Continental Shelf Northern Unit

Internal Report No. 78/8

Shipboard Report on Leg 2 of M S Ferder Shallow Drilling Programme 1978. May 12 - 26.

Cruise 78/Ferder/05

by

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1. Introduction

The purpose of the second leg of the Norwegian drillship m.s. Ferder was to continue the programme of drilling selected priority sites, and if necessary bad weather sites, initiated during the first leg in which pre-Quaternary rocks would be encountered. These sites occur mainly between the north of Lewis and the Shetlands. In addition to the ship's equipment a Fugro designed re-entry system was employed, together with additional wireline drilling equipment provided by Christensen Diamond Products, and a NEC Gas penetration rate meter. A consultant (L. Hill) was contracted to advise IGS on drilling matters.

2. Personnel

J A Chesher	IGS-CSNU	Chief Scientist
M Dean	IGS-CSNU	
R Holmes	IGS-CSNU	
S Brown	IGS-CSNU	
L Hill	Len Hill (Drilling Consultant) Ltd.	

3. Cruise Results

A summary log of operations is presented in Appendix I

and a breakdown time analysis of these operations into steaming, mooring, logging, drilling, port calls, standby, and weather delays is geiven in Table A. A graphic representation of the cruise details inculding weather, time analysis, mud consumption and daily costs is given in Table B. A breakdown of the daily costs is given in Table C.

It can be seen from the above data that very little time was lost due to weather but problems with equipment caused a significant period of downtime (see equipment performance).

In total 5 sites were occupied namely:- 78/4 (Site 97); 78/5 (Site 9); 78/6 (Site 18A); 78/7 (Site 17) and 78/8 (Site 66), the location of which are shown in Fig. 1. Borehole 78/6 was not completed due to drilling difficulties. A summary table of borehole time and cost analysis is given in Table D. The limited number of boreholes completed were largely a result of the difficulties encountered drilling particular lithologies and the slow rates of penetration, (see Table E). For future reference graphs showing penetration rate per hour in various lithologies with the particular type of bit used are given in Table E.

4. Geological Results

A summary of the geological borehole logs and site details are given in Appendix II.

Borehole 78/4 situated 9km SE of Stornoway proved the presence

of probable Upper Jurassic shales beneath 55.77m of Quaternary clays. The presence of Jurassic in this area to the west of the postulated position of the Minch Fault, leads support to the conclusion that the Minch Fault is not a continuous line in the Mesozoic in this area downfaulting Jurassic against basement and Permo-Triassic to the west. Instead it follows the coast to downfault the Stornoway beds to the east and is taken up en echelon to the east of Stornoway to downfault the Jurassic against basement.

Borehole 78/5 situated 50km north-west of the Butt of Lewis proved probable Permo-Triassic sandstones beneath 52m of Quaternary boulder clay. As predicted from deep seismic information this confirms the hypothesis that the Mesozoic to the west of the Minch Fault is very thin and the thick Jurassic basin seen in the Minches is no longer present.

Borehole 78/6 was sited to investigate the nature of the Tertiary and underlying Mesozoic to the north-north-west of Cape Wrath. However, due to the difficulty in drilling through the thick surface layer of muddy gravel this site had to be abandoned and borehole 78/7 undertaken in its place to attempt to achieve the same objectives.

Borehole 78/7 sited 85km north-north-west of Cape Wrath proved 84m of Quaternary boulder clay overlying 36m of probable sand. No recovery was obtained in this sand presumed to be the feather edge of the Tertiary. Beneath the sand red and greenish grey mudstones were recovered of presumed Permo-Triassic age. The presence of Permo-Triassic sediments in this region would tend to confirm the absence of late

Mesozoic sediments adjacent to the basement highs.

Borehole 78/8 drilled 4.0m of sand overlying red mottled marls and thin calcareous sandstones of presumed Permo-Triassic age. This borehole proved the continuation of the West Fair Isle basin to the east of the Orkneys.

5. Equipment Performance

Fugro Re-entry system

The re-entry system reached full heave compensation before the drill string and therefore became a limiting factor as to the sea conditions in which it could be used. The guide arms for lowering the bit to the seabed were also too weakly constructed and were continually breaking.

The Fugro system was eventually lost on borehole 78/7 due to the main hoist wire parting. Inspection of the hoist wire showed marked wear for a length of about 10m indicating considerable abrasion perhaps caused by broken bearings in the system. These small bearing would have been better as sheave blocks. Attempts at recovery by fishing down the drillstring failed due to the inability to attach a strong enough hoist wire to the system.

NEC Recorder

The NEC gas rate of penetration and weight of bit meters were of limited value due to difficulty of calibration. The

pen on the penetration meter did not function and negated this part of the equipment. Both parameters given by the NEC recorder were easily obtainable from the driller.

Drilling equipment

Bits

The tungsten carbide bits could not cope with a sufficient variety of lithologies and were continually being changed for other bit types. A heavier duty tungsten carbide bit as was used in the previous year, would have been advantageous but the two on board were incompatible with the new Christensen barrel. The inability to use a pilot bit in the rock roller meant considerable time lost by pulling the string to change to a coring bit. The rates of penetration with different bits in various lithologies are given in Table E.

Barrels

The latching system on the barrels, when fishing caused much delay in that the fish would not sink to the bottom to latch onto the inner barrel in the heavy mud used to keep the hole open. The leaf type of latch system also seemed more prone to damage and harder to latch to inner barrel.

The crossover sub to join the rock roller to the drillstring was incompatible. Last year's tungsten bits would also not fit onto the new Christensen outer barrels.

Difficulty was also encountered dropping the push sample tube down the drillstring due to the very close tolerances of the

two pieces of equipment. It was not possible to use the drill string stabilisers since they did not fit through bit guide.

Slips

The ship's slips often failed to hold the drillstring and seemed to require frequent repair. This was considered to be due to the excessive swell present in the area, the failing of the ship's acting, partly as a failsafe arrangement. It was felt that a large part of this problem would not have occurred if the ship had limited its working to only good weather conditions.

Core catchers

The stainless steel IGS core catchers were of insufficient strength to retain core in sandy material, the wieght of material caused the catchers to invert and lose the sample.

Gamma Log

The gamma log proved unuseable for the first part of the leg firstly due to a faultly ratemeter dial caused by loose screws and secondly, due to the dirve mechanism being inadequately secured to the drive spindle. The amount of wire on the gamma log is excessive for the drum size causing spilling over drum faces and considerable time wastage to disentangle. A power drive to bring the tool up the hole would be advantageous.

6. Conclusions and Recommendations

1. It was obvious that to achieve the objectives at a particular borehole, the site was not always practical in terms of drilling rates, unless one spent a disproportionate amount of time at one site. Future planning should take note of drilling rates and how much time it is reasonable to

allocate to achieve the objectives concerned.

2. The presence of a drilling consultant is probably of value on the first leg and especially in discussions prior to the cruise in relation to the equipment to be used. However, on subsequent legs he often inhibits the drillers initiative by his presence, and such decisions that are necessary are made by the chief scientist in conjunction with the captain, both of whom have the requisit level of experience.

3. Discussions on drilling equipment and re-entry systems prior to the cruise must be held in the presence of the persons who have the responsibility for using the gear, in this case the captain Hans Jacobsen.

4. Assembly drawings together with complete inventories of equipment must be present on board to save unnecessary searching for gear.

5. Although it was recommended after the previous years work that a good selection of bits to cope with various lithologies encountered should be on board this was not the case this year. Only one type of tungsten carbide bit was available and this produced unacceptably slower drilling rates than the type used in the previous year. The rock roller should have had a pilot roller bit to obviate the necessity for pulling the string and changing the bit to take a core.

A greater number of holes could have been completed had the

drilling rates been faster, and this was the main limiting factor of the cruise.

6. Several instances and time delays were caused by the Christensen equipment not being compatible either with itself or the ship's gear, e.g. the crossover sub to connect the rock roller to the string was the wrong type, the push tube assembly would not easily slide down the string etc. All gear must be checked for compatibility prior to a cruise.

7. Many hours were lost trying to get the latch assembly down the hole in heavy viscous mud to latch onto the inner barrel. This type of leaf latch assembly was undoubtedly inferior to the knob type used in the previous year, when these problems were not encountered.

8. The slips often proved inadequate and failed several times. These should be renewed before use in the future.

9. Telephone communication and telex from ship to shore was often a lengthy and difficult process via Norwegian stations and it was impossible for the shore to reach the ship from Britain. Crystals to enable British stations to be used should be fitted for future use.

10) If anchor loss is chargeable to IGS the wires used should be to IGS satisfaction prior to commencement of charter. The anchor loss on leg 2 could have been prevented if good quality anchor wire had been used.

Not payable by IGS

11) A less archiac gamma logging tool should be purchased.

12) The charter of a drill ship should be a complete package and include all drilling facilities, and so avoid the necessity for IGS to become involved in drilling logistics and drilling companies such as Christensen.

13) The comment of Dr Evans on Leg 1 that two weeks is too short for a leg was also felt to the case on Leg 2 in that by the time one had become familiarised with the ship and the programme it was time to disembark.

14) The NEC gas rate of penetration and weight of bit meters were of limited value, since it proved extremely difficult to calibrate, and anyway both parameters are easily obtainable from the drillers.

carried out

15) Investigate costs and value of X-raying pipe prior to use to attempt to prevent loss of string by metal failure.

16) The Fugro re-entry system was an untested prototype, not compatible with the heave compensation limitations of the ship and reached maximum heave far sooner than the ship. The guide arms were also far too weakly constructed and were continually failing. It would be cheaper for IGS or the owners of Ferder to buy its own re-entry system (estimated cost £5000) rather than to pay the hire rate of £10,000.

17) This leg confirmed the suitability of the m.s. Ferder for our shallow drilling programme. In sea states with considerable Atlantic swell the ship was still able to work

satisfactorily.

18) The drilling results of this leg can be considered to be successful. Such delays as were encountered were mainly a direct result of lithological drilling problems that would have to be overcome on any drilling setup.

APPENDIX I

Summary Ship's Log

Friday 12 May

0000-0125	Drilling at 78/3.
0125-0520	Pulled string, diamond bit only 10% worn.
0520-0615	Lifting anchors.
0615-0750	Steaming to site 97 off Stornoway (78/4).
0750-0840	Laying anchors.
0840-1830	Drilling at site 78/4.
1830-1900	IGS crew change: J Chesher, M Dean, R Holmes, S Brown joined ship and D Evans, C Deegan, K Rochow, M Smith disembarked by small fishing boat charge (The Providence).
1900-2400	Drilling rate slowed at ~50m depth, presumed in solid. Continued drilling.

Saturday 13 May

0000-1800	Drilling at site 97.
1800-1820	Fishing vessel bringing gear aboard ship, e.g. radar valves, metal for bit guide etc.
1820-1840	Gamma logging hole, but tool did not function correctly. Ratemeter dial had all screws loose and needle jamming and chart paper could not move whilst winding in probe.
18040-2100	Lifting casing (2100. Fishing boat returned to ship to bring oxygen bottles, not previously delivered from mainland).
2100-2210	Lifting anchors.
2210-2400	Steaming to site 9 (78/5).

Sunday 14 May

0000-0650	Steaming to site 9 (78/5).
0650-0750	Laying anchors and manoevering into position.
0750-0815	Lowering re-entry system.
0815-1005	Lowering drill string.
1005-1040	Drilling and sampling at 78/5.
1040-1405	Repairing hydraulics for powerswivel.
1405-1610	Drilling.
1610-1630	Lifting re-entry system from seabed to moonpool due to re-entry system lifting off seabed in swell.
1630-2400	Drilling and sampling.

Monday 15 May

0000-0115	Drilling and sampling.
0115-0155	Lowering re-entry frame.
0155-0345	Pulling pipe to change to diamond bit.
0345-0455	Changing bit.
0455-0900	Running pipe and pulling re-entry system.
0900-2000	Drilling and sampling at 78/5.
2000-2130	Pulling pipe.
2130-2200	Lifting anchors.
2200-2320	Repairing hydraulics to anchor winch.
2320-2400	Lifting anchors.

Tues
Tuesday 16 May

0000-0650	Steaming to site 18A (78/6).
0650-0755	Laying anchors and manoevering into position.
0755-0915	Running pipe.
0915-1230	Drilling very slowly - less than 1m in 1 hour.
1230-1320	Lifting pipe to change bit from TC to rock roller.
1320-1735	Manufacturing crossover sub to connect 4½" regular rock roller bit to 4" I.F. drill string.
1735-1900	Running pipe.
1900-1940	Drilling.
1940-2400	Pulling pipe off seabed and waiting on weather. Hole collapsed due to soft muddy gravel.

Wednesday 17 May

0000-0220	Waiting on weather.
0220-0320	Running pipe.
0320-0700	Drilling.
0700-1425	Pulling pipe, difficulties encountered due to hole collapsing and hard to pull out string.
1425-1530	Lifted anchors.
1530-1730	Steaming to site 17 (78/7).
1730-1900	Laying anchors at 78/7.
1900-2115	Running pipe.
2115-2400	Drilling.

Thursday 18 May

0000-0300	Repairing slips on drill floor.
0300-2300	Drilling and sampling.
2300-2400	Difficulty latching fish onto inner barrel.

Friday 19 May

0000-0015	Difficulty with fishing gear.
0015-0130	Drilling and sampling. 0130. Drill string sheared loosing 45m of gear consisting of 9 drill collars, 2 drill pipes, 1 inner and 1 outer barrel and 1 TC bit.
0130-0200	Lowering re-entry system.
0200-0440	Pulling pipe, changing bit to rock roller, lowering pipe.
0440-0510	Repairing slips.
0510-0615	Finishing lowering pipe.
0615-1700	Drilling and sampling.
1700-1920	Lowering re-entry system and pulling pipe to change bit due to high torque on string and lack of progress.
1920-2030	Repairing slips.
2030-2400	Lowering pipe and preparing outer barrel. Changed to TC bit.

Saturday 20 May

0000-0845	Drilling and sampling.
0845-1035	Pulling pipe to change to diamond bit due to no progress.
1035-1055	Running string.
1055-1315	Repairing re-entry guide.
1315-1530	Finished running pipe.
1530-2400	Drilling and sampling.

Sunday 21 May

0000-0330	Drilling and sampling.
0330-0425	Repairing drill slips.
0425-1050	Drilling and sampling.
1050-1530	Core barrel stuck in hole, impossible to latch onto inner barrel. This is due to high viscosity of mud necessary to keep hole open preventing latch assembly sinking; or caused by sand backfilling above inner barrel.
1530-2015	Drilling and sampling.
2015-2220	Difficulty connecting fish latch assembly to inner barrel possible die to high viscosity of mud.
2220-2400	Drilling.

Monday 22 May

0000-0825	Drilling and sampling.
0825-0900	Changed piston slips.

0900-0905	Drilling.
0905-1100	Wire of re-entry system parted. Time spent freeing broken wire from drillpipe.
1100-1915	Drilling and sampling.
1915-2015	Attempted logging hole but drive mechanism faulty.
2015-2135	Pulling pipe to 5m above sea bottom to prepare for fishing for re-entry system.
2135-2400	Preparing for fishing for re-entry frame on sea bottom.

Tuesday 23 May

0000-0815	Preparing to fish for re-entry system by threading heavy bar and wire down inside of drill pipe to catch underneath re-entry system.
0815-1730	Pulling remainder of pipe; slow process due to necessity to unthread each pipe from central wire now attached to re-entry system.
1730-1945	Attempted lifting re-entry but proved too heavy and wire broke.
1945-2005	Pulling anchors.
2005	Starboard bow anchor wire broken, lost anchor. Anchor wire was below standard due to rust, as had been commented on previously, and its breaking was not unexpected. IGS should not be deemed responsibile for this anchor loss.
2005-2125	Continued lifting anchors.
2125-2400	Steaming to 78/8 (Site 88).

Wednesday 24 May

0000-1030	Steaming to 78/8.
1030-1352	Lowering anchors, delay due to Decca jumping 1 lane.
1352-1515	Preparing and running pipe.
1515-2400	Drilling and sampling.

Thursday 25 May

0000-1340	Drilling and sampling.
1340-1420	Inner core barrel stuck in outer barrel- unable to retrieve.
1420-1530	Pulled pipe.
1530-1700	Lifting anchors.
1700-2400	Steaming to Aberdeen.

Friday 26 May

0000-0600	Steaming to Aberdeen.

0600-0930	Awaiting pilot.
0930-1100	Manoevering into Aberdeen Harbour.
1100-2400	In port to change crew and fit McClelland's re-entry system and bring sufficient supply of new drill barrels and coallrs onto deck, to replace those lost on Leg 2.

APPENDIX II

Summary Borehole Logs

Borehole 78/4 (Site 97)

9km SE of Stornoway
Latitude 58°8.6'N Longitude 06°17.6'W
Water Depth 80 metres.

		Thickness m
Drift		
1.	Clay, silty, dark to medium grey, soft becoming firmer towards base. Occasional pebbles present.	52.04
2.	Clay, silty, pale reddish-brown with abundant pebbles and large 'gabbroic' pebbles at base.	3.73
	UPPER JURASSIC ?	
3.	Shale or mudstone, black, fairly soft, with abundant shell fragments and occasional ammonintes. Bedding dips at approximately 17½°.	14.28
	Total Depth	70.05

Borehole 78/5 (Site 9)

50km NW of Butt of Lewis
Latitude 58°50.55'N Longitude 06°54.7'W
Water Depth 163 metres.

		Thickness m
Drift		
1.	Sand, grey, medium grained, with abundant scaphlopods.	00.30
2.	Clay, black, very soft with occasional pebbles.	15.06
3.	Clay, pale brown grey with black streaks moderately firm.	5.03
4.	Sand ? , no recovery	20.63
5.	Clay, sandy, red brown compact with abundant pebbles. Large boulders of hornblende gneiss at base. Boulder Clay?	10.98

		Thickness m
PERMO-TRIASSIC?		
6.	Sandstones, dark brick red with pale greenish grey reduction patches, fine grained, interbedded with dark brick red slightly micaceous siltstones. Bedding nearly horizontal.	2.50
	Total Depth	54.50

Borehole 78/6 (Site 18A)

110km NNW of Cape Wrath

Latitude 59°32.75'N Longitude 5°46.4'W

Water Depth 121m

		Thickness m
Drift		
1.	Sand, yellowish grey, medium, shelly	0.50
2.	Gravel, muddy with well rounded pebbles	6.50
	Borehole abandoned due to inability to penetrate muddy gravel	
	Total Depth	7.0

Borehole 78/7 (Site 17)

85km NNW of Cape Wrath

Latitude 59°20.57'N Longitude 5°35.45'W

Water Depth 104m

		Thickness m
Drift		
1.	Mud, gravelly, sandy with shell fragments	10.00
2.	Clay, sandy, grey brown with frequent metamorphic pebbles.	74.00
TERTIARY?		
3.	No recovery, possible sand	36.00
PERMO-TRIASSIC?		
4.	Mudstone, silty, red and grey green, soft, micaceous with thin white lenses. Bedding dips at 10°.	7.78
	Total Depth	127.78

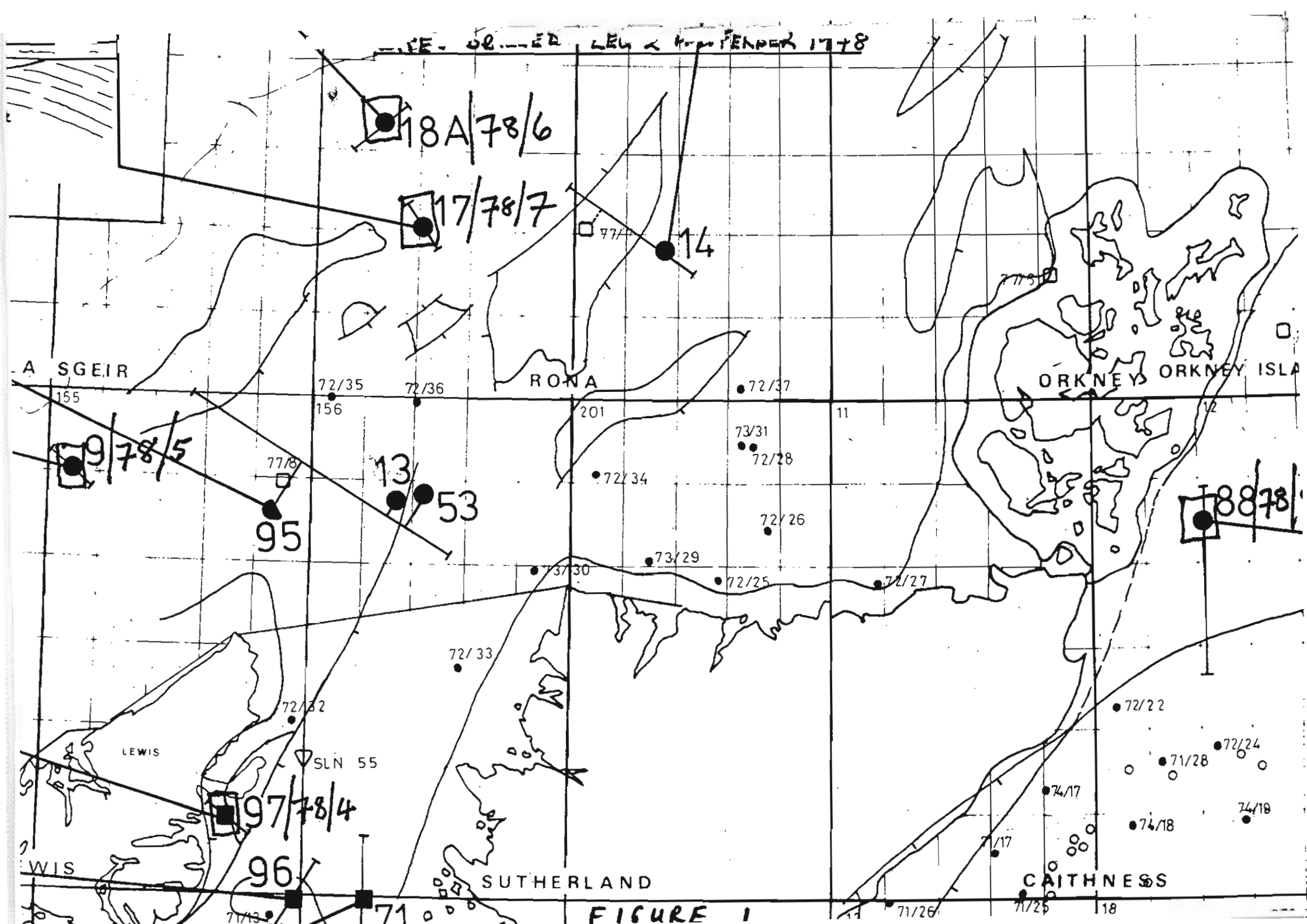
Borehole 78/8 (Site 88)

21km ESE of Ronaldsay

Latitude 58°44.75'N Longitude 2°35.8'W

Water Depth 74 metres.

		Thickness m
Drift		
1.	Sand, olive grey, shelly, medium-coarse grained	3.90
PERMO-TRIASSIC?		
2.	Mudstones and siltstones, brick red with green reduction spots, with thin inter-bedded red calcareous micaceous sandstones	10.74
	Total Depth	14.64


18A/78/6
17/78/7
14
9/78/5
95
13
53
8878
96
97/78/4
71
A SGEIR
RONA
ORKNEY
ORKNEY ISLA
LEWIS
SLN 55
SUTHERLAND
CAITHNESS
72/35
72/36
72/37
72/34
73/31
72/28
72/26
73/29
73/30
72/25
72/27
72/33
72/32
72/22
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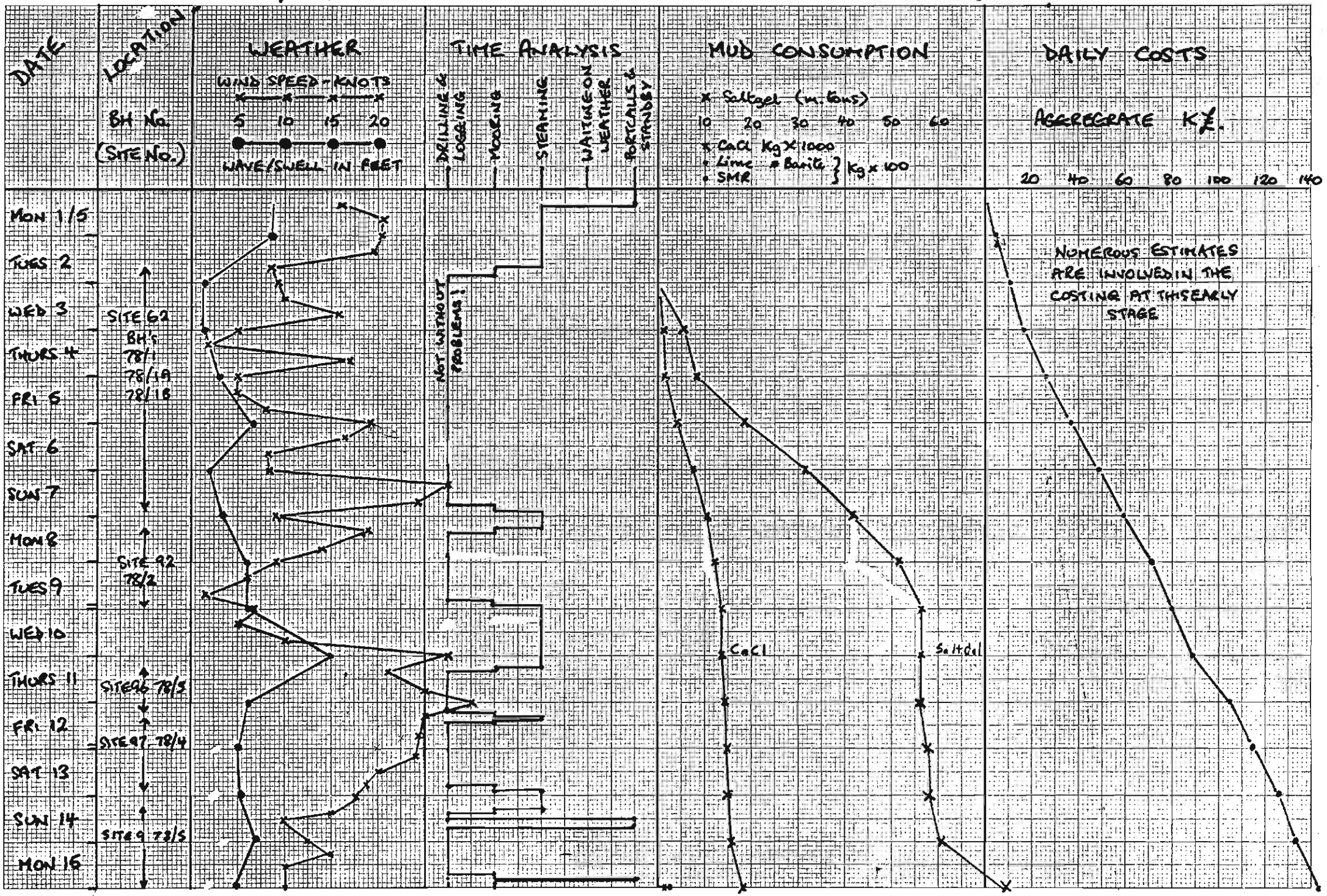
71/26
71/25
155
156
201
11
18

FIGURE 1


DATE
LOCATION
BH No.
(SITE No.)
WEATHER
WIND SPEED - KNOTS
5 10 15 20
WAVE/SWELL IN FEET
TIME ANALYSIS
DRILLING & LOGGING
MOORING
STEAMING
WAITING ON WEATHER
PORTCALLS & STANDBY
NOT WITHOUT PROBLEMS!
MUD CONSUMPTION
Saltgel (m. tons)
10 20 30 40 50 60
CaCl Kg x 1000
Lime
SMR
Barite
Kg x 100
DAILY COSTS
AGGREGATE K£
20 40 60 80 100 120 140
NUMEROUS ESTIMATES ARE INVOLVED IN THE COSTING AT THIS EARLY STAGE
MON 1/5
TUES 2
WED 3
THURS 4
FRI 6
SAT 6
SUN 7
MON 8
TUES 9
WED 10
THURS 11
FRI 12
SAT 13
SUN 14
MON 16
SITE 62
BH's 78/1 78/19 78/18
SITE 92 78/2
SITE 96 78/3
SITE 97 78/4
SITE 9 78/5
CaCl
Salt Gel

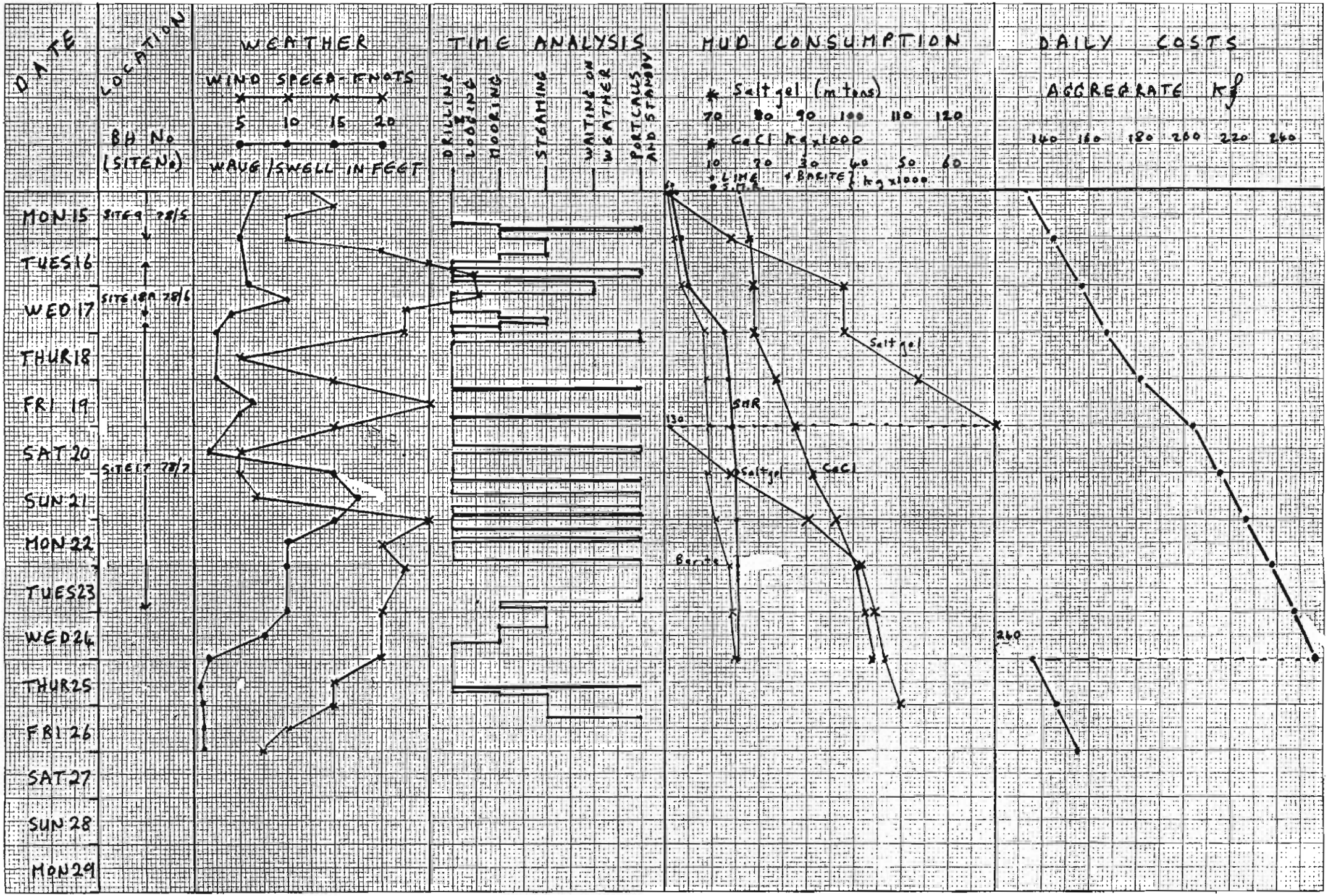

DATE
LOCATION
BH No (SITE No)
WEATHER
WIND SPEED KNOTS
5 10 15 20
WAVE/SWELL IN FEET
TIME ANALYSIS
DRILLING
LOGGING
MOORING
STEAMING
WAITING ON WEATHER
PORTCALLS AND STANDBY
MUD CONSUMPTION
Salt gel (m tons)
70 80 90 100 110 120
CaCl kg x1000
10 20 30 40 50 60
LIME S.M.B.
BARITE kg x1000
DAILY COSTS
AGGREGATE £
140 160 180 200 220 240
MON 15
TUES 16
WED 17
THUR 18
FRI 19
SAT 20
SUN 21
MON 22
TUES 23
WED 24
THUR 25
FRI 26
SAT 27
SUN 28
MON 29
SITE 9 28/5
SITE 18A 28/6
SITE 17 28/7
Salt gel
SMB
130
Salt gel
CaCl
Barite
240

TABLE C

I.G.S. EDINBURGH/M.S. FERDER OPERATIONS - ESTIMATED RUNNING COSTS IN £000's STERLING

DESCRIPTION OF EXPENDITURE 1978	DAY No.	1	2	3	4	5	6	7	TOTAL FOR THE WEEK ENDING	TOTAL C/F CUMULATV. WEEK ENDING
	DATE:	1.5.78	2.5.78	3.5.78	4.5.78	5.5.78	6.5.78	7.5.78		
	Br. Fwd.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	7.5.78	7.5.78
HIRE OF M.S. FERDER AS A UNIT		2.499	4.000	4.000	4.000	7.000	7.000	7.000	35.505	35.505
RENTAL STINGRAY FR. & COMPEN.		1.820	.160	.160	.160	.160	.160	.160	2.780	2.780
RENTAL CHRISTENSEN EQUIPMENT		1.625	1.625	1.625	1.625	1.625	1.625	1.625	11.375	11.375
RENTAL SAFETY JT. & FISHING TAP		.044	.044	.044	.044	.044	.044	.044	.308	.308
MUD & CHEMICALS		Nil	Nil	.823	.411	1.646	1.908	1.640	6.428	6.428
DIAMOND/ROCK BITS		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
CONSUMABLE SPARES		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
SUB CONTRACTORS COSTS PERSONNEL		.352	.352	.352	.352	.352	.352	.352	2.464	2.464
COST OF MESSING		.028	.028	.028	.028	.028	.028	.028	.196	.196
NEC Gas Equipment ROP/WOB		1.020	.020	.020	.020	.020	.020	.020	.240	.240
TOTAL DAILY COST		6.488	6.229	7.052	6.640	10.875	11.137	10.869	59.296	
TOTAL CUMULATIVE COST B/F		6.488	12.717	19.769	26.409	37.284	48.421	59.296	59.296	
TOTAL CUMULATIVE COST DAILY		6.488	12.717	19.769	26.409	37.284	48.421	59.296		59.296

TABLE C

I.G.S. EDINBURGH/M.S. FERDER OPERATIONS - ESTIMATED RUNNING COSTS IN £000's STERLING

DESCRIPTION OF EXPENDITURE 1978	DAY No.	8	9	I0	II	I2	I3	I4	TOTAL FOR THE WEEK ENDING	TOTAL C/ CUMULAT^V WEEK ENDING
	DATE:	8.5.78	9.5.78	I0.5.78	II.5.78	I2.5.78	I3.5.78	I4.5.78		
	Br. Fwd.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	I4.5.78	I4.5.7
HIRE OF M.S. FERDER AS A UNIT	35.505	7.000	7.000	7.000	7.000	7.000	7.000	7.000	49.000	84.50 5
RENTAL STINGRAY FR. & COMPEN.	2.780	.I60	.I60	.I60	.I60	.I60	.I60	.I60	I.I20	3.900
RENTAL CHRISTENSEN EQUIPMENT	II.375	I.625	I.625	I.625	I.625	I.625	I.625	I.625	II.375	22.750
RENTAL SAFETY JT. & FISHING TAP	.308	.044	.044	.044	.044	.044	.044	.044	.308	.6I6
MUD & CHEMICALS	6.428	I.586	.6I3	Nil	.0I4	.367	Nil	.367	2.947	9.375
DIAMOND/ROCK BITS	Nil	Nil	Nil	Nil	7.000	Nil	Nil	Nil	7.000	7.000
CONSUMABLE SPARES	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil		
SUB CONTRACTORS COSTS PERSONNEL	2.464	.352	.352	.352	.I76	.I76	.I76	.I76	I.760	4.224
COST OF MESSING 2.Christensen left I0.5.78	.I96	.032	.032	.032	.023	.023	.023	.029	.I88	.384
NEC Gas Equipment ROP/WOB Recor	.240	.020	.020	.020	.020	.020	.020	.020	.I40	.380
Weather Forecasts & Telephone	.022	.022	.022	.022	.022	.022	.022	.022	.I54	.I76
TOTAL DAILY COST		I0.84I	9.868	9.255	I6.084	9.437	9.070	9.437	73.992	
TOTAL CUMULATIVE COST B/F	59.296	70.I37	80.005	89.260	I05.344	II4.78I	I23.85I	I33.288		
TOTAL CUMULATIVE COST DAILY		70.I37	80.005	89.260	I05.344	II4.78I	I23.85I	I33.288		I33.28

TABLE C

T.C.S. EDINBURGH/M.S. FERDER OPERATIONS - ESTIMATED RUNNING COSTS IN £000's STERLING

DESCRIPTION OF EXPENDITURE 1978	DAY No.	15	16	17	18	19	20	21	TOTAL FOR THE WEEK ENDING	TOTAL C/ CUMULAT' WEEK ENDING
	DATE:	15.5.78	16.5.78	17.5.78	18.5.78	19.5.78	20.5.78	21.5.78		
	Br. Fwd.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	21.5.78	21.5.78
HIRE OF M.S. FERDER AS A UNIT	84.505	7.000	7.000	7.000	7.000	7.000	7.000	7.000	49.000	133.505
RENTAL STINGRAY FR. & COMPEN.	3.900	.160	.160	.160	.160	.160	.160	.160	1.120	5.020
RENTAL CHRISTENSEN EQUIPMENT	22.750	1.625	1.625	1.625	1.625	1.625	1.625	1.625	11.375	34.125
RENTAL SAFETY JT. & FISHING TAP	.616	.044	.044	.044	.044	.044	.044	.044	.308	.924
MUD & CHEMICALS	9.375	2.555	3.824	.403	2.536	2.620	2.169			
DIAMOND/ROCK BITS Diamond Pilot Insert £500 Roller Rock Bit £400 T.C.Bit £120	7.000	.500	.400	.120	Nil	Nil	Nil	Nil	1.020	8.020
CONSUMABLE SPARES Lost in BH78/7 1 CB & Inner Barrel & Drill Collars. 2 Jnts Pipe	Nil	Nil	Nil	.300	Nil	12.320	Nil	Nil	12.620	12.620
SUB CONTRACTORS COSTS PERSONNEL	4.244	.176	.176	.176	.176	.176	.176	.176	1.232	5.476
COST OF MESSING	.384	.023	.023	.023	.023	.023	.023	.023	.151	.535
Mec Gas ROP & WOB Recorders	.380	.020	.020	.020	.020	.020	.020	.020	.140	.520
Weather Forecasts & Phone	.176	.022	.022	.022	.022	.022	.022	.022	.154	.330
TOTAL DAILY COST		12.125	13.394	9.893	11.606	24.010	11.233			
TOTAL CUMULATIVE COST B/F	133.288	145.413	158.707	168.707	180.313	204.323	215.556			
TOTAL CUMULATIVE COST DAILY		145.413	158.707	168.707	180.313	204.323	215.556			

I.G.S. EDINBURGH/M.S. FERDER OPERATIONS - ESTIMATED RUNNING COSTS IN £000's STERLING

DESCRIPTION OF EXPENDITURE 1978	DAY No.	22	23	24	25	26	27	28	TOTAL FOR THE WEEK ENDING	TOTAL C/ CUMULATV WEEK ENDING
	DATE:	22-5-78	23-5-78	24-5-78	25-5-78	26-5-78	27-5-78	28-5-78		
	Br. Fwd.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.		
HIRE OF M.S. FERDER AS A UNIT	133 505	7000	7000	7000	7000	7000	7000	7000	49 000	182 505
RENTAL STINGRAY FR. & COMPEN.	5·020	·160	~~·160~~	~~·160~~	—	—	—	—		
RENTAL CHRISTENSEN EQUIPMENT	34·125	1·625	1·625	1·625	1·625	1·625	1·625	1·625	11·375	45 500
RENTAL SAFETY JT. & FISHING TAP	·924	·044	·044	·044	·044	·044	·044	·044	·308	1232
MUD & CHEMICALS	26 165	1,865	~~·360~~	NIL	708	NIL				
DIAMOND/ROCK BITS	8·020	NIL	NIL	NIL	NIL	NIL	NIL	NIL		
CONSUMABLE SPARES T.C. Bit T.C. Plot	12 620	NIL	NIL	·150	·050	·050	NIL	9		
SUB CONTRACTORS COSTS PERSONNEL	5·476	·176	·176	·176	·176	·176				
COST OF MESSING	·545	·023	·023	·023	·023	·023				
H&C	·520	·020	·020	·020	·020	·020	·020	·020	·140	·660
WK + PHONE	·330	·022	·022	·022	·022	·022	·022	·022	·154	484
TOTAL DAILY COST		10935	9430	9 060	9668	8960				
TOTAL CUMULATIVE COST B/F	227 208	238 143	247 573	256 633	266301	275261				
TOTAL CUMULATIVE COST DAILY		238 143	247 573	256 633	266301	275261				

ON HIRE 0900hrs

ACTIVITY (MAY)	MON 1	TUES 2	WED 3	THUR 4	FRI 5	SAT 6	SUN 7	MON 8	TUES 9	WED 10	THURS 11	FRI 12	SAT 13	SUN 14	MON 15	TUES 16	WED 17	THURS 18	FRI 19	SAT 20	SUN 21	TOTAL
STEAMING	15·0	16·8					2·0	6·6	1·5	24·0	6·5	1·6	1·8	6·8		7·0						
MOORING & RAISING		3·4					1·3	1·7	1·5		1·2	1·8	1·2	1·0	1·1	1·0	2·6					
LOGGING							0·8		1·2													
DRILLING ETC.		3·8	24·0	24·0	23·5	23·2	19·9	15·	19·8		15·7	20·6	21·0	12·3	21·5	7·5	17·0	21·0	22·5	21·75	16·5	
PORT CALLS																						
STANDBY + DOWNTIME					0·5	0·8		0·8			0·6			3·9	1·4	4·0	2·0	3·0	1·5	2·25	7·5	
WAITING ON WEATHER																4·5	2·4					

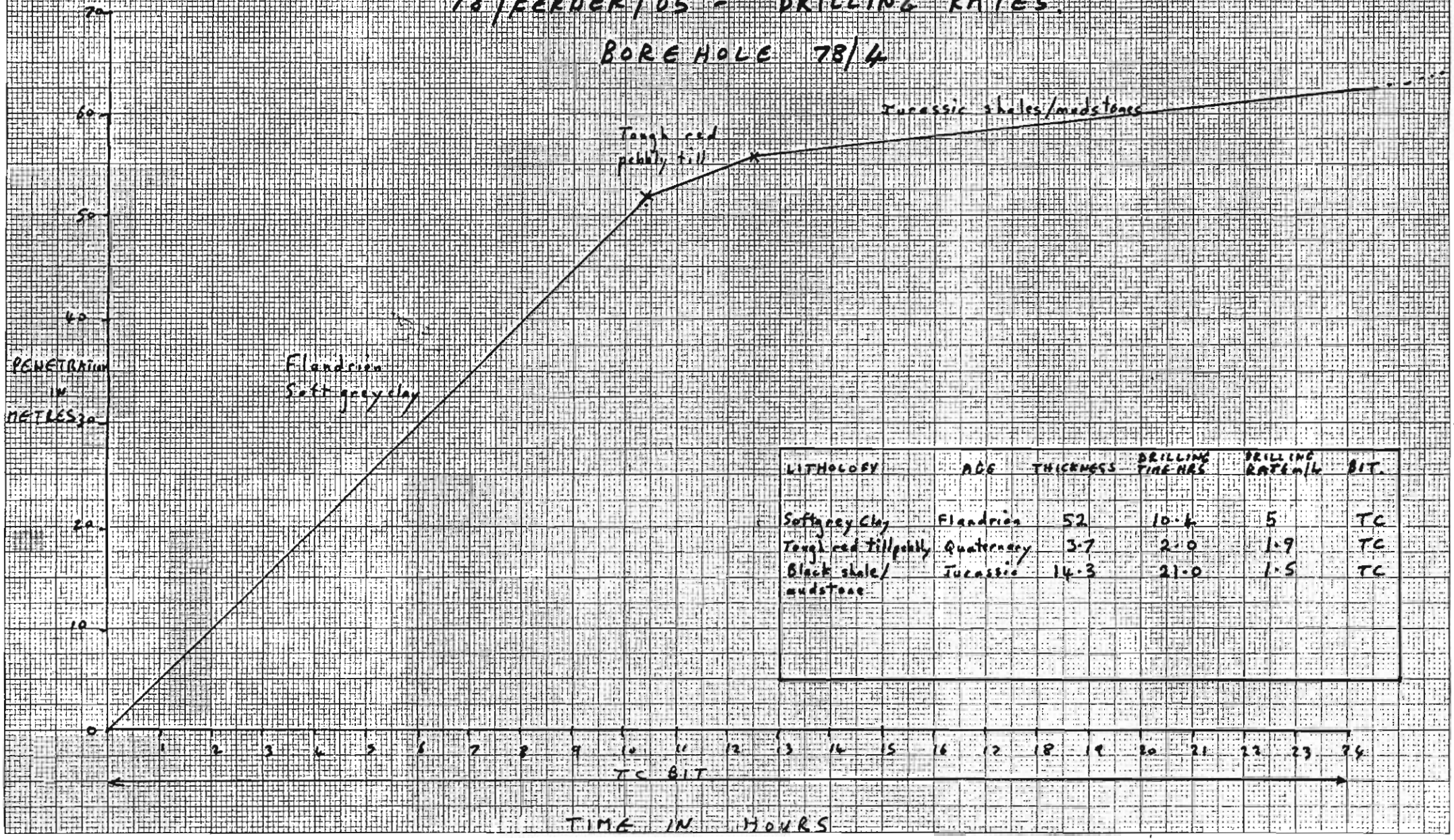
ACTIVITY	CARRIED FORWARD	MON 22	TUES 23	WED 24	THURS 25	FRI 26	SAT 27	SUN 28	MON 29	TUES 30	WED 31	THURS 1	FRI 2	SAT 3	SUN 4	MON 5	TUES 6	WED 7	THURS 8	FRI 9	SAT 10	TOTAL
STEAMING			2·5	10·5	7·0																	
MOORING & RAISING				3·5	1·5																	
LOGGING		1·0	1·75																			
DRILLING ETC.		18·0		10·0	14·75																	
PORT CALLS																						
STANDBY + DOWNTIME		5·0	19·75		0·75																	
WAITING ON WEATHER																						

BOREHOLE NO	7[illegible]	7[illegible]	7[illegible]	7[illegible]7	78
SITE NO	97	9	18A	17	88
WATER DEPTH	c80m	c163m	121m.	104m.	74m.
TOTAL TIME ON SITE (DATES)	1½ days 37·2 hrs (12-13th)	1¾ days. 41 hrs (14-15th)	1¼ days. 32·5 hrs (16-17th)	6 days 148 hrs (17-23rd)	1 day 24 hrs (24-25th)
TIME MOORING & RAISING	2·0 hrs.	1·75 hrs.	2·1 hrs.	3·2 hrs.	
TOTAL DEPTH	70·5 metres	54·50 metres	7·0 metres	127·78 m.	14·64 m
THICKNESS QUATERNARY	55·77 m.	52·00 m.	7·0 m.	84·0 m.	3·90 m
QUATERNARY LITHOLOGY	52·49 soft grey clay 3·28 Red brown pebbly clay	41·02 Soft grey clay 10·98 Red brown pebbly clay	7·0 m Muddy gravel.	8·40 m Sandy clay + pebbles	Sand. shelly
THICKNESS SOLID	14·28 m.	2·50 m.	—	43·78 m.	10·74 m
SOLID LITHOLOGY (AGE)	14·28 Black U Jur. shale	2·50 Red sandstone Permo-Trias	—	36·0 m Tertiary sand? 7·78 m Permo-Trias strata	Red marls + salts
RECOVERY QUATERNARY	28·78 m = 51·2%	15·08 m = 29%	2·0 m. = 28·6%	9·46 m = 11·2%	1·0 m = 25·6%
RECOVERY SOLID	7·95 m = 55·7%	1·52 m = 60·8%	—	5·88 m = 13·4%	1·78 m = 16%
TOTAL RECOVERY	36·37 m = 52·1%	16·60 m = 30·0%	2·0 m = 28·6%	15·32 m = 11·9%	2·78 m = 19%
MUD – SALT GEL	2·4 m. tons	16·2 m. tons	23·0 m tons	75·5 m tons	
MUD – STR		250 kg	1025 kg.	175 kg.	
MUD – LIME	60 kg.	380 kg.	40 kg	2340 kg.	
MUD – BARYTE		200 kg.	650 kg.	450 kg.	
MUD – OTHER					
MUD COST	£367·60	£3222	£4227	£12,223	
BIT USUAGE					

78/FERDER/05 — BOREHOLE SUMMARY TABLE D

78/EGRDER/05 - DRILLING RATES.

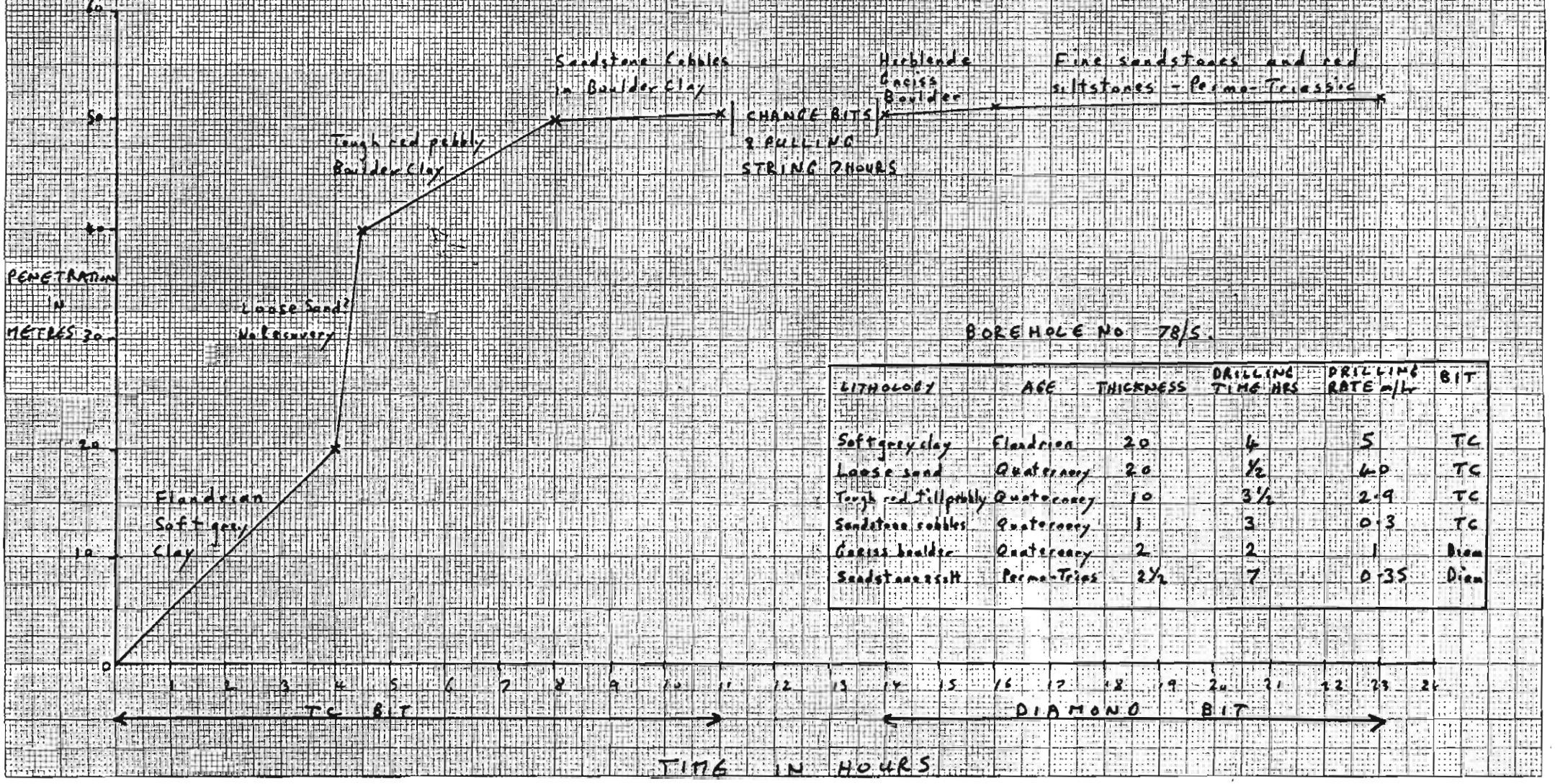
BORE HOLE 78/4



LITHOLOGY	AGE	THICKNESS	DRILLING TIME HRS	DRILLING RATE m/h	BIT.
Soft grey Clay	Flandrian	52	10·4	5	TC
Tough cod till pebbly	Quaternary	3·7	2·0	1·9	TC
Black shale/ mudstone	Jurassic	14·3	21·0	1·5	TC

78/FERDER/05 - DRILLING RATES

BOREHOLE 78/S.

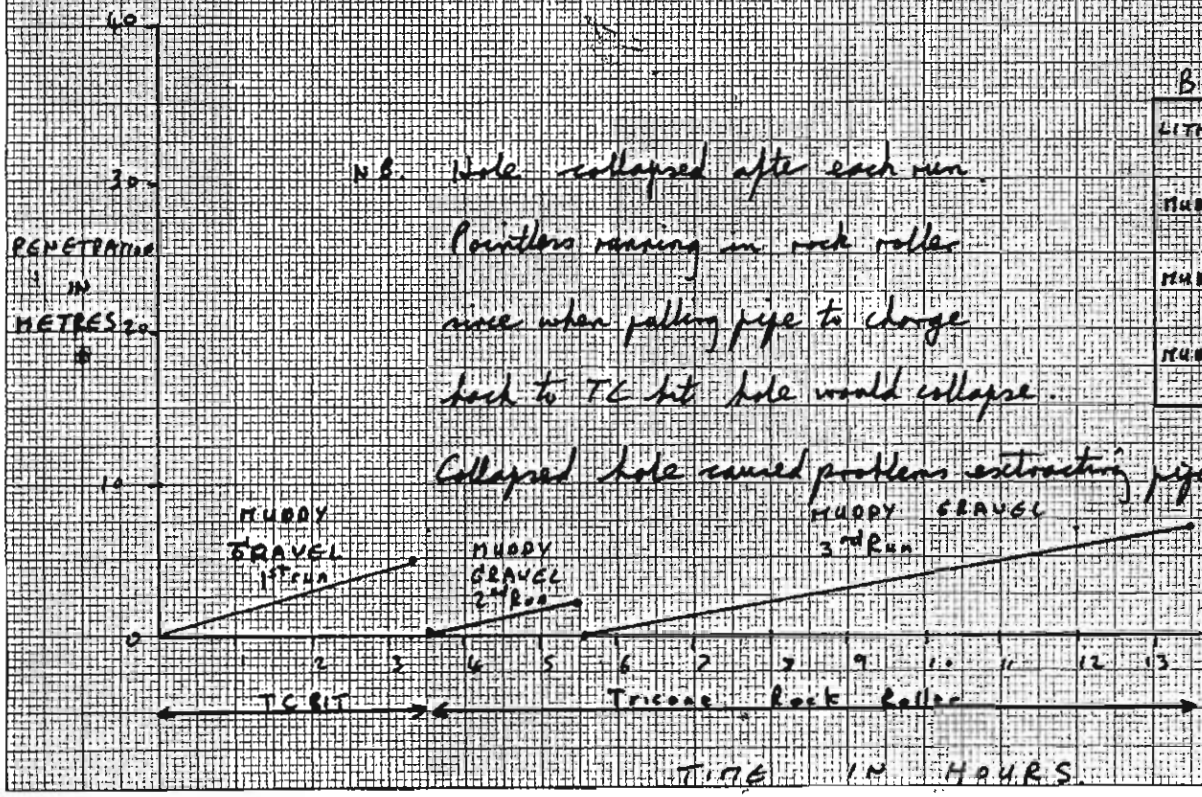


BOREHOLE NO 78/S.

LITHOLOGY	AGE	THICKNESS	DRILLING TIME HRS	DRILLING RATE m/hr	BIT
Soft grey clay	Flandrian	20	4	5	TC
Loose sand	Quaternary	20	½	40	TC
Tough red till pebbly	Quaternary	10	3½	2·9	TC
Sandstone cobbles	Quaternary	1	3	0·3	TC
Gneiss boulder	Quaternary	2	2	1	Diam
Sandstone & silt	Permo-Trias	2½	7	0·35	Diam

78/FERDER/05 - DRILLING RATES.

BOREHOLE 78/6



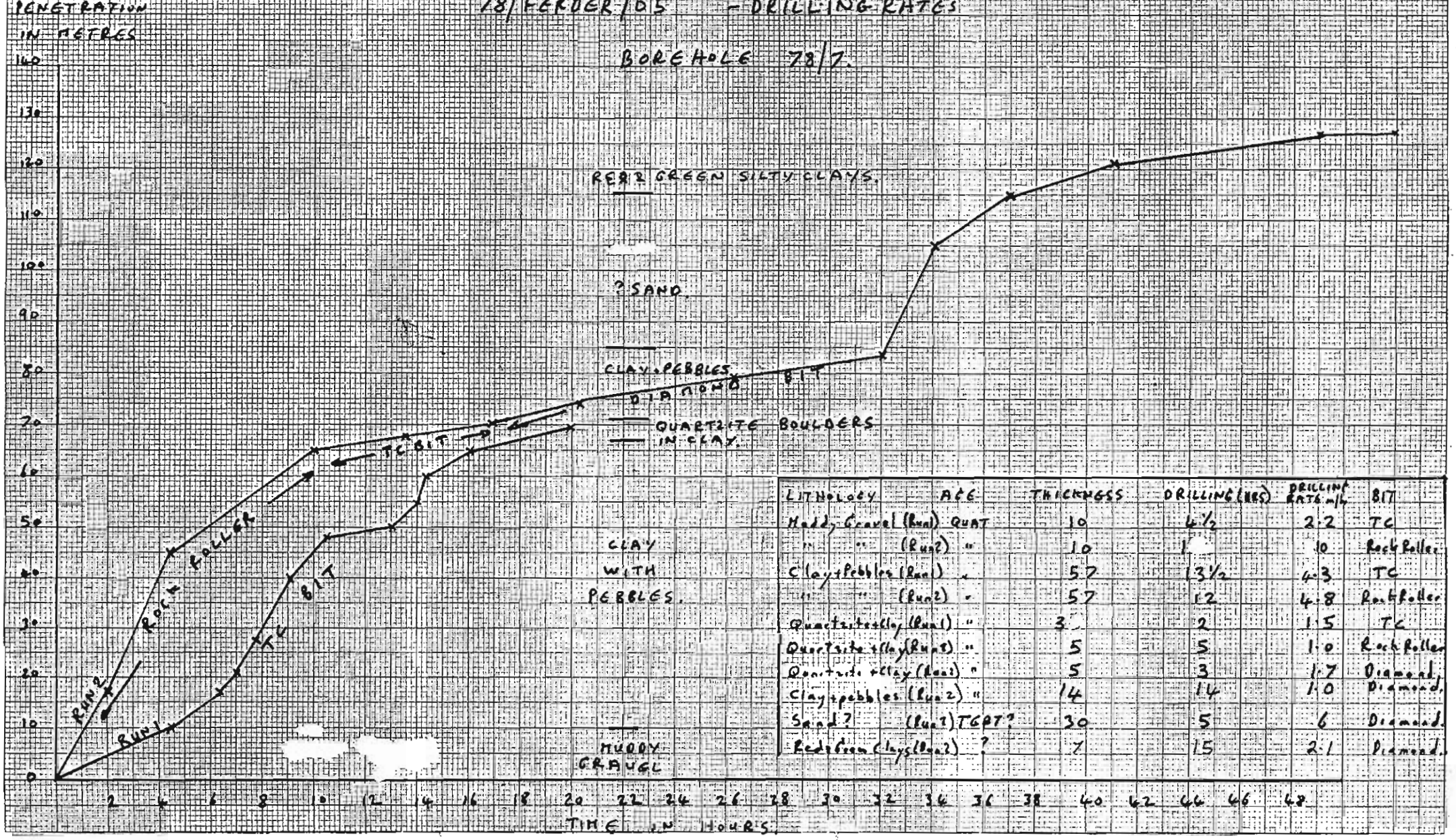
N.B. Hole collapsed after each run. Pointers moving on rock roller once when pulling pipe to change back to TC bit but hole would collapse. Collapsed hole caused problems extracting pipe from 7 metres.

BOREHOLE 78/6.

LITHOLOGY	AGE	THICKNESS	DRILLING TIME HRS	DRILLING Rate m/hr	BIT.
MUDDY GRAVEL	QUAT	5	3½	1·4	TC
MUDDY GRAVEL	QUAT	2	2	1·0	Rock Roller
MUDDY GRAVEL	QUAT	7	8	0·9	Rock Roller

78/FEROER/05 - DRILLING RATES

BOREHOLE 78/7.



LITHOLOGY	AGE	THICKNESS	DRILLING (HRS)	DRILLING RATE m/h	BIT
Mudd, Gravel (Run1)	QUAT	10	4½	2·2	TC
" " (Run2)	"	10	1	10	Rock Roller
Clay+Pebbles (Run1)	"	57	13½	4·3	TC
" " (Run2)	"	57	12	4·8	Rock Roller
Quartzite+clay (Run1)	"	3	2	1·5	TC
Quartzite+clay (Run3)	"	5	5	1·0	Rock Roller
Quartzite+clay (Run4)	"	5	3	1·7	Diamond
Clay+pebbles (Run2)	"	14	14	1·0	Diamond
Sand? (Run1)	TGAT?	30	5	6	Diamond
Red Green Clays (Run2)	?	7	15	2·1	Diamond

78/FERDER/05 - DRILLING RATES.

BOREHOLE 78/8

LITHOLOGY	AGE	THICKNESS	DRILLING TIME HRS	DRILLING RATE m/h	BIT
Sand	Quat	4·0	1	4·0	TC
Red mottled siltstones & mudstones	Permo-Triassic	11·0	35	0·3	TC