Cruise Report

British Enterprise Four

Leg 4: 12-26 Sept 1984

C D R Evans

Introduction

The leg, which started from Kyle of Lochalsh, set out to finish the vibrocoring and gravity coring on the Foula sheet (60°N - 04°W). Eleven vibrocores and 96 gravity cores were occupied on the sheet and, in addition, 15 sites were gravity cores on Flett (61°N - 04°W) and 24 on Little Minch (57°N - 06°N). The leg was beset with problems. A crew man died of a heart attack early on the morning of 15 September: this necessitated a journey into Lerwick. On 16 September the umbilical cable to the vibrocorer failed and the instrument could not be used for the rest of the leg. Bad weather prevented operations through most of 19-20 and 23 September. On 23 September repairs to a sodden gravity core motor took some 18 hours.

The samples taken were of excellent quality and provide a wealth of information in this deep-water area. The ship was excellent in all respects.

Personnel

C. Evans - party chief
M. Stoker - geologist
M. Ruckley - lab. assist.
B. Lonie - technician
E. McElvanney - data manager
M. Stewart - BGS geochemist
T. Crosby - geologist
C. James - geologist
C. Graham - lab. assist.
N. Campbell - technician
A. Bent - Student
J. Gibbons - geochemist working for ARCO.

Diary

12 September. The BGS crew were assembled in Kyle by 1500 hrs. Between 1500-2015 hrs the launching of the vibrocorer was practised by both shifts under the watchful eye of D. Ardus. During the first launch the

metal collar, under the spring at the top of the umbilical cable, was broken because the winch driver did not pay out enough cable during the recovery stage. An attempt was made to strengthed this section using seizing wire.

13 September. The ship sailed at 0821 and headed for the Foula sheet.

14 September. Started operations at 0815 and eight sites were vibrocored in water depths of between 410-180 m. No problems. At 2330 operations changed to gravity coring because the signal from the transponder (after 14 hrs of use) was weak. The second transponder, which was supposed to have been fully charged also gave poor results into the DP system.

15 September. Completed two gravity core sites. Shipek results abyssmal - 20 grams per recovery - and its deployment was suspended. At 0230 operations were suddenly suspended when the bridge informed the deck crew that a crew member had died of a heart attack. The seaman, who was on shift at the time had felt unwell during the previous day. He had returned to the accomodation and collapsed and died into the stewards cabin. After attempts to revive him had failed the ship headed for Lerwick to arrive at 1400 hrs. The captain saw to the necessary paperwork on the shore side and the vessel left at 2342. The BGS staff aboard contributed £25 to a BUE fund to assist the mother with burial costs.

16 September. Restarted vibrocoring at 0935. Three shallow sites completed but the transponder signals appeared to be weak. The charger and transponder were examined and no fault found. One of the transponders had been on charge over 14 hrs during the previous 24 hrs. At 1330 the electrical system to the vibrocorer tripped out and could

not be reactivated. The corer was recovered with the barrel half out of the frame. When the system was restarted on deck sparks were heard coming from the cable and frame. Examination of the umbilical cable showed a hollow, fused section where the cable had been badly bent on an earlier leg. Vibrocoring operations were not possible with the cable in this state.

Gravity coring started at 1545. As the shipek grab had given such poor results the samples for PSA were taken from the top of the gravity core. The 5' gravity corer barrel was quickly found to be inadequate as many of the samples filled the barrel. A 10' barrel (with a pin connector) was quickly constructed by welding 2 x 5' barrels together. Most subsequent samples exceeded 5' in length but none attained a length of 10'.

17 September. Gravity cored all day collecting 26 sites in water depths of between 430 - 1123 m.

18 September. Gravity cored until 2250 collecting 22 sites in the process. Operations suspended in Force 7 winds with constant swell coming over stern.

19 September. Attempted two sites between 0650-0802. However, steadily increasing swell and Force 7-8 winds forced operations to be stopped. During the afternoon period the swell was very heavy - estimates of 8-11 m and the aft deck was frequently engulfed in feet of white water.

20 September. Waiting on weather all day: conditions of the previous day persisted into the evening when the wind began to decrease.

21 September. Gravity coring restarted at 0645 and 20 sites occupied

during the day. N. Fannin's telex of 12 new sites on the Flett Sheet came through at 1800.

22 September. Gravity coring all day with 28 sites completed including the 12 extra sites notified the previous day. The exact location of the last five of these sites was doubtful because the Decca Main Chain was particularly unstable after 2100.

23 September. Completed three sites by 0320 when operations were suspended in a Force 7 northerly with a short heavy swell. Operations restarted at 2230. A shower of sparks issued from the electric motor on the gravity coring winch on restart. The blown fuse in the engine room was repaired and sparks again exploded from the motor casing on restart. Water at the same time was frequently coming over the stern. Operations suspended until daylight or an improvement in weather.

24 September. The junction box on the motor was opened at 0400 but the fault was found to be in the motor itself. This was taken off in daylight and by 0900 was all in pieces in the hanger. Water and rust was found inside the casing. On spraying with a WD-40 subsitute and then drying with heaters two of the three phases on the motor were found to be sound. The third remained stubbornly a short circuit. Murchison House was informed of the situation and a van was organized to take the motor for rewinding when the ship docked the next day. At mid-day a break in the windings was seen, cleaned up, sprayed with a plastic coating and sleeved up. This immediately brought the third phase into operational used. Edinburgh were informed of our success and the motor was closed up and put back on the winch. This latter operation took place in Force 7 and all the repair work was greatly assisted by the

efforts of the ship's chief engineer. At 1620 the winch was working. The vessel was underway to the Little Minch sheet to gravity core and shipek until the port call.

25 September. Shipek and gravity corer operations extended from 0840 until midnight. Twenty-four sites were occupied most of which were successful in obtaining a solid rock or sea bed sediment sample.

26 September. Sampling operations terminated 0010. Vessel along side Kyle of Lochalsh 0740. Relief personnel start aboard 0900. CDRE, ACC, and CJ away 11.15

Ship Equipment

The ship's performance and the attitude of the crew could not be faulted. The DP system is a great advance on the Whitehorn: it allows the vessesl to be used in rougher conditions and the samples are more accurately positioned with respect to the chosen site. The crew were always helpful, efficient and eager. The laboratory area and aft deck are noisey; new more efficient ear muffs were brought aboard at the start of the leg but fewer than half the BGS staff used them regularly.

The only minor problem may be the transponders (are they the responsility of BGS?). The appeared not to be providing a strong enough signal to the ships' DP sensor: this could be a DP fault rather than transponder fault for it appeared to occur when both were charged up. The master knewn of this problem and wanted to test the DP system at the first convenient opportunity.

There is no doubt in my mind that the sea keeping qualities of this vessel are way above those of the Whitethorn. This enables samples to be collected in rougher conditions and to stay out in adverse weather rather than run for shelter (for the comfort of the whole crew). The amount of water taken over the stern during these adverse conditions needs consideration. A rigorous system of lashing down, covering and removing items from the deck must be implemented before any weather shut down. Two washing up bowls have gone to date plus one galvanized bottle container and the winch motor by was affected water for the first time in two years.

BGS Equipment

The vessel sailed with a 6 m vibrocoring system, gravity coring system, shipek grab and an underwater camera.

a) Vibrocorer. The eleven vibrocore stations proved not too difficult to occupy. All hands became familiar with the procedure after the first few attempts. However, the system is still clumsey and open to operator error. Means of minimizing these possibilities should be considered.

Penetration in the depths below 300 m was excellent, at shallower depths the occasional sandier unit limited penetration (with 20 mins vibration) to less than 6 m. Gravel caused no return at one site on the outer shelf.

b) Gravity coring system. This performed well with the standard core in depths below 300 m being over 2 m long. The quality of the core was good with no disturbance. Down to about 1100 m the system appeared easy to operate with no need for a trigger system though at these depths the payout speed on the winch set at free fall is barely equal to that when driving the corer out.

We averaged about 25 sites a day with this system using the top of the gravity core as the sea bed sediment sample. It is my firm conviction that these samples are adequate for all our needs below about 300 m (the mud-line). A whole range of sub-units were recovered from which a detailed understanding of glacio-marine sedimentation may be obtained. If we used a vibrocorer how would we show the extra 3 m recovered from 2.5 to 5.5 m below sea bed on our 1:250,000 sheets?. We need not extend the range of this generation of vibrocorer below 500 m. What we need is to increase the sophistication of the gravity corer in the 1000 - 2500 m water depths. We also need to look more at the collected samples and not be obsessed with merely the collection technology.

c) Shipek grab. This failed to work. On most occasions it merely collected a spoon full of sample. In the work area the surface sediment consisted of about 5-10 cm of muddy med. sand. It is the fault of the grab and we need to find a better grab which bites a more controlled, less deep section of the sea bed. This is necessary because sedimentation rates are slower in the deep ocean and the shipek's 15 cm scoop could pick up and mix a long time span of sediment. Action is needed here, perhaps a simple small box corer.

d) Camera System. It was noted that an underwater camera system was aboard. However, as the purpose of the leg was to finish sampling the Foula Sheet no time was available to try the camera.

Detailed description of equipment failure is beyond the scope of this report. The umbilical cable to the vibrocorer was barely operational because of kinks when the leg started and it came as no surprise to all aboard when it failed. It does show that the electrical section is likely to fail before the hoist outer steel cables. The gravity corer motor had been submerged under foaming white water on countless occasions during the leg. Some protection (canvas jacket) needs to be made to try and prevent a recurrence of the problem. A small unfilled drill hole was found on the outer casing: this was partially covered by the end flange. The filling of this hole with electrical putty may make a future soaking of the motor less likely.

The lab facilities were good. The camera system needs a mounting which depends less on black tape and string. The motor on the core cutting machine appears barely adequate. The cutting rig works very well, it could be positioned outside the laboratory - in the hanger - to increase the working space in the laboratory. Numerous other minor modifications, such as storage in the hanger wings or on top of the engineering container could refine an already adequate system.

Geology

Geological samples were obtained from the Foula area using a gravity corer, backed up by vibrocoring in water depths above 500 m and a shipek grab where the substrate allowed. Vibrocoring permitted a maximum recovery of 6 m, although the majority of the samples were collected at depths greater than 500 m using the gravity corer with an recovery of 2-2.5 m.

The aim of the programme was to record the lithologies and lithofacies variations on the continental slope, commencing at the shelf break and progressing onto the slope which dips north-west at a gradient of between 0.8 and 1.0 degrees. Specific attention was paid to the sites chosen in small valleys incised into the slope. The recent sediment cover showed little variation apart from at the shelf break where it was thicker (40 cm) and of a coarser nature. Otherwise the cover consisted of olive, grey fine to coarse poorly sorted shelly gravelly sand, which was generally between 5-10 cm thick and decreased in thickness down the slope.

The contact of this cover with the underlying sediment was generally sharp and erosional. Below 600 m a stiff olive clay was noted at sea bed in some cores, this again showed an abrupt contact with the underlying sediments.

The subsurface geology was divided into four facies described below.

i) Facies A:- This consists of a dark grey (5Y, 4/1) stiff, silty, pebbly mud with shear strength values between 40 and 115 kpa. Clasts with a maximum length of 50-60 mm are common throughout and include gneiss, metabasics, sandstones, and small pieces of Kimmeridge clay. This facies occurs on the shelf break at water depths between 200-300 m as far north as 60° 40'N.

The distinctive feature of this facies is its high shear strength suggesting that it may be a re-deposited till. Alternatively it may have been deposited in a proximal glacial marine environment where the substrate was partially frozen and ploughed up by ice fields. Side scan tracks from this area would tend to support the latter.

ii) Facies B:- Lithologically this consists of sandy pebbly mud to pebbly mud displaying shear strengths between 5 and 10 kpa and a dark gray colour (5Y, 4/2 - 10YR, 4/1). Clasts are common and up to 40 mm in length, often displaying distinct glacial striations, shell fragments and occasional complete valves are also found. Some of the cores show distinct bedding with thin layers of shelly gravelly sand occuring rhythmically down the core.

This facies type occurs over much of the slope below 300 m. The matrix becomes noticeably finer from a sandy mud to silty mud with increasing water depth. Stiff clay balls, common to this facies, are rip up clasts, whilst the isolated gravelly sand pockets are frozen agglomerates which subsequently melted after deposition.

iii) Facies C:- This consists of a dark grey to olive grey (5Y, 4/1, 5Y, 5/2) homogenous mud, with shear strengths between 4 to 8 kpa and rare clasts. A faint colour banding or mottling was observed in many of the cores and dark grey ferrous monosulphide patches were common.

A common feature in cores recovered from below 1000 m was the presence of a distinctive greyish brown (2.5Y, 5/2) clay band, 10 - 50 cm thick. Facies C is restricted to (water depths between 500 and 1200 m) in the very north of the area.

The general dark clay colour and monosulphide patches suggest high organic concentrations and a reducing environment. The grey brown unit may be the result of more oxygenated water or a decrease in organic input.

iv) Facies D:- This is a dark greyish brown (10YR, 4/2) mud, displaying shear strengths between 5 and 9 kpa. Monosulphide patches are common, occasionally occuring in rhythmic layers. It is essentially restricted to the north-east area at depths of between 300 and 400 m although it can be traced out to deeper water as a thin band in some cores.

The lack of clasts and the distinctive colour suggests an environment protected away from the ice-rafted debris zone with a high organic input.

The four facies types suggest an overall galcio-marine environment with a source from the south or south-east; the glacial input into the marine environment decreases down the slope and Facies C reflects essentially marine, oceanic processes with a very limited input from the glacial environment.

Organic Geochemistry Sample Collection

An approach was made by ARCO (Atlantic Richfield Oil Compnay) to BGS for information concerning superficial marine sediment sampling in areas the sea area off NW Scotland, involved in the forthcoming 9th Round Leasings. It was agreed by Nigel Fannin and ARCO that the type of sampling required could be carried out from the British Enterprise Four, already working in the area by the addition of two extra scientific personnel to be financed by ARCO.

Samples were taken from all suitable sediment cores at depths 1 m and where possible at 3 m and 5 m. A 10 cm section was cut from the plastic liner tube containing the whole core. The sediment was extruded onto clean paper towel and its entire outer surface removed, by shaving with a clean palete knife, to minimise any contamination. Clean rubber gloves were worn throughout the sample manipulation for the same reason.

Samples were stored in clean cans with the addition of 5 mls of bactericide to aid preservation. The cans were sealed by hammering on a tight fitting lid but a totally satisfactory seal was not always obtained.

The remainder of the core, after being sliced in half along its length for geological description was examined under a UV lamp in a darkened room for any fluorescence indicating the possible presence of polyaromatic hydrocarbons.

A brief summary of the core description, the positions from which the samples were taken, and any relevant observations was made in addition to the usual documentation.

Blank samples consisting of air from the working deck plus biocide were taken at regular intervals and a can containing a piece of plastic liner tube.

We understand that the samples are to be analysed for trace C_1 -,C_5 hydrocarbons by a specialist firm.

M E Stuart

Analytical Chemistry Research Group

BGS

J Gibbons

OGU University of Newcastle upon Tyne.

Site Number		Equip-ment	Depth of sample below seabed	Results
+60-04	125	CS	1 m	-
+60-04	126	CS	1 m	-
+60-04	127	CS	1 m	-
+60-04	128	CS	1 m	-
+60-04	129	CS	1 m	-
+60-04	130	CS	1 m	-
+60-04	131	CS	1 m	-
+60-04	132	CS	1 m	-
+60-04	133	CS	1 m	-
+60-04	134	CS	1 m	-
+60-04	135	CS	1 m	-
+60-04	136	CS	1 m	-
+60-04	137	CS	1 m	-
+60-04	138	CS	1 m	-
+60-04	139	CS	1 m	-
+60-04	140	CS	1 m	-
+60-04	141	CS	1 m	-
+60-04	142	CS	1 m	-
+60-04	143	CS	1 m	-
+60-04	144	CS	1 m	-
+60-04	145	CS	no sample taken	-
+60-04	146	CS	1 m	-
+60-04	147	CS	1 m	-
+60-04	148	CS	no sample taken	-
+60-04	149	CS	1 m	-
+60-04	150	CS	1 m	-
+60-04	151	CS	1 m	-
+60-04	152	CS	1 m	-
+60-04	153	CS	1 m	-

VE=Vibrocorer

CS=Gravitycorer

Site Number		Equip-ment	Depth of sample below seabed	Results
+60-04	107	VE	1 m	-
			3 m	-
			6 m	-
+60-04	108	VE	1 m	-
			3 m	-
			5.5 m	-
+60-04	109	VE	1 m	-
			2.7 m	-
+60-04	110	VE	not recovered	
+60-04	111	VE	1.5 m	-
			3.3 m	-
			4.3 m	-
+60-04	112	VE	1 m	-
			3 m	-
			5.9 m	-
+60-04	113	VE	1 m	-
			3 m	-
			6 m	-
+60-04	114	CS	1.2 m	-
+60-04	115	CS	poor recovery	-
+60-04	116	CS	1 m	-
+60-04	117	CS	1 m	-
+60-04	118	CS	1 m	a couple of small fluorescing bodies
+60-04	119	CS	1 m	-
+60-04	120	CS	1 m	-
+60-04	121	CS	1 m	a few fluorescing bodies
+60-04	122	CS	0.8 m	-
+60-04	123	CS	1 m	-
+60-04	124	CS	1 m	-

VE=Vibrocorer

CS=Gravitycorer

Site Number		Equip-ment	Depth of sample below seabed	Results
+60-04	154	CS	1 m	-
+60-04	155	CS	1 m	-
+60-04	156	CS	1 m	-
+60-04	157	CS	1 m	-
+60-04	158	CS	1 m	-
+60-04	159	CS	1 m	-
+60-04	160	CS	1 m	-
+60-04	161	CS	2 m	-
+60-04	162	CS	1 m	-
+60-04	163	CS	1 m	
+60-04	164	CS	poor recovery	-
+60-04	165	CS	1 m	-
+60-04	166	CS	1 m	-
+60-04	167	CS	1 m	-
+60-04	168	CS	1 m	-
+60-04	169	CS	1 m	-
+60-04	170	CS	1 m	-
+60-04	171	CS	1 m	-
+60-04	172	CS	1 m	-
+60-04	173	CS	1 m	-
+60-04	174	CS	1 m	-
+60-04	175	CS	poor recovery	-
+60-04	176	CS	1 m	-
+60-04	177	CS	1 m	-
+60-04	178	CS	1 m	-
+60-04	179	CS	1 m	-
+60-04	180	CS	no sub-sample	-
+60-04	181	CS	1 m	-

VE=Vibrocorer

CS=Gravitycorer

Site Number		Equipment	Depth of sample below seabed	Results
•60-03	257	VE	1 m	-
•60-03	258	VE	1 m	occasional fluorescing bodies of
			2 m	Jurassic shale
•60-03	259	VE	1 m	occasional
			2 m	fluorescing bodies of Jurassic shale
•60-03	260	CS	1 m	-
•60-03	261	poor recovery		-
•60-03	262	CS	1 m	-
•60-03	263	CS	1 m	-
•60-03	264	CS	1 m	-
•60-03	265	CS	1 m	-
•60-03	266	CS	1 m	-
•60-03	267	CS	no sub-sample	-
•60-03	268	CS	1 m	-
•60-03	269	CS	1 m	-
•60-03	270	CS	1 m	-
•60-03	271	CS	1 m	-
•60-03	272	CS	1 m	-
•60-03	273	CS	1 m	-
•60-03	274	CS	1 m	-
•60-03	275	CS	1 m	-
•60-03	276	Cs	poor recovery	-
•60-03	277	CS	1 m	-
•60-03	278	CS	1 m	
•60-03	279	CS	1 m	
•60-03	280	CS	1 m	
•60-03	281	CS	a very poor recovery	
•60-03	282	CS	2 attempts, no recovery at all	

VE=Vibrocorer

CS=Gravitycorer

Site Number		Equip-ment	Depth of sample below seabed	Results
+60-03	283	CS	no recovery, only shale	
+60-03	284	CS	2 attempts no recovery	
+60-03	285	CS	1 m	-
+60-03	003	CS	1 m	-
+60-03	009	CS	1 m	-
+60-03	013	CS	1 m	-

VE=Vibrocorer

CS=Gravitycorer

Total 106 samples

Plus Several samples of Air only

Several samples of Air and biocide only

1 Sample of plostic liner