb	20:33:53	58° 50.32'	7° 53.98'	NIOZ					0.2 m2					OK
B3	13353#2	896	44	13-Feb	22:32:00	58° 50.48'	7° 54.28'	NIOZ *	y	y	y	y						OK
B2	13354#1	1108	45	14-Feb	00:35:30	58° 53.50'	7° 56.47'	NIOZ					0.2 m2					OK
B2	13354#2	1102	45	14-Feb	02:34:00	58° 53.29'	7° 56.61'	M/C	y	y	y	y						OK
B2	13354#3	1104	45	14-Feb	04:10:50	58° 53.36'	7° 56.00'	BEDHOP										OK
B1	13355#1	1317	45	14-Feb	07:14:00	58° 57.67'	7° 59.56'	NIOZ					0.2 m2					OK
B1	13355#2	1316	45	14-Feb	09:22:18	58° 57.74'	7° 59.90'	BEDHOP										OK
B1	13355#3	1316	45	14-Feb	11:51:00	58° 57.90'	7° 59.70'	M/C	y	y	y	y						8 SHORT CORES
C1	13356#1	1310	45	14-Feb	13:23:00	58° 59.58'	7° 55.91'	M/C	y	y	y	y						4 LONG CORES
C1	13356#2	1309	45	14-Feb	14:39:00	58° 59.61'	7° 56.02'	M/C	y	y	y	y						OK
C1	13356#3	1304	45	14-Feb	16:12:14	58° 59.67'	7° 55.77'	BEDHOP										OK
C1	13356#4	1314	45	14-Feb	18:40:35	58° 59.83'	7° 55.86'	NIOZ					0.2 m2					OK
C2	13357#1	1107	45	14-Feb	20:42:00	58° 55.13'	7° 51.57'	NIOZ										NO SAMPLE
C2	13357#2	1109	45	14-Feb	22:21:00	58° 55.08'	7° 51.50'	M/C										NO SAMPLE
C2	13357#3	1110	45	14-Feb	23:25:00	58° 55.15'	7° 51.73'	MC										1 SHORT CORE

1. PERSONNEL

1.1 DML/SAMS SCIENTIFIC PERSONNEL
JONES, K.J. (Principal Scientist)
BREUER, E.
EZZI, I.
HARVEY, R.
HARVEY, S.M.
LAMONT, P.
McGARR, P.
ROBERTS, M.
WATSON, J.

1.2 REPRESENTATIVE, ENTERPRISE OIL LTD.
NORTHCOTE, R.

1.3 R.V.S. TECHNICAL SUPPORT
RYMER, C.
DUNSTER, D.
HOWARTH, P.
JONES, J.
KNIGHT, G.
TILLING, J.

1.4 SHIP'S PERSONNEL

PLUMLEY, R.C.	Master
CHAMBERLAIN, R.J.	Chief Officer
ATKINSON, R.M.	2nd Officer
HOOD, M.P.	3rd Officer
MOSS, S.A.	Chief Engineer
CLARKE, J.R.	2nd Engineer
BELL, S.J.	3rd Engineer
PERRIAM, R.J.	3rd Engineer
RANT, B.N.	ETO
DRAYTON,M.J.	CPO(D)
LEWIS, T.G.	PO(D)
ALLISON , P.	SG1A
CRABB, G.	SG1A
KESBY, S.	SG1A
LUCKHURST, K.R.	SG1A
MACLEAN, A.	SG1A
PRINGLE, K.	MM1A
STAITE, E.	Senior Catering Manager
HAUGHTON, J.	Chef
SWENSON, J.J.	Messman/Steward
ORSBORN, J.A.	Steward
SHIELDS, S.	Steward

Table 3.

Station	Discovery station No.		Julian day	Date	Time	Ship's	Position	Gear	HC	HM	PS	Sediment radionuclides	Macro-benthos	Salinity	Temperature	Beam attenuation	Water column geochemistry	Status
C2	13357#4	1105	46	15-Feb	01:06:49	58° 55.27'	7° 51.57'	BEDHOP										OK
C3	13358#1	918	46	15-Feb	03:40:28	58° 52.34'	7° 49.06'	BEDHOP										OK
C3	13358#2	927	46	15-Feb	06:07:47	58° 52.30'	7° 49.11'	CAMERA TEST										OK
C3	13358#3	914	46	15-Feb	07:38:00	58° 52.25'	7° 49.57'	M/C	y	y	y	y						OK
C2	13357#5	1112	46	15-Feb	09:15:00	58° 55.25'	7° 51.22'	M/C		y		y						1 CORE
C2	13357#6	1115	46	15-Feb	11:09:00	58° 55.48'	7° 51.16'	NIOZ										NO SAMPLE
C2	13357#7	1119	46	15-Feb	12:38:00	58° 55.20'	7° 52.07'	NIOZ										FAILED TO FIRE
C3	13358#4	905	46	15-Feb	14:14:00	58° 52.37'	7° 49.08'	NIOZ										LOST
A9	13350#5	705	46	15-Feb	17:15:00	58° 50.22'	7° 50.18'	CTD						y	y	y	y	OK
A3	13359#1	1277	46	15-Feb	20:00:00	58° 57.97'	7° 55.84'	CTD						y	y	y		OK
A5	13360#1	1173	46	15-Feb	22:10:00	58° 55.55'	7° 54.69'	CTD						y	y	y		OK
A7	13361#1	1013	46	15-Feb	00:05:25	58° 52.96'	7° 52.27'	CTD						y	y	y		OK
A8	13349#8	919	47	16-Feb	02:03:18	58° 51.71'	7° 50.91'	CTD						y	y	y	y	OK
C3'	13362#1	870	47	16-Feb	13:32:00	58° 52.41'	7° 48.23'	USNEL					0.25 m2					OK
C2	13357#8	1105	47	16-Feb	15:47:00	58° 55.02'	7° 51.21'	USNEL										EMPTY
C2	13357#9	1087	47	16-Feb	17:03:00	58° 55.34'	7° 49.83'	USNEL										EMPTY
A6	13348#6	1108	47	16-Feb	18:55:58	58° 54.11'	7° 53.48'	BEDHOP										OK
B3	13353#3	890	47	16-Feb	21:30:02	58° 50.61'	7° 53.62'	BEDHOP										OK
A9L3	13363#1	665	48	17-Feb	11:05:00	58° 50.08'	7° 48.51'	ROCK DREDGE										OK
A9	13350#6	665	48	17-Feb	14:06:00	58° 50.03'	7° 49.64'	AGASSIZ										SMALL CATCH
A9	13350#7	659	48	17-Feb	17:10:00	58° 49.86'	7° 49.14'	AGASSIZ										EMPTY TORN
A9L4	13364#1	569	48	17-Feb	20:09:00	58° 50.18'	7° 45.32'	ROCK DREDGE										OK
A9L5	13365#1	870	48	17-Feb				ROCK DREDGE										ABORTED
A9L5	13365#2	855	49	18-Feb	04:24:00	58° 51.36'	7° 49.91'	ROCK DREDGE										OK
C2	13366#1	1095	49	18-Feb	07:29:00	58° 49.8'	7° 49.83'	AGASSIZ										EMPTY
C2	13366#2	1103	49	18-Feb	10:24:00	58° 55.99'	7° 51.66'	AGASSIZ										SMALL CATCH
D1	13367#1	1117	49	18-Feb	13:38:00	58° 56.32'	7° 50.59'	USNEL										FAILED
D1	13367#2	1116	49	18-Feb	16:11:20	58° 56.27'	7° 50.49'	USNEL										EMPTY
D1	13367#3	1107	49	18-Feb	17:59:00	58° 55.92'	7° 50.04'	M/C	y									I CORE
D1	13367#4	1088	49	18-Feb	19:56:45	58° 56.42'	7° 49.78'	BED HOP										OK

trawl and dredge times are start of trawl (ie on bottom)
box core times are pull out times
ctd times are either at bottom or first bottle fired
bed hop times are first exposure
* subcored for geochemistry

Table 4.

Station	Discovery station No.	Depth (m)	Date	Time	Gear	Ship's	Position	Sampling	Gear	Position
A2	13345#1	1289	09-Feb	16:40:00	AGASSIZ	58° 58.38'	7° 57.56'	start	59° 00.96'	7° 53.54'
								end	58° 58.98'	7° 57.10'
A9L1	13351#1	741	12-Feb	06:34:00	ROCK DREDGE	58° 50.84'	7° 50.86'	start	58° 49.43'	7° 53.06'
								end	58° 50.46'	7° 51.55'
A9L2	13352#1	801	12-Feb	10:31:00	ROCK DREDGE	58° 50.63'	7° 49.95'	start	58° 49.61'	7° 53.35'
								end	58° 50.62'	7° 50.01'
A8	13349#5	974	12-Feb	15:30:00	AGASSIZ	58° 51.98'	7° 49.55'	start	58° 51.52'	7° 54.03'
								end	58° 49.95'	7° 51.24'
A6	13348#4	1115	12-Feb	20:33:00	AGASSIZ	58° 54.59'	7° 53.35'	start	58° 55.91'	7° 50.85'
								end	58° 55.40'	7° 51.73'
A2	13347#5	1278	13-Feb	01:30:00	AGASSIZ	58° 58.29'	7° 58.26'	start	58° 59.16'	7° 56.66'
								end	58° 57.73'	7° 59.65'
A9	13350#6	665	17-Feb	14:06:00	AGASSIZ	58° 50.03'	7° 49.64'	start	58° 50.20'	7° 48.79'
								end	58° 49.89'	7° 50.24'
A9	13350#7	659	17-Feb	17:10:00	AGASSIZ	58° 49.86'	7° 49.14'	start	58° 50.23'	7° 47.87'
								end	58° 53.00'	7° 48.74'
A9L4	13364#1	569	17-Feb	20:09:00	ROCK DREDGE	58° 50.18'	7° 45.32'	start	58° 50.41'	7° 44.39'
								end	58° 50.14'	7° 45.46'
A9L5	13365#1		17-Feb	aborted	ROCK DREDGE	58° 50.50'	7° 47.47'			
A9L5	13365#2	855	18-Feb	04:24:00	ROCK DREDGE	58° 51.36'	7° 49.91'	start	58° 51.54'	7° 49.43'
								end	58 °51.40'	7° 49.83'
C2	13366#1	1095	18-Feb	07:29:00	AGASSIZ	58° 49.80'	7° 49.83'	start	58° 56.63'	7° 49.38'
								end	58° 53.60'	7° 50.82'
C2	13366#2	1103	18-Feb	10:24:00	AGASSIZ	58° 55.99'	7° 51.66'	start	58° 56.54'	7° 49.67'
								end	58° 55.92'	7° 52.26'

2. INTRODUCTION AND OBJECTIVES

The work carried out during this cruise was undertaken to support the Environmental Assessment required for exploration drilling operations within Tranche 38, Block 154/1 (58° 50' - 59° 00'N, 07° 48'-08°00' W) licenced to Enterprise Oil Ltd. The survey objectives were:

a) To sample benthic macro- and megafauna populations along 3 cross-slope transect lines within the block (Figure 1).

b) To test for the occurrence of the coral, *Lophelia* on the basis of existing knowledge of the environment where this coral is found in the NE Atlantic.

c) To carry out photographic surveys of the seabed at all benthic stations along the three transect lines.

d) To obtain undisturbed sediment cores from all benthic stations for geochemical, hydrocarbons and particle size analysis.

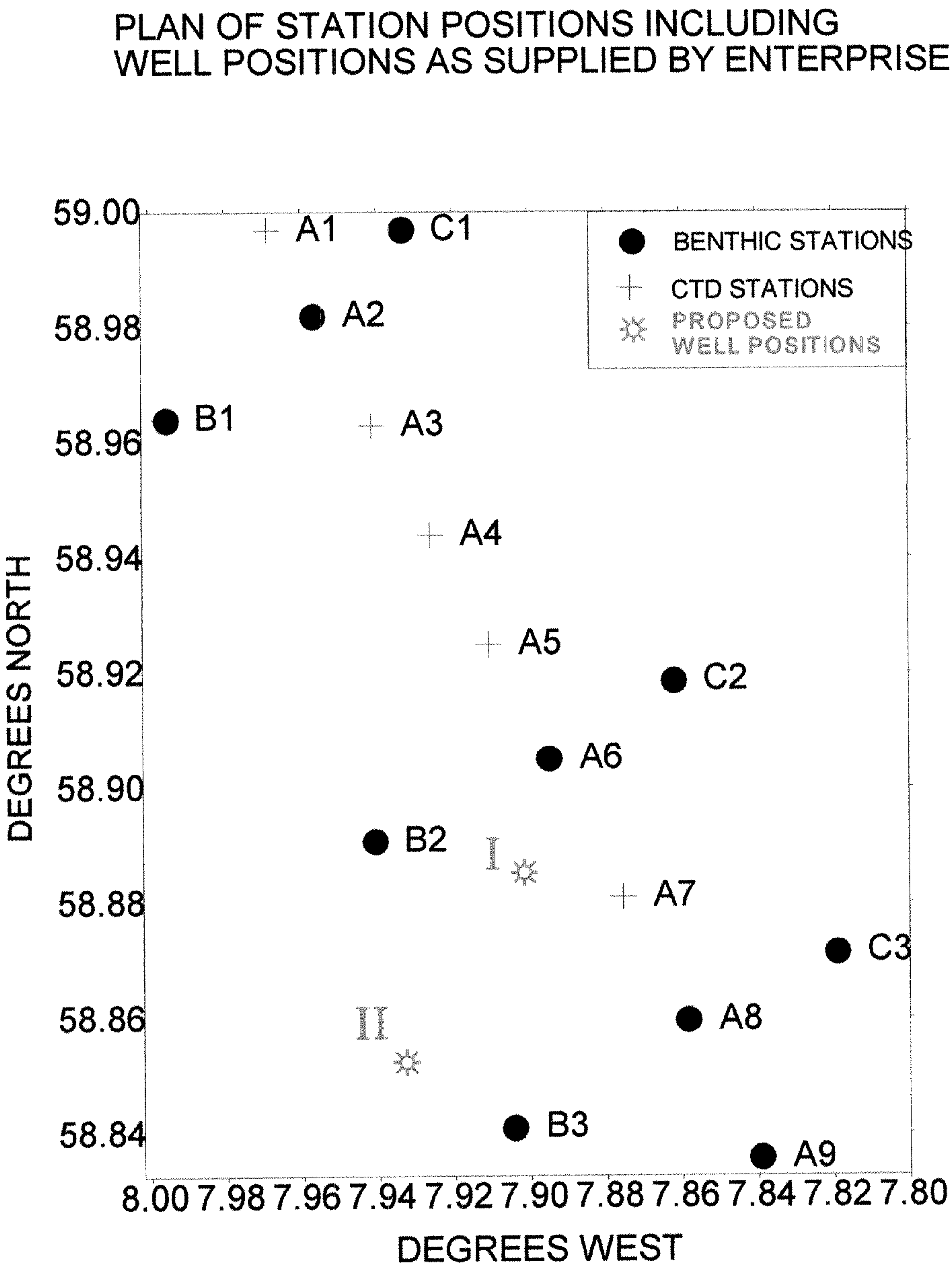
e) To make CTD measurements at 8 stations along the main central transect line and collect water samples for determination of distributions of suspended particulate material (SPM).

3. SURVEY DESIGN AND SAMPLING

The sampling strategy for water column and benthic measurements was designed to optimise resolution of cross-slope, depth-related changes in properties and communities, whilst enabling spatial variability across the block to be determined. Water column measurements were carried out to provide one cross-slope transect across the area. The nominal station positions occupied during the cruise are shown in Figure 1. Benthic samples were collected at four stations along the A line, and three stations along each of B and C lines. CTD measurements were made at stations A1, A2, A3, A5, A6, A7, A8 and A9 and water sample collection for geochemical measurements at A2, A6, A8 and A9. Precise station positions were determined by DGPS at the time of sampling. All station positions use the WGS84 datum.

Two station naming protocols were maintained in parallel during the cruise. In order to comply with historical precedent set on the Discovery to maintain a continuous and consistent station nomenclature spanning cruises over many years, each new station was given a new unique station number and for each item of gear deployed at that station this identifier was suffixed with an incrementing hash(#) number. Thus for example station 13357#1 and 13357#2 represent deployments of the box corer and multicorer respectively at the same nominal site. Additionally station names as given in Figure 1 were also used. Both numbers for each of the stations worked are given in Table 3.

Figure 1.


PLAN OF STATION POSITIONS INCLUDING
WELL POSITIONS AS SUPPLIED BY ENTERPRISE
BENTHIC STATIONS
CTD STATIONS
PROPOSED
WELL POSITIONS
A1
C1
A2
B1
A3
A4
A5
C2
A6
B2
I
A7
C3
II
A8
B3
A9
59.00
58.98
58.96
58.94
58.92
58.90
58.88
58.86
58.84
DEGREES NORTH
8.00 7.98 7.96 7.94 7.92 7.90 7.88 7.86 7.84 7.82 7.80
DEGREES WEST

C1

4. SAMPLING PROTOCOLS

4.1 Benthic Faunal Sampling

4.1.1 Box coring

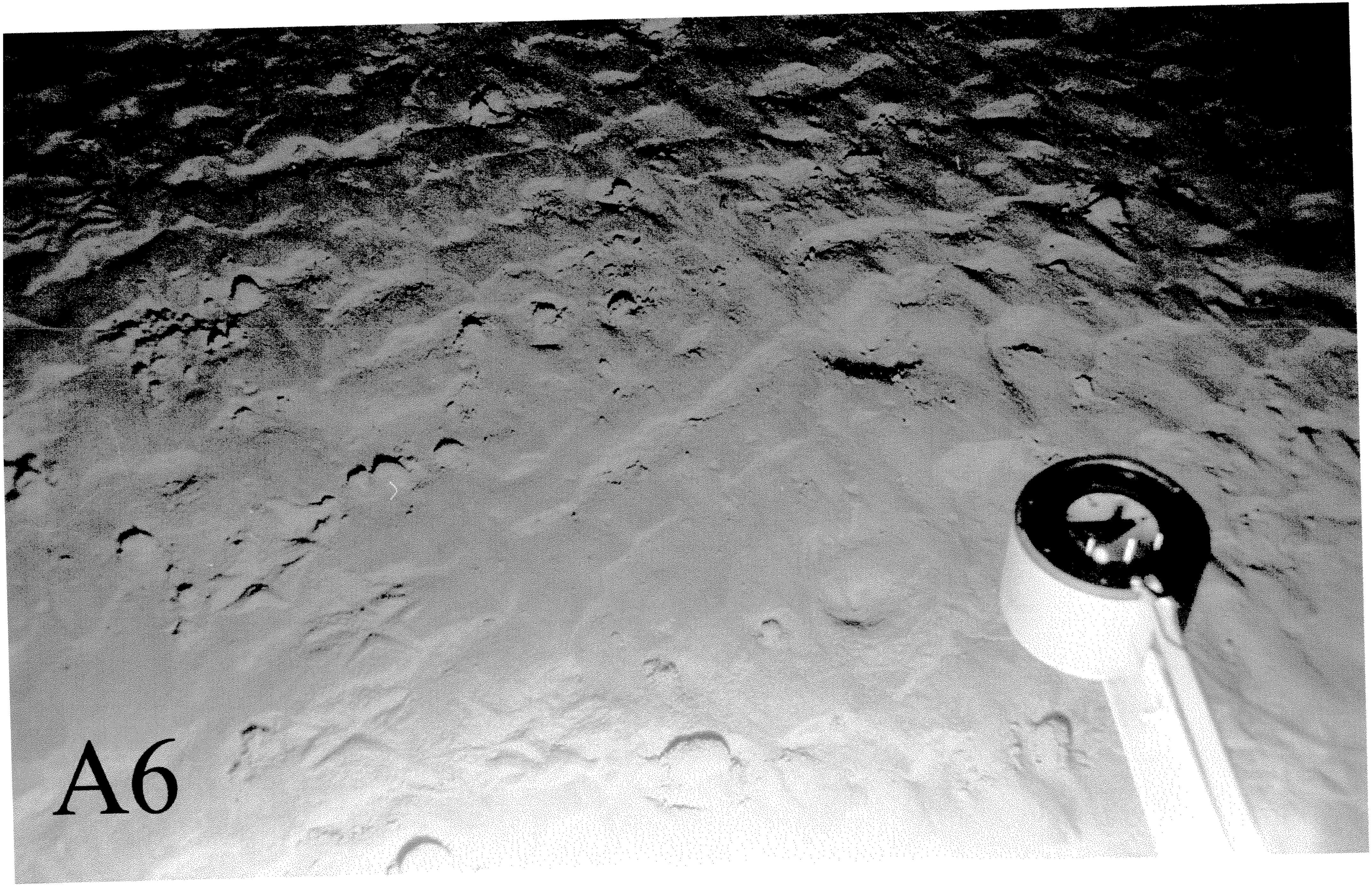
The box corers were deployed from the starboard midships gantry, where the effect of the ship's pitching motion on the gear is minimised. An acoustic beacon was initially fitted to the warp 50 m above the sampler and it's approach to the bottom monitored on the echo sounder. The corers were typically lowered at 40 m/min and allowed to contact the bottom at 30 m/min. The load on the coring wire was monitored on a chart recorder. It was found that bottom contact was easily detected by this means, and use of the acoustic beacon was discontinued. After bottoming the gear, a further 10 metres of warp was paid out to ensure adequate penetration of the corer before recovery commenced. Typical wire loads on recovery of the NIOZ corer were 3-4 tonnes.

On recovery of box core samples, the overlying water was siphoned onto a 0.3 mm mesh. The core surface was photographed, then any epifaunal animals were carefully removed and preserved. Depth markers 10 cm long were inserted around the margins of the core and the sediment carefully excavated using a hand trowel. The upper 3 cm of sediment, which normally contains the majority of the macrofauna was placed immediately in formaldehyde, and sieved after the deeper layers had been processed. Any fauna encountered during excavation of the 4-10 cm layer below was removed in order to minimise possible damage during subsequent washing and sieving of the sample. This layer was softened by soaking and gently stirring it by hand in buckets of filtered seawater prior to pouring the muddy suspension through a 0.3 mm mesh sieve. Clay lumps were gently broken up with spray jets. The remaining sediment from 11-25 cm was excavated and emulsified in a similar fashion but was sieved on a 1 mm mesh and preserved separately. Sediment deeper than 25 cm was discarded. All fauna was preserved in buffered formaldehyde.

4.1.2 Agassiz Trawl and Rock Dredge

The Agassiz trawl and rock dredge were initially deployed using towing warp of 2.5 times the water depth (scope ratio) at the stations >1000 m, and with 3 times water depth at the shallower stations. Owing to the high sea states prevailing, a section of 6 inch chain was attached immediately in front of the gear to help to weight it down. A 100 m wire pennant connected this to the main trawl warp, in order to reduce the risk of damage to the latter. This increased deployment/recovery time slightly, as the pennant had to be spooled onto a slower auxiliary winch on deck. Following the loss of the NIOZ corer, it was necessary to use the heavy coring warp for further trawls and dredges. In order to avoid bottom contact of this wire, the pennant was again used, and an acoustic beacon was attached 100 m from the inboard end of the pennant. The height of the beacon above the bottom was then monitored on the precision echo sounder. This allowed some surprisingly low scope ratios for the warp to be used when fishing the gear; around 1.2 - 1.5 times the water depth.

The Agassiz trawl was generally towed for 45 minutes at the deep stations and 20-30 minutes at the shallower stations. This difference reflects the greater abundance of fauna at the shallower stations and also some difficulty experienced with fishing the gear in the sea


A6

conditions prevailing. Rock dredges were towed for 10-15 minutes, which was sufficient to fill the net and the trailing 'mud bucket' on most occasions with rocks and sediment.

Material recovered in the Agassiz trawl was roughly sorted in the laboratory and the invertebrate catch preserved in borax buffered 4 % sea-water formaldehyde. A proportion of the fish catch was removed from the net, placed in aluminium foil-lined buckets, separated into species and finally frozen in foil. This procedure was designed to eliminate contamination by chemicals emanating from the ship and to allow subsequent analysis of environmental accumulations (if any) of hydrocarbons.

Rock dredge samples were washed with a spray of filtered seawater (0.1 mm filter aperture) and all rocks carrying a significant fauna were retained, either preserved as above, if they bore soft bodied fauna, or stored dry after washing in freshwater in the case of encrusting bryozoa. The fine material in the trailing bucket was washed with filtered seawater and sieved on a 1 mm mesh before preservation in buffered formaldehyde.

4.2 Sediment Geochemistry

Sediment cores were taken from 11 benthic stations. At 9 of those stations samples were collected for geochemical and particle size analysis (A2, A6, A8, A9, B1, B2, B3, C1, C3). Due to sedimentary conditions at the additional 2 stations (C2, D1) coring (multi-corer and box corer) was ineffective and after numerous attempts only 1 core was obtained from each site. The core from C2 was used for metal analysis and the core from D1 was used for hydrocarbon analysis. The possibility of particle size analysis on the C2 core by laser technique will be evaluated.

Sediment cores were collected using either the SMBA multi-corer or the NIOZ box corer. The multi-corer was used at all stations except A9 and B3, where stony ground necessitated sub-coring from sediment collected using the NIOZ box corer. Once collected, cores for metal and particle size analysis were sectioned at 0.5 cm intervals to 15 cm depth using trace metal-clean Teflon and butyrate slicing rings, plates and spatulas. Samples for hydrocarbon analysis were collected by sub-coring the collected core down to the 2 cm mark with clean metal slicing materials. Once sliced and bagged (canned for hydrocarbons) the samples were then immediately frozen for later analysis.

4.3 Water sampling

4.3.1 Geochemical samples

Water samples for the geochemical analyses of suspended particulate matter were collected at 8 depths chosen with reference to water column density structure and transmissometer profiles at the four main benthic stations. Samples were transferred from the Niskin bottles, mounted on the rosette sampler, to clean 10 l polypropylene flasks using a clean plastic bucket, which was filled by opening the bottom of the Niskin bottle and thereby ensuring that any large, rapidly settling particles which may have settled below the tap were included in the sample. The water samples were then filtered through 0.45 micron polycarbonate filters (Nucleopore) filters using positive pressure of 20 psi. The filters were then removed and stored frozen at -20°C for later analyses.


B3

4.3.2 Suspended particulate material (SPM) for gravimetry.

Water was collected from four depths at each CTD station. These depths were chosen after consideration of the transmissometer profile obtained on the CTD to provide samples representing a wide range of SPM concentrations. Water was transferred from the Niskin bottles, mounted on the rosette sampler, to clean 10 l polycarbonate flasks using a clean plastic bucket which was filled by opening the bottom of the Niskin bottle and thereby ensuring that any large, rapidly settling particles which may have settled below the tap were included in the sample.

The sample was then filtered through a pre-weighed glass fibre filter. The filter was then rinsed with 100 ml distilled water to remove the salt. The volume of sample filtered was noted. The filter paper was then removed and replaced in a labelled plastic petri dish and stored frozen at -20°C prior to drying and weighing back at the laboratory.

4.4 Photographic surveys

The POL (Proudman Oceanographic Laboratory) 'UMEL' Bed-hopping camera system was used to obtain photographs of the sea bed at each of the sampling stations. This comprised a pressure- sealed camera and flash system mounted on a frame, which was deployed from the ship using the CTD wire. The height of the camera frame above the seabed was monitored by a pinger which was displayed both visibly and audibly on an Simrad echo sounder. When the camera frame was suspended the pinger output one 'ping' per second. When bottom contact was made the frequency increased to two 'pings' per second. Bottom contact was made by a weight suspended below the frame on a 75 cm long wire, so that when contact was made the camera was a precise, known distance above the bed. The weight's touching the sea bed caused loss of tension in this wire, which actuated a switch. Thus the shutter was operated and simultaneously the ping rate altered to signify bottom contact. The camera was alternately lowered until bed contact was made and then raised to a height of 5 m above the bed whilst the flash recharged and the film was advanced. Photographic surveys were undertaken at each benthic station whilst the ship was drifting. The approximate time interval between successive pictures was 4-5 minutes. The time, ships position and water depth were recorded as each frame was exposed.

The camera uses 35 mm film in standard 36 exposure cassettes. However, because of the long film path, and the difficulty of unloading a fully wound film, the number of exposures taken on a deployment was limited to a maximum of 25. Ilford FP4 Plus film (125 ISO) was used, and this was processed on board ship in diluted (1+14) Ilfosol S for 6-6.5 minutes soon after exposure to obtain negatives of good contrast. Negatives were scanned into PC- jpeg file format using a Polaroid Sprintscan 35/LE negative scanner and images processed for immediate viewing and analysis using Micrografx Picture Publisher™ software. Preliminary detailed analysis of negatives for faunal content was carried out using a binocular microscope at suitable magnification.

Photographs taken with this system cover an oblique area of the seabed (camera angle, 45°). The field of view is 1 m across the image, and about 2 m front to back, allowing a good assessment to be made of the size of seabed features. A compass mounted on the camera


A9

frame is also visible on the image, allowing the orientation of features to be determined. Quantitative analysis of images is facilitated by the use of a transparent overlay bearing a 'Canadian' (perspective) grid superimposed on the image.

5. OPERATIONAL SUMMARY

5.1 Cruise Narrative

Saturday 7 February

DML scientific party arrived Fairlie at 0900. All gear and personnel embarked on ship by 11:00. The scientific party were given a safety briefing at 12:30. Because of winch problems, sailing was delayed by 1.5 h. The ship departed Fairlie at 15:30 and set a course to the working area, taking the route to the west of the Hebrides.

Sunday 8 February

With a worsening midnight forecast of Westerly 7-9 and already very rough sea conditions, the Master called the PS at 02:00 to suggest that the course was altered to take the inshore route through the Minch to Butt of Lewis. In view of the small extra distance penalty the PS agreed to the course alteration. A progress update was faxed to Brian Edmonds at 08:40 and a cruise planning meeting involving the PS, Master and Chief Officer, Bosun, RVS Liaison Officer and Enterprise Representative was held at 09:00 to discuss the outline plan of work, priorities, gear deployments and working practices. Scientific cruise meeting held 12:45: in attendance all DML/SAMS, RVS staff and Richard Northcote. Topics discussed: Staff introductions; RVS systems and support; Role of Enterprise Representative; Scientific objectives; Working area and priorities; Station recording protocols; Communications and liaison; Safety and good working practices.

Weather conditions showed little improvement during the day and since conditions would be unsuitable for operations in the working area the decision was made to remain in relatively sheltered deep (~100 m) water to the east of the Butt of Lewis and carry out gear trials pending an improvement in weather. The ship arrived on station at 16:20. Winch and sea bed camera systems were tested during the late evening. Despite problems experienced with detecting the pinger frequency change when the bed hop camera made bed contact (which were probably due to large wire angle) the bed hop camera performed satisfactorily producing useable negatives. The Oceanic Instrumentation (OI) camera was then deployed. Again detecting the pinger was a problem and the first deployment no frames were exposed either because of failure of the altimeter trigger for the camera or because of difficulty in assessing the height of the gear above the bed. A second deployment, with an RVS pinger clipped to the wire 10 m above the camera improved depth detection and yielded 49 frames exposed. The image quality of these was however poor due either to lighting or exposure problems. On the basis of these trials and given that there was likely to be insufficient time within the survey period to determine and remedy the OI camera system problems, it was decided to carry out the photographic survey with the Bed-hop camera using monochromatic film recommended by its supplier. Following these trials the ship hove to in winds gusting to 25 knots awaiting signs of improvement.

Monday 9 February

Slight improvement in winds allowed the ship to make course for the working area at 04:15. Daily report faxed to Brian Edmonds at 09:00, but some problems with picking up the satellite. Report eventually sent after several retries. Station A2 was reached at 12:12. Wind and swell conditions were still poor and the only sampling option possible was the Agassiz trawl. The ship repositioned 3 miles downwind of A2 and the trawl was deployed at 14:35. Wind and swell conditions worsened during the trawl, with winds increasing to 40-50 knots. The trawl was recovered on deck at 19:30, with a ripped net and the frame severely damaged. There were heavy seas, with the swell breaking over the after deck. In view of the dangerous conditions scientific operations were suspended and the ship hove to awaiting improvement.

Tuesday 10 February

Winds of 65 knots were recorded during the evening of 9 February through the early hours of 10 February. With a slight improvement at 07:00 the decision was made to attempt CTDs and water sampling along the “A” line, no other sampling being possible. CTD’s were successfully completed at A1. Noisy outputs from the transmissometers experienced at A1 were rectified by changing the break-out box on the CTD system and replacing one of the transmissometers with a backup unit brought by DML.
At A2 a wind shift at 15:25 forced the ship to lie cross swell to maintain station. This resulted in it rolling heavily. The CTD cast was aborted and once the instrument was on deck scientific activities were again suspended awaiting weather improvement.

Wednesday 11 February

Work was resumed at 02:28 with CTDs and water sample collection at A2 followed by A6. Moderating wind and swell conditions allowed box coring to be carried out throughout most of Wednesday. NIOZ box cores were successfully obtained at A6, A8 and A9 along the main benthic transect, although progress was slower than hoped because of the need to do repeated deployments at several stations due either to too deep penetration of the corer into the sediment or to misfires of the NIOZ box corer closure mechanism. Some of these failures were thought to be caused by the swell conditions, rather than the gear malfunction. Displacement of an “O” ring seal from the closure mechanism of the corer brought box coring prematurely to a halt at 00:30 on 12 February, before the final box core on the A line could be taken at A2. The corer needed to be partially dismantled to refit the seal and left for a sufficient time to allow the adhesive to cure, curtailing box coring for at least 12 h.

Thursday 12 February

The Bed-hop camera was deployed at A6 at 01:33 in marginal conditions for this instrument. 8 frames were exposed, but the deployment was prematurely terminated because of difficulty in detecting pinger output. The ship was then repositioned to begin rock dredge hauls at the western edge of the block. Rock Dredges were completed at 2 stations A9L1 and A9L2 followed by Agassiz trawls at A8 and A6 and A2. In order to minimise down-time due to wire changes between the trawl and coring wires, RVS personnel suggested that the trawl warp could be used for coring activities rather than the coring wire which had been used for box coring earlier in the cruise, since the pull out tensions observed for box and multicores were well within the safe working limits of the trawl warp. This was agreed to by the PS on the understanding that RVS personnel were entirely satisfied that this would not compromise the safety of the gear.

Friday 13 February

The final box core on the A line was completed at A2 at 06:27. In much improved weather and swell conditions a series of multicorer drops along the A line was begun. Multicore samples were successfully retrieved at A2, A6 and A8 and Bed-hop photography completed at A8 and A9. In the light of information from the previous box core sample at A9 and photographic information on bed type, it was decided that multicoring at this site would be unsuccessful because of difficulty in penetration and risk of breaking core tubes on the stony surface. A NIOZ box core sample was therefore taken successfully, and this sub-cored for geochemical analysis. Box cores for both faunal and geochemical analysis were taken at B3.

Saturday 14 February

Box core and multicore sampling and photography were successfully completed at B2, B1 and C1 during the morning and early-afternoon. At station C2 the box corer deployment failed and the silicone seal was again found to be displaced on recovery. Similarly the multicorer failed to retrieve any cores on this station on its first deployment and only retrieved one short core out of a possible eight on its second deployment. Coring was therefore postponed until the box corer seal had been repaired.

Sunday 15 February

The Bed-hop camera was successfully deployed during the early hours at C2 and C3 and cores were also successfully obtained from C3 using the multicorer. The ship was repositioned at C2 and a further attempt made to obtain cores using the multicorer. One core only was recovered. Two further attempts to obtain box cores at C2 were attempted, both unsuccessful. The station was therefore aborted and the ship moved to C3. Although cause difficulty in sampling at C2 was unknown, it was thought more likely to be related to sediment type than to gear failure. Box coring attempts resumed at C2 at 14:23 in 908 m depth. Hauling to begin recovery of the corer began at 14:46. On withdrawal of the corer from the sediment, the cable broke and the corer was lost at 58° 52.3248' N 07° 49.1132' W. The peak pull-out tension of 4.49 tonnes was not unusually high compared to that at previous stations. Recovery of the cable showed that the break occurred approximately 120 m above the gear. Work was temporarily suspended to allow assessment of the incident.

Work recommenced at 16:49, beginning a series of CTD casts and water sampling along the "A" line to complete the series aborted earlier in the cruise. Casts were carried out at A9, A3, A5, A7 and A8, and this series was completed at 02:45 on 16 February. Station A4 was not sampled because of time constraints.

Monday 16 February

Weather once again conspired against us. A very deep depression rapidly moved through the area after the CTD stations were completed, forcing a cessation of work at 03:54, before the final 2 seabed photographic surveys could begin. The ship hove to at B3 in 30 knot northerly winds. Conditions had improved by 13:00 but were still unsuitable to resume Bed-hop camera work. The ship therefore returned to C3 to box core using the backup USNEL boxcorer. The ship was positioned about 0.5 mile north of the original C3 box coring site to avoid the (unlikely) possibility of entanglement with the lost NIOZ box corer. After successfully recovering a core at C3 the ship returned to C2 to attempt to obtain a box core. Two successive deployments failed to retrieve a sample and the station was finally abandoned. Bed-hop photography was successfully completed at A6 and B3 at 23:30 which completed the photographic survey of the area. Following the loss of the box corer and uncertainty over the safety of the trawl wire for further use, trawling was suspended. Permission to use the coring warp for trawling was received from RVS during the course of the day.

Tuesday 17 February

Weather conditions again worsened, halting work. To make good use of the down-time a slow speed echo sounder survey was initiated over a canyon-like feature suggested from bathymetry provided by Enterprise, with the objective of defining areas for future rock dredges to search for corals. The prescribed track was completed at 03:54 and the ship hove to pending review of conditions at 07:00. Conditions had marginally improved by 08:00 and the ship positioned to carry out a rock dredge at 10:25 at A9L3. This was followed by two Agassiz trawls at A9. The first returned with a torn net and only a small catch. The second returned ripped with no catch. The station was therefore abandoned to avoid further gear damage. A rock dredge was then successfully carried out to the east of the block, over steep ground at a depth of 569 m at A9L4. A further dredge across the canyon-like feature had to be abandoned early in the deployment because of swell conditions and work was suspended pending improvement.

Wednesday 18 February

The final rock dredge at A9L5 was completed 05:28 before the ship moved back to station C2 to begin further investigations into the area which had previously caused difficulties in sampling. Two Agassiz trawls were carried out at C2. The first was recovered empty, probably because the gear may not have been on the bottom due to misinterpretation of the depth of the pinger on the echo sounder trace. The second returned with a mixed catch. Box coring, multicoring and photography were then carried out at a new station, D1, which was sited north of C2 along the 1100 m contour to help establish whether the sediment conditions at C2 were localised or typical of the NW corner of the block. Two box coring attempts using the USNEL box corer failed to return a sample, and the multicorer recovered only 1 sample which was sliced for hydrocarbon analysis. Sea bed photographs were successfully taken at D1 at 21:00. A request to carry out sampling at two Statoil stations in, or close to, the Enterprise block could not be addressed because of insufficient time, with a deadline for return to Fairlie of 11:00, 20 February. This being the case the ship made course for Fairlie.

Thursday 19 February

On passage to Fairlie, taking route through the Minch because of wind and swell conditions.

Friday 20 February

Arrive Fairlie, 11:00. All DML gear and personnel disembarked by 14:30. Ship sails Southampton.

5.2 TIME ALLOCATION RECORD (Fairlie - Fairlie)

In Port:	Mobilisation DML staff, Fairlie	6.70 h
	Demobilisation, Fairlie	2.50 h
	Total	**9.20 h**
At Sea:	Outward Passage	39.45 h
	Inward Passage	39.00 h
	Survey	229.85 h
	Total	**308.30**
Survey:	Active Time[1]	185.11 h
	Down Time	
	Weather	42.74 h
	Repairs	2.00 h
	Total	**229.85**

[1] Includes: a) gear tests carried out whilst hove to during passage leg; b) time for repositioning ship, changing wires and setting up equipment prior to deployment; c) repeat deployments when gear recovered damaged or empty.

6. CONCLUSIONS

6.1 Achievement of Objectives

i. Nine of the ten benthic biology stations proposed in the scientific scope were sampled. Eight of these were sampled using the NIOZ box corer, the other using the USNEL box corer after the loss of the NIOZ equipment. It was not possible to collect box core samples from C2 or from an adjacent additional station D, (see below).

ii. Photographic images of the sea-bed were obtained at the ten benthic stations and additionally at D1 using a Bed-hop camera. These images are of a quality suitable for analysis of the epifauna and bed forms present in the area and clearly indicate depth-related differences across the block.

iii. Sediment cores were taken from all ten benthic stations for geochemical and particle size analysis. Undisturbed cores were usually taken using the SMBA multicorer but, because of the stony ground at A9 and B3, samples were obtained by sub-coring a box core sample. Only one core was available from C2, due to sediment type (see below). This core was sectioned for metals analysis. Similarly only one core was obtained from the adjacent station D1. The top 2 cm of this core was retained for hydrocarbon analysis. Some sediment size analysis might be possible on both of these cores using a laser technique which requires smaller samples than other methods.

iv. CTD deployments, which included measurements of temperature, salinity and beam attenuation, were completed at 8 stations and water sampling at the 4 main benthic stations.

v. Agassiz trawls were carried out at 3 of the 4 main benthic stations on the central transect line. Damage to the trawl on 2 deployments of the Agassiz trawl at A9 (700 m) resulted in this station being abandoned.

vi. Four rock dredge hauls were completed at different sites in the steepest region of the slope within the block and one on shallower, steeper ground to the east.

Before the cruise we were fully aware, from previous experience, that the conditions in the study area in February might preclude scientific observations for long periods. Throughout the duration of the work the wind and swell conditions were often unfavourable and frequently severe. Figure 2. shows that work frequently continued in winds of Beaufort Force 7-8 and the scientific equipment was, on many occasions, working at the margin of its weather capability. This caused interruptions to the scientific programme and made long term forward planning of activities very difficult. That more time was not lost to weather, is largely attributable to the use of a larger vessel with midships gear deployment, which allowed safe working to continue in high wind and large swell conditions. The use of a smaller vessel (e.g. R.R.S. Challenger) would have resulted in a much higher proportion of down-time and likely failure to meet all scientific objectives. All sampling objectives set for the cruise were addressed and, with two exceptions, successfully achieved. Our inability to obtain box cores and the requisite number of cores for geochemical/hydrocarbon analysis at C2 and an Agassiz trawl at A9 appeared to be due to the nature of the seabed rather than gear malfunction. The difficulty in obtaining sediment samples at C2 and latterly at D1 was particularly frustrating. With hindsight, it is possible that inclusion of a Shipek or Day grab in the choice of equipment available for benthic faunal sampling might have enabled a quantitative sample to be obtained. In the case of geochemistry sampling it is less clear how cores with undisturbed surface might have been recovered, although larger gravity corers (e.g. Kasten) might have allowed cores to be recovered to investigate sedimentology of the area in the vicinity of C2 in more detail.

6.2 Preliminary Observations and Interpretation

Much analysis is still to be carried out on the samples collected before conclusions can be reached about the benthic fauna and geochemistry of the block. However, during the course of the cruise it was possible to make some preliminary observations and interpretations which are summarised below. These interpretations may need modification as information becomes available during the coming months.

6.2.1 Benthic biology

a) Box coring (Macrofauna)
Box coring was successfully carried out, using the NIOZ box corer, at all benthic stations except C2, C3 and D1. Following the loss of the NIOZ box corer at C3 on February 15, the USNEL box corer was used. A satisfactory sample was obtained with this at C3, but multiple drops at C2 and D1 failed to return samples.

The 1300 m stations showed a soft, upper bioturbated horizon overlying stiffer clay. Faunas of the upper horizon appeared to be dominated by foraminifera and polychaetes. At 1100 m an upper horizon of firm sand, made coring difficult. Amphipod crustaceans were a feature of these samples. Sediments in the 900 m cores were of mixed sand, with occasional pebbles, the brittle star *Ophiocten* gracilis being abundant on the surface of one core. Sand, gravel and cobbles predominated at 700 m where the NIOZ corer produced a surprisingly good sample for such coarse (but relatively open) sediment. Burrowing faunas were poorer at these two shallower depths, and amphipod crustaceans were prominent, suggesting a mobile sediment. Further analysis of these samples will require considerable sorting under the microscope.

b) Trawls and dredges (Megafauna)
A combination of bottom type and sea conditions resulted in repeated damage to the Agassiz (beam) trawl (one trawl frame being wrecked), and for the most part catches were small. They confirmed the identity of many species seen in the photographs, as well as providing specimens of additional cryptic species. The rock dredge was deployed on the stony groundbetween 550m and 800 m and particularly at 700 m. It is not the best (though the most robust) faunal sampler, and catches were small, revealing encrusting sponges, serpulid worms, bryozoans and bivalves as well as the burrowing bivalve *Astarte*. The most abundant species, making up around 70% of the fish catch, was the cut-throat eel *Synaphobranchus kaupi* and this was also present in a number of seabed photographs.

c) Sea-bed photography (Megafauna)

On each Bed-hop deployment a sequence of up to 22 photographs was taken resulting in 207 photographs for the cruise. All but the last sequence (185 negatives total) were examined during the cruise under a binocular microscope (see 7.3) and the recognisable megafauna scored as presence or absence data. Some negatives showed views partly obscured by mud clouds created by the camera frame disturbing the bottom. Completely obscured photographs and blank frames were noted in order to correlate the record of photograph sequence with ship position, and hence gear (=photograph) positions, for future analysis. Useable photographs were grouped into four depth ranges (1300, 1100, 900 and 700 m) and the percentage occurrence of seabed type and recognisable megafauna was calculated and expressed in Table 1. Representative images from the four depth ranges can be found in **Section 11.** of this report. The transition of principal sediment types where mud in the deeper stations gives way to sandier sediments around 1100 m grading into a stony bottom in the shallower stations is illustrated in the results in the first three rows of Table 1. The hydrodynamic regime is indicated by the presence of current-induced sediment ripples which were most prominent at the 1100 m stations. Although current-swept situations are often favoured by filter feeders, these organisms need secure anchoring and the lack of suitable substrata in the form of pebbles and cobbles probably accounts for their absence at these stations. The observed frequencies of occurrence for a range of filter and suspension feeding fauna are displayed in Figure 3.

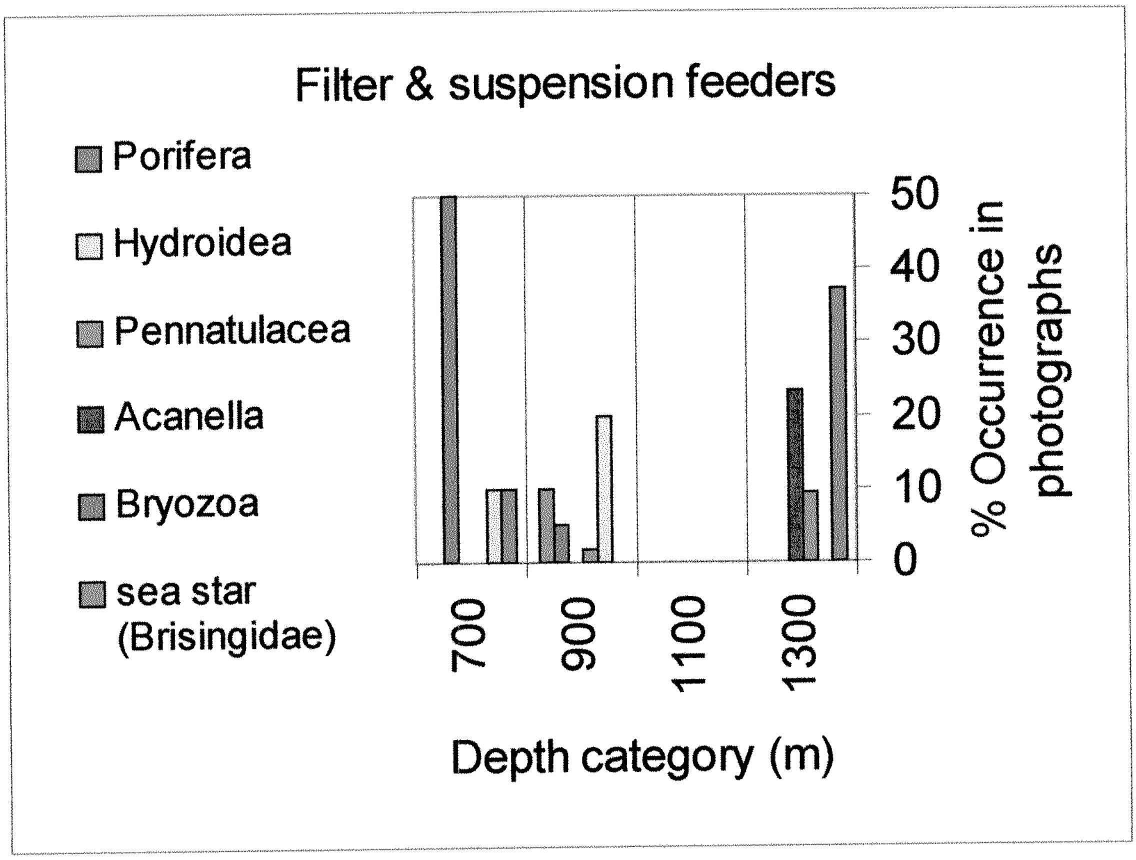
Table 1.

Bed-Hop photographs, preliminary analysis

Observed occurrence per photograph by depth category

Depth category (m) / Sites	**1300** A2, B1, C1 %	**1100** A6, B2, C2 %	**900** A8, B3, C3 %	**700** A9 %
Mud	40	35	0	0
Sand	0	35	0	0
Stones	0	0	100	100
Ripples	0	89	12	0
Trawl marks	12	8	2	0
FAUNA				
Porifera	37	0	0	10
Hydroidea	0	0	20	10
Pennatulacea	9	0	2	0
Polychaeta	26	3	2	10
Munida spp.	16	0	20	15
Crustacea total	2	5	5	5
Gastropoda	0	2	0	0
Asteroidea	5	3	0	0
Ophiuroidea	5	5	93	0
Echinoidea	2	3	18	10
Holothuroidea	0	3	2	0
Fish	2	0	2	5
Eels	19	21	18	0
Incertae sedis	0	0	2	0
Xenophyophores	37	53	0	0
Acanella	23	0	0	0
Aphrodite (Polychaeta)	2	0	0	0
Bryozoa	0	0	5	50
Feather star	0	0	10	0
Fecampidae cocoon (Turbellaria)	2	2	0	0
No. of photographs	***43***	***62***	***60***	***20***

Figure 3. Preliminary analysis of occurrence of benthic faunal types in sea bed photographs



Further up the slope, at 900 and 700 m, stones and small pebbles occur at the sediment surface. These provide suitable anchoring for a variety of fauna most notably sponges, hydroids and bryozoans which are all filter feeders for whom gaining height of a few centimetres above the sediment is an advantage in that significantly higher current flow rates are experienced. Polychaete worms, which form calcareous tubes attached to stones are also common at these depths; however, unlike *Lophelia* they probably have short life spans of less than a decade. As expected from previous work, brittle stars (*Ophiocten* gracilis.) dominated the megafauna at 900 m and crustaceans were also well represented. *Ophiocten gracilis* is thought to be a detritus feeder and occurs in sufficient numbers here for its density to be estimated successfully from the sea bed photographs, as has been accomplished in previous studies.

Structures resembling the xenophyophore *Reticulammina*, were observed in many photographs from the two deeper station groupings. These are large testate protists (single celled animals) which can measure from 1 to 6 centimetres across and are only found below 500 m depth. The body is a multi-nucleate plasmodium enclosed within a branching organic tube system. The tubes can be anastomosing, fusing together to form a rigid structure, but they are extremely fragile and would disintegrate in a trawl or dredge. One or two small examples were recovered on the surface of boxcores and were removed into separate vials before the sediment was extracted. Most of the limited knowledge about these organisms has accumulated in the last twenty five years.

Egg cocoons of an undescribed parasitic turbellarian worm were observed in four photographs, and seven cocoons were recovered in the Agassiz trawl from deployment 13347#5 at station A2 (1300 m). The cocoons contain viable egg capsules and were brought back to Oban to be maintained at 6°C for a time in the hope that funding can be found to culture these animals to maturity. They belong to the family Fecampidae, shallow water examples of which parasitise crustaceans. In 1993 cocoons from 1500 m with viable eggs were cultured for the first time and larvae readily obtained but funding was not available at that time for further study such as providing surrogate hosts. The adult of this species (and its host) is unknown, as is its effect on the host crustacean population.

d) Coral distributions

The distribution of the colonial scleractinian *Lophelia pertusa* has been shown by Faeroese studies to be associated with regions of the continental slope where the bottom gradient steepens and near-bed currents are amplified by interaction of internal waves with the slope. The working hypothesis tested during the cruise was that *Lophelia* and other colonial corals would be found on the steepest slopes in the block where a suitable hard substrate and current regime were likely to be present. Rock dredges were used to sample these areas in addition to Agassiz trawls over the less rough ground. No live corals were collected, but in two dredges dead fragments of a scleractinian coral (possibly *Solenosmillia variabilis*) were recovered. Living solitary scleractinian corals were collected at two of the sampling sites using the Agassiz trawl. In addition, several colonies of the octocoral *Acanella* were recovered in one Agassiz haul. Previous experience has shown that this species of gorgonian coral is usually found at depths of c. 2000 m in the North Atlantic. However here *Acanella* was found at 1300 m.

6.2.2 Sediment Geochemistry

Preliminary inspection of vertical distributions within the upper 15 cm of the cores collected in the area revealed generally two layers: a light, sandy coloured upper layer consisting of fine sand and a lower, dark grey layer at the bottom of the core consisting of silt/clay. The transition between these layers was at approximately 6 cm. At the shallower stations small to medium sized pebbles were distributed throughout the core. The top sandy sediment appeared to be very porous with a low water content, and was abrasive and non-cohesive. The deeper sediment was less porous, sticky and had a low water content. There was no evidence of anoxia in the cores. Cores, taken with difficulty at station C2 and D1, differed from this general distribution in that the upper sand layer was thicker and consequently the cohesive clay layer also deeper in the core. The problems experienced in collecting core samples from these stations may have been attributable to the difficulty in the instrument penetrating the sand layer and the lack of a significant clay layer to plug the base of the core and prevent wash-out on return of the sampler to the surface.

6.2.3 Water column measurements

Evidence for the presence of warm, saline slope current water (10.1°C, 35.41 ppt) was seen in CTD profiles made in the block. Light transmission profiles suggest a gradient of suspended solids concentration across the block, with generally highest concentrations in the east. Several peaks in suspended solids concentration were evident down all profiles. In addition to peaks at the surface associated with lowered salinity and near the bottom, probably associated wit local bed resuspension, strong mid-water peaks in attenuation in the central regions of the block are suggestive of offshore advection of resuspended material from the upper slope.

7. GEAR REPORTS

7.1 Box Corer

Initially the NIOZ corer was used, as it is known to work more reliably in rougher sea states. Eighteen deployments were made and a 55% success rate was achieved. Some failures were thought to result from entanglement of the warp in the release mechanism. This problem is weather-related, as it was prudent to pay out 10 m extra warp after bottoming the sampler, in order to allow adequate penetration of the corer before the heave or drift of the ship snatched it from the bottom. The compact sandy sediment encountered at some stations probably resulted in the corer levering the sample box out of the sediment during recovery, allowing the sample to escape before the bottom of the box could be sealed. One deployment failed due to the sample box coming free on one side.. Following the loss of the NIOZ corer, the USNEL corer was used. Five deployments resulted in a 20% success rate. All failures occurred while attempting to core in the hard sandy sediment at station C2.

7.2 Multicorer

The corer was operated without the use of a pinger since it was possible to determine bottom contact with the ships tension meters. The speed of the Discovery winch system, with a maximum payout rate of 60 m min^{-1}, limited the rate of deployment and recovery of the gear. It is common practice on RRS Challenger to deploy and recover the corer core at speeds > 90m/min. The DML Multiple Corer worked well on most stations providing good quality undisturbed cores. The number of core tubes used at C1 had to be reduced to obtain better penetration due to the compactness of the surface sediment.

7.3 Bed-hop camera

The performance of the Bed-hop camera during the survey is summarized in Table 2. A high proportion of the exposed frames were deemed, on preliminary examination to be useable for analysis of the sediment and faunal types, and for an estimation of the hydrographic conditions prevailing at the sites. Some frames were not useable owing to the presence in the frame of a transient high concentration of suspended particulate material which obscured other bed features. This was thought to be due either to the camera frame contacting the bottom at too high a velocity or to its being dragged along the bottom for a period of time, thus raising a cloud of material. Another explanation might be the exposing of multiple frames at a spot already disturbed by the weight's first contact with the bottom. This latter explanation is thought to be less likely because of the camera system's slow recycling time (10 seconds for flash recycling, 32 seconds for winding on mechanism to move the film from one frame to the next). The drift of the ship during this period would be expected to move the camera laterally by a sufficient extent to present to it an undisturbed area of the sea bed for the next exposure. The camera was lowered to the seabed at between 5 and 7 metres per minute between exposures. This rate didn't vary between exposures, or different deployments, and so is unlikely to be a contributing factor. Thus the most likely explanation is an occasional prolonged bottom contact by the camera, and its being dragged by the ship, raising a cloud of material which would appear on subsequent exposures. The occasional poor pinger returns experienced, probably as a result of using the camera in marginal weather conditions, made it extremely difficult to assess the position of the camera relative to the sea bed. The results from site A2 provide a particularly good example of this problem. Here 8 bottom contacts were logged, but when the film from this deployment was processed it was found that the camera had used 28 frames. Three of these were blank, presumably due to a malfunction of the flash, but a number of the exposed frames showed the cloud of suspended material referred to above.

Table 2. Summary of Bed-hop camera photographs

Station	No. logged	No. 'hits', incl. blanks and overlaps	No. exposed	No. useable
A2	8	28	25	13
A8	20	22	22	22
A9	20	21	21	20
B2	22	22	22	22
B1	22	23	6	6
C1	22	26	22	15
C2	20	21	18	17
C3	22	25	20	15
A6	22	22	22	22
B3	22	23	23	20
D1	12	16	16	12

When used in good conditions the Bed-hop camera system can be relied upon to produce good results with relative ease. There were however occasions during the survey when the camera was deployed in very difficult conditions, when the need to complete the work, to a certain extent, outweighed the better judgement of the operator. The operational problems experienced during these deployments were not at all unexpected. The fact that a high proportion of the exposures made during this survey are fully useable is a testament to the robustness of the system.

7.4 Agassiz Trawl and Rock Dredge

The Agassiz trawl is designed to fish on smooth sediment bottoms. With the exception of the excellent and varied catch from the second haul at A2 (1300 m), catches were poor. Eight deployments resulted in 4 reasonable samples being obtained. One trawl was wrecked, probably through contacting a large glacial erratic boulder, followed by being towed sideways for some distance. Sea conditions played their part in this, as it was often impossible to tell from the rapid oscillations in the warp tension trace whether the gear was fishing properly or had come fast on the bottom and then released. Damage to the nets was frequent and required many hours of repair work to the two nets available. The rock dredge performed adequately on the mixed ground for which it is designed, with a 100% success rate (5 deployments).

7.5 CTD system

Eight CTD casts were completed during the cruise. The CTD system consisted of a Neil Brown Mk IIIb CTD, used in conjunction with two SeaTech, 20 cm path length instruments, working at a wavelength of 660 nm. and a Chelsea Instruments Aquatrakka fluorometer. A General Oceanics multi-bottle array system, model 1015. was used to collect water samples in twelve, 10 l General Oceanics Niskin bottles.

After initial problems with a channel on the CTD breakout box, a spare unit was fitted and the A/D channel settings changed. This improved the data from one RVS transmissometer (S/N:T1010D) but the second transmissometer (S/N:T1011D) continued to have a noisy output. This unit was therefore replaced with a 25cm path length, SeaTech transmissometer supplied by DML (S/N:356). No further problems were experienced.

The tone fire rosette module functioned normally, with only three mis-fires out of 79 bottles fired.

7.6 Echo Sounder

The system used was an SIMRAD EA500 in conjunction with a 10KHz fish. This was used as a transceiver for depth soundings and a receiver for pinger work. There were no major problems with the system during the cruise although occasional loss of the audible signal from the pinger on the camera system at times made operation of the bed hop camera difficult and the apparent inability to obtain spot depth soundings whilst using the echo sounder in passive mode with a pinger increased the risk to gear.

7.7 Loss of the NIOZ box corer

Although early deployments of the NIOZ box corer were undertaken on the coring wire, on the suggestion of C. Rymer, RVS, the deployment of the NIOZ box corer had been switched from the coring wire to the trawl wire to reduce the down time for wire changes for coring and trawling. This decision had been carefully considered by Chris Rymer and was made on the basis that the stations were shallow (~1000 m), the weight of the corer was 1.5 tonnes and that the pull out tension observed and recorded at 4 successful stations when using the coring did not exceed 4.5 tonnes. Given that the S.W.L. of the trawl warp at its outboard length is 5.2 tonnes with a breaking load of 13 tonnes, it was considered that the loads expected and previously observed were well within the capability of the trawl warp. During these deployments typical pay out speeds for deployment were in the order of 50 m min^{-1} which was reduced to 30 m min^{-1} before the gear was lowered to the sea bed. After paying out 10-15 m cable to allow the gear to settle, hauling began at 10 m min^{-1} until the gear was off the sea bed and then the rate of haul was increased to 50 m min^{-1} for recovery to the surface. Tension was monitored both in the winch cab and in the laboratory and was recorded by the ships computer logging package.

Four successful box core deployments were achieved using the trawl wire before the loss of the gear and for all of these the operating parameters were as previously observed. A successful multicore sample was retrieved at the station where the gear was lost (C3) and no indication of unusual sediment type was apparent. Martyn Harvey was watch leader at the time of the loss of the gear and was monitoring its deployment. At 14:23 on 15 February, at station C3, the NIOZ was deployed in the usual fashion. The gear reached the sea bed at 14:44, 16 m of wire were payed out and hauling began 14:46. An indication of the gear beginning to pull out was observed as an increase in wire tension at 14:47, however the tension rapidly fell back after peaking at 4.9 tonnes indicating that the corer had become detached. On recovery of the wire, at 15:15, it was found that the wire had parted 120 m above the corer. At the time of breakage nobody was on deck and there was at no time any risk to ship's complement or of any damage to the vessel. The ships position at time of loss was DGPS 58° 54.3248' N, 07° 49.1132' W in water of 908 m depth. A sample of the broken wire was taken for testing ashore and the trawl wire taken out of service for the remainder of the cruise. Reports were filed by Chris Rymer and the Master of the Discovery to RVS informing them of the loss and requesting them to advise necessary authorities on the loss of gear on the sea bed. Brian Edmonds, Enterprise Ltd. and Dr. Graham Shimmield, DML were advised of the loss by the Principal Scientist.

8. ACKNOWLEDGEMENTS

I would like to thank and commend the Master, officers and crew of the RRS Discovery for the professionalism of their approach to completion of the work often under difficult and rapidly changing conditions. The success of the cruise is largely attributable to a great team effort, not only at sea from the ships staff, RVS technical support and all my colleagues from DML/SAMS, but also onshore, before the cruise, from staff at Dunstaffnage who responded to the "unprogrammed" challenges in the week immediately before sailing and those at RVS who organised the cruise at relatively short notice. We are particularly grateful to John

Humphery of the Proudman Oceanographic Laboratory, Birkenhead for provision of the Bed-hop camera equipment and for the valuable advice on its use. Thanks also go to Richard Northcote for his help in co-ordinate conversions for station positions and Brian Edmonds from Enterprise Oil Ltd. for supply of bathymetric maps of the study area and encouragement and support during the cruise.

9. STATION AND SAMPLE SUMMARY

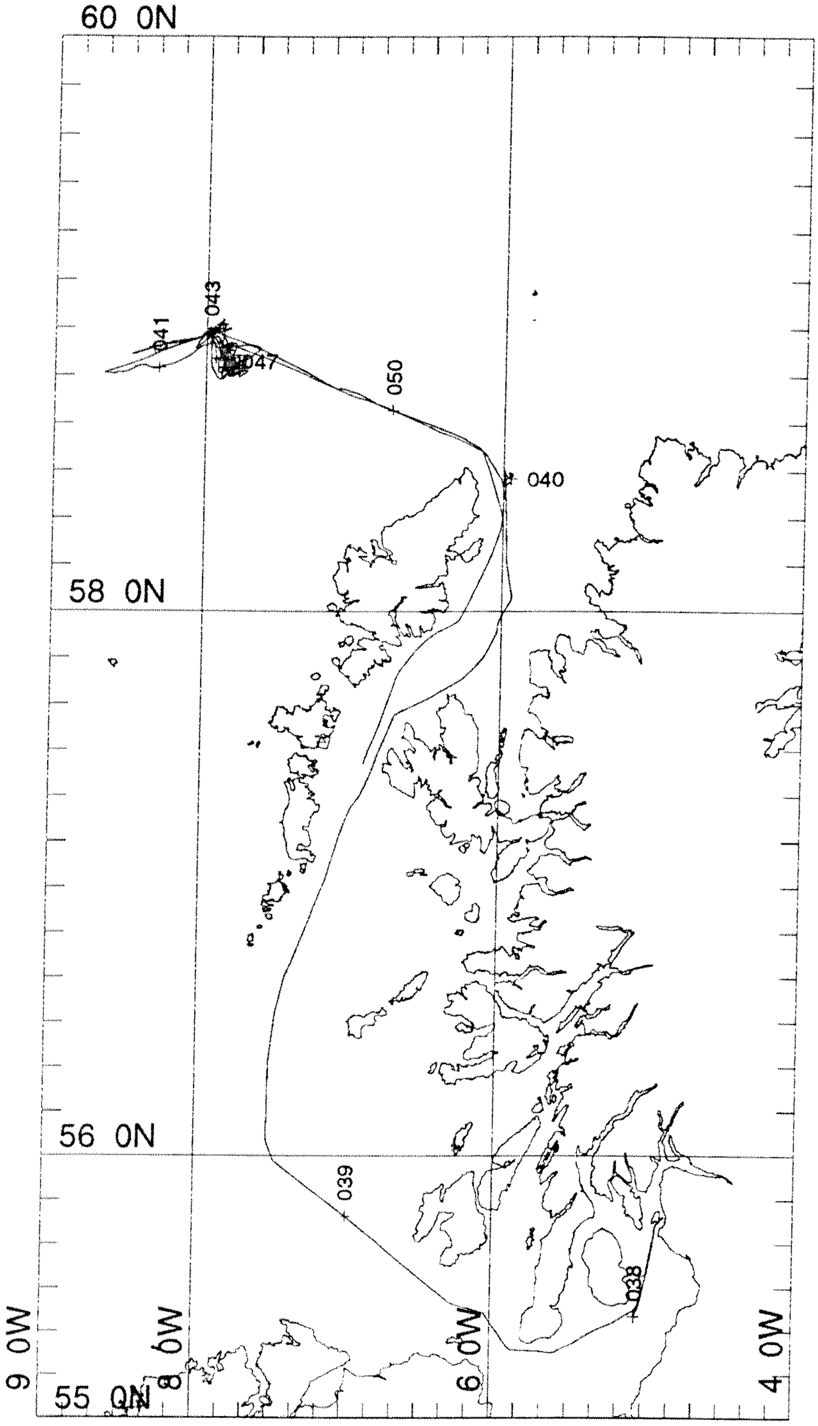
Tables 3 and 4 summarise gear deployments and samples obtained. All positions were determined using DGPS and are given in Degree-decimal minute format.

10. CHARTS

Chart 1.	Cruise track
Chart 2.	Cruise track within the survey area.
Chart 3.	Box core and multicore positions.
Chart 4.	CTD positions. The CTD numbers on the chart refer to cast number in chronological order. These correspond to survey station numbers as follows:

CTD01	A1
CTD02	A2
CTD03	A6
CTD04	A9
CTD05	A3
CTD06	A5
CTD07	A7
CTD08	A8

Chart 5.	Summary of Rock Dredge and Agassiz Trawl tracks. NB Rock Dredges A9L4 and A9L3 fall outside the survey block. Details of positions are given in Table 4.
Charts 6-10	Rock Dredge tracks.
Charts 11-15	AgassizTrawl tracks.
Charts 16-23	Bedhop camera tracks. NB positional data for A6 and B3 and D1 are still to be processed.



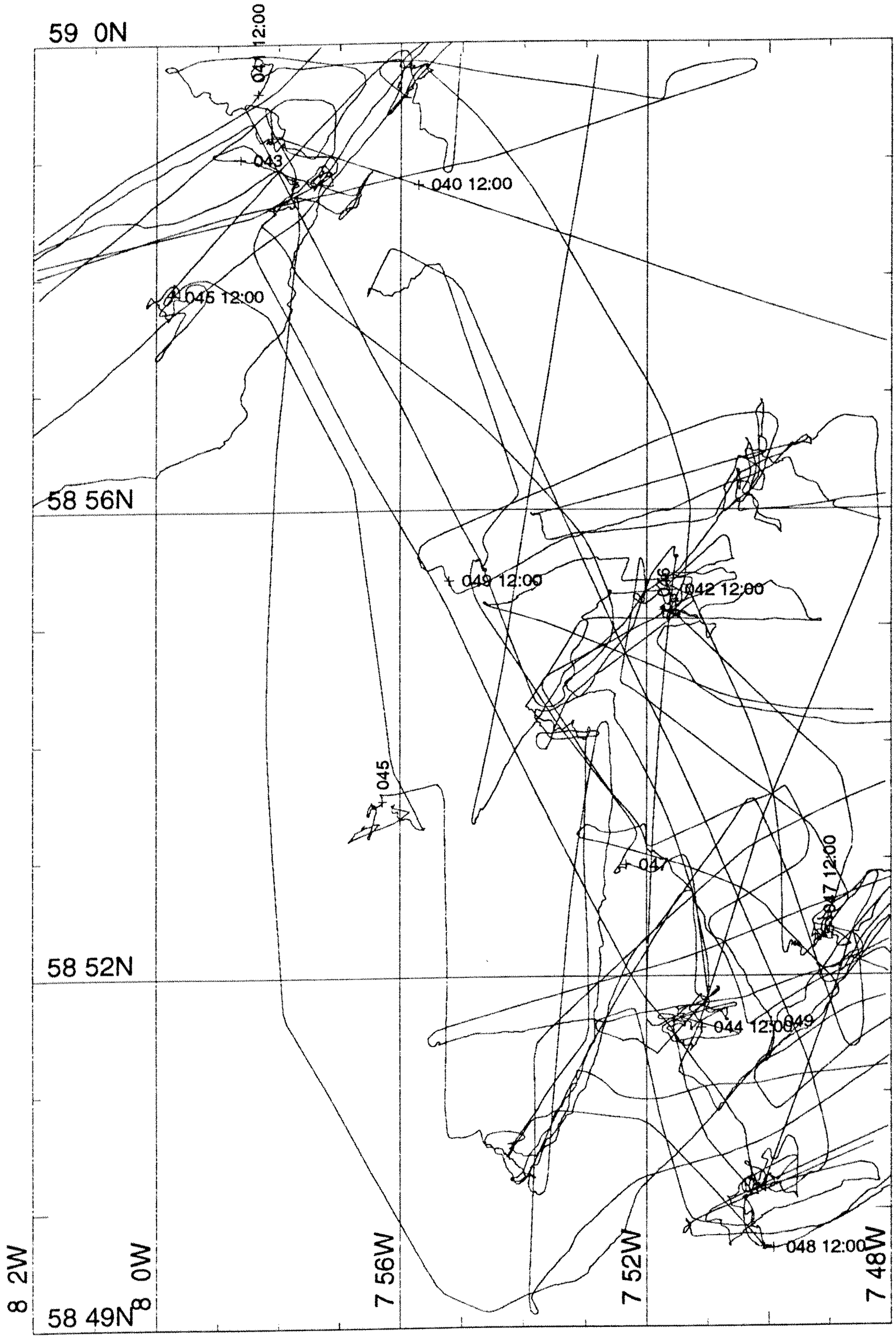
MERCATOR PROJECTION

SCALE 1 TO 3000000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

D230c

Chart 1



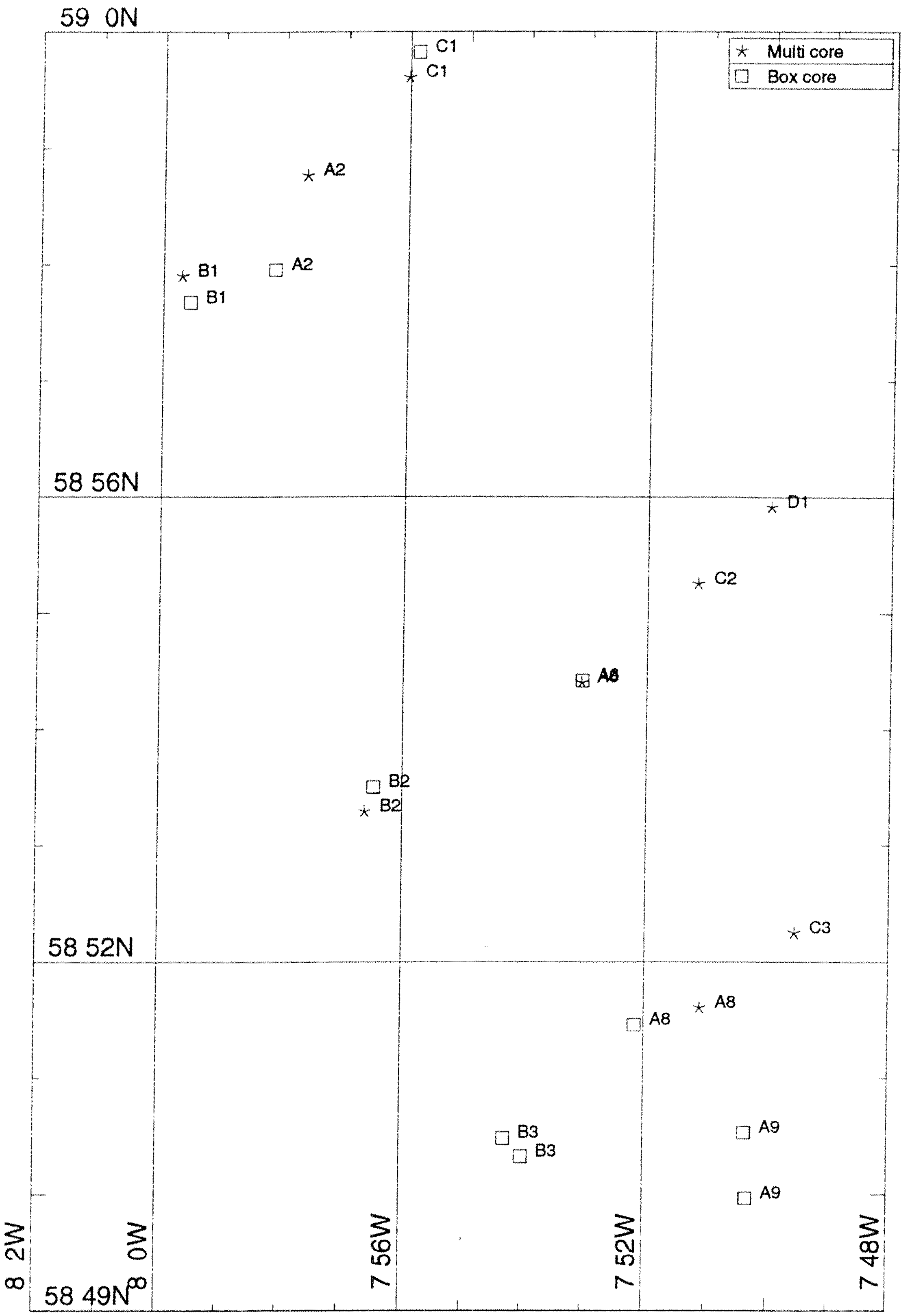
MERCATOR PROJECTION

SCALE 1 TO 100000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

D230c

Chart 2



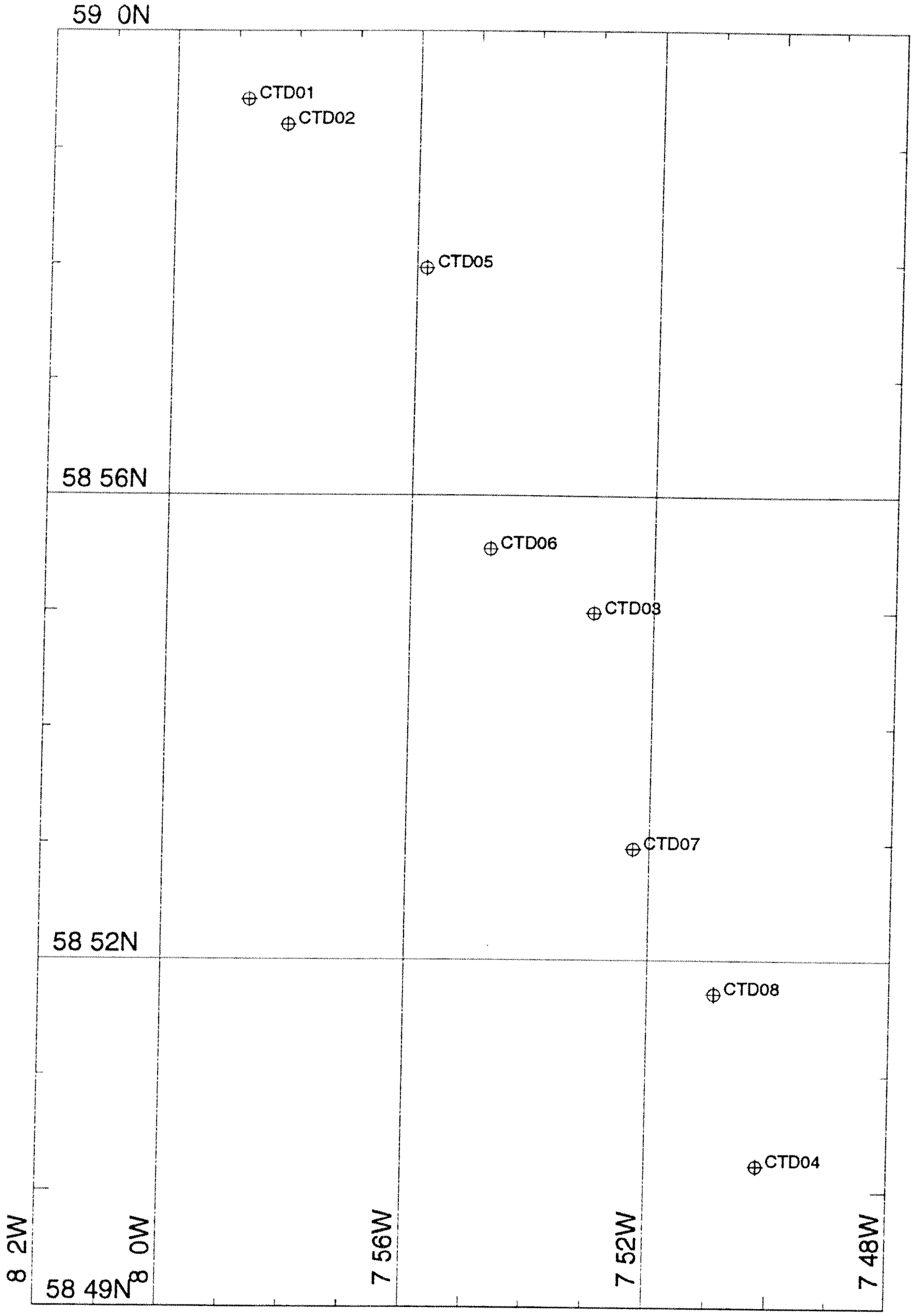
MERCATOR PROJECTION

SCALE 1 TO 100000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

D230c Core Sites

Chart 3



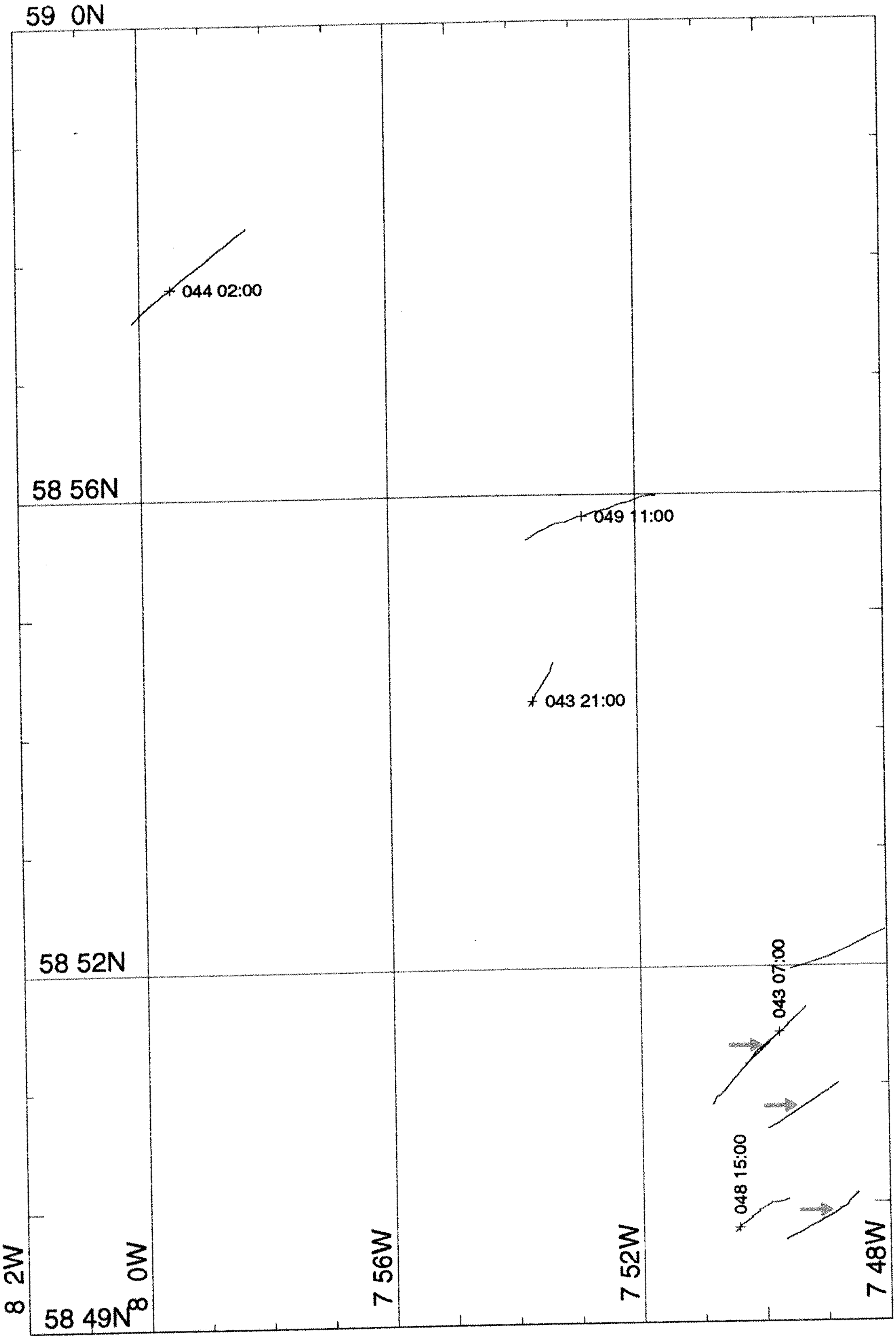
MERCATOR PROJECTION

SCALE 1 TO 100000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

D230c CTD casts

Chart 4



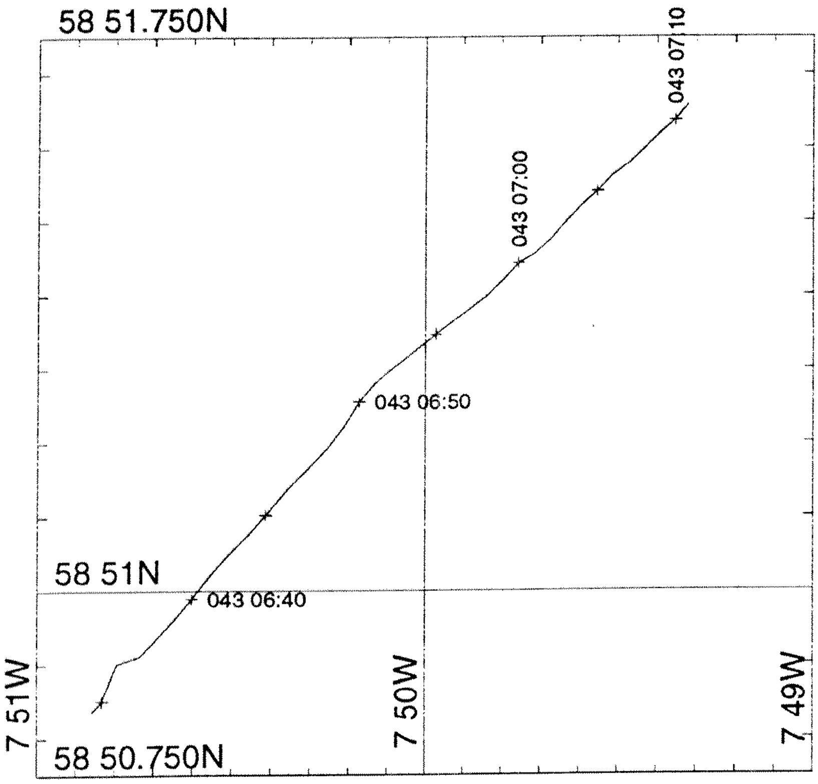
MERCATOR PROJECTION

SCALE 1 TO 100000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

D230c Rock Dredge(red) Agassiz Trawl(black)

Chart 5



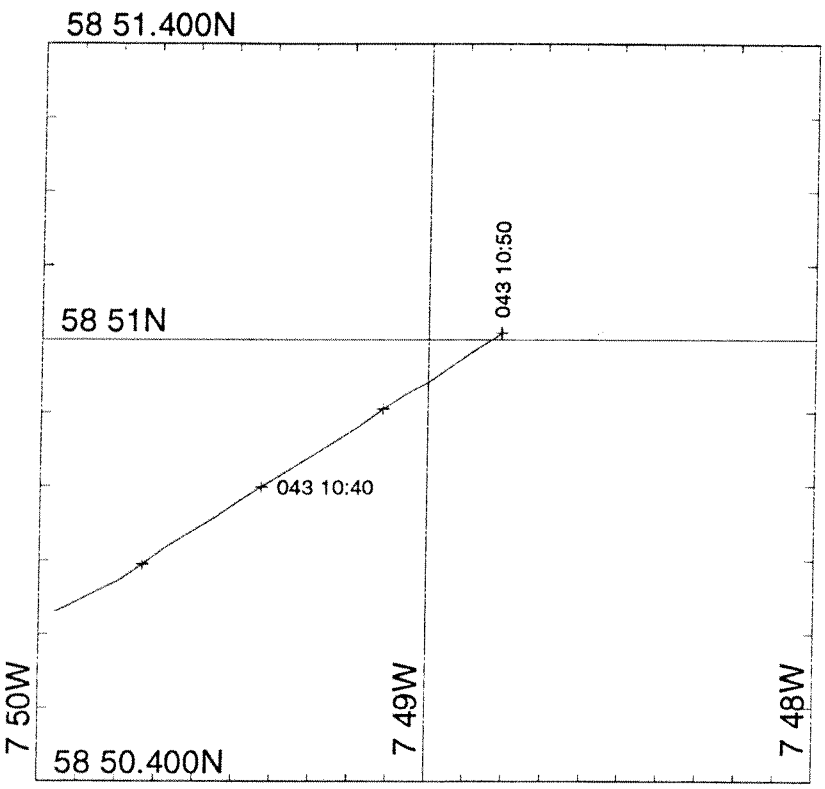
MERCATOR PROJECTION

SCALE 1 TO 20000 (NATURAL SCALE AT LAT. 58)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

13351#1 D230c Rock Dredge

Chart 6



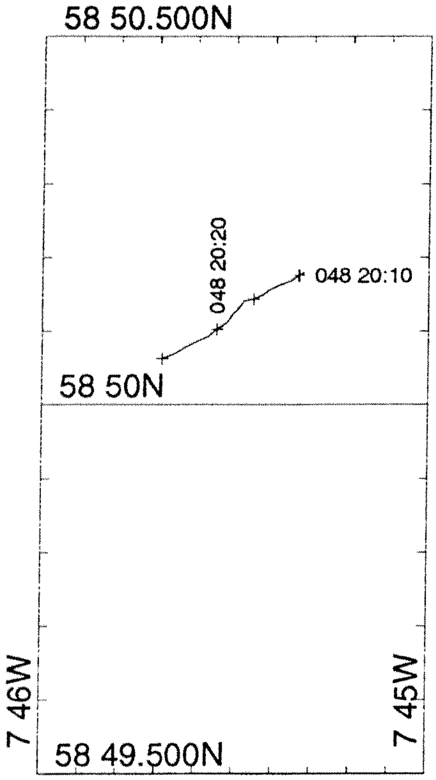
MERCATOR PROJECTION

SCALE 1 TO 20000 (NATURAL SCALE AT LAT. 58)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

13352#1 D230c Rock Dredge

Chart 7



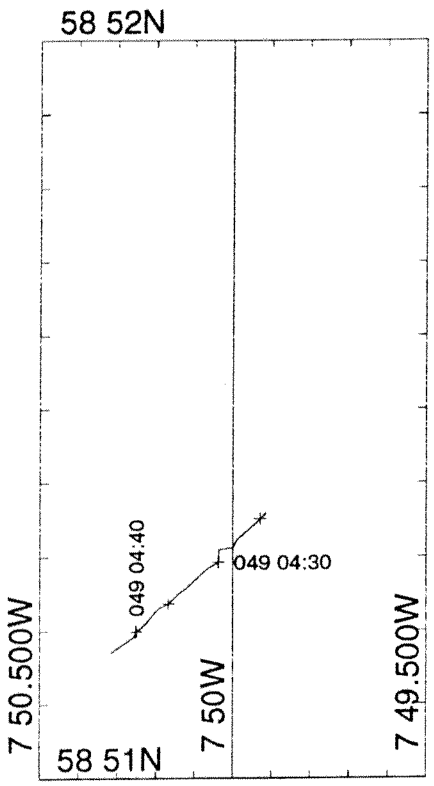
MERCATOR PROJECTION

SCALE 1 TO 20000 (NATURAL SCALE AT LAT. 58)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

13364#1 D230c Rock Dredge

Chart 8



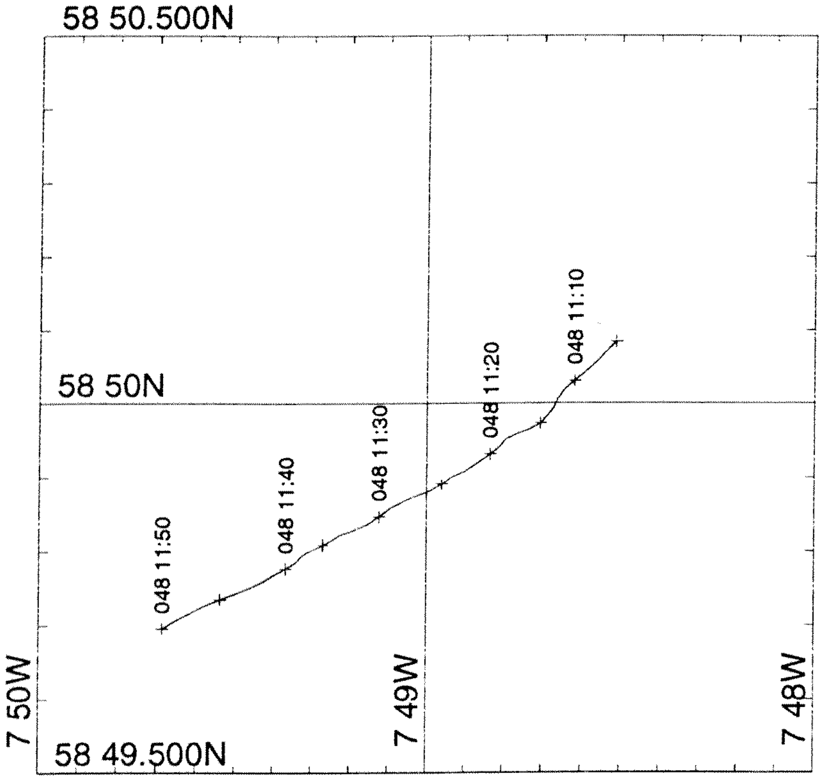
MERCATOR PROJECTION

SCALE 1 TO 20000 (NATURAL SCALE AT LAT. 58)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

13365#2 D230c Rock Dredge

Chart 9



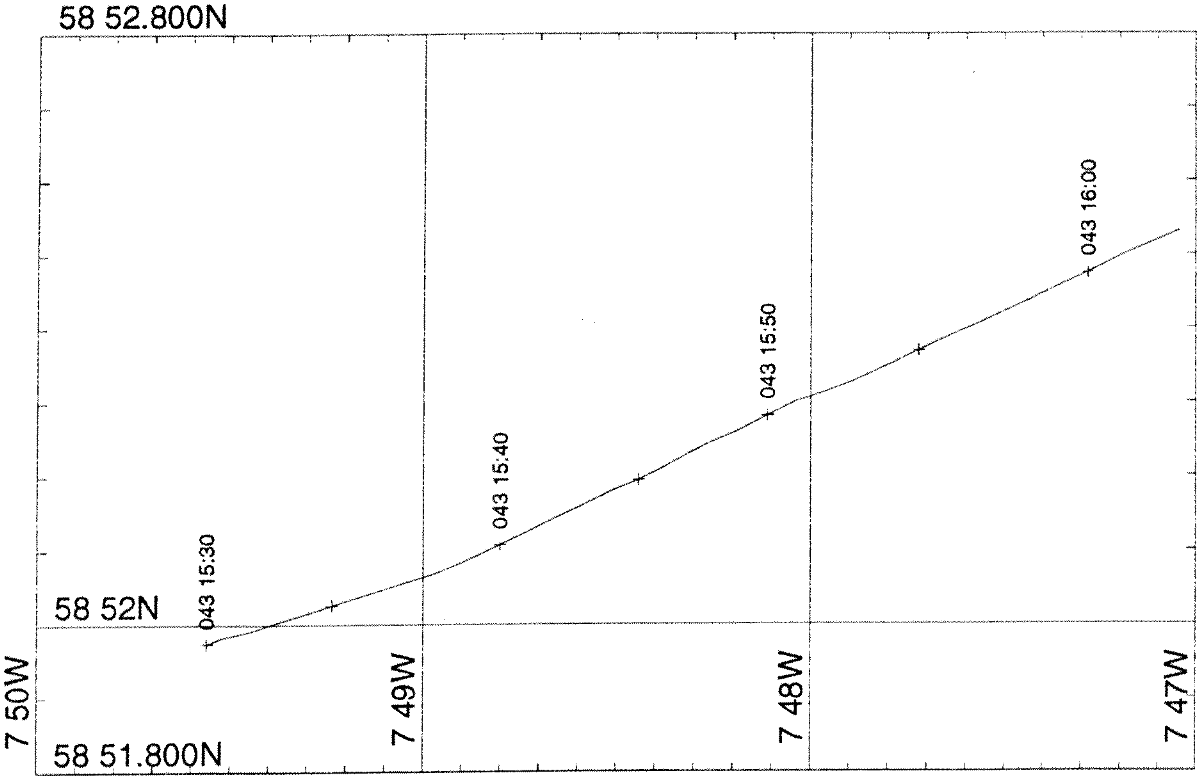
MERCATOR PROJECTION

SCALE 1 TO 20000 (NATURAL SCALE AT LAT. 58)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

13363#1 D230c Rock Dredge

Chart 10



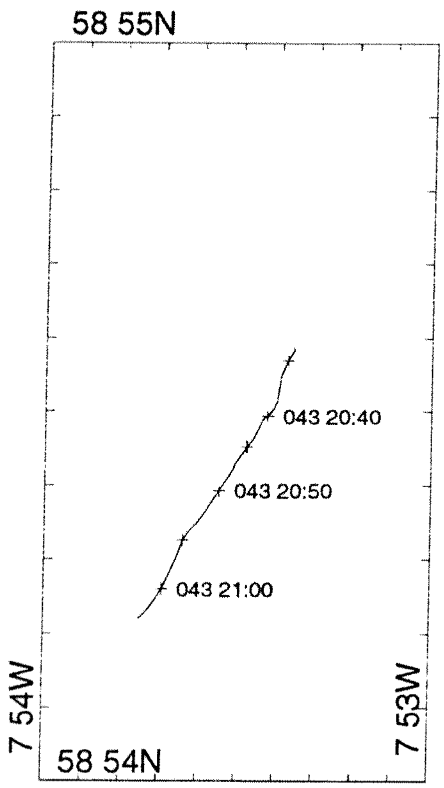
MERCATOR PROJECTION

SCALE 1 TO 20000 (NATURAL SCALE AT LAT. 58)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

13349#5 D230c Agassiz Trawl

Chart 11



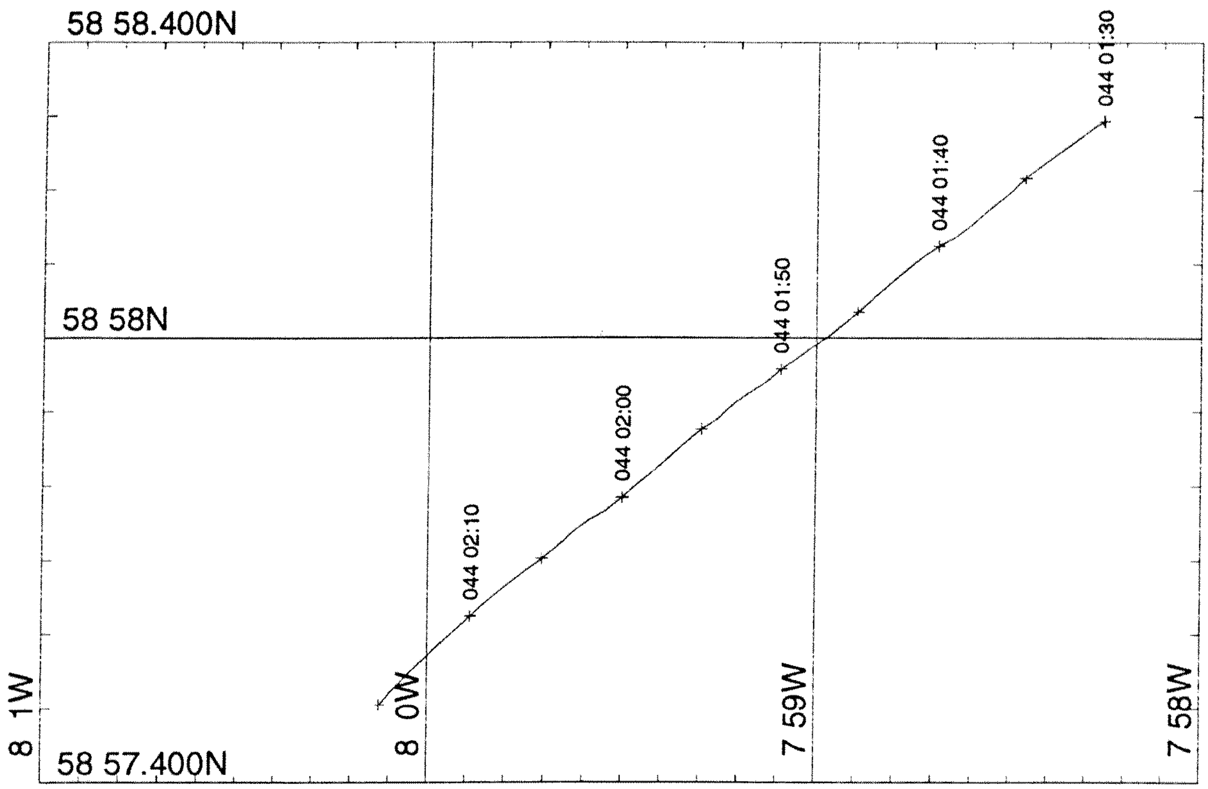
MERCATOR PROJECTION

SCALE 1 TO 20000 (NATURAL SCALE AT LAT. 58)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

13348#4 D230c Agassiz Trawl

Chart 12



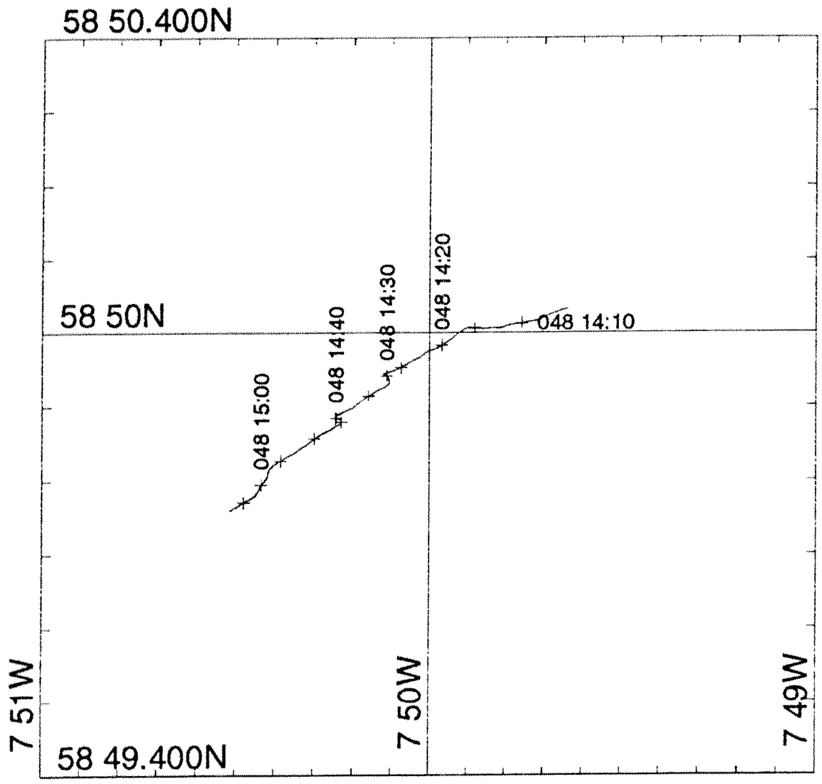
MERCATOR PROJECTION

SCALE 1 TO 20000 (NATURAL SCALE AT LAT. 58)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

13347#5 D230c Agassiz Trawl

Chart 13



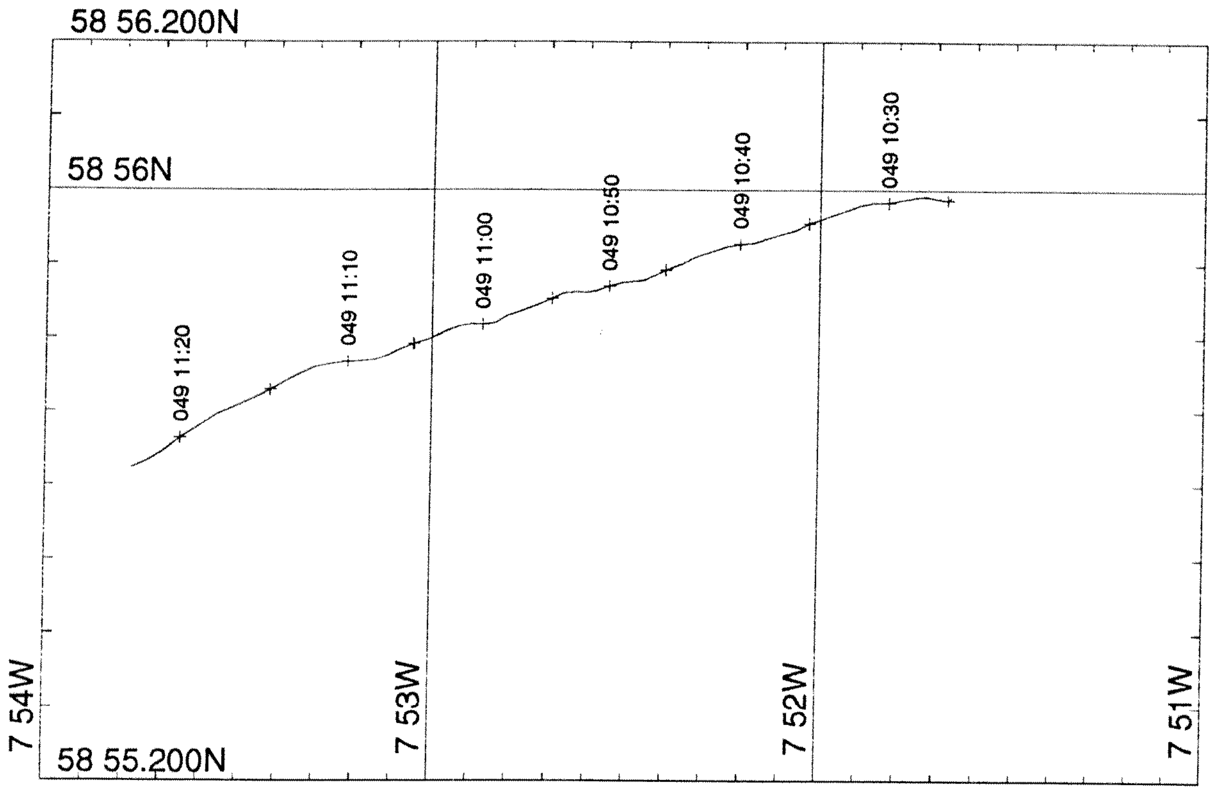
MERCATOR PROJECTION

SCALE 1 TO 20000 (NATURAL SCALE AT LAT. 58)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

13350#6 D230c Agassiz Trawl

Chart 14



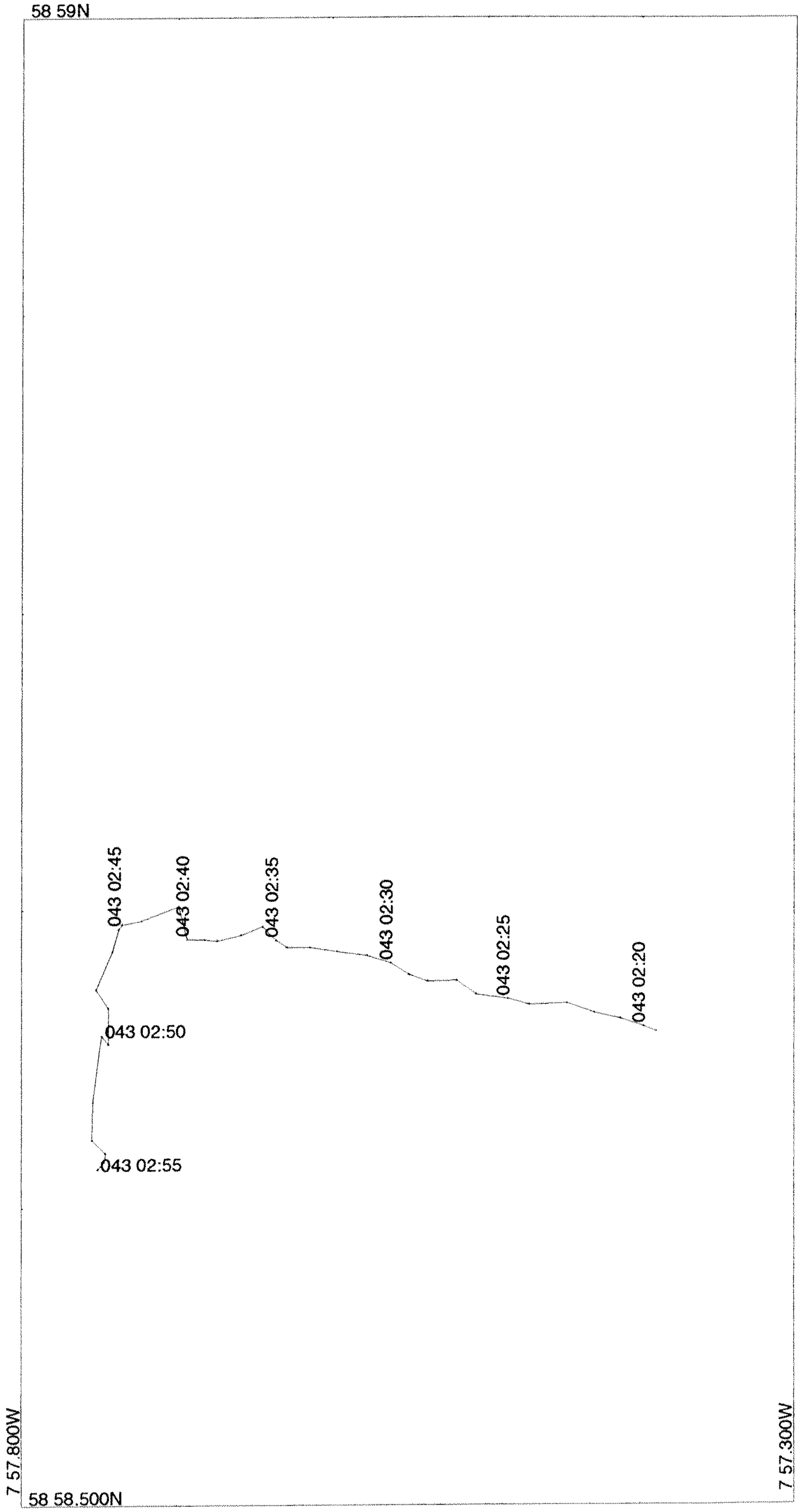
MERCATOR PROJECTION

SCALE 1 TO 20000 (NATURAL SCALE AT LAT. 58)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

13366#2 D230c Agassiz Trawl

Chart 15



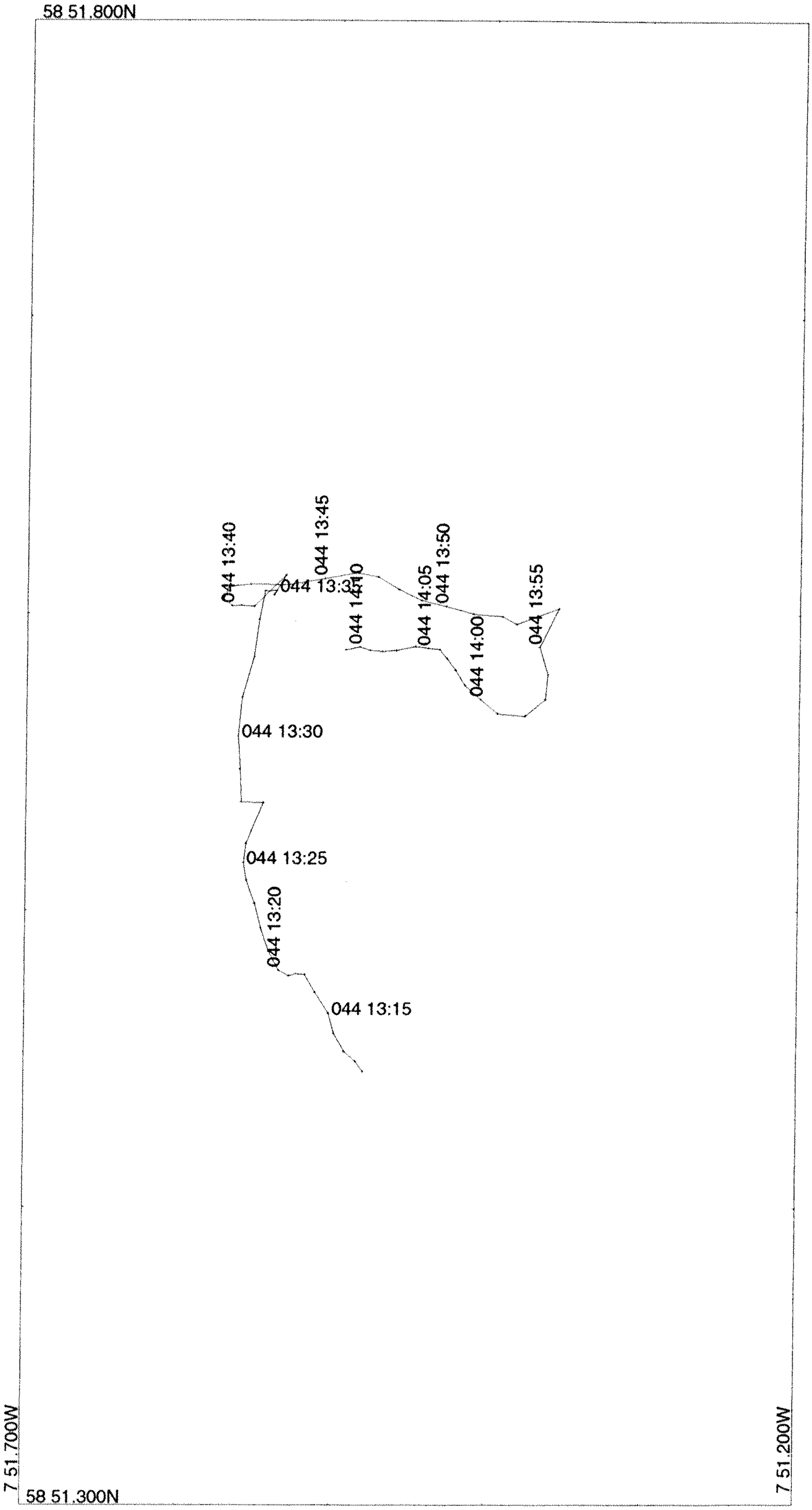
MERCATOR PROJECTION

SCALE 1 TO 4000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

D230c site A2 station number 13347#4

Chart 16



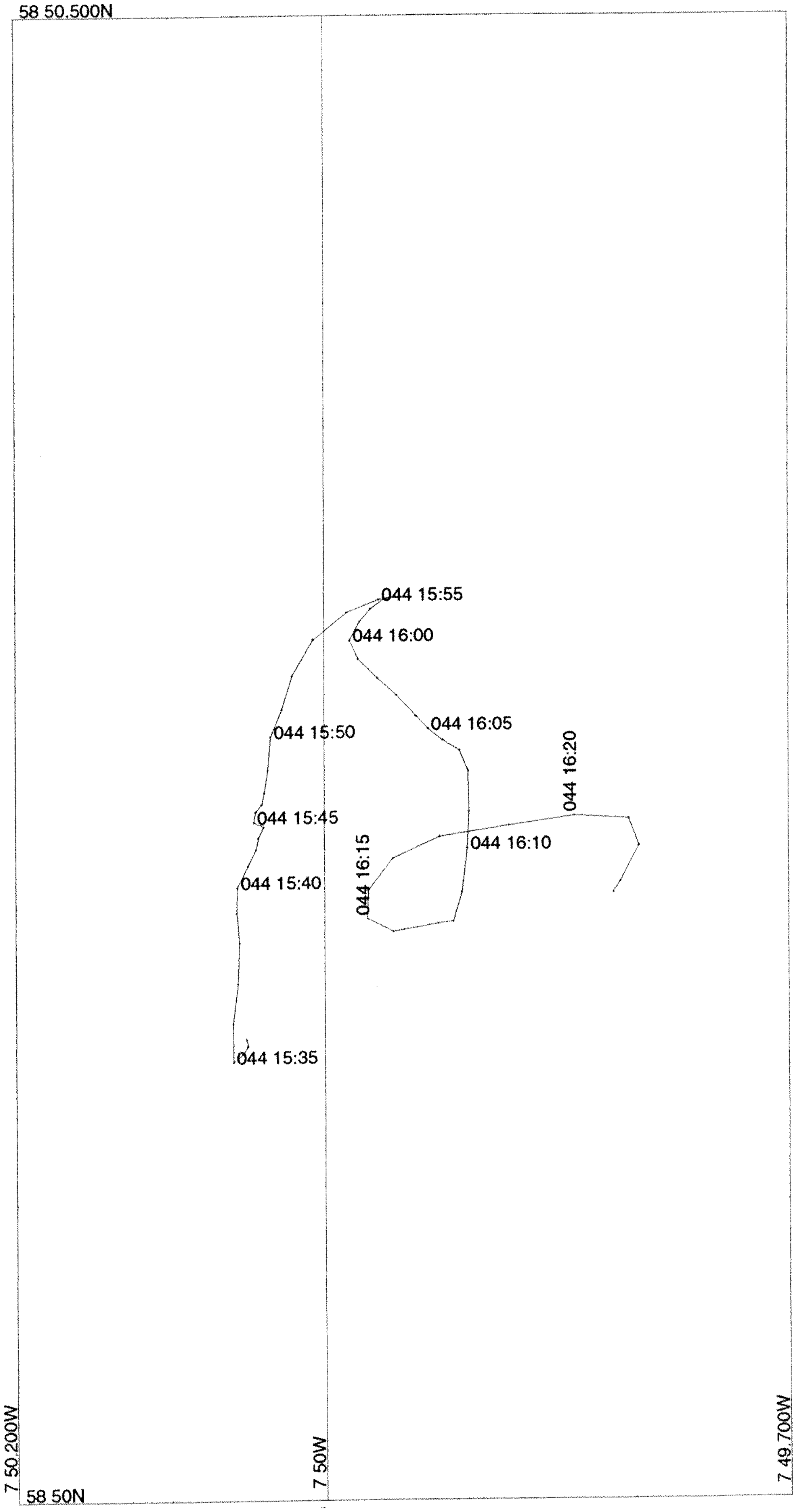
MERCATOR PROJECTION

SCALE 1 TO 4000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

Chart 17

D230c site A8 station number 13349#7



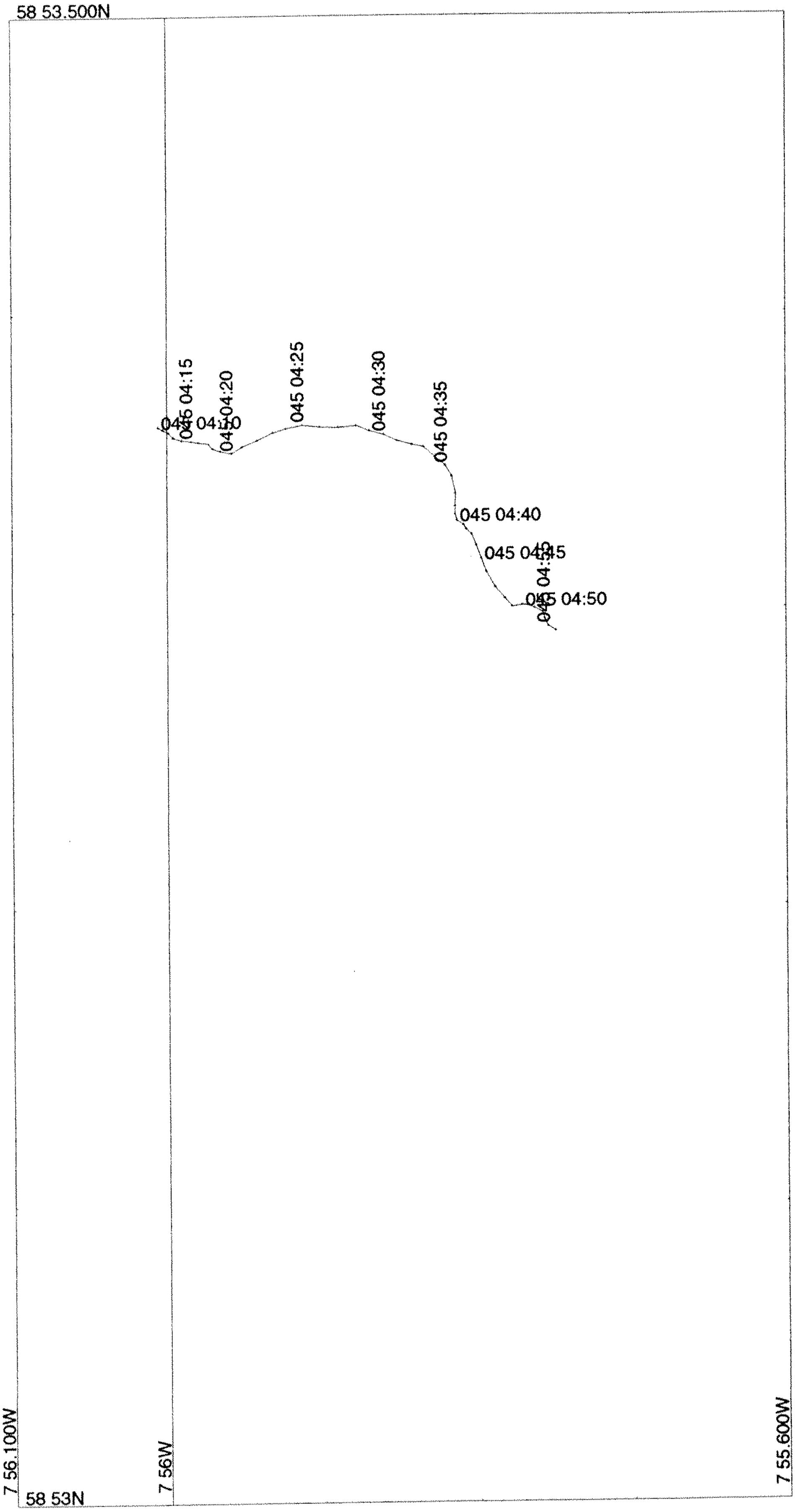
MERCATOR PROJECTION

SCALE 1 TO 4000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

D230c site A9 station number 13350#3

Chart 18



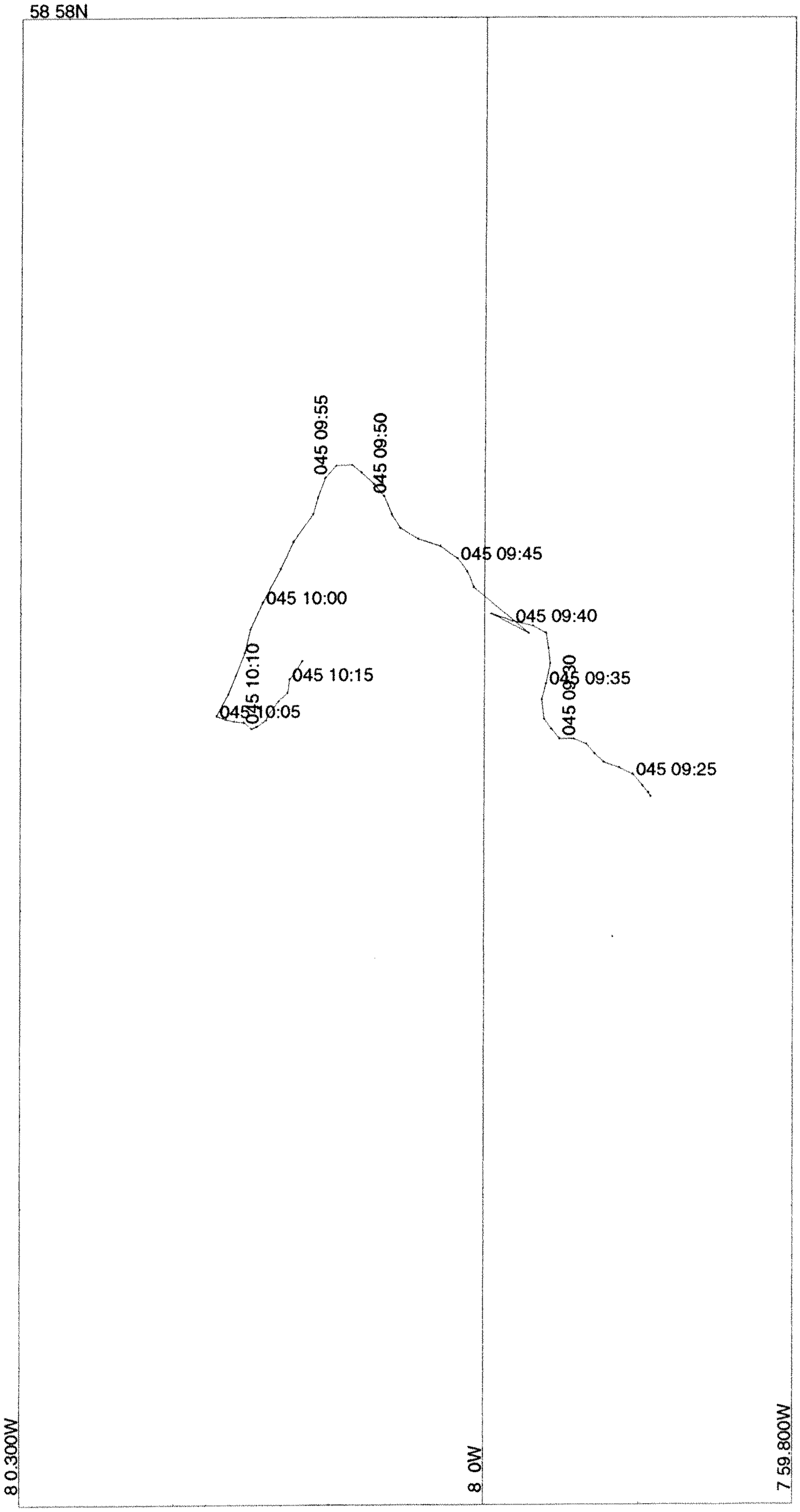
MERCATOR PROJECTION

SCALE 1 TO 4000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

Chart 19

D230c site B2 station number 13354#3



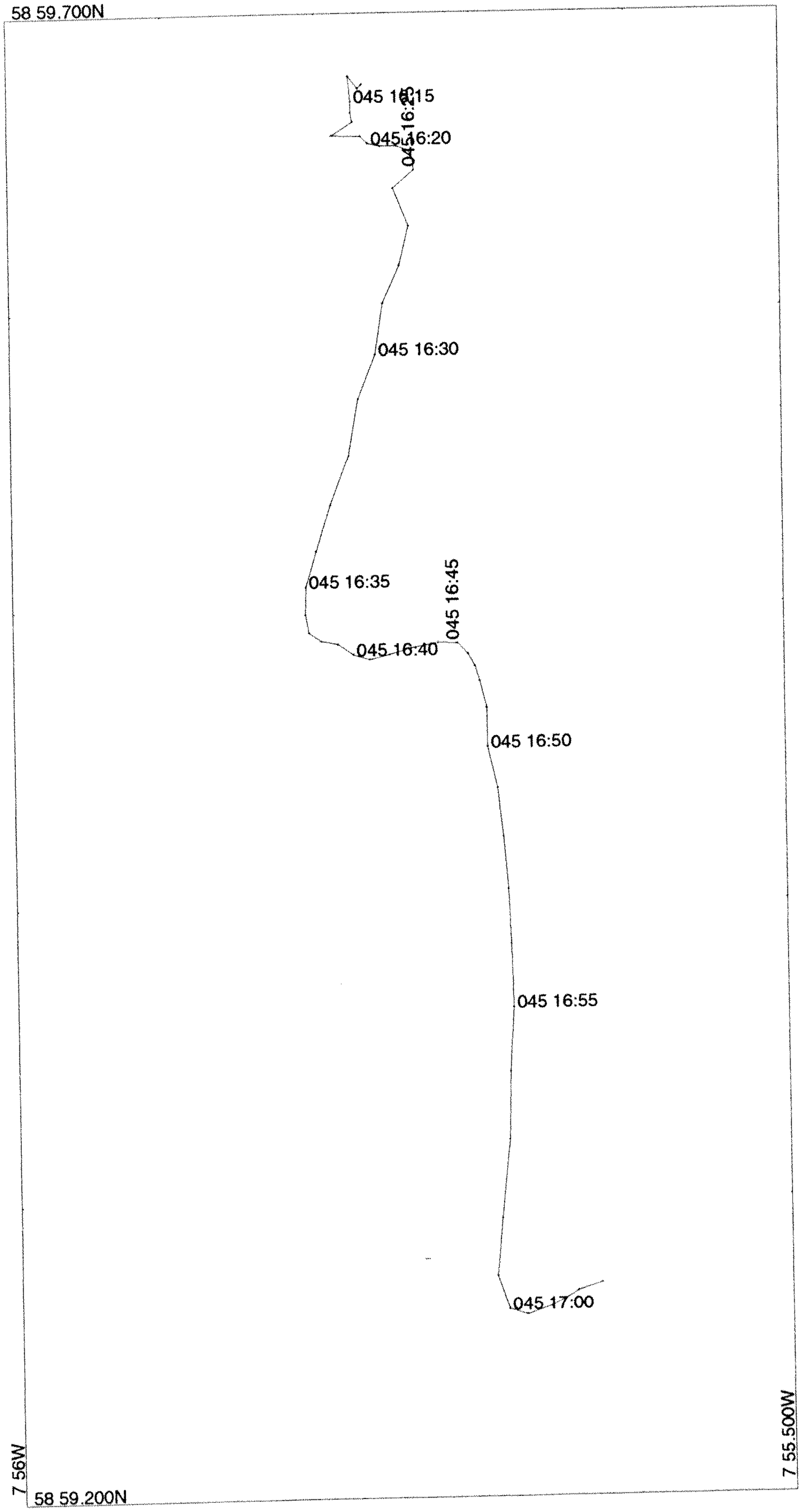
MERCATOR PROJECTION

SCALE 1 TO 4000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

Chart 20

D230c site B1 station number 13355#2



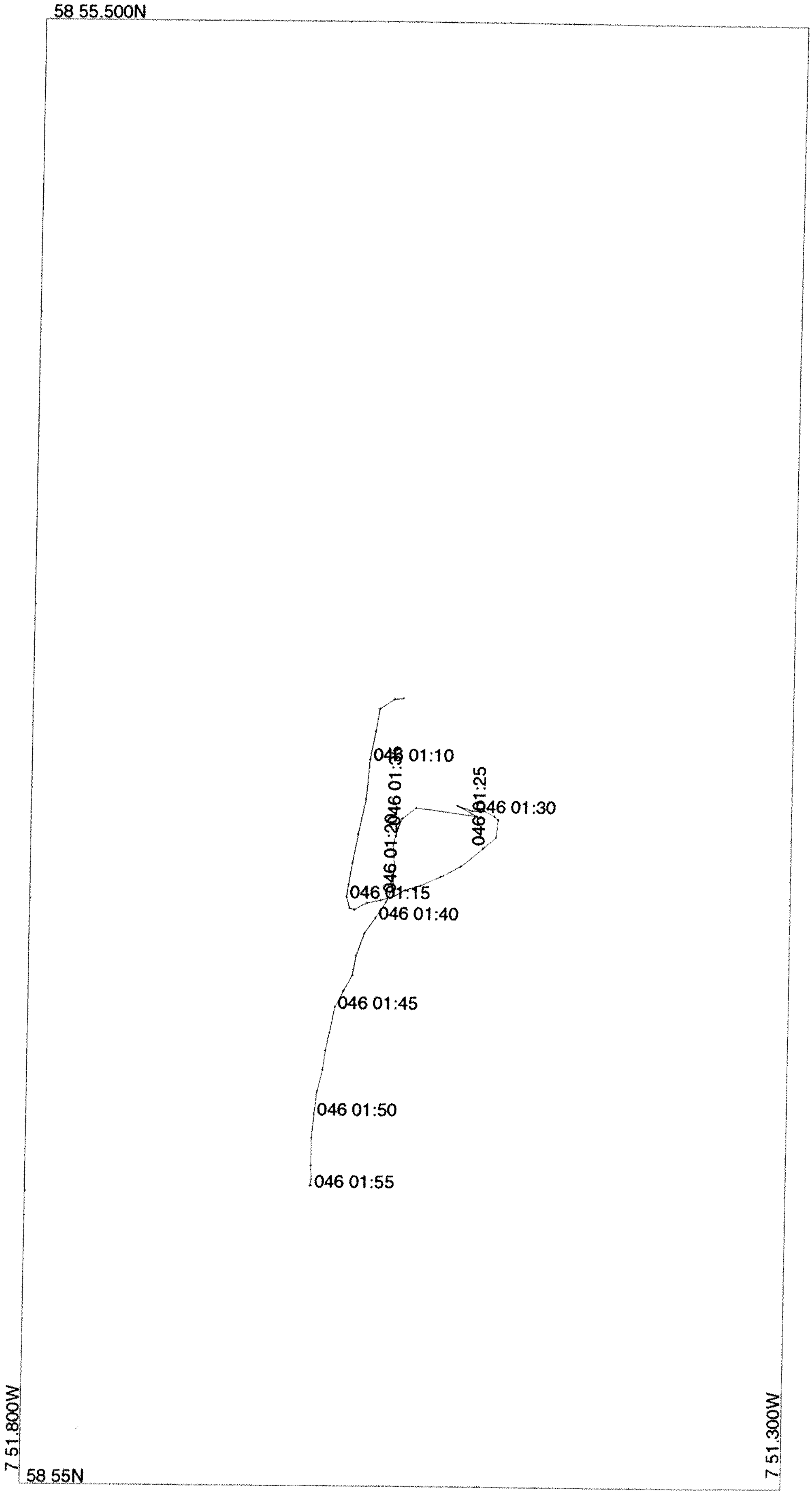
MERCATOR PROJECTION

SCALE 1 TO 4000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

D230c site C1 station number 13356#3

Chart 21



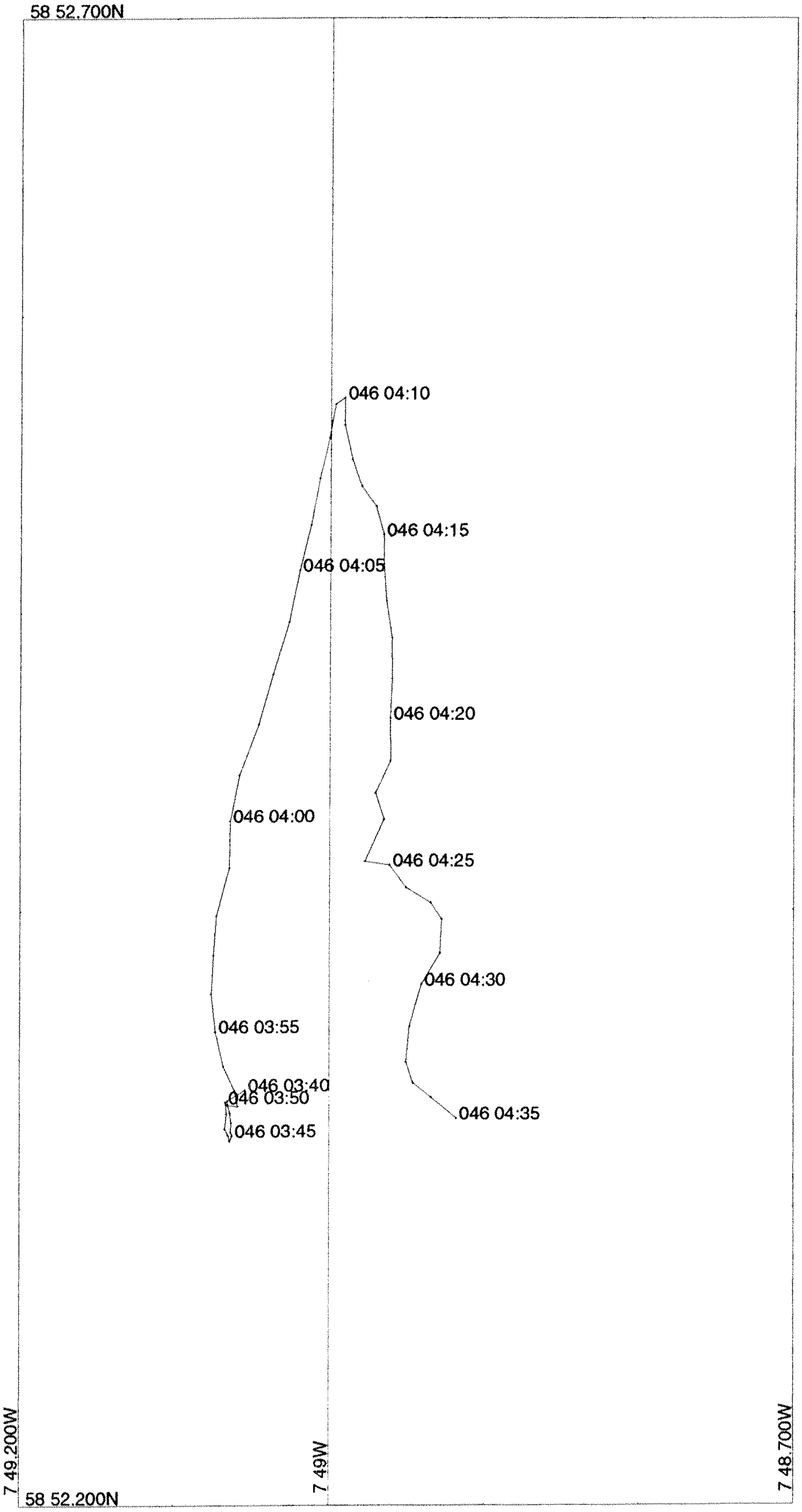
MERCATOR PROJECTION

SCALE 1 TO 4000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

Chart 22

D230c site C2 station number 13357#4



MERCATOR PROJECTION

SCALE 1 TO 4000 (NATURAL SCALE AT LAT. 59)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0

D230c site C3 station number 13358#1

Chart 23

11. SEA BED PHOTOGRAPHS

Photograph C1

Depth region:	lower slope, 1304m
Sediment:	muddy, (low current activity)
Fauna:	filter feeders, sponge, gorgonian (Acanella)

Photograph A6

Depth region:	middle slope, 1108
Sediment:	hard sandy surface
Fauna:	scarce large fauna, burrowing sea star bottom left

Photograph B3

Depth region:	middle slope, 900m
Sediment:	stony sediment plus muddy sand
Fauna:	dense population of brittle star (Ophiocten) filter feeders growing on stones filter feeding basket star/Gorgonian left of centre

Photograph A9

Depth region:	upper slope, 720m
Sediment:	muddy sand, many small stones and pebbles
Fauna:	sea urchin and sponge on rock, above left of centre pit dug by squat lobster top right