INSTITUTE OF GEOLOGICAL SCIENCES

GEOPHYSICAL DIVISION

MARINE GEOPHYSICS UNIT

REPORT NO. 34

Cruise Report: Northern North Sea regional geophysical survey. MGU Project No. GP/MG/72.4, M.V. Researcher

by

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May 1973

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INTRODUCTION

During June and July the Institute of Geological Sciences undertook a geophysical survey of part of the northern North Sea; the area is shown in Fig. 1. The survey consisted of measuring gravity, magnetics, bathymetry, side-scanning sonar and continuous shallow seismic profiles. The gravity results are computed into Bouguer anomaly maps to investigate deep structures while the shallow seismic and sonar records provide the Institute's Continental Shelf Unit II with a preliminary survey to aid planning of their drilling and sampling programme, as well as giving data on sub-surface structures.

These surveys were carried out using a data logging system which recorded all logged parameters at typically 2 minute intervals on paper and one second intervals on magnetic tape. The provision of the Edo Western precision sub-bottom and bottom profiler with a digitrack unit should have enabled the depths also to be recorded on tape. Unfortunately the instrument's late delivery and several instrument faults made it impossible to interface it correctly into the data logger for the major part of the survey.

NARRATIVE

After fitting two Decca Hi-fix systems and being delayed by bad weather the MV Researcher left Aberdeen on June 18. For the first part of the survey rough seas were encountered until June 23 when gale force winds caused abandonment of the survey and the return of the ship to Aberdeen. The gale abated on June 24 and surveying commenced and continued until June 26, the end of the first leg when the ship entered Leith. During this leg some of the gravity survey was lost due to a failure in the La Coste gravity meter which was never satisfactorily rectified and help was requested from R.V.B. to assist in the overhaul of the meter while in Leith. During the worst of the weather some of the gravity profiles had to be rejected. In these the trace wandered over 10-20 milligals.

The seismic results even in the rough seas and at speeds of 7-8 knots were good and only when the gales were encountered was work abandoned. Faults occurring in a tape interface unit and tape recorder made plans to record seismic data in analogue form on magnetic tape impracticable. These faults were not rectified until the end of the project.

Sailing from Leith was delayed to await replacement parts for the data logger tape deck, which arrived, and paper for the Edo Western Echo-sounder, which did not. The ship left Leith on the morning of June 29. As a result of work done in Leith the La Coste gave a much smoother trace but also the weather was good during this second leg with generally calm seas. A short survey was done at the instigation of Continental Shelf Unit II in the Forth Estuary and in the coastal area towards Aberdeen. The Hi-fix system was re-set off Aberdeen and surveying continued in the planned area with good results. On July 3 further repairs to the gravity meter were necessary; one of the gyros and two operational amplifiers were replaced. A short visit

to Aberdeen was made on July 4 to re-align the new gyro and obtain a gravity base reading. While in Aberdeen the Edo Western paper arrived and the instrument was operated continually from that time. On leaving Aberdeen two more days were spent in the area before a profile was surveyed to the Norwegian coast where a two day visit to Stavenger had been arranged.

The MV Researcher left Stavenger on July 8 as arranged and a profile was run from the Norwegian coast back to the survey area parallel and several miles from a previous line. The weather was good for the next few days and excellent results were obtained for the whole of this leg right up to July 19 when the ship entered Aberdeen. This period was free from the repeated breakdowns which had occurred previously.

On leaving Aberdeen on July 22 trouble was encountered with the gravity meter once more. A disengaged gear in the auto reader was eventually traced as the fault. This was repaired and at the same time one of the gyros became faulty necessitating replacement. A brief call was made in Aberdeen on July 24 for re-setting the gyro and for final adjustments to the gravity counters made necessary by the auto reader fault. The survey continued after this until August 1st which was the end of the survey.

INSTRUMENTATION

La Coste and Romberg Air-Sea Gravity Meter: During this survey the meter gave considerable cause for worry. There were a large number of failures in both mechanical and electrical components. During the survey the pitch axis gyro was changed three times and several amplifiers were replaced. The mains power supply was changed to a

small auxiliary generator and then back to the ship's supply in attempts to obtain better results. The mechanical gears in the auto reader had to be repaired and the gravity counter and chart recorder were subsequently re-set.

Apart from the breakdowns the poor operation of the meter in rough seas gave much concern; as well as the gravity trace having an approximately sine wave amplitude of 10-15 milligals the resulting smoothed trace was found to be in error by 7-10 milligals (too high) depending on the severity of the weather, and the ship's heading with respect to the swell. When pitching into a sea with a wind force of 6 to 7, it became impossible to read the record. Sea states associated with winds force 5-6 gave, in previous years, no marked reduction the quality of gravity measurement, but during this project, such sea states amounted to marginal conditions. The cross coupling computer appeared suspect on many occasions and when repairs or replacement of components appeared to correct the anomalous readings, these actions were found to provide only temporary solutions. Of the area surveyed at least 10% of gravity coverage will be lost due to failures or quality deterioration.

Following this project, complete overhaul of the instrument was recommended to the Research Vessel Base, and this was subsequently undertaken late in 1972, the instrument being returned for a period to the La Coste and Romberg laboratories in Austin, Texas.

Seismic Profiling System: The equipment consisted of a Huntec 2A Recorder incorporating a 2C signal Processor, a 50 element multispark system firing up to 1000 joules, an ICS designed, Geomecanique built, hydrophone and facilities for recording on magnetic tape using a Huntec Interface Unit and a Hewlett Packard tape recorder.

An E G & G recorder, hydrophone and 3-element spark array were kept on continuous standby. For the whole survey the Hunting system was in operation with excellent results even in rough seas and wind force 6 to 7. The ship's speed was 7 to 8 knots for most of the survey. Work was abandoned in wind force 7 and above and especially in a short choppy sea.

It had been intended to record some of the profiles on magnetic tape but faults in the interface unit and the tape recorder made this impossible. Trial profiles using a Bolt air gun and Geomecanique (flexotire) hydrophone to determine the thickness of the Quaternary sediments did not materialise, due to a delay in delivery of the air-gun.

A limitation to 50 elements in the sparker source instead of the 100 to 200 elements used in previous years resulted in a longer pulse width as seen on the records, furthermore, the rate of electrode wear was very much increased. This limitation was imposed as a result of tests carried out in February in Barry which showed that the longer arrays led to an unacceptably high incidence of capacitor breakdown. In future years a return to 100-element spark arrays is envisaged as E G & G capacitor banks are now using a new type of capacitor capable of taking the peak voltages and currents associated with discharge through the larger multi-element arrays.

Edo Western Sub-Bottom Profiler: This equipment was delivered to the ship at Lowestoft at the start of the cruise whereupon it was discovered that the digitrack unit was faulty. Unfortunately it was n possible to repair this until mid-way through the cruise so that the recording of depth in the data logging system was not possible for most of the project. Both the recorder and transmitter worked perfectly but some difficulty was encountered with the towing of the fish which was overcome by several ad-hoc modifications.

Unfortunately, a delay in the supply of recording paper for this instrument limited its use to the latter part of the cruise during which records were consistently good and very little difficulty was encountered in operation. The Edo Western engineer visited the ship near the end of the project and modified the digitrack unit. After further investigations by IGS and RVB staff this was set-up to work satisfactorily. Unfortunately time did not allow proper interfacing of this equipment with the data-logger, but this was accomplished during a later project in 1972.

Some sub-bottom features were defined in parts of the area and it would be interesting to do comparative trials with this instrument against the O.R.E. sub-bottom profiler.

Decca Data-Logger: The logger functions as a dual system in which a paper print-out is obtained as well as digital magnetic tape recordings; both were used throughout the survey. The data recorded were from the two Hi-fix chains, with the proviso of a Decca Main Chain in lieu of one or other of the Hi-fix chains, gravity, magnetics, time and with the possibility of depth measurements. For most of the survey the data logger functioned correctly and the print-out is complete for the whole survey. Faults in the magnetic tape deck lost several days of records. In each case an engineer had to be called to correct the faults. It would be an advantage for future years to have a spare tape deck and adequate spares for the logging system as a whole.

M.S.47 Transit Sonar: Good results were obtained with this instrument especially considering that the speed of tow was about 7 knots. The transducer was mounted on the port side amidships and the installation was trouble free after a modification to the mountings for protective purposes.

At the beginning, the area surveyed was quite featureless and with

the sonar depicting nothing but the sea bottom it was beginning to look as though there was a fault in the system. However as the survey progressed areas of more pronounced features were reached giving excellent sonar records.

Barringer Magnetometer: During the survey the magnetometer was trouble free, the only difficulty encountered was a drift in chart zero which meant recalibration every two or three hours. Some erratic readings occurred during the middle part of the survey which subsequently disappeared. It was presumed these were the result of magnetic storms.

RESULTS

During the survey over 5000 nautical miles or 8000 kilometres were surveyed and Table 1 gives the list of the traverses depicting the type of instruments used. In addition an extra 400 miles was surveyed in the Norwegian profiles and work requested by CSU II in the approaches to the Forth.

The area surveyed of acceptable quality by the gravity meter is about 80% of the total, the rest being unuseable due to insurument failures and errors associated with bad weather conditions.

During the survey Bouguer gravity anomaly values were calculated using a Hewlett Packard programmable calculator on a 10 minute fixed interval data acquisition. Tracks were plotted on a UTM series of charts at 1:100 000 scale and at 1:250 000 scale.

Data was recorded on magnetic tape every second and on a print-out every two minutes. Failures in the data logging system resulted in only about 50% of results being recorded on tape; but 100% were recorded on printed paper. Seismic and sonar records were anotated every 10 minutes in syncronisation with the other instruments under control

of the data logger.

The seismic results are good with a new recording paper giving a print right through, invaluable for matching traverse when surveyed in opposite directions. A combination of 1 000 joules, a multispark electrode, and a firing interval of 1 second gave good resolution with penetration to about $^{1}/_{3}$ second. This was perfectly adequate for the CSU II geologist onboard to interpret results in preparation for possible borehole sites and sub-bottom mapping.

TABLE 1

MGU PROJECT 72.4

LINE NO	DATE	GRAV	MAG	SPARKER	EDO WESTERN	MS 36	MS 47	DATA LOGGER	HF PTX 1	HF PTX 2	MAIN CHAIN	FIXES	MILES N	K. METRES
1	18.6.72	-	*	1000 J	*	-	*	*	*	-	*	1-122	159	295
2	19.6.72	*	*	1000 J	-	*	*	*	*		*	1-130	160	297
3	20.6.72	*	*	1000 J	-	*	*	*	*		*	1-139	160	297
4	21.6.72	Very Poor	*	1000 J	-	*	First Part	*	*		*	1-151	160	297
5	22.6.72	*	*	1000 J	-	-	*	*	*	*	-	1- 47	60	111
6	22.6.72	*	*	1000 J	-	-	-	*	*	*	-	1- 48	60	111
7	23.6.72	*	*	1000 J	-	-	-	PLO	*	*	-	1- 14	19	35
8	24.6.72	*	*	1000 J	-	Part	*	PLO	*	*	-	1-118	160	297
9	25.6.72	*	*	1000 J	-	-	*	PLO	*	*	-	1- 51	66	122
10	25.6.72	*	*	1000 J	-	-	*	PLO	*	*	-	1- 22	26	48
11	30.6.72	*	*	1000 J	-	*	*	PLO	*	*	-	1- 68	94	174
12	30.6.72	*	*	1000 J	-	*	*	PL & ML	*	*	-	1- 20	27	50
13	30.6.72	*	*	1000 J	-	*	*	PLO	*	*	-	1- 10	18	33
14	1.7.72	*	*	1000 J	-	*	*	PLO	*	*	-	1- 47	60	111
15	1.7.72	*	*	1000 J	-	*	*	PLO	*	*	-	1- 45	60	111
16	1.7.72	*	*	1000 J	-	*	*	PLO	*	*	-	1- 45	60	111
17	2.7.72	*	*	1000 J	-	*	*	PLO	*	-	*	1- 56	60	111
18	2.7.72	*	*	1000 J	-	*	*	PLO	*	-	*	1- 23	22	40
19	2.7.72	-	*	1000 J	-	*	*	PLO	*	-	*	1- 16	21	39
20	3.7.72	*	*	1000 J	-	*	*	PLO	*	-	*	1- 56	72	133
21	3.7.72	*	*	1000 J	-	*	*	PLO	*	*	-	1- 70	98	181
22	4.7.72	*	*	1000 J	-	*	*	PLO	*	*	-	1- 43	60	111
23	5.7.72	*	*	1000 J	*	-	*	*	*	*		1-122	160	297
24	6.7.72	*	*	1000 J	*	-	*	PL part	-	-	-	1- 83	110	
25	8.7.72	*	*	1000 J	-	*	*	-	-	-	-	1- 84	95	
26	9.7.72	*	*	1000 J	*	-	*	*	*	*	*	1-132	160	297
27	10.7.72	*	*	1000 J	*	-	*	*	*	*	*	1- 17	20	37
28	11.7.72	*	*	1000 J	*	-	*	*	*	*	*	1-117	155	288
29	11.7.72	*	*	1000 J	*	-	*	*	*	*	*	1-137	166	308
30	12.7.72	*	*	1000 J	*	-	*	*	*	*	*	1- 13	19	35

PLO: Print log only
* In use
\- Not in use

TABLE 1 MGU PROJECT 72.4

LINE NO	DATE	GRAV	MAG	SPARKER	LDO WESTERN	NS 36	NS 47	DATA LOGGER	HI FIX 1	HI FIX 2	MAIN CHAIN	FIXES	MILES N	K. METRES
30	12.7.72	*	*	1000 J	*	-	*	*	*	*	-	1- 13	19	35
31	12.7.72	*	*	1000 J	*	-	*	*	*	*	-	1-123	164	304
32	13.7.72	*	*	1000 J	*	-	*	*	*	*	-	1- 50	60	111
33	14.7.72	*	*	1000 J	*	-	*	*	*	*	-	1- 48	60	111
34	14.7.72	*	*	1000 J	*	-	*	PLO	*	*	-	1- 48	60	111
35	15.7.72	*	*	1000 J	*	-	*	PLO	*	*	-	1- 49	60	111
36	15.7.72	*	*	1000 J	*	-	*	PLO	*	*	-	1- 52	60	111
37	16.7.72	*	*	1000 J	*	-	*	PLO	*	*	-	1- 50	60	111
38	16.7.72	*	*	1000 J	*	-	*	PLO	*	*	-	1- 47	60	111
39	16.7.72	*	*	1000 J	*	-	*	PLO	*	*	-	1- 21	30	56
40	17.7.72	*	*	1000 J	*	-	*	PLO	*	*	-	1- 23	30	56
41	17.7.72	*	*	1000 J	*	-	*	PLO	*	*	-	1- 35	43	80
42	17.7.72	*	*	1000 J	*	-	*	PLO	*	*	-	1- 48	60	111
43	18.7.72	*	*	1000 J	*	-	*	*	*	*	-	1- 47	60	111
44	18.7.72	*	*	*	*	-	*	*	*	*	-	1- 45	50	92
45	19.7.72	*	*	*	*	-	*	*	*	*	-	1- 48	62	115
46	22.7.72	*	*	*	*	-	*	*	*	*	-	1-130	160	297
47	23.7.72	*	*	*	*	-	*	*	*	*	-	1-125	160	297
48	25.7.72	*	*	*	*	-	*	*	*	*	-	1-135	160	297
49	26.7.72	*	*	PART	*	-	PART	PRINT	*	*	-	1-134	160	297
50	26.7.72	*	*	*	*	-	*	P	*	*	-	1- 31	37	69
51	27.7.72	*	*	*	*	-	*	P	*	*	-	1- 29	33	61
52	27.7.72	*	*	*	*	-	*	P	*	*	-	1- 27	33	61
53	28.7.72	*	*	*	*	-	*	P	*	*	-	1-103	120	222
54	28.7.72	*	*	*	*	-	*	P	*	*	-	1-129	160	297
55	29.7.72	*	*	*	*	-	*	P	*	*	-	1- 24	33	61
56	30.7.72	*	*	*	*	-	*	P	*	*	-	1- 32	38	70
57	30.7.72	*	*	*	*	-	*	P	*	*	-	1- 98	118	219
58	31.7.72	*	*	*	*	-	*	P	PART	PART	-	1- 30	36	67
59	31.7.72	*	*	*	*	-	*	P	*	*	-	1-101	126	233
60	1.8.72	*	*	*	*	-	*	P	*	*	-	1- 9	12	22

PLO: Print log only
* In use
\- Not in use