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M.V. EMERALD CRUISE 77/EM/06 -Leg 3

Duration Friday 2nd September - Thursday 15th September, 1977

1) Location of Area

The area selected for work by M.V. Emerald during Leg 3 was the East Shetland area defined between latitudes  $60^{\circ}\text{N}$  and  $61^{\circ}\text{N}$  and longitudes  $0^{\circ}\text{W}$  and  $1^{\circ}\text{W}$ . The area encompasses two 1:100,000 Sheets, namely  $60^{\circ}\text{N } 01^{\circ}\text{W}$  and  $60^{\circ}30'\text{N } 01^{\circ}\text{W}$ . Water depths in this region average over 100m and in many places reach as much as 150m.

2) Objectives

The purpose of the cruise was twofold. Firstly to systematically sample the area to map out the surface sediment distribution and investigate the Quaternary using vibrocorer at selected sites, gravity sediment corer, and shipek grab. The second objective was to complete the solid geological interpretation using the 1 metre rock drill and gravity corer.

Previous geophysical work in the area has been undertaken by M.V. Briarthorn during cruise 74/4, and this had been followed by a preliminary shallow drilling investigation of the solid geology using the Bedford Institute of Oceanography drill and the Institute of Geological Sciences 1 metre rock drill during M.V. Emerald cruise 76/EM.

3) Personnel

J.A. Chesher (Senior Scientist)

M. Dean

H. Robertson

P. Wiggins

N.A. Ruckley

C. Graham

Cruise details are listed in Appendix I.

4) Equipment

The following equipment was used aboard the M.V. Emerald, a 183 foot Ice A Sterntrawler.

IGS 1 metre rock drill  
IGS Electric vibrocorer  
Gravity Corer  
Shipek Grab  
Cone Dredge  
MS 47 Kelvin Hughes transit sonar  
ORE Pinger and EPC recorder  
Simrod EQ echo sounder (ship equipment)  
Decca (MK12) main chain navigator (ship equipment)  
Spirotechnique and Sub-Sea television systems  
National Panasonic videotape recorder.

An account of equipment performance is listed in Appendix II.

5) Cruise results

The table, Appendix III, summarises the number of stations occupied in the East Shetland area and the equipment used. A total of 176 stations were completed during the 12 day period of which 9 were vibrocore, 4 were rock drill, 113 were gravity rock corer, 54 were gravity sediment corer, 168 were shipek grab and 19 were cone dredge. Daily time analysis plots for the above equipment were kept correct to the nearest 0.1 hour, and are available on file.

During the period of the cruise weather was generally poor accounting for the limited number of vibrocorer and rock drill sites. A total of 48 hours were lost due to weather. In spite of weather factors the area grid sampling was completed for surface sediment analysis, and several solid geological boundaries were accurately defined. It is estimated a total of 10 vibrocorer

86 rock drill sites remain to be occupied to totally complete the Quaternary and solid geological interpretation of the area.

#### 6) Geological Results

Previous geological summaries of the area are given in Reports 76/9 (Chesher and Arduş) and 74/4 (Chesher). The results of the present cruise are summarised on the following maps.

- i) Cruise Sheet  $60^{\circ}\text{N } 01^{\circ}\text{W}$  - showing sample station location, equipment used at each station, and summary of geological result at each station.
- ii) Cruise Sheet  $60^{\circ}30'\text{N } 01^{\circ}\text{W}$  - showing data as above.
- iii) Sediment distribution  $60^{\circ}\text{N } 01^{\circ}\text{W}$  - showing sediment distribution, colour, grain size, and shell content after Folk 1969.
- iv) Sediment distribution  $60^{\circ}30'\text{N } 01^{\circ}\text{W}$  - showing data as above.
- v) Solid and Quaternary  $60^{\circ}\text{N } 01^{\circ}\text{W}$  - showing location of rock outcrops, solid sample stations and distribution of Quaternary.
- vi) Solid and Quaternary  $60^{\circ}30'\text{N } 01^{\circ}\text{W}$  - showing data as above.

#### Surface Sediments

Sediment type in the East Shetland area consists of two main facies, a shell sand and an olive grey sand or silt. There is very little gradation between the two sediments, the distribution of the two facies being actively controlled by the topography.

The olive grey sands are restricted in occurrence to a central area of lower topography namely the Unst basin, which trends NNE across the area, to a small basin between Whalsay and Fetlar, and to the extreme southern and eastern part of the area. These sands vary from fine to very fine grained and

often pass into mainly silts. They are characterised by a distinct olive grey to grey colour and generally contain less than 20% shell debris. Complete scaphlopods are common in these sands. In the basin between Fetald and Whalsay the sands are highly micaceous and reflect the presumed source area of the adjacent land which consists of mica schists, phyllites and shales.

Shell sands occur in the regions of higher topography adjacent to the coast extending to the north of Unst and in the east of the area on the Pobie Bank. In these areas the sand occurs as a thin veneer, overlying rockhead, often only a few centimetres in thickness. The sand is generally coarse to medium grained consisting of between 80% and 99% shell material. The shell material consists of small bivalves, foraminifera, scaphlopoda, echinoid spines and broken shell debris.

#### Solid Geology

The solid geology of the East Shetland consists of a predominantly Dalradian basement in which a NNE trending Mesozoic basin, termed the Unst Basin, extends from  $60^{\circ}20'N$  to north of  $61^{\circ}N$  across the centre of the area. Overlying the basement in the southern part of the area are strata of Devonian age.

The present work accurately delimited the northern limit of the Devonian strata to the east of the Unst, but further work is required to delimit this boundary in the west. Dalradian strata is also thought to continue to the north of Unst as a direct continuation of the strata exposed on land, but to date sampling has not been able to substantiate this hypothesis. The presence of Mesozoic strata within the Unst Basin already indicated by previous drilling was further confirmed by vibrocoring during this cruise which recovered red and green micaceous siltstones and marls of Permo-Triassic aspect.

#### Quaternary

The presence of Quaternary glacial deposits within the area

is mainly confined to the lower areas of the Unst Basin, the higher platform areas long since having had any glacial deposits that may have been deposited there removed by erosion.

The Quaternary within the Unst Basin consists of soft pink brown tenaceous clays with occasional small well rounded pebbles, closely resembling the red clays of the Moray Firth (see Chesher and Lawson, 1977).

APPENDIX I

Ship's Log

Leg 3 - Friday 2nd September - Friday 16th September

Personnel: J. Chesher (Senior Scientist)  
M. Dean  
H. Robertson  
P. Wiggins  
N. Ruckley  
C. Graham

Saturday 3rd September

0000-1200 In port, Peterhead, routine port visit.  
1200-2400 Steaming to E. Shetland area.

Sunday, 4th

0000-0800 Steaming to E. Shetland area.  
0800-1500 Routine sampling GC and SG. Weather too bad for vibrocoring (SW7-9).  
N.B. Lost cone dredge 1200 hrs due to wire parting as dredge streamed with current. Rotten wire.  
1500-1725 Steaming for shelter in Dales Voe due to bad weather.  
1725-2400 At anchor in Dales Voe waiting on weather. Checks on ORE etc.

Monday, 5th

0000-2400 At anchor Dales Voe waiting for weather, SW7-9 loc 10.

Tuesday, 6th

0000-0800 At anchor due to bad weather.  
0800-1200 Commenced routine sampling in embayment between Whalsay and Fetlar.  
1200-1930 Vibrocoring in vicinity of 60°30'N, 00°30'W.  
1930-2400 Bombing, shipek grab and cone dredge, during night. Weather worsening gradually.

Wednesday, 7th

0000-0745 Routine night sampling.  
0745-0830 Commenced laying anchors for vibrocoring.  
0830-2000 Vibrocoring and shipek grab in E. Shetland area north of 60°30'N. Slight delay 0930-1000 with forward anchor shackle.  
2000-2400 Routine sampling in northern part of Sheet 60°30'N, 01°W.

Thursday, 8th

0000-0730 Routine sampling in northern part of Sheet 60°30'N, 01°W.  
N.B. N.A. Ruckley bruised and cut fingers starting

Sykes winch at 0130hrs.  
Lost NX barrel and adaptor due to pin insecurely  
positioned at 0000hrs.

0730-0930 Vibrocoring in north of Sheet 60°30'N, 01°W.  
0930-2000 Routine sampling (abandoned vibrocoring due to  
weather).  
2000-2400 Routine sampling Sheet 60°N 01°W.

Friday, 9th

0000-1400 Routine sampling Sheet 60°N 01°W continued bombing  
and shipek during day due to weather- NW7  
1400-1405 H. Robertson caught Sykes winch handle on thumb,  
badly bruised, skin broken. Electric start on  
winch essential.  
1405-2000 Routine sampling eastern half of Sheet 60°N 01°W.  
2000-2130 Lost gravity corer. Links twisted and caught in  
shute as bomb lifted aboard slightly too far.  
Wire parted. Effected replacement of gravity corer.  
2130-2400 Routine sampling.

Saturday, 10th

0000-0700 Routine sampling eastern part of Sheet 60°N 01°W.  
0700-1700 Vibrocoring in 60°N 01°W.  
N.B. Vibrocore gate failed to open on second station.  
1700-2030 Attempted to use drill at site 107:- problems with  
television due to lack of picture in water and  
also initial settinf up due to faulty fuse. Raised  
to surface, fault due to half flooded camera  
through rear.

2030-2400 Routine sampling in 60°N 01°W.

Sunday, 11th

0000-0800 Routine sampling in 60°N 01°W.  
0800-1000 Laying anchors at drill site - reoccupation of 107.  
Installation of Sub Sea System television system.  
N.B. Wiggins hit on nose by Marlin Spike operated  
by Senior Scientist while extracting core from  
rock barrel.  
1000-1120 Effecting repairs on midi drill - pressure bag  
compensator bag punctured.  
1120-1200 Lowered drill to seabed. Drill rotated but did  
not lower in carriage.  
1200-1300 Checked out drill on deck - alright.  
1300-1430 Lowering drill to seabed. Drilling 30m and recovery.  
1420-1500 Poor core, inconclusive result, redrilling at above  
site.  
1500-1530 Drill carriage did not lower to seabed. Lifted aboard.  
1530-1630 Relowering drill to seabed. Difficulty in starting  
rotation off rat.  
1630-1730 Electric cable with plastic hose and television  
cable caught under rudder due to current. Sixty  
feet of cable trapped. Strong current not evident  
at site.  
1730-2030 Heaving anchors and steaming to Lerwick to obtain  
diver services to release cables from ship.  
2030-2400 In port Lerwick.

N.B. Cable problem would not have been expected under the conditions prevailing. With the weight of the plastic hose and cable it should not have been swept under the ship but any slack should have hung in a near vertical position. Also curvature possible with the hose over the cable would make it difficult to be swept around rudder or propeller. A likely possibility is that the buoys attached to the cable gave it sufficient buoyancy to move in the current present and be caught up under the ship. Buoys could well have been caught around the rudder.

Monday, 12th

0000-1300 In port Lerwick. Diver inspection of rudder and propeller at 0815-1000hrs. Two metres plastic hose and 3m cable recovered. One turn around stern gland of cable, net trapped in nozzle.  
1300-1500 Steaming to sampling area due east of Whalsay.  
1500-2400 Routine sampling in region of 60°30'N 01°W.

Tuesday, 13th

0000-0800 Routine sampling in S. part of Sheet 60°30'N 01°W.  
0800-1100 Laying anchors at midi drill site - reoccupation of 133. Tied electric cable and TV cable to hoist cable against ship using Hiab and pulley.

1100-1230 Steaming to site 22 for mididrill.  
1230-1545 Laying anchors and drilling at site 22.  
1545-1645 Steaming to site 152.  
1645-1900 Laying anchors and drilling at 152.  
1900-2230 Steaming for shelter due to gale 8-10 SW.  
2230-2400 At anchor Dales Voe due to weather.

Wednesday, 14th

0000-1640 At anchor Dales Voe.  
1640-2400 Steaming and routine sampling S of Whalsay.

Thursday, 15th

0000-0800 Routine sampling.  
0800-0900 Steaming to Lerwick slightly early due to weather for routine port call.  
0900-2400 In port Lerwick - routine port call.

## APPENDIX II

### Equipment Performance

In general most of the equipment proved satisfactory throughout the cruise, and little time was lost due to equipment failure. However, several points arise specific to certain items of equipment, and these are listed below.

#### Gravity Corer

The use of a pin to change from sediment to rock corer proved expedient in changing barrels. The pins might be replaced by a bolt and nut or a bolt with a lynch clip because if the pin lug was not bent over correctly the pin dropped out losing the sediment barrel and adaptor. Also the pin lug often opened within barrel making extraction of pin difficult.

The spliced joint of wire cable at the bomb proved subject to wear during recovery into the trough due to swinging of the bomb in heavy weather and lack of sufficient control on winch. Because of this factor it is essential in all weather conditions for the winch operator to be able to clearly see the bomb, a series of hand signals causes too much delay to prevent such damage happening. Reinforcement of this section of cable would be advantageous. A rapid method of splicing cable would also be invaluable since time was lost making new splices.

The starting of the Sykes winch for the gravity corer by handle proved difficult and dangerous. Several persons badly cut or bruised their hands trying to start the winch. For safety reasons an electric start is imperative.

#### Vibrocorer

This proved satisfactory although gate operation did not always operate. Since there is a significant gap between the gate and cutting shoe any fine sediment will be lost, and any

tough material is retained by catcher, hence the value of the gate is questionable. Pistons were not used and this fact did not appear to impair core recovery. Handling of the barrel when full proved a person intensive operation requiring 3 people to lift the barrel. Extraction of the core by pushing with hub extractor and piston at the top end proved very satisfactory. The 60 foot length of plastic hose on the electric cable seemed excessive, 30 foot should be sufficient, and the value of buoys attached to the above hose seemed dubious.

#### Shipek Grab

This proved satisfactory though lifting wire was badly corroded. A stainless steel wire would be advantageous.

#### Midi Drill

The initial leak in hydraulic compensation bag needed repairing. The rubber bags used in this system seem very vulnerable and a more substantial method of housing could be developed. The captive nut did not release on several occasions preventing the carriage from travelling down. The drilling rate in hard crystalline gneissose basement was 0.30m/1hr, a rate that could perhaps have improved upon using more weight on the bit, or a different bit type, or a different drilling rate using a variable speed more powerful electric motor system.

The presence of buoys on the electric cable is superfluous, and the problem encountered of the cable being caught under the ship probably resulted from the additional buoyancy of the cable which, if it had any slack instead of hanging vertically under its own weight, was able to stream under the ship. It is essential to attach the power and television cables to the hoise wire every 5-10 metres to prevent this occurring.

#### Television

The Spirotechnique camera failed on the first occasion it

was used due to flooding. This flooding was due to the frame of the camera within the housing being assembled skew resulting in the rear end cable plug housing gouging grooves in the metal seating and permitting flooding by water due to the now inadequate sealing by the 'O' ring. The flooding of the camera and ruining of the paper capacitors inside put the camera out of action for the entire cruise and the lack of any spare meant this system could not be used further. It also caused the loss of one drill site.

The Sub Sea low light system proved very satisfactory giving 6m-12m visibility above the seabed without lights. This extremely good visibility (cf 1-2m on the Spirotechnique) enabled a more rapid assessment of the approach of the seabed, and permitted the drill to be lowered gently. The lights were useful but not essential while drilling to clarify the picture. Any shock or vibration encountered by the camera caused lines on the picture which took a few seconds to settle down again.

#### Cables

Apart from the penetrometer cable only one power cable was available for use with the vibrocorer and rock drill. This cable proved too short in the water depths encountered and had to be spliced to spare lengths on board to enable it to reach the seabed. Since water depths had been specified prior to the cruise this situation should not have occurred. The penetrometer cable is too expensive and difficult to manage to be used as a conventional rock drill or vibrocorer cable and a standard 4-core cable should always be carried as a spare. It should also be noted that the penetrometer cable cannot have plastic hose covering fitted without remaking the plugs at one end, a time consuming operation.

### Core Storage

The waxing of cores and then storage in drums is superfluous since wax seal is damaged in drum. Cores need to be stored in a protected container e.g. a large core box.

APPENDIX III

NO. OF STATIONS AND EQUIPMENT USED

Date Oct. 1977	No. of sites	Shipek	Sediment Core	Rock Core	Midi Drill	Vibro corer	Cone Dredge
4	6	6	2	6	0	0	5
5	0	0	0	0	0	0	0
6	12	11	7	6	0	2	9
7	16	15	9	1	0	4	5
8	28	28	14	16	0	1	0
9	30	30	15	17	0	0	0
10	20	17	6	12	0	2	0
11	12	11	0	12	1	0	0
12	14	13	1	5	0	0	0
13	11	10	0	11	3	0	0
14	14	14	0	14	0	0	0
15	13	13	0	13	0	0	0
—	—	—	—	—	—	—	—
12	176	168	54	113	4	9	19