INSTITUTE OF GEOLOGICAL SCIENCES
MARINE GEOLOGY UNIT
Internal Report No. 80/7

Whitethorn Cruise Report

Cruise No. 80/WH/04

31 July - 13 August 1980

Leg 5

by

J. A. Chesher

Date of completion of Report 14th August, 1980

CONTENTS

1. Introduction

This cruise was the fifth and final leg of a routine survey programme to complete the geological investigation of the area between 56°N and 58°N from the east coast of Scotland to the median line. Standard sampling equipment was used, namely: vibrocorer, gravity corer, and shipek grab.

The weather proved very good and only a few hours were lost due to down time resulting in a high level of vibrocores being occupied and completed. This resulted in the work that had been preplanned prior to the start of the programme being achieved apart from some sample stations on the Peterhead NE Sheet and the Marr Bank SE Sheet. The majority of the work undertaken during this leg was on the Devil's Hole Sheets. A geological report of the area is given in Appendix II and a geochemical report in Appendix III.

2. Personnel

J A Chesher	IGS	MGLU	Senior Scientist
C E Deegan	IGS	HU	Day Geologist/Laboratory
R A Nicholson	IGS	ACU	Geochemist
N A Ruckley	IGS	MGLU	Surveyor
W Lonie	IGS	MGLU	Senior Technician
N Campbell	IGS	MGLU	Technician
R Sutherland	IGS	HU	Night Laboratory
D Tappin	IGS	MGLU	Night Geologist

Following the amalgamation of Continental Shelf North and South units into one Marine Geology Unit (MGLU), D. Tappin was on board from the former Continental Shelf Southern unit to provide continuity between what had previously been two separate units.

3. Equipment

The ship's and IGS equipment were the same as on previous legs, the sampling equipment consisting of:- 20ft retraction vibrocorer
- gravity corer
- Shipek Grab.

4. & 5. Ship's Performance and IGS Equipment and Performance

Both IGS equipment and ship's equipment and performance have been fully documented in previous reports this year (see Chesher Internal Report No. 80/8), and will not be repeated here. It will suffice to comment that no significant problems were encountered during this leg. The ship has now been better trimmed and the heavy roll characteristics present on the first leg largely eliminated. In addition the vibrocorer hoist winch speeds have been rectified to give both a fast and slow speed consistent with last years performance, namely at fast speed 25 metres per minute on hoist and 40 metres/minute on lower.

6. Results

The number of stations occupied and equipment used may be summarised as follows:-

Sheet No.	Total No. Stations	Shipek	Gravity corer Sediment	Vibrocorer
56°30'N1°W	9	9	4	5
56°N 0°E	53	53	21	31
56°30'N 0°E	69	69	34	33
56°N 1°E	8	8	3	5
56°30'N 1°E	16	16	9	7
Total	155	155	71	81

7. Conclusions

1. The leg proved highly successful with an average of 8 vibrocorer stations occupied during a working day period of 16 hours.

2. The use of the mates in laying anchors relieved the pressure of long hours on the master and paved the way to 24 hour vibrocoring in the future.

3. The value of the gravity sediment corer was extremely limited the surface sediments being rarely penetrated. Vibrocoring is the only viable method of sampling the Quaternary in this area.

4. The results obtained by vibrocoring undoubtedly give an understanding of the top 6 metres of the succession where several distinct facies can be identified, which is obviously valuable for pipeline routes, etc. but as a method of studying a Quaternary succession over 1km in thickness the results are very limited. They cannot easily be correlated with the geophysics due to the lack of resolution within the pulse width of the geophysical records obtained by shallow seismic techniques.

If the object of this sampling programme is to collect samples that will enable an overall interpretation of the Quaternary succession to be undertaken a better approach may well be to spend the funds available on a shallow drilling programme that will give results that are more easily correlatable with the shallow seismic records of the area.

5. The use of computer printout 1:100 000 reliability sheets which did not show the type of sampling equipment used at each station or a summary of the geology at each station was a distinct disadvantage both in planning the priority sequence of vibrocorer sites to occupy and in

compiling a geological interpretation of the area.

APPENDIX I

Ships Log

Thurs. 31 July

0000	In port Aberdeen, routine port visit. Departure delayed due to harbour being closed whilst crashed helicopter brought in.
2000	Steaming from Aberdeen to sample Sheet 56N 01W

Fri. 1 August

0000	Steaming to first site
0200	Routine night sampling
0600	Manoeuvring onto vibrocorer site
0640	Anchoring
0715	Vibrocoring
0850	Lifting anchors
0924	Steaming to next site
1018	Anchoring up
1036	Vibrocoring
1136	Lifting anchors
1205	Steaming to next site
1310	Laying anchors
1350	Vibrocoring throughout day, on Marr Bank NE

Sat. 2 August

0000	Routine sampling on Devil's Hole sheets NW
0700	Vibrocoring on Devil's Hole sheet
2300	Routine sampling

Sun. 3 August

0000	Routine sampling Devil's Hole sheet
0700	Vibrocoring Devil's Hole sheet NW. Slight delay on 2nd station to relay anchors, forwarded one not holding and fouled

Anchor on 3rd station

Mon. 4 August

0000	Routine sampling Devil's Hole NW
0730	Vibrocoring Devil's Hole NW
1200-1625	(Ship downtime) Generator problem with Rolls Royce. Stopped running due to battery flat which triggered off alarm. Charging circuit possibly fault.
1625	Vibrocoring continued
2345	Routine sampling

Tues. 5 August

0000	Routine sampling Devil's Hole NW
0800-1035	(Ship downtime) Generator fault with battery as on previous day
1035	Vibrocoring sheet Devil's Hole NW
2300	Routine sampling

Wed. 6 August

0000	Attempted routine sampling but abandoned due to weather
0700	Vibrocoring sheet Devil's Hole NW
2300	Routine sampling Devil's Hole SW

Thurs. 7 August

0000	Routine sampling Devil's Hole SW
0700	Vibrocoring Devil's Hole SW sheet. NB lost gravity corer during night due to rope parting at splice.
2230	Routine sampling Devil's Hole SW

Fri. 8 August

0000	Routine sampling Devil's Hole sheet SW
0700	Vibrocoring Devil's Hole SW. NB Fouled anchor bow starboard 1300-1500 by wire on seabed. Burnt off.

Sat. 9 August

0000	Routine sampling Devil's Hole SW
0700.	Viborocoring Devil's Hole sheet SW

Sun 10 August

0000	Routine sampling Devil's Hole SE sheet
0700	Vibrocoring Devil's Hole SE sheet

Mon. 11 August

0000	Routine sampling Devil's Hole SE sheet
0730	Vibrocoring Devil's Hole SE sheet. Bent two barrels in afternoon due to ship drifting and retraction wire breaking.

Tues. 12 August

0000	Routine sampling
0900	Vibrocoring Devil's Hole SW. Slow steaming speed between stations due to strong winds and seas.
1400	Steaming to Leith

Wed. 13 August

0000	Steaming to Leith
0600 - 2400	In Leith routine port call

APPENDIX II

Geological Report - by C. E. Deegan

A. Introduction

During the cruise a number of distinct lithotypes were encountered and after a while it became possible to group them into facies associations and suggest relationships between them. The facies designation was noted on the left hand side of the data sheets and the lettering system at present is arbitrary reflecting only the order in which the facies were encountered.

B. Facies Descriptions

1. Facies A. These consist of olive and olive-grey fairly clean sands, usually moderately well sorted. Any fines present are also olive coloured. They contain a fauna which include Camellibranchs, echinoids, pectinara, worms and forams. The distinctive features of these sands is that the quartz grains are normally opaque with an olive/brown surface stain or coating and in one instance grains seemed to have a manganese coating. These sands become finer grained and more muddy towards the north-east of the survey area and in one instance they gave a strong odour of H_2S.

2. Facies B. Lithotypes here are poorly sorted gravelly muddy sands and muddy sandy gravels. The sand fraction is identical to that of Facies A in that quartz grains are stained olive/brown. The gravel fraction may be lithic pebbles and very large abraded Camelibranch and ?Dentolium shells. Facies A and B occur at the surface over most of the area and clearly interdigitate with one another. In retrospect they should probably be grouped as variants of the same facies.

3. Facies C. This consists of generally well sorted, very clean fine to medium grained grey brown to dark grey sands. In some cores they grade downwards into a very fine grained, very well sorted sand. Quartz grains in these units are transparent and glassy with usually some orange, pink and brown stained grains in the browner varieties. The sand is so well sorted that it is markedly thixotrophic and dewaters rapidly. Some samples contain small mud pellets suggesting that the sands may contain thin mud laminae which have been disrupted by coring. Glauconite is common to very abundant and locally dark brown, fibrous woody fragments and black ligmitic carbonaceous grains occur, particularly in the north-west. Muscovite mica is abundant in some samples and accumulations of black magnetite grains, sometimes as distinct laminae are seen.

To the north the facies tends to become more muddy and where it is in association with facies E the two may be difficult to separate; there is probably interdigitation of the two facies in many places. The sorting and lateral extent of facies C suggests that it is a well winnowed shallow marine sand sheet. The laminae of magnetite grains and muscovite mica are suggestive of foreshore and beach face stratification. The presence of glauconite seems to confirm a marine origin for the deposit but it is conceivable that the glauconite is not autochitinous and has been reworked from Cretaceous or Tertiary sediments. The softness of glauconite grains however would suggest that this is not likely.

4. Facies D. Only a few samples of this facies were found in the early part of the cruise. It is a brownish-grey, soft to firm, gravelly sandy mud with most of the gravel fraction composed of large shell fragments. It is not clear how this relates to the other facies at

present. The quartz grains in the sand fraction are similar to those of facies C while the mud fraction is similar to facies F.

5. Facies E. These sediments are grey and grey-brown very muddy sands tending towards sandy muds. The sand fraction is usually fine to very fine grained and contains glauconite. The grey variety in particular looks exactly like fresh mortar. The quartz grains in the sand fraction are identical to those of Facies C and it seems likely that this facies interdigitates with C.

6. Facies F. These are brownish and grey, soft sticky silty clays and clays. They often have a buttery texture and no fauna or shell remains were found in them. They appear to underlie Facies E but there is probably some interdigitation between the facies. Their general characteristics suggest that they may be lacustrine clays, but their environment of deposition should be easy to determine on palaeontological grounds.

7. Facies G. This consists of extremely stiff to hard, dark greenish grey clay with isolated patches containing some silt or fine sand grains. A few small isolated pebbles and granules occur and rare shell fragments. One small piece of chalk (presumably Upper Cretaceous) was clearly identified. This material has the toughness of a boulder clay but presumably is a marine clay with ice rafted debris in it which has been compacted by the weight of an ice sheet.

8. Facies H. This was only encountered in one core beneath Facies A sands but is quite distinctive. It consists of a well sorted medium to coarse grained clean sand with some very coarse sand and granule grade material. It has a distinctive brown to greyish brown colour and white

shell material gives it a speckled appearance. It contains some 10% of shell debris all of which is abraded and rounded. Quartz grains are mainly glassy but quite a high proportion are stained pink, light brown and orange; some well rounded glauconite grains occur. Lithic grains appear to be mainly of Old Red Sandstone and Dalradian types. In parts of the core it seems to get coarser grained and become a gravelly shell sand. The texture of this sediment suggests that it may have formed part of a sand wave field at some time.

C. Facies Relationships

In the absence of geophysics and palaeontology it is difficult to establish stratigraphical relationships and until cores are cut it is not possible to establish the nature of the contacts between the units. However some tentative conclusions can be drawn and these are illustrated in Fig. 1.

The map is a sub-crop map of Facies A and B. These form a virtually continuous blanket over the whole area and are clearly the youngest (?Recent) sediments therefore they are omitted from the map and section. They have been found overlying every other facies. Facies G was cored on the shoulder of a linear channel similar in form to the Devil's Hole and because of its consistency it can be inferred that it forms the walls and base of the channel and is thus the oldest deposit seen. Within the channel facies B was found overlying E and F respectively. Away from the channel facies C occurs above E and F and thus a sequence of facies can be constructed as shown below. The positions of facies D and H are uncertain but structural considerations allow an assessment to be made (see Fig. 1).

Facies Sequence

		A + B (Youngest)	
Possible Interdigitation	H		
		C	
		E	Possible Interdigitation
		F	D?
		G (Oldest)	

Facies A sands are normally very distinctive because of their olive/brown stained quartz grains. However where A overlies sand of facies C one or two samples suggest that there may be a mixture of facies A quartz grains with facies C grains. It is possible that there may be some interdigitation of the two facies but as the section (Fig. 1) shows it is also possible that facies C sands were reworked and redeposited during Facies A time. Examination of contacts when the cores are cut should resolve this. In any case some effort should be made to ascertain the nature of the olive-brown staining on the facies A sands (and the olive colour of their associated fines). If this colour is an original feature it could be important in provenance studies. A further possibility is that the grain coatings could be removed by some diagenetic process thereby converting Facies A sands into Facies C type sands with depth.

The clays of Facies F seem to undergo a subtle colour change towards the north-east where bluish, greenish and olive tints are seen. As implied on the section (Fig. 1) these clays may be different (?older) than the facies F clays further west, although they are similar to facies F in every other respect. If such pre-facies F clays exist they may also be inferred to underlie facies F in the channels such as the Devil's Hole. Facies C sands in the north-east also change colour slightly becoming a bluish-grey (the colour being imparted by the small proportion of mud matrix) but the quartz grains remain the same. This may be a simple lateral variation on the facies C sands samples in the north-east may be part of a different gravel body.

D. Speculation

At this stage in the investigation it is not possible to deduce a geological history but the sequence of facies does suggest a sequence of events which is not nacessarily continuous.

Facies G may well have been deposited as marine clay in front of an advancing ice sheet which later over-rode the clays causing their compaction. During the retreat of the ice sub-glacial channels may now have been cut into this clay and the nature of the channels associated with the Devil's Hole (closed at both ends) suggests sub-glacial erosion. During retreat of the ice it is likely that the area was left as a low lying periglacial plain with extensive lakes in which the clays of facies F were deposited. Facies C is almost certainly a marine sand but the way in which it coarsens upwards suggests a a regressive deposit. Therefore it is possible that a quiet marine transgression inundated the periglacial plain producing facies E type deposits and a subsequent more rigorous regression reworked these sediments and produced facies C type sands. Facies H is likely to be a post glacial deposit recording a period of lower sea level and facies A and B are relatively recent.

The above deductions are merely events which may be separated by significant time gaps. During the spasmodic regression of an ice sheet environmental conditions may change rapidly in response to eustatic and isostatic oscillations so that a number of advances and retreats may occurred between the deposition of Facies G and the Facies F clays.

E. Conclusion

The above speculation serves only as an attempt to organise the data collected so far into a model which suggests many avenues of future investigation which must be pursued. Three or four strategically positioned, cored shallow boreholes in this region could provide most of the answers.

C.E. Deegan

APPENDIX III

Geochemistry Report

Routine sub-sampling of Shipek grab material has continued with a total of 151 samples collected during this leg. The total number of prepared splits taken from northern areas this year for geochemical analysis is 869. The number of EL and pH readings measured was down substantially compared to previous legs due to the high incidence of sandy bottom sediment encountered on the Devil's Hole sheets. The validity of this EL/pH data is in question, as individual measurements taken within a particular sample can vary considerably, depending on the depth to which either of the electrodes is inserted (surface measurements are unreliable due to gradual oxidation of the sample on exposure to the air). This procedure needs to be reviewed before next field season, and a decision taken on whether or not to continue the measurements in the light of the past two years experience (IGS has been approached for such data for the assessment of the oxidation/reduction characteristics of sediments in connection with the marine corrosion of platform structures). Geochemical sampling in some of the deeper parts of the Devil's Hole area was not feasible this time due to higher priority sites not yet having been occupied. Some thought might be given to those areas in the future as it is suspected that the fine sediment they contain may be a sink for the heavy metals copper, lead, zinc and mercury (important elements from the pollution aspect of our work). A number of samples collected this year have not had splits taken for particle size analysis (PSA). This parameter is very important in the interpretation of offshore geochemical data and every effort should be made to obtain sufficient sediment for a PSA to be carried out. We (GIR) have discontinued doing these analyses ourselves for three reasons

a) because it is labour intensive and we do not have the staff available. (b) because it is duplication of effort - CSNU put all their PSA's out to contract (c) sub-sampling for PSA is open to large errors and ideally requires a complete sample for the results to be truly representative.

Safety Aspects

If Whitethorn is to be used in the future it might be considered relevant to locate one of the RFR inflatable liferafts on or near the working platform. Whilst I concede that the B.E.L.L. probably cover the most likely incident of somebody falling overboard, it is not beyond the realms of possibility that personnel working on the deck might find themselves in an emergency situation where movement to the bridge deck is at best restricted or at worst completely impossible.

R A Nicholson
August 1980

APPENDIX IV

TIME UTILISATION ANALYSIS

DATE	IN PORT	ON PASSAGE	BETWEEN STATIONS	ANCHORING	ON STATION	DOWNTIME			NO.V/E STATIONS	NO.GS/CS STATIONS	REMARKS
						WEATHER	EQUIP'T	SHIP			
July 30	16.5	7.5									
31	19.9	4.1									
Aug. 1		2.2	8.0	5.2	8.3			0.3			
2			9.1	6.4	8.5						
3			10.9	6.3	6.8						
4			9.8	4.6	5.5			4.1			
5			9.7	5.7	6.1			2.5			
TOTAL %											

Continued Next Page ...

TIME UTILISATION ANALYSIS

DATE	IN PORT	ON PASSAGE	BETWEEN STATIONS	ANCHORING	ON STATION	DOWNTIME			NO.V/E STATIONS	NO.GS/CS STATIONS	REMARKS
						WEATHER	EQUIP'T	SHIP			
Aug. 6			6.5	5.2	5.6	6.7					
7			12.7	5.4	5.9						
8			9.2	7.1	7.2			0.5			
9			12.2	5.1	6.7						
10			12.4	5.2	6.4						
11			12.1	4.7	5.9		1.3				
12		9.5	9.7	2.1	2.7						
TOTAL	36.4	23.5	122.3	63	75.6	6.7	1.3	7.4			
%			44%	23%	27%	2%	1.5%	2.5%			