NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF GEOLOGICAL SCIENCES

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Report No. 103

Cruise Report on Project 80/01
A Regional Geophysical Survey in
the southern North Sea

Edited by

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PREFACE

1980 Geophysical survey - overall cruise summary

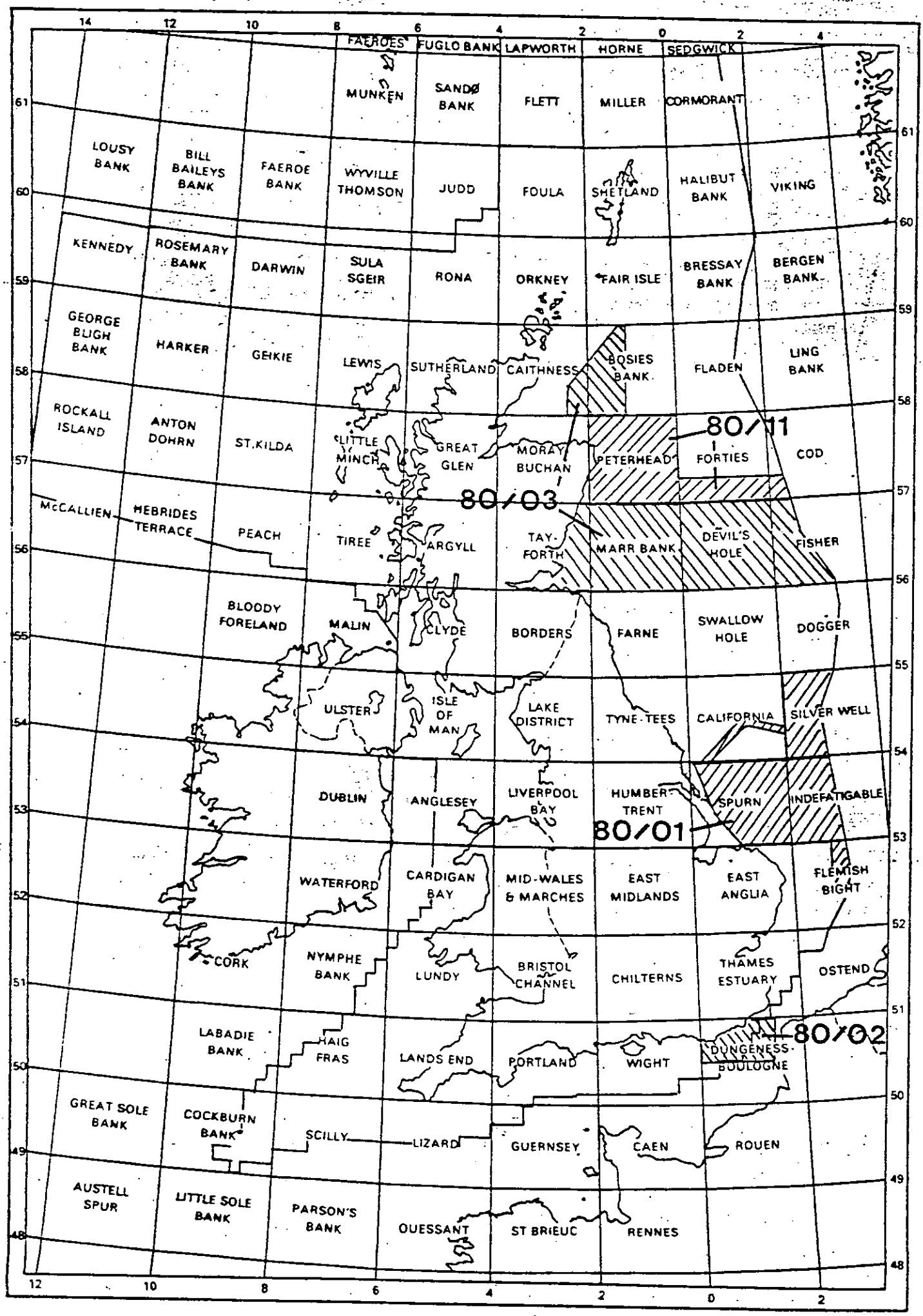
The 1980 geophysical survey programme was divided into eleven legs, comprising four projects, as follows:

	Dates	Project No.	Area	Port
Mobilisation	9 Apr-20 Apr	-	-	South Shields
Leg 1 (80/01 PART1)	21 Apr-6 May	80/01	S. North Sea	Hull
Leg 2 (80/01 PART1)	7 May-20 May	80/01	S. North Sea	Gt Yarmouth
Leg 3 (80/01 PART1)	22 May-4 June	80/01	S. North Sea	Gt Yarmouth
Leg 4 80/02	6 June-17 June	80/02	English Channel	Gt Yarmouth
Leg 5 80/01 PART2	19 June-30 June	80/01	S. North Sea	Sunderland
Maintenance period	30 June-4 July	-	-	Sunderland
Leg 6 (80/03)	5 July-16 July	80/03	N. North Sea	Dundee
Leg 7 (80/03)	19 July-30 July	80/03	N. North Sea	Dundee
Leg 8 (80/03)	31 July-13 Aug	80/03	N. North Sea	Dundee
Leg 9 (80/03)	15 Aug-26 Aug	80/03	N. North Sea	Dundee
Leg 10 (80/03)	28 Aug-8 Sept	80/03	N. North Sea	Dundee
Leg 11 80/11	10 Sept-22 Sept	80/11	N. North Sea	South Shields

Projects 80/01, 80/02 and 80/03 were full regional surveys utilising multi-system seismics together with gravity and magnetics. Project 80/11 consisted only of gravity and magnetic surveying.

This report covers Project 80/01 and similar reports for other projects are listed below:

Project 80/02	Report No. 104
Project 80/03	Report No. 105
Project 80/11	Report No. 106



1980 GEOPHYSICAL SURVEY AREAS

INTRODUCTION

This report covers the operation of Project 80/01, a regional geophysical survey in the southern North Sea.

The primary objectives were to complete the geophysical survey of the Indefatigable and Spurn sheets of the IGS 1:250,000 map series in advance of a bottom sampling programme to be carried out by the Institute of Geological Sciences Marine Geology Unit later in the season, and to re-run several lines surveyed in 1979 (Project 79/02 on the Flemish Bight sheet. The inshore limit of the survey was controlled by the 15m depth contour. A secondary objective was to run one line along a proposed pipeline route on the California sheet.

The vessel used was the NERC research ship, RRS Shackleton which has an overall length of 61m, beam of 11m, draught of 4.4m and displacement of 1658 tons.

Geophysical methods employed were shallow seismic (sparker and airgun) high resolution seismic (pinger and boomer) side scan sonar, gravity and magnetics.

The senior scientist, geophysical, geological, navigation and technical reports produced for each leg of the survey, summary lists and log sheets on which this report is based, are held on open file in the Marine Geophysics Unit, Institute of Geological Sciences, Murchison House, West Mains Road, Edinburgh. The authors of the reports for each leg are given in Table 1.

Shackleton proved to be a most suitable vessel for our requirements and a total of 5856km were surveyed during the 59 days dedicated to this project. Excellent co-operation was received from the Master, Officers and Crew throughout the cruise.

Leg 1: South Shields-Hull, 21 April-6 May 1980

Following a largely straightforward mobilisation period the vessel sailed from South Shields on 21 April as planned. The primary objective of this first leg of the 1980 survey season was to conduct equipment trials to arrive at the optimum configuration for the southern North Sea survey.

The setting-up and trials of the geophysical systems were conducted during the daytime and the calibration of the satellite navigation system was completed, without major problems, over several successive nights. The equipment trials were completed after one week, the optimum seismic combination consisting of Huntec deep tow boomer, Edo Western pinger, 500J or 1kJ multielectrode sparker and 5in^3 air-gun, the latter being towed shallow, suspended from a catamaran thus reducing the bubble pulse. The sparker EPC4600 recorder was used as master, controlling the cycling of all the other seismic systems via a magnetic tape and control system. Gravimeter, magnetometer, echo sounder and transit sonar were run on all lines.

Considerable ringing problems were experienced with the Huntec boomer plate, a new design aimed at reducing ringing thus making it suitable for use in shallow water. A Huntec representative joined the ship off Newcastle on 24 April to carry out tests on the new plate. These were somewhat inconclusive and it was decided to continue using the boomer, despite the excessive ringing whilst awaiting the delivery of a second plate from Huntec. For this reason the towed pinger, used with a TSS swell filter, was also operated to good effect, in some situations producing superior records to the boomer.

The Huntec representative disembarked at Hull on 28 April when a brief call was made to replace faulty sparker modules and two 263C hydrophones.

Tests of the recently acquired UDI side scan sonar system were disappointing and brought to an abrupt end when the main tow cable termination developed a leak after only three hours in the water.

On completion of the trials routine survey commenced and lines 1-8 inclusive were surveyed. Data quality was generally good despite some interruptions for poor weather. Apart from one brief period of coincidence the satellite distribution was good and post-processing navigational accuracy is within 200m. Considerable long course errors were observed when the vessel was pitching heavily.

In the Indefatigable area an eastward thickening succession of Quaternary and Tertiary sediments were defined with, in the north, two steep-sided, WNW-ESE trending channels cut into the Quaternary to a depth of 90m below seabed. These contain a partial infill of up to 50m of acoustically transparent sediment, possibly clay, with local acoustic blanking indicating the presence of gas. Bed-rock appears to crop out extensively on the northern margin of the Spurn sheet.

Leg 2: Hull-Great Yarmouth, 7 May-20 May 1980

The vessel sailed from Hull on 7 May and completed 1779km of regional survey comprising lines 9-32 inclusive, using the equipment configuration developed during Leg 1. In the early stages the weather was poor resulting in moderate quality seismic data, deteriorating enough to force a twelve hour shut-down on 10 May. Thereafter, the weather and data quality were good.

The Huntec boomer was initially operated with a replacement plate which had been fitted in Hull. However, the characteristics of this plate were marginally worse than the original one which was refitted. Thus, boomer records continued to be of poor quality.

Further tests were carried out on the UDI side scan sonar system, the main tow cable termination having been replaced in Hull. These proved to be disappointing with a considerable amount of cross-talk. It also proved impossible with the current winch configuration to tow the Huntec boomer and side scan sonar together without severe danger of entanglement and the practice was suspended.

Experimentation with the simultaneous display of air gun and sparker on one EPC 3200 recorder was successful and should provide a useful, additional aid to interpretation.

Navigational accuracy continued to be good (within 200m) with the exception of Line 32, fix 63 onwards when a short, as yet unexplained failure of the system occurred making navigation on this line unreliable. The fault cleared itself towards the end of the line and did not recur.

Gravity results continued to be good, Shackleton being a very stable vessel, and data tie in well with the 1978 survey. If the results from line 4 (leg 1), which were collected in deteriorating weather conditions are excluded, then a mean cross-tie value of 0.7mGal is obtained based on 98 crossovers.

The area surveyed forms the northern half of the Spurn and Indefatigable sheets which encompass the East Midlands Shelf in the west and passes eastwards across the Sole Pit inversion zone into the Anglo-Dutch basin which contains a thick Quaternary section. These structural elements were recognised in the seimsic records, the detailed survey showing their relationships to be more complex than was hitherto appreciated.

Leg 3: Great Yarmouth-Great Yarmouth, 22 May-4 June 1980

The vessel sailed from Great Yarmouth early on 22 May and, after a brief period of side scan sonar and Huntec boomer trials, completed lines 33-68 inclusive, totalling 1822km of regional survey including, for the first time, the operation of the side scan sonar on all lines. Apart from a brief period (ten hours) of downtime on 24 May due to moderately poor weather, survey proceeded with virtually no equipment downtime and, with calm weather throughout the leg, the seismic data quality is generally high. The same basic seismic configuration of 500J or 1kJ sparker and $5in^3$ air gun was used as on previous legs.

A UDI engineer attended at Great Yarmouth to carry out modifications to the side scan sonar system including the replacement of one transducer. The engineer sailed with the vessel for one day to complete tests and adjustments before being landed by small boat off Great Yarmouth on the evening of 22 May. The side scan operation was considerably improved by removing the tubes which surround the transducers. Subsequently, further mechanical adjustments were made to correct the angle of the starboard transducer which appeared to be orientated too shallow resulting in considerable surface reflections.

A high pass filter was fitted to the Huntec boomer before the start of the leg in an attempt to reduce the ringing. No improvement was apparent so with the pinger continuing to provide good records, it was decided to use the side scan sonar as a routine survey tool at the expense of the boomer since both could not be towed together.

Initially the sparker gave serious acoustic interference on the side scan records. This was reduced by keying the side scan from a zero pulse output from the pinger recorder thus synchronizing it with the other seismic systems. This enabled the sparker interference to be phased to a convenient point, ie near maximum range, of the side scan record. A subsequent advance on this arrangement was to use the programmer on an EPC 4100 recorder (normally used for boomer)

to inhibit transmission of the side scan on the sparker firing sweep. The reduction in horizontal resolution was more than compensated for by the removal of sparker interference.

Navigational accuracy remained good, again being within 200m. The failure noted on Line 32 occurred briefly on Line 34 but did not appear to adversely affect navigation. It did not occur again throughout the remainder of the leg.

Before the start of the leg the gravity meter optics were adjusted and gravity results continued to be excellent tying well with previous data and giving a mean cross-tie of 0.83mGal based on 251 crossovers to date.

The seismic records further emphasised the difference in geological regime between the Spurn and Indefatigable sheets. In the latter a thick Tertiary succession is overlain by an eastward thickening, complex Pleistocene succession which is locally 300-400m thick. Both the Tertiary and sub-glacial Pleistocene wedge out westwards and occur only as localised outliers throughout much of the Spurn sheet. In the Spurn area folded and faulted Jurassic rocks, locally pierced by salt diapirs are generally unconformably overlain by Cretaceous sediments.

Leg 5: Great Yarmouth-Sunderland, 19 June-30 June 1980

The vessel sailed from Great Yarmouth at midday on 19 June to recommence the southern North Sea survey after a break of one leg which was spent in the eastern English Channel (Project 80/02, Report No. 104). Lines 69-83 inclusive, totalling 1561km were completed. The first priority was to complete the programme in the Spurn/Indefatigable area and to re-survey nine lines using the side scan sonar which had not been available on Legs 1 and 2. This was completed during the first six days and the vessel moved north to the California sheet area to survey a proposed pipeline route (Line 78) concentrating on the near surface features.

Five further lines were run on the Silver Well sheet as a preliminary to further geophysical work in this area next season. Towards the end of the leg the weather deteriorated and the sparker records were below average quality, the air gun, however, continued to give useful data in the deeper part of the seismic section.

A second side scan tow fish was made available for this leg and after comparison of the two fish in different operating modes a satisfactory system was achieved. However, some modifications to the system are required to make it fully acceptable. On one occasion the winch brake jammed-on resulting in the fish hitting the seabed, but no damage resulted. The tow fish also became entangled in the moorings of a fishing buoy and after release the tow cable was reterminated as a precaution. No serious damage was apparent but corrosion was found inside the termination assembly.

Navigational accuracy continued to be good, being within 200m. Before the start of the leg, plug EXTERNAL 2 on the MX200 interface was rewired. This eliminated the fault which had occurred once on each of Legs 2 and 3 and which had recurred frequently on Leg 4 (Project 80/02, Report No. 104).

Gravity records continued to be good with excellent cross-ties throughout the leg. However, the results were consistently 1 to 2mGal higher than those obtained earlier in the season and 3 to 4mGal higher than results obtained in previous surveys in the Silver Well area. It is felt that this discrepancy is due in part to a ship's main power failure and in part to incorrect base tie values. These have been corrected during post survey processing and the corrected values are given in Table 3.

Seismic data from the early part of the leg confirmed further the geological features observed on previous legs. The line (no. 78) in the California area revealed, in the west, an area with sand waves up to 11m high with approximately 150m between crests. Poorly bedded formations at the eastern end of the line have been interpreted as eastward thickening Quaternary and Tertiary sediments with possibly boulder clay at outcrop.

EQUIPMENT PERFORMANCE SUMMARY

The care taken in setting up and testing systems over an extended period during Leg 1 minimised later technical problems.

The gravity meter, magnetometer, echo sounder, MS47 transit sonar and data logging systems all operated throughout the survey period without significant problems.

Satellite navigation system

The receiver frequency standard was replaced during Leg 1 after the original unit displayed a frequency drift of approximately 2½Hz per day. The intermittent fault observed once on each of Legs 2 and 3 and more seriously on Leg 4 was eliminated by re-wiring plug EXTERNAL 2 on the MX200 interface. Tape deck No. 2 showed a tendency to rewind before EOT throughout the survey. The doppler sonar was operated in minimum manual blanking mode in water depths of 25m or less thus minimising shallow water errors.

Sparker system

After replacement of faulty modules during Leg 1 the sparker system operated without significant problems.

Air gun system

Apart from a cracked shuttle during Leg 3 the air gun system operated without major problems.

Huntec boomer

Throughout the survey the performance of the boomer was most disappointing. The new design of plate, in use for the first time with this system, did not appear to meet the specifications as claimed by the manufacturers. Virtually all problems encountered concerned these new plates and the matter has been taken up with the manufacturers.

UDI side scan sonar system

This system was in use for the first time and a considerable number of 'teething' problems were encountered, some of which still have to be resolved. The main tow cable termination failed, leaking water after only three hours in service on Leg 1. One transducer was replaced and modifications made to the receiver electrodes after considerable cross-talk was observed during Leg 2. It was not until Leg 3 that the system came into operational use and there remain some problems with the operating controls and geometry of the tow fish to be finally sorted out. The winch still needs modification having failed on occasion as well as exhibiting throughout a long delay (up to 20 secs) before responding to the start control.

Hydrophones

A considerable number of problems were experienced with hydrophones during the trials period. Every hydrophone tested failed after a short time in use for one reason or another and for one brief period there were no hydrophones in operational condition. However, all were successfully repaired before the end of the trials period apart from two EG & G 263C hydrophones which were replaced during the short port call midway through Leg 1. Thereafter no further problems were encountered.

EPC graphic recorders

As with the hydrophones the only major problems with the graphic recorders were encountered during the setting up period. Thereafter all machines operated well with no more than the usual amount of routine maintenance between lines and during port calls.

Seismic control and analogue tape system

The seismic control system operated well, but major problems were encountered with the tape recording of seismic data. These have yet to be resolved and no seismic data were recorded after Leg 1.

TABLE 1

Project 80/01 Personnel

Leg 1: 21 April-6 May
South Shields-Hull

		Leg Report
A Dobinson		Senior Scientist
A S Mould		Navigation
C P Brett		
E J Armstrong	IGS, MGU	
P R Roberts		Technical
K Hitchen	IGS, HCU	
K Robertson		
M Gallon	RVS, Barry	
S Smith		
T D J Cameron	IGS, MGLU	Geology
A J Ogilvy	21-28 April, Comap Ltd	
R Hutchins	24-28 April, Huntec Ltd	

Leg 2: 7-20 May
Hull-Gt Yarmouth

M C Tully		Senior Scientist/Gravity
G A Day		
M Glen	IGS, MGU	Navigation
H Stanley		
P R Roberts		Technical
A Skuce	IGS, HCU	
J Price		
I Innes	RVS, Barry	
K Smith		
C D R Evans	IGS, MGLU	Geology

Leg 3: 22 May-4 June
Gt Yarmouth-Gt Yarmouth

		Leg Report
A S Mould		Senior Scientist
C P Brett		
E J Armstrong	IGS, MGU	Geophysics
J R Walker		Navigation
D Ham	IGS, HCU	
R W Powell		Technical
C Paulson	RVS, Barry	
J Taylor		
M Garratt	EMOOS Ltd	
T D J Cameron	IGS, MGLU	Geology
J Lowe	UDI 22 May only	

Leg 5: 19 June-30 June
Gt Yarmouth-Sunderland

A Dobinson		Senior Scientist/Navigation
M C Tully		Gravity
G A Day	IGS, MGU	
P R Roberts		Technical
C S Dewar	IGS, HCU	
C Paulson		
M Gallon	RVS, Barry	
J Strangward		
D Leachman	EMOOS Ltd	
A Crosby	IGS, MGLU	Geology

LINE NO.	LAST FIX	START Day Time	END Day Time	LINE LENGTH KM	NAVIGATION		BATHYMETRY ATLAS DESO 10 EDIG 10	GRAVITY LACOSTE & ROMBERG S75	MAGNETICS BARRINGER	DATA LOGGING		SONAR		SEISMIC				
					SATNAV-DOPPLER SONAR	OTHER				DECCA-IGS	MONITOR LABS 9400	KELVIN HUGHES MS 47	UDI AS350 DUAL CHN. SIDE SCAN	PINGER EDO WESTERN	BOOMER HUNTEC DEEP-TOW	SPARKER EG&G	AIRGUN BOLT 600B	WATERGUN SODERA MICA-T
01	133	120 2150	121 1950	195	✓		✓	✓	✓	✓		✓		✓	✓	✓ 3kJ FIX 1-22	✓ 1 IN³	
02	42	122 0030	122 0720	51	✓		✓	✓	✓	✓		✓		✓	✓	✓ 5kJ	✓ 5 IN³	
03	35	122 1510	122 2050	55	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "	
04	73	122 2230	123 1030	114	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓ 1kJ FIX 4-END	✓ "	
05	44	125 1100	125 1810	69	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "	
06	49	125 1920	126 0320	70	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "	
07	52	126 0830	126 1700	87	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "	
08	34	126 1940	127 0110	53	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "	
09	128	129 1720	130 1430	195	✓		✓	✓	✓	✓	✓	✓		✓	✓ FIX 1-20	✓ "	✓ "	
10	122	130 1700	131 1310	191	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "	
11	39	131 1550	131 2210	48	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ 1 IN³	
12	87	132 0000	132 1420	127	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ 5 IN³ FIX 1-20	
13	117	132 1610	133 1130	178	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ 5 IN³	
14	19	133 1450	133 1750	26	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "	
15	93	134 1130	135 0300	114	✓		✓	✓	✓	✓	✓	✓		✓		✓ "	✓ "	
16	34	135 0440	135 1010	49	✓		✓	✓	✓	✓	✓	✓		✓		✓ "	✓ "	
17	8	135 1210	135 1320	10	✓		✓	✓	✓	✓	✓	✓		✓		✓ "	✓ "	
18	40	135 1630	135 2300	49	✓		✓	✓	✓	✓	✓	✓		✓		✓ "	✓ "	
19	26	136 0000	136 0610	46	✓		✓	✓	✓	✓	✓	✓		✓		✓ "	✓ "	
20	23	136 0530	136 0910	34	✓		✓	✓	✓	✓	✓	✓		✓		✓ "	✓ "	

LINE SUMMARY

TABLE 2

TABLE 2

LINE NO.	LAST FIX	START Day Time	END Day Time	LINE LENGTH KM	NAVIGATION			BATHYMETRY ATLAS DESO 10 EDIG 10	GRAVITY LACOSTE & ROMBERG S75	MAGNETICS BARRINGER	DATA LOGGING		SONAR		SEISMIC					
					SATNAV-DOPPLER SONAR	OTHER					DECCA-IGS	MONITOR LABS 9400	KELVIN HUGHES MS47	UDI AS350 DUAL CHN. SIDE SCAN	PINGER EDO WESTERN	BOOMER HUNTEC DEEP-TOW	SPARKER EG&G	AIRGUN BOLT 600B	WATERGUN SODERA MICA-T	
21	23	136 1040	136 1420	46	✓		✓	✓	✓	✓	✓	✓	✓		✓		✓ 1KJ	✓ 5IN³		
22	29	136 1700	136 2140	54	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "		
23	37	136 2300	137 0500	56	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "		
24	45	137 0630	137 1350	63	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "		
25	47	137 1520	137 2300	57	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓ 500J	✓ "		
26	34	138 0050	138 0620	59	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "		
27	58	138 1320	138 2250	78	✓		✓	✓	✓	✓	✓	✓ PART	✓		✓	✓	✓ "	✓ "		
28	27	139 0040	139 0500	49	✓		✓	✓	✓	✓	✓		✓		✓	✓	✓ "	✓ "		
29	24	139 0640	139 1030	38	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "		
30	20	139 1150	139 1500	28	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "		
31	49	139 1900	140 0300	69	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "		
32	83	140 0540	140 1920	115	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓ "	✓ "		
33	62	144 1620	145 0230	85	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ 1KJ	✓ "		
34	17	145 0430	145 0710	24	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ 1KJ	✓ "		
35	23	145 1910	145 2250	34	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
36	24	146 0010	146 0400	28	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
37	38	146 0620	146 1230	56	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
38	31	146 1620	146 1920	47	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ 500J	✓ "		
39	28	146 2130	147 0200	44	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
40	24	147 0340	147 0730	35	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		

LINE SUMMARY

TABLE 2

LINE NO.	LAST FIX	START Day Time	END Day Time	LINE LENGTH KM.	NAVIGATION			BATHYMETRY ATLAS DESO 10 EDIG 10	GRAVITY LACOSTE & ROMBERG S75	MAGNETICS BARRINGER	DATA LOGGING		SONAR		SEISMIC					WATERGUN SODERA MICA-T
					DOPPLER SONAR	SATNAV-	OTHER				DECCA-IGS	MONITOR LABS 9400	KELVIN HUGHES MS 47	UDI AS350 DUAL CHN. SIDE SCAN	PINGER EDO WESTERN	BOOMER HUNTEC DEEP-TOW	SPARKER EG & G	AIRGUN BOLT 600B		
41	25	147 0940	147 1350	38	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ 500 J	✓ 5 IN^3		
42	29	147 1536	147 2016	45	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
43	34	147 2154	148 0324	48	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
44	22	148 0600	148 0930	33	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
45	24	148 1124	148 1514	36	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
46	29	148 1822	148 2302	52	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
47	27	149 0108	149 0528	52	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
48	29	149 0820	149 1300	47	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
49	35	149 1500	149 2040	53	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ 1 KJ	✓ "		
50	45	149 2220	150 0540	63	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
51	21	150 1024	150 1344	41	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ 500 J	✓ "		
52	55	150 2034	151 0534	106	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ 1 KJ	✓ "		
53	41	151 0720	151 1358	73	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
54	47	151 1652	152 0032	82	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ 500 J	✓ "		
55	43	152 0210	152 0906	81	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ 1 KJ	✓ "		
56	28	152 1230	152 1700	60	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
57	24	152 1830	152 2220	49	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
58	26	152 2314	153 0324	51	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
59	27	153 0440	153 0900	55	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
60	22	153 1040	153 1410	38	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		

LINE SUMMARY

TABLE 2

LINE NO.	LAST FIX	START Day Time	END Day Time	LINE LENGTH KM.	NAVIGATION			BATHYMETRY ATLAS DESO 10 EDIG 10	GRAVITY LACOSTE & ROMBERG S75	MAGNETICS BARRINGER	DATA LOGGING		SONAR		SEISMIC					WATERGUN SODERA MICA-T
					SATNAV-DOPPLER SONAR	OTHER					DECCA-IGS	MONITOR LABS 9400	KELVIN HUGHES MS 47	UDI AS350 DUAL CHN. SIDE SCAN	PINGER EDO WESTERN	BOOMER HUNTEC DEEP-TOW	SPARKER EG&G	AIRGUN BOLT 600B		
61	15	153 1714	153 1934	28	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ 1KJ	✓ 5 IN³		
62	30	153 2120	154 0208	53	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
63	30	154 0460	154 0930	57	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
64	15	154 1204	154 1424	27	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
65	18	154 1646	154 1936	31	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
66	21	154 2224	155 0144	37	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
67	59	155 0650	155 1630	91	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
68	22	155 1820	155 2150	42	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
69	63	171 1800	172 0420	76	✓		✓	✓	✓	✓			✓		✓		✓ "	✓ "		
70	46	172 2100	173 0430	74	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
71	59	173 1010	173 1950	95	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
72	34	173 2110	174 0240	55	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
73	70	174 0830	174 2000	116	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓ "	✓ "		
74	133	174 2250	175 2050	191	✓		✓	✓	✓	✓	✓	✓	✓ FIX 1-60	✓	✓		✓ "	✓ "		
75	120	175 2320	176 1910	187	✓		✓	✓	✓	✓	✓	✓		✓	✓		✓ "	✓ "		
76	67	176 2100	177 0800	121	✓		✓	✓	✓	✓	✓	✓		✓	✓		✓ "	✓ "		
77	28	177 0830	177 1300	52	✓		✓	✓	✓	✓	✓	✓		✓	✓		✓ "	✓ " PART		
78	92	177 2110	178 1220	154	✓		✓	✓		✓	✓	✓		✓	✓		✓ "	✓ " PART		
79	39	178 1420	178 2040	54	✓		✓	✓	✓ FIX 9-END	✓	✓	✓	✓ FIX 31-END	✓ FIX 1-31 36-END	✓		✓ "	✓ "		
80	61	178 2350	179 0950	111	✓		✓	✓	✓	✓	✓	✓		✓	✓		✓ "	✓ "		

LINE SUMMARY

TABLE 2

LINE NO.	LAST FIX	START Day Time	END Day Time	LINE LENGTH KM	NAVIGATION		BATHYMETRY ATLAS DESO 10 EDIG 10	GRAVITY LACOSTE & ROMBERG S75	MAGNETICS BARRINGER	DATA LOGGING		SONAR		SEISMIC					
					SATNAV - DOPPLER SONAR	OTHER				DECCA - IGS	MONITOR LABS 9400	KELVIN HUGHES MS47	UDI AS350 DUAL CHN. SIDE SCAN	PINGER EDO WESTERN	BOOMER HUNTEC DEEP-TOW	SPARKER EG&G	AIRGUN BOLT 600B	WATERGUN SODERA MICA-T
81	71	179 1520	180 0300	112	✓		✓	✓	✓	✓	✓		✓	✓		✓ 1kJ	✓ 5IN³	
82	79	180 0540	180 1840	114	✓		✓	✓	✓	✓	✓		✓	✓		✓ "	✓ "	
83	32	180 2210	181 0320	49	✓		✓	✓	✓	✓	✓	✓ PART	✓ PART	✓		✓ "	✓ "	

LINE SUMMARY

TABLE 2

TABLE 3

CORRECTED GRAVITY BASE TIES

Date	Day	Time GMT	Place and berth	g at main base mGal	g at berth corrected for tidal effects mGal	Meter reading corrected for tidal effects Meter divs.	Drift mGal
21.04.80	112	0641	South Shields Middle Dock	981506.98	981509.5	12301.4	
							+ 0.2
06.05.80	127	1014	Hull Albert Dock	981379.7	981379.4	12170.3	
							- 0.7
20.05.80	141	1530	Great Yarmouth South Quay	981301.5	981302.6	12092.1	
							+ 0.5
22.05.80	143	0240	Great Yarmouth South Quay	981301.5	981302.6	12092.6	
							+ 2.7
19.06.80	171	0800	Great Yarmouth South Quay	981301.5	981303.0	12095.7	
							+ 2.5
30.06.80	182	0700	Sunderland Weir Dockyard	981506.98	981500.8	12297.8	

APPENDIX 1

Equipment Carried

Navigation

1. Magnavox satellite navigation system integrated with MX610/MX600 doppler sonar and Arma Brown Mk I Mod 5 gyro compass.

2. Decca Mk 21 main chain receiver - optional integration with above.

Gravity

LaCoste and Romberg S75 air-sea gravity meter. World Wide land gravity meter for base ties.

Magnetics

Barringer proton magnetometer - two tow cable/sensor assemblies.

Bathymetry

Atlas Deso 10 echo sounder with hull mounted transducers (33 and 210KHz) and Edig 10 digitiser unit.

Data logging

1. Decca/IGS data logger.

2. Monitor Labs 9400 data logger.

Sonar

1. Kelvin Hughes MS47 transit sonar - hull mounted, port scanning.

2. UDI AS350 dual channel side scan system with catamaran tow fish, 2500' tow cable and remote controlled winch. Recording on an EPC 3200 graphic recorder.

Seismic

1. Edo Western 248 pinger, 3.5KHz, 10KW transducer in tow fish assembly. Used with TSS Model 302 swell filter, recording on EPC 4600 graphic recorder.

2. Huntec deep tow boomer system with remote controlled winch, two Krohn-hite bandpass filters, recording on an EPC 4100 graphic recorder.

3. EG & G sparker system - up to 5KJ capability, one three element and one nine element spark array, Krohn-hite band-pass filter, TSS Model 307 TVG amplifier, recording on an EPC 4600 graphic recorder.

4. Air gun system:- Bolt 600B, two guns with standard ($1-40in^3$) range of chamber sizes, Krohn-hite bandpass filter, TSS Model 307 TVG amplifier and recording on an EPC 4600 graphic recorder.

5. Sodera Mica-T $80in^3$ water gun recording as for air gun system.

6. Analogue tape and seismic control system (IGS) incorporating a Racal Store 4 tape deck.

7. Hydrophones

   (a) Huntec ST2.

   (b) EG & G 265.

   (c) EG & G 263C, 2 off - used with sparker.

(d) Teledyne 7 channel (10m) - used with sparker latter half of season.

(e) Geomecanique 30m used with air gun.

(f) Geomecanique 50m 3 section - used with air gun/water-gun.

8. Seismic amplifiers - Bell and Howell, 10 off.

9. Additional EPC 3200 recorder - normally used for additional display of air gun or simultaneous display of air gun and sparker.

10. Spare EPC 4600 recorder.

11. Spare Racal Store 4 tape deck.

Miscellaneous

1. Two UDI closed circuit television systems for monitoring remote winches.

2. Hewlett Packard 9810 desk top calculator with 9862A graph plotter.

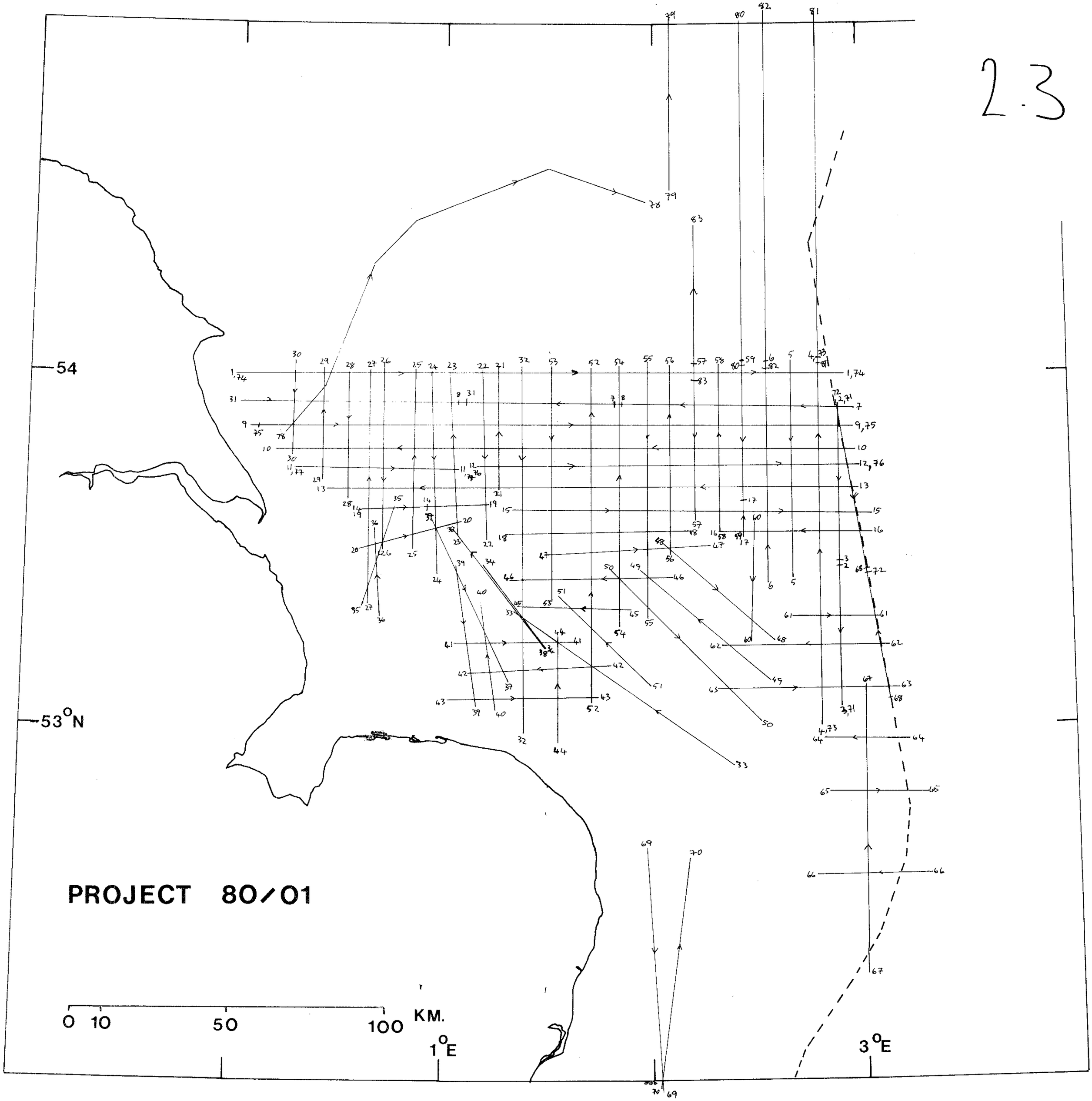


FIGURE 1