INSTITUTE OF GEOLOGICAL SCIENCES

CONTINENTAL SHELF DIVISION

MARINE GEOPHYSICS UNIT

Report No. 88

Project 76/04: Gravity Survey of the North Sea on m.v. Sperus

Compiled by

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INTRODUCTION

In the summer of 1976, the Department of Energy commissioned the Marine Geophysics Unit of the Institute of Geological Sciences to carry out a gravity and magnetic survey of the British sector of the North Sea between 51°N and 62°N. Work was to start on the survey as soon as possible in 1976 and to continue the following year.

In order to obtain a reasonable coverage of the area, it was planned to survey along E-W lines, 7.5km apart and along N-S lines, 15km apart, with infill lines where the anomaly pattern indicated it to be necessary.

In 1976, it was envisaged that instruments could be calibrated, an open N-S and E-W grid of the whole area could be completed and that a start could be made on surveying on the closer grid within the open one.

Prior to commencing the survey, a ship suitable for this type of work had to be chartered. The vessel chosen was the m.v. Sperus which was chartered from Cosag Marine Services Ltd of London. The m.v. Sperus has an overall length of 210ft, a beam of 36ft, a draught of 13ft, net tonnage of 921 tons and is powered by two British Polar 650 BHP engines. She has accommodation for up to 12 scientific personnel, which was adequate for the envisaged manning level of 6-8 persons.

Considerable modifications had to be carried out to the vessel prior to the installation of scientific equipment.

To ensure the minimal amount of down-time due to gravity meter failure, a LaCoste and Romberg air-sea gravity meter was leased from the manufacturers for the survey, to be used alongside the NERC Askania GSS-3 meter.

MOBILISATION

A sea chest was fitted to the ship to house the Magnavox doppler sonar transducer. A housing was manufactured for the transducer of an Edo Western pinger so that it could be hull-mounted. The upper part of the forward hold was converted into an operational laboratory. The recording consoles for all the equipment were installed in this laboratory. The consoles for the gravity meters, the satellite navigation system and the data logger were mounted on the laboratory deck. The recorder for the Atlas Deso 10 was mounted on a bulkhead and those for the pinger and magnetometer were sited on benches. The teletype for the satellite navigation system was sited to one side of a large desk which was used for on-line monitoring and plotting of navigation data. Adequate benching and desks were fitted so that running repairs to equipment could be easily carried out and data could be processed. A light table was installed so as to facilitate plotting of data.

Direct access to the laboratory, the gas hold and lower hold from the living accommodation was affected by the cutting of existing bulkheads and installation of stairs. The gas hold is immediately aft of the forward hold and is near the centre of gravity of the ship. For this reason it was chosen as the site for the small container in which the Askania gravity meter was housed. A ship's store forward of the laboratory was turned into a store room for recording paper, magnetic tape and spares for the equipment. The UPS system was installed in the lower part of the forward hold.

The generators were housed in a specially modified container which was placed on the starboard deck aft of the upper deck accommodation.

SUMMARY

On reflection, this project can be deemed to have been only partially successful. There were several contributing factors to the lack of achievement, a prime factor being the weather.

In all, forty lines were surveyed covering a total of 6861km. Of those forty lines, eleven were abandoned because of bad weather and/or high sea states. Approximately 2110km were surveyed in good conditions, ie winds of force 4 or less and little or no swell; 1470km were surveyed when there were similar wind conditions but a large swell. Of the remaining 3280km, most were surveyed with wind force 6 or greater. Both the swell and the wind were, predominantly, from either a northerly or southerly direction and consequently little shelter was afforded by the coast. Irrespective of whether the ship was in port or not, for over 30% of the period of the project the wind was force 7 or greater and in these conditions it is impossible to carry out a gravity survey.

Most of the equipment was subject to problems. The exceptions being the echo sounder and the pinger which only required routine maintenance. The problems with the major items of equipment were resolved gradually as the project progressed but the performance of the LaCoste and Romberg gravity meter was a source of concern throughout. The satellite navigation/doppler sonar system was calibrated successfully once the transducer housing had been re-manufactured and the system had been earthed

properly. Subsequently, only minor modifications to calibration factors were required. In good weather, the system gave moderately good quality data but as weather became poor the data quality deteriorated. Bunching of satellite was a problem on a number of occasions and this greatly reduced the number of good satellite passes and there were, on occasions, long periods without updates. Therefore, to obtain updates of a reasonable magnitude, less than 200m, dead reckoning had to be as accurate as possible. The surveying speed of 10-12 knots and poor weather were not conducive to this. It was noted on lines A, B and C, which were run at 5-6 knots in sheltered waters, that the system performance was similar to that experienced during the previous summer with mean updates of less than 100m.

During the early stages of the survey, the magnetometer was very noisy, mainly because of poor cable and bad connections. Once a new cable had been fitted, the system functioned adequately for the remainder of the project.

The Askania GSS-3 gravity meter and Brown platform operated well after a card in the gyro torquing circuit of the platform had been replaced. The leased LaCoste and Romberg gravity system appeared to function well. However, it was very sensitive to bad weather conditions and was inoperable in any condition above force 4. In good conditions, the LaCoste and Romberg was consistently reading 2mgal lower than the Askania, but in poor weather it was reading up to 10-12mgal lower. Until sufficient

lines with intersections had been run so that an evaluation of data misties could be made, it was not possible to assess whether either one meter or both meters were functioning incorrectly. When sufficient data had been collected, the mean mistie of LaCoste and Romberg data gathered in good conditions was less than that of the Askania, but overall the Askania data was consistent with no large variations in individual mistie values, whereas with the LaCoste and Romberg data there were large discrepancies between data collected in good and in poor conditions. It was concluded from this that the Askania was working correctly but there was some malfunction in the LaCoste and Romberg. The LaCoste and Romberg system was checked out thoroughly while the ship was in port but no obvious fault could be found. From the analogue traces it looked as though the fault lay in the cross-coupling circuitry. A LaCoste and Romberg 9400 data logging system was sent by the manufacturers so that the correction parameters could be monitored and data tapes sent back to the USA for analysis. About 50% of the data were collected in marginal surveying conditions and whilst a reasonable proportion of the Askania data appears to be useable, it is doubtful if much of that from the LaCoste and Romberg will be of use.

In conclusion, the amount of meaningful data collected, compared with the time and effort expanded, was disappointing. However, the ship had been chartered and modified to our

requirements with the view to chartering it again the following year to continue the survey. Most of the problems with installation were ironed out with any outstanding problems being of a minor nature and easily rectified. Valuable experience was gained by the operators of the way in which the ship behaved in every type of sea conditions and of the behaviour of each individual instrument relative to its environment. All this should enhance the standard of the survey in the next year.

TABLE 1

Personnel for Project 76/04

Leg 1

26 September-1 October

G A Day	Senior Scientist	Marine Geophysics Unit
A Dobinson		
R A Floyd		
D K Smythe		
P R Roberts		
D Graham		MSES, IOS Barry
P Hillary		

Leg 2

4 October-12 October

M C Tully	Senior Scientist	Marine Geophysics Unit
A S Mould		
N Kenolty		
D K Smythe		
P R Roberts		
G A Day	4-7 October	
D Graham		MSES, IOS Barry
P Hillary		

Leg 3

M C Tully	Senior Scientist	Marine Geophysics Unit
R A Floyd		
P Towle		
A S Mould		
J A Chalmers		
A J Davies		
A Cumming		MSES, IOS Barry
P Hillary		

Leg 4

28 October-11 November

R A Floyd	Senior Scientist	Marine Geophysics Unit
J A Chalmers		
P Towle		
A K Rochester		
A J Davies		
R McQuillin	28 October-2 November	
A S Mould	5-11 November	
C Poulson		MSES, IOS Barry
P Walters		

Leg 5

12 November-25 November

A Dobinson	Senior Scientist	Marine Geophysics Unit
N Kenolty		
A S Mould		
D Young		
A J Davies		
A Cumming		MSES, IOS Barry

TABLE 2

Ports of Call

Dates	Berth and Port	Reason
20-26 September	Edinburgh Dock, Leith	Mobilisation & drydocking
29 September	Victoria Pier, Lerwick	Gravity base check and diver to inspect doppler sonar housing.
1-2 October	Leith	In drydock to modify wel ring on doppler housing.
2-4 October	Albert Dock, Leith	Installation of LaCoste & Romberg gravity meter.
12-16 October	Imperial Dock, Leith	Personnel change and bad weather. Gravity base check.
18-21 October	Holmsgarth No 3, Lerwick	Bad weather and gravity base check.
27-28 October	Edinburgh Dock, Leith	Gravity base check and installation of LaCoste & Romberg 9400 logging system.
29-30 October	Iron Ore Quay, South Shields	Problem with sat/nav.
1-2 November	Iron Ore Quay, South Shields	Bad weather.
10-12 November	King George IV Wharf, Dundee	Member of ship's crew injured. Gravity base check and personnel change.
18-20 November	Blyth	Repair to ship's steering gear.
25 November-1 December	Imperial Dock, Leith	Gravity base check and personnel change. Bad weather and eventually demobilisation.

TABLE 3

Types of Equipment Installed on m.v. Sperus

1. Askania GSS-3 gravity meter and Brown platform.

2. LaCoste and Romberg air-sea gravity meter S75, 2 October-30 November.

2a LaCoste and Romberg 9400 data acquisition system, 27 October-30 November.

3. Barringer magnetometer.

4. Edo Western pinger with hull mounted transducer.

5. Atlas Deso 10 echo sounder with hull mounted transducer and digital readout unit (Edig 10).

6. Magnavox satellite navigation system integrated with MX600 doppler sonar.

7. Decca Mk21 main chain receiver.

8. Decca data logger.

9. Three 60KVA AC generators.

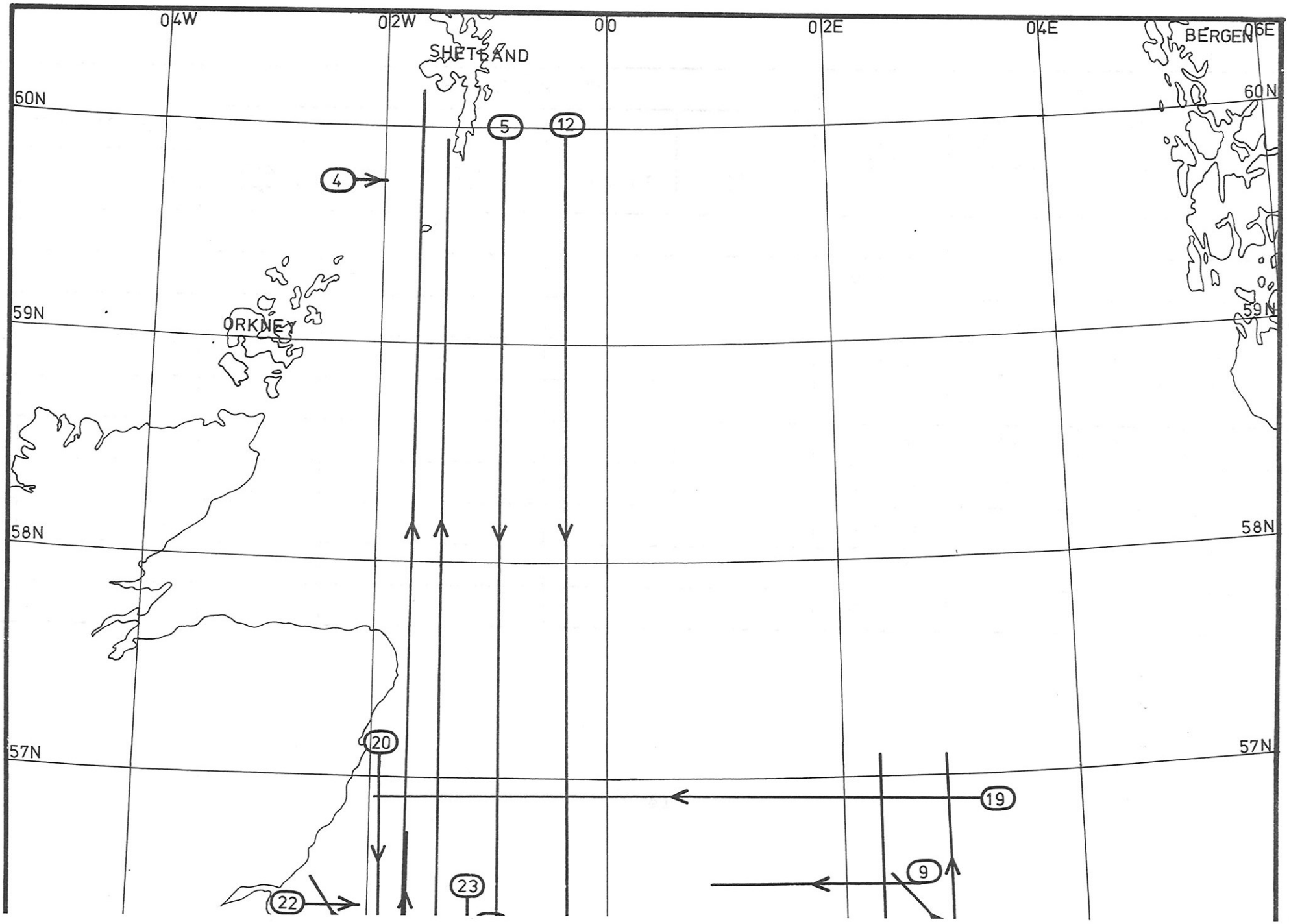
10 Stabilised no-break power supply system (UPS).

TABLE 4

Line No	No of Fixes	Line Length (km)	Primary Nav Aid	EQUIPMENT USED					
				Echo Sounder	Pinger	Magneto-meter	Date Logger	GRAVITY METER	
								L & R S75	GSS-3
1	24	70	SN + DS		-		-		
2	20	62	SN + DS		-	-			
3	144	560	SN + DS						
4	7	22	SN + DS				-		
5	231	600	SN + DS			77-231			
6	29	90	SN + DS					1-26	
7	133	410	SN + DS			15-133			
8	33	91	SN + DS						
9	44	175	SN + DS					1-34	
10	27	75	SN + DS			-			
11	154	535	SN + DS			5-154			
12	150	426	SN + DS			1-61	-		
13	73	187	SN + DS						
14	63	183	SN + DS						

Line No	No of Fixes	Line Length (km)	Primary Nav Aid	EQUIPMENT USED				GRAVITY METER	
				Echo Sounder	Pinger	Magneto-meter	Data Logger	L & R S75	GSS-3
15	80	239	SN + DS						
16	186	481	SN + DS			1-59 & 161-186			
17	117	326	SN + DS						
18	44	121	SN + DS						
19	111	312	SN + DS						
20	61	148	SN + DS						
21	37	104	SN + DS			-			
22	13	32	SN + DS						
23	75	189	SN + DS						
24	90	259	SN + DS						
25	35	95	SN + DS						
26	77	101	SN + DS			1-73			
27	24	67	SN + DS			-			
28	54	165	SN + DS			-			
29	31	88	SN + DS			12-31			
30	32	91	SN + DS						

Line No	No of Fixes	Line Length (km)	Primary Nav Aid	EQUIPMENT USED				GRAVITY METER	
				Echo Sounder	Pinger	Magneto-meter	Data Logger	L & R S75	GSS-3
31	29	84	SN + DS						
32	23	64	SN + DS						
33	66	178	SN + DS						
34	9	22	SN + DS			-			
35	14	40	SN + DS			-			
36	31	86	SN + DS			-			
37	14	33	SN + DS			-			
A	18	12	SN + DS			-			
B	16	13	SN + DS			-			
C	35	25	SN + DS			-			


04W
02W
00
02E
04E
06E
SHETLAND
BERGEN
60N
59N
58N
57N
ORKNEY
5
12
4
20
19
9
23
22

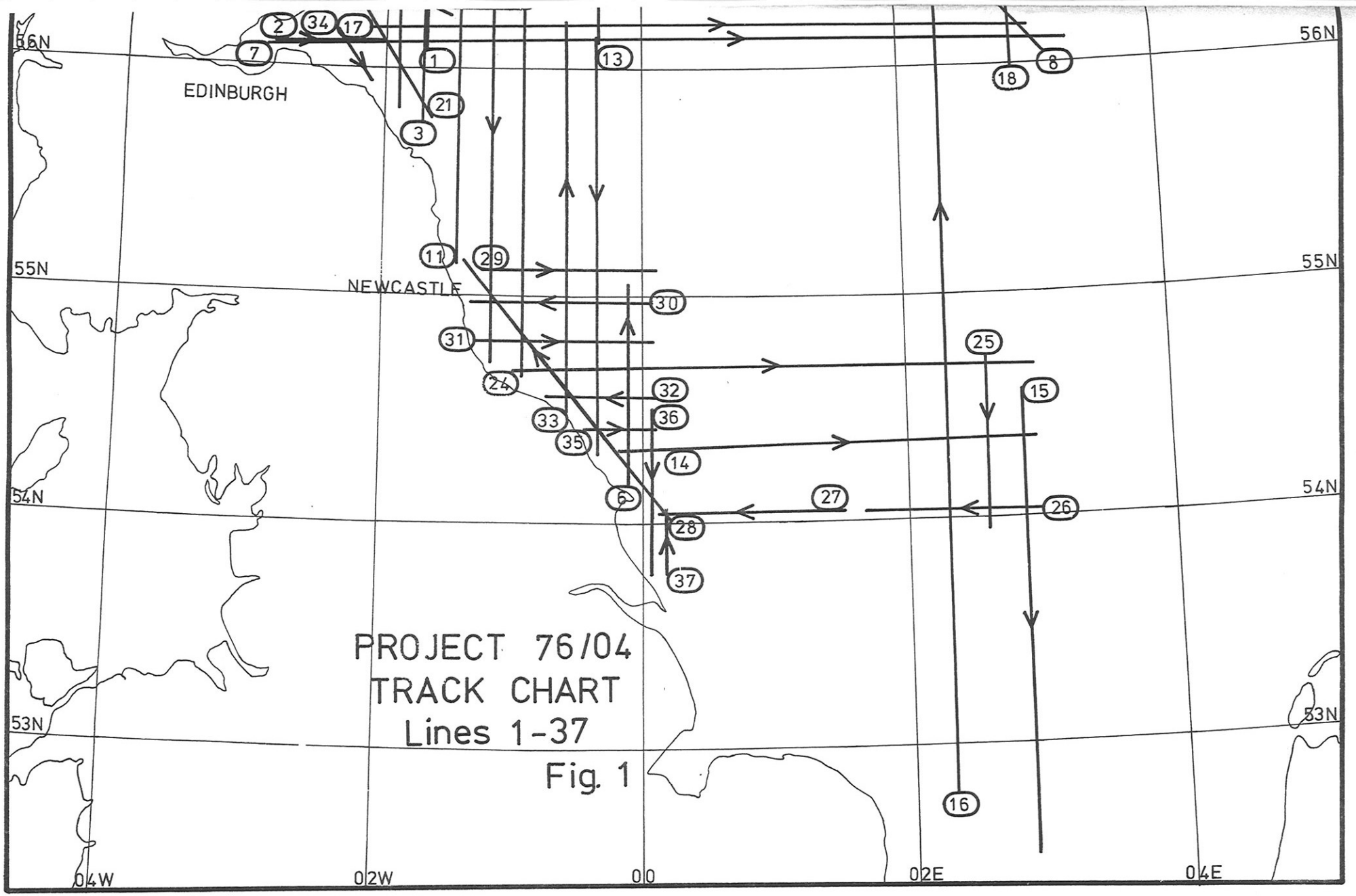

56N
55N
54N
53N
EDINBURGH
NEWCASTLE
04W
02W
00
02E
04E
PROJECT 76/04
TRACK CHART
Lines 1-37

Fig. 1