

DEPARTMENT OF EARTH SCIENCES
UNIVERSITY OF CAMBRIDGE

Telephone (0223) 51686
Telegraphic address: Geophysics, Cambridge.
Telex No : 817297 Astron G

BULLARD LABORATORIES
MADINGLEY RISE
MADINGLEY ROAD
CAMBRIDGE CB3 0EZ

Cruise Report

RRS JOHN MURRAY

Cruise 7 / 80

11 July - 1 Aug

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Final plans (27 June)

Report of Proceedings (30 July)

Final shot times & positions (Sept)

To Clewley 31 Oct 1980

UNIVERSITY OF CAMBRIDGE

DEPARTMENT OF GEODESY & GEOPHYSICS
MADINGLEY RISE
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Tel. (0223) 51686
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Professor J. A. Jacobs

27 June 1980

Dear Sir

RRS John Murray: Cruise 7/80
Seismic Explosions in the North Sea

You have received either the Notification of this cruise (in February) or a letter from me (in April). As a result of correspondence there have been some minor changes to the programme and I now enclose a revised programme and shot firing schedule. Please observe that, although times in the Provisional Programme were quoted in BST, in this Revised Programme and Schedule they are in GMT (zone Z). For British Summer Time (zone -01) you must ADD 1 hour; for Norwegian Summer Time (zone -02) you must add 2 hours.

The following changes have been made:

1. At the request of Ranger Oil Co., shot S5 has been moved $3\frac{1}{2}$ nautical miles to the WSW.
2. At the request of the Norwegian Fisheries Directorate, the following changes have been made to shots in Norwegian waters:
shots N3 and N4 are reduced to 500 kg
shot N5 is reduced to 750 kg and its position has been shifted 10 nautical miles to the SSE. It is still in an unallocated block.
3. As a result of co-operation from NORSAR and the University of Bergen, a major refraction line will be attempted across the shield in southern Norway. The third leg of John Murray's cruise (visit to Kristainsand and repeat of shot N5) will not take place. The time saved will be set aside for possible delay to the programme from bad weather. Instead, the Norwegian coastguard service will fire six 825 kg shots (H_1 to H_6) on the bottom at position N5, starting in the ~~evening~~ ^{morning} on July ~~28th~~ ^{31st}. Consult enclosures for details.

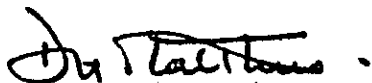
Communications for this experiment will be as follows: there will be two informed control centres - Dr Mary Fowler in Cambridge and Dr Svein Mykeltveit at NORSAR. Land recording parties should telephone one or other of these for information. Details follow. Each day at around 0800 (z) RRS John Murray will speak with her base in Barry, South Wales (tel 0446 737451 Mr Chris Adams, Operations Office) by radiotelephone. Messages will be passed on by the Research Vessel Base to Dr Fowler in Cambridge (0223 69023). Dr Fowler will telephone NORSAR (010 47 2 716915) and also the secretary at the Dept of Geophysics (0223 51686). If you want to know anything, phone Mary. If you cannot get a reply from her house, try the Dept of Geophysics (best in working hours).

Their numbers are 0223 69023 and 0223 51686 respectively. All telephone numbers have been given for dialling from Britain.

At sea, the ship will transmit a warning signal, before shots are fired, on VHF Channel 16 and on 2182 khz. These will be voice transmissions in English.

In 1977 all the shots were fired as programmed. Nevertheless, bad weather and accidents may occur which will oblige us to depart from this programme. However, since the PUSSES on which we record are pre-programmed when they are laid, there will be time to make known any changes in the programme. Once the PUSSES are laid the shots must be fired into the recording windows of 10 minutes duration, or not fired at all.

Yours sincerely



D H Matthews

encs

Distribution:

Dr R E Long, Durham University; Dr D T Hopkins, Reading University; Prof M H P Bott, Durham University; Dr P K H Maquire, Leicester University; Dr H Bartersen, Inst fur Geophysik, Kiel; Dr A W B Jacob, DIAS Dublin; Dr A R Ritsema, RNMI, Holland; Dr C W A Browitt, IGS Seismological Unit, Edinburgh; Dr M Warner, Edinburgh University; Dr H I S Thirlaway, Atomic Energy Authority, Berks; Dr M Fowler, Cambridge; Mr B Cassell, Cambridge.

Shell UK, Aberdeen; Placid Int Oil Ltd, The Netherlands; Amoco UK, London; BNOG Ltd, Aberdeen; BNOG, Glasgow; Saga (Norsk), Norway; BP, London; Esso, Surrey; Ranger Oil, London; Transocean Oil, London; Texaco UK, London; Premier Consolidated Oilfields, London; Premier, Glasgow; Phillips Petroleum, London; Petronord Group, Norway; Gulf Oil, Glos; Elf Aquitaine, London; Elf Aquitaine, Norway; Conoco, Aberdeen; Conoco, London; Burmah Oil, Glasgow; BP, Norway; Arpet Petroleum, London.

Miss V Ewan, Foreign & Commonwealth Office, London; R F Fowler, Dept of Trade; Hydrographer of the Navy, Min of Defence; Radio Navigation Warning Section, Min of Defence; Flag Officer Submarines; Defence Secretariat; Cdr J Perry, Directorate of Naval Warfare; P O Telecommunications Headquarters Marine Division; Chief Inspector of Fisheries, Min of Ag; J H Aitken, Dept of Energy; A Aasbø, Fisheries Directorate, Norway; Miss Elisabeth Steffanson, Norwegian Petroleum Directorate; R Robertson, Dept of Ag & Fisheries for Scotland.

REVISED PROGRAMME: JOHN MURRAY CRUISE 7/80

Note: all times are GMT

Leg 1

Fri 11 July Load explosives. Sail Barry before 1700 hrs(z)
Sat 12)
Sun 13) Leave England to port. Rehearse large charge firing drill
Mon 14) with 5lb charge.
Tue 15)
Wed 16 ETA P12 0700. Lay P12 etc
Thu 17 Lay P1 before 1700 Shot S1 (125 kg) at 1900.
Fri 18 1600 shot F2 (1000 kg)
Sat 19 0700 shot F4 (1000 kg)
 1900 shot F7 (500 kg)
Sun 20 1300-1900 shots S8, N1, S7 and S6.
 Recover P12.
Mon 21 Recover P11 to P1. Complete before dark (2000). Depart for Dundee.
Tue 22 Enter Dundee pm.

Leg 2

Wed 23 Reammunition. Sail 1200.
Thu 24 Arrive P1 pm. Commence laying.
Fri 25 Lay P1- P6.
Sat 26 Lay P12-P7. Fire shots S2, S3, S4 and S5, 1200-1900.
Sun 27 Shots N2 (500 kg) at 0500 hr, N3 (500 kg) at 1100, N4 (500 kg)
 at 1800.
Mon 28 Shot N5 (750 kg) at 0500. On completion return to P12.
Tue 29 ETA P12 0200. Recover PUSSEs.
Wed 30 On completion depart P1 for Barry (790 miles) or Plymouth (570 miles)
Thu 31 (Last possible day to complete programme planned for Sat 26).
Fri 1 August (Last possible day for shots N2, N3 and N4).
Sat 2 earliest possible arrival at Plymouth @ 8 knots (last possible day
 for shot N5 at 0500(z)).
Sun 3 earliest possible arrival at Barry (pm) (last possible day complete
 PUSS recovery and still get to Plymouth).
Mon 4
Tue 5
Wed 6 Cruise ends. HW Plymouth 1400.

Note on programme

If bad weather intervenes the John Murray programme can be delayed by multiples of 24 hours. The PUSSEs are pre-programmed, so once laid, shots must be fired at the correct times (into 10 minute windows) or not fired at all.

DHM 28 July 1980

Times are GMT. Add 1 hour for BST. Add 2 hours for Norway.

REVISED SHOT FIRING SCHEDULE

Leg 1

JULY

S ₁	125 kg.	1900/17	
F ₂	1000 kg.	1600/18	(floated)
F ₄	1000 kg.	0700/19	(floated)
F ₇	500 kg.	1900/19	(floated)
S ₈	250 kg.	1300/20	(or S ₆)
N ₁	500 kg.	1500/20	(or S ₇)
S ₇	250 kg.	1700/20	(or N ₁)
S ₆	125 kg.	1900/20	(or S ₈)
Total	3750 kg.		

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Leg 2

S ₂	75 kg	1200/26	
S ₃	75 kg	1400/26	
S ₄	75 kg	1700/26	
S ₅	125 kg	1900/26	
N ₂	500 kg	0500/27	(floated)
N ₃	500 kg	1100/27	(floated)
N ₄	500 kg	1800/27 (or 2000/27?)	(floated)
N ₅	750 kg	0500/28	(floated)

Total 2600 kg

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DHM 28 July 1980

CAMBRIDGE SHOTS PLANNED FOR RRS JOHN MURRAY CRUISE 7/80 11 JULY - 6 AUGUST 1980

(LISTED FROM WEST TO EAST)

SHOT	SIZE kg	DEPTH	DETONATION DEPTH	POSITION		CONCESSION	
F2	1000	50m	+ 45m	56°14.2'N	2°12'W	25/25	n.a.
F4	1000	55m	+ 50m	56°27.7'N	1°12'W	26/20	n.a.
F7	500	180m	+ 92m	56°43'N	0°20.4'E	28/07	rel Sh/ES '76
S1	125	100m	c.80m	56°50'N	0°55'E	28/05 & 10	rel Transocean '78 & Sh/ES '70
S2	75	90m	c.80m	56°54'N	1°16'E	29/02	rel Pla '78
S3	75	90m	c.80m	56°58'N	1°36'E	29/03 & 04	Arpet and rel Sh/ES '70
S4	75	80m	c.80m	57°02'N	1°57'E	22/30	Arpet
S5	125	75m	c.75m	57°04.5'N	2°11'E	23/26	Texaco
S6	125	70m	c.70m	57°10'N	2°38'E	*07/11	rel Phil '71-'74
S7	≤ 250	65m	c.65m	57°13'N	2°52'E	*07/12	rel Con '71
S8	≤ 250	60m	c.60m	57°18'N	3°24'E	*08/08	rel Phil '71-'74
N1	500	60m	+ 55m	57°17'N	3°08'E	*08/07	rel Sh '71-'77
N2	500	60m	+ 55m	57°21'N	3°41'E	*08/09	rel Con '74-'77
N3	500	75m	+ 70m	57°29'N	4°26'E	*09/08	rel Esso '71
N4	500	85m	+ 80m	57°39'N	5°17'E	*10/04	n.a.
N5	750	140m	+ 80m	57°36'N	6°00'E	*10/03	n.a.

P.U.S.S. POINTS FROM WEST TO EAST

<u>P.U.S.S.</u>	<u>POSITION</u>		<u>DEPTH</u>	<u>CONCESSION</u>	
P1	56°53'N	1°12'E	90m	29/02	rel Pla '78
P2	56°54'N	1°19'E	90m	29/02	Pla
P3	56°55.5'N	1°25'E	90m	29/03	Sh/ES
P4	56°56.5'N	1°31'E	93m	29/03	Arp
P5	56°58'N	1°37'E	92m	29/04	rel Sh/ES '78
P6	56°59'N	1°43'E	90m	29/04	rel Sh/ES '78
P7	57°00'N	1°49'E	90m	29/04 & 22/30	rel Sh/ES '78 & Arp '78
P8	57°01.5'N	1°55'E	88m	22/30	Arp
P9	57°02.5'N	2°01'E	85m	23/26	Texaco
P10	57°04'N	2°07'E	80m	23/26	BP
P11	57°05'N	2°13'E	75m	23/27	Rang
P12	57°06'N	2°18'E	70m	23/27	Rang

*NORWAY offshore area

+Charges fired on a pallet suspended from a surface buoy.

Remainder, free sinking.

Norwegian Program.

Thurs 31 July	0600 ^Z (2) shot H ₁ (825 kg) at position N5. 1800 (z) shot H ₂
Fri 1 Aug	1800 (z) shot H ₃
Sat 2	1800 (z) shot H ₄
Sun 3	1800 (z) shot H ₅
Mon 4	1800 (z) shot H ₆
Tues 5	Spare day
Wed 6	Spare day

All shots will be fired by Norwegian naval personnel from a coastguard cutter at position N₅ (57° 36'N, 6° 00'E). They will be 825 kg amatol. If the charge fails to detonate they will try again half an hour later. If bad weather delays their program, they will fire at 0600^Z (~~2~~) next morning.

If John Murray's program has not been completed by Weds 30th there will be a two or three day pause in the Norwegian shots to enable the seismometers to be moved back to the coast to receive her shots.

D.H.M.

30th June, 1980.

Report of Proceedings

JOHN MURRAY 7/80

11 July 1980 (Barry) - 23 July (Dundee) - 1 Aug (Plymouth)

A SEISMIC REFRACTION LINE FROM EDINBURGH TO NORWAY USING PUSSES

Loading of the ship

The ship sailed from Barry with 3,850 kg. explosive, two doughnut and two spar buoys, twelve "quarter ton" chain anchors, twelve PUSSES complete with their mooring wires (totalling 3,696 m. of 10mm wire weighing 3026 kg. in all), sundry inflatable buoys and two danbuoys, an extra inflatable boat and outboard, and miscellaneous laboratory equipment and nauticalia totalling perhaps another ton. On deck, in addition to the ammunition lockers, was a winch to handle the PUSS moorings wound on wooden drums. She had slightly less than full fuel and water tanks and was above her marks, and stable.

Narrative and Results

A summary of events and weather appears as appendix 1. Positions are shown on figure 1. The weather on Leg 1 was poor for midsummer: we lost a day waiting for an opportunity to lay the PUSSES and we were able to fire only three out of the eight shots for which there were recording windows. Fuse burning trials were carried out on the 12th July north of Land's End, but a trial deployment of a small test charge and sand was unsuccessful in spite of the shelter of Mount's Bay, although we learned a lot from it. ^{We fired a trial shot on 18 July.} The first floated 1 ton shot was fired successfully in calm water on 19th but after the loss of the one ton charge on 20th at point F4 (discussed under Cambridge Equipment) the ship was prevented by stress of weather from attempting shot F7 and it was decided to abandon shots S8, N1, S7 and S6, planned for the next day, and to remain hove-to in the hope of being able to fire shot F7 during the sole remaining 10 minute window, originally intended for Shot N1. After F7 was fired PUSS recovery went well and we entered Dundee with twelve useful tapes containing records of the three shots that we had fired.

For the second leg the weather was good, with no wind stronger than force 6. All the eight shots were fired and recorded on all twelve PUSSES. Airgun shots from an unknown geophysical prospecting ship appear on all PUSSES in three of the eight windows. We hope to be able to deconvolve these out of the records and we may be able to get some refraction information from them if the ship's owners can be traced.

It proved to be possible to wind all the PUSS moorings over the ship's main wire, enormously speeding the operations of laying and recovery. This enabled us to complete laying in one day and we were able to get back on to our previously planned schedule for the shots of the 26th.

The second leg was a success. It remains to be seen whether the objectives of the experiment can be wholly attained without the five shots that we missed on the first leg.

PUSS laying and recovery procedure

A PUSS mooring is illustrated in figure 2. PUSS laying and recovery can be effected from John Murray in winds (and seas) less than force 7. Stronger winds increase the risk of damage to the wires. The mooring is based on simple current meter moorings originally designed by the Lowestoft Fisheries Lab, and Bosuns understand it.

Bouyed charge firing procedure

There is a detailed account in the 1980 edition of the Child's Guide to Shot-firing at Sea. Here it will suffice to say that the charge was fired by slow burning fuse linked with twin Cordtex detonating fuses to two primers in the explosive. Figure 3 illustrates the rig.

The charge, 1,000 or 500 kgs, 40 or 20 boxes, was lashed on to a stout pallet measuring 1.0 x 1.25 metres. The pallet was lowered on a plaited polyester 10mm diam. dropper rope of breaking strain 2250 kg, fitted with soft eyes and nominally 9m less in length than the expected depth of water. The dropper rope was connected by a length of expendable rope to the ship's main wire running over the A-frame, (it was this rope that broke on the 20th July). The dropper rope was attached by a short (1m) strop to the ring beneath a JW Automarine T1 lifting bag fitted with a radar reflector. The T1 buoy was prevented from spinning during laying (and from sinking if damaged by the Cordtex) by a pellet buoy on a 20m buoyant rope (b.s. 3,000kg, Nelson multiplait). Also attached to the eye at the top of the dropper rope was a 2m length of terylene non-buoyant rope and 14m of the buoyant rope. By this rope the charge was towed until the fuses were lit, and to this rope the end of the Cordtex was attached (with tie-wraps). The end of the Cordtex was sealed and bouyed with a rubber tyre, and to it were taped the detonators of two 4m slow burning fuses, giving a burning time of 7 mins, during which the ship went 1 mile away from the explosion after a standing start. These large charges all blew out in spite of being fired at depths varying between 50 and 100m.

Experience on this cruise suggests that such charges can be layed in winds and seas up to force 6. In winds above force 4 the surging up-and-down of the stern provides the difficulty. The charge does not sink at once. 1,000kg of geophex weighs only 264kg in water, but the drag forces are much greater than this. In

winds of force 6 vigilance and co-operation between the Chief Officer, at the stern, and the Captain, on the Bridge, are required to keep the charge towing very slowly, dead astern.

RVS Equipment performance

The Simrad echo sounder operated adequately in the fish finding mode with digital read-out. The ships winches and cranes were reliable and engine trouble did not imperil the experiment thanks to the dedication of the ship's company.

The 3m. long Norcem-Plast Spar buoys, if fitted with lights and radar reflectors are superior to the MCO doughnut buoys, most of which capsized during leg 1. The 10 lights supplied for the doughnut buoys included two with flat batteries which we replaced in Dundee. But two of these lights flooded on leg 1, so for leg 2 we again had only 10 out of the twelve buoys lit by the large lights and the remaining two by new ORE lights sent from RVS.

Communications between the Chief Officer and the shotfirer at the stern and the Bridge, lab and winchroom are vital to such delicate operations. It is my opinion, not shared by all the officers, that the walkie-talky radios in use do not provide the best solution and that a reliable "Tannoy" system (cf R.N.) with wandering lead microphones [†] headsets is still the best.

Cambridge equipment performance

We obtained 24 good tapes from the two lays of the 12 PUSSES. Background noise is conspicuously less than it was in 1977. Two clocks were found to have stopped on recovery from leg 1. We believe this to be due to defects in the newly purchased PP9 batteries that we had fitted. In Dundee we bought 48 more batteries and on Leg 2 the trouble did not reoccur. One Glenair hydrophone cable flooded on Leg 1. Excellent trim signals were obtained throughout from Rugby MSF both on the Toolex low-power 60 khz receiver erected on the flying bridge and on the Eddystone model 1570 receiver in the lab, thus eliminating a source of bother experienced in 1977.

All the gear purchased for PUSS and for charge laying proved adequate and the techniques conceived ashore required only most minor modifications at sea. But I had forgotten to provide expendable rope to connect the top of the dropper rope with the ship's wire - a rope that is cut after the lifting buoy is in the water. Out of several miscellaneous lengths of rope brought along for luck I selected a dirty but little used length of 16mm plaited terylene, originally purchased as a dropper rope in 1976 and considerably thicker than this years 10mm droppers. This rope proved too weak when lowering the 1 ton charge on Sunday 20th July. The dropper rope made for this charge was 41 m long. When the charge was already some 30m down and the outboard end of the disposable rope was sawing up and down in the winch room

with the surge of the ship, the rope parted. We have reason to believe that the bowline by which the disposable rope was shackled to the end of the dropper rope caught in the main winch traveller and was chafed through: the winchwire was covered in terylene fluff and there was no knot on the end of the dropper as the shackle dropped over the side. The charge sank 20m to the bottom and we cut the cordtex fuse. The charge was lost, though there was no danger to personnel. Decca positions were read instantly in the lab and on the Bridge and subsequently communicated to the shore. This loss was due to my poor judgement of the residual strength of the rope when bent into a bowline, and to my lack of foresight in failing to think of the necessity to provide an expendable rope for the operation. On subsequent lays we used new 20mm polypropylene with a hard eye in the inboard end and a soft eye at the (disposable) outboard end. Although the new 10mm dropper ropes proved adequately strong there was considerable stretch in them when the ship was surging in the sea, and that made attaching the Cordtex hard; 12mm droppers (b.s. 3,200kg) would be better.

Explosive safety

Too many people are involved with loading and unloading explosives, directly contravening one simple fundamental rule of safety. Loading in Barry, three people kept the tally but none of us agreed; in Dundee two of us tallied, and disagreed. It is hard to tally when so many willing hands grab each box as it comes in on the pallet. Fortunately I have the highest respect for the ICI lorry drivers and their ability to count. We need only two ICI men plus maybe one docker to transfer the boxes from van to pallet, someone to drive the crane and open the lockers, and only two men on board to transfer the boxes from the pallet to the locker and one man to tally. The rest should stand well back on the quay. The police should be informed that they are there to prevent anyone going away with explosives under his coat.

In fact nothing was lost: once on the ship, records were kept meticulously by the Chief Officer and everything ran smoothly. But doubt should never have crossed our minds. Explosives must be handled by the minimum number of people that are needed to do the job.

At the time of writing (Wednesday, 30 July) we have heard no warning broadcast to fishermen of the presence of 1 ton of geophex at site F4. Why not? This is a serious matter.

Thanks

It has been a happy and largely successful cruise, thanks to the Captain, Officers, Bosun and ship's company. Food was, as usual outstanding. We are particularly grateful to the Captain and the Chief Engineer, and we are grateful too to Chris Adams and Stan Smith for their part in planning and in fitting out the ship for work in this most crowded bit of sea.

D. H. Matthews

RRS John Murray 30 July 1980.

Personel

Dr Drum Matthews

Dr Phil Christie

Dr Bob White

Penny Barton

Martin Raynes

Capt Nils Harding

DIARY.

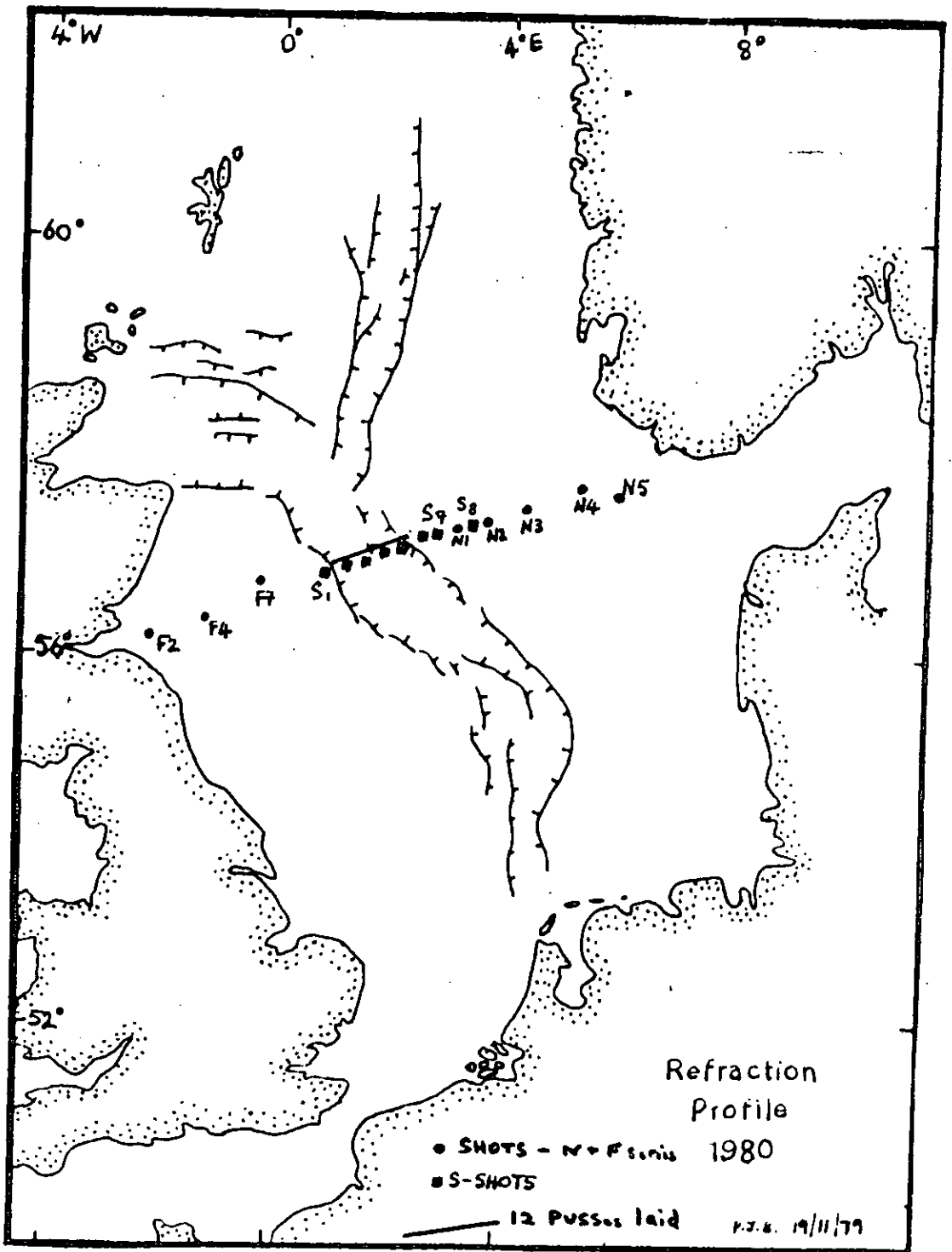
LEG ONE

Weds.	9 July	loading	
Thurs.	10	setting up	
Fri.	11	load explosives sailed 1900	force 6 N'ly
Sat.	12	charge lowering trial in Mount's Bay	force 6 NW'ly
Sun.	13	passage up Channel	force 4 W'ly
Mon.	14	passage thro' N.Sea	force 7 E'ly, N'ly
Tues.	15	prepared PUSS	force 7-8 N'ly
Weds.	16	reset PUSSes 0700 accepted 24 hour delay	hove-to 8-5 N'ly
Thurs.	17	reset 0700. Layed PUSSes	force 2-4 SSW
Fri.	18	test shot fired 1130 shot S1 (125kg) 2000	force 4 force 2
Sat.	19	floated charge F2 (1 ton)	calm
Sun.	20	lost charge F4 0800 (1 ton) hove-to	freshening, 6-7 force 8-9
Mon.	21	floated charge F7 (700kg) 1600 recovered P ₁ - P ₇ , 2000-2400	force 4 moderating
Thurs.	22	recovered P ₈ - P ₁₂ 0630-1030 passage to Dundee	freshening, 6-7 W'ly
Weds.	23	enter Dundee 0800 PUSS refit	

LEG TWO

Thurs.	24 July	load explosives am sail Dundee 1500	S'ly 4-5 but calm
Fri.	25	layed PUSS 0900-1900 regained original schedule	force 4, calm
Sat.	26	Shots S2, S3, S4 & S5	force 4-5 S'ly
Sun.	27	floated charges N2(0600) N3 (1200), N4 (1900), each 500kg.	freshening 3-6
Mon.	28	floated charge N5 (0600) 750kg.	calm
Tues.	29 July	recovered PUSSes 0400-1300 destroyed remaining explosives	calm
Fri.	1 Aug.	arrive Plymouth 1900	
Sat.	2	unloading	

FIGURE 1



Positions of shots and Pusses.

FIGURE 2

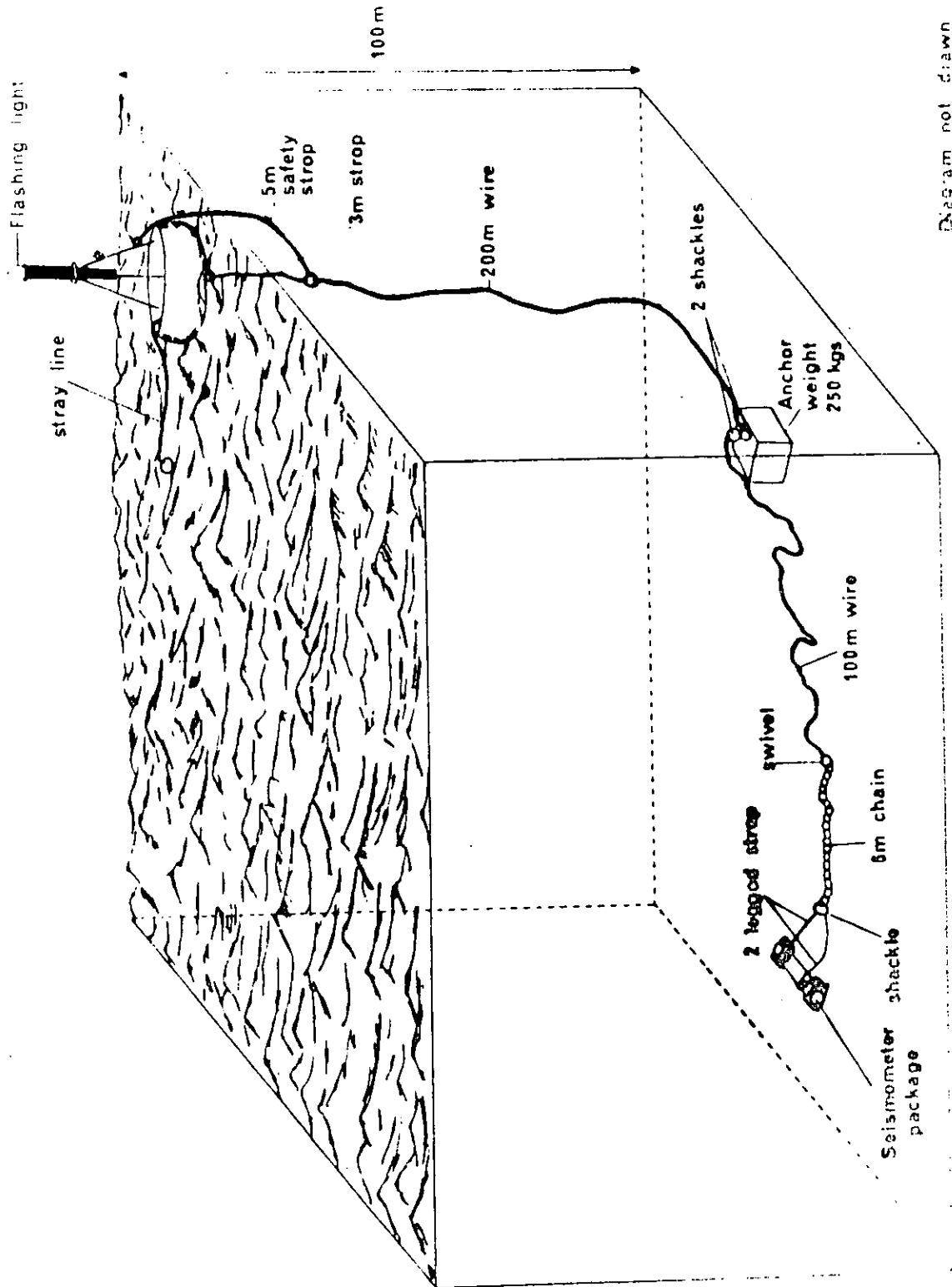
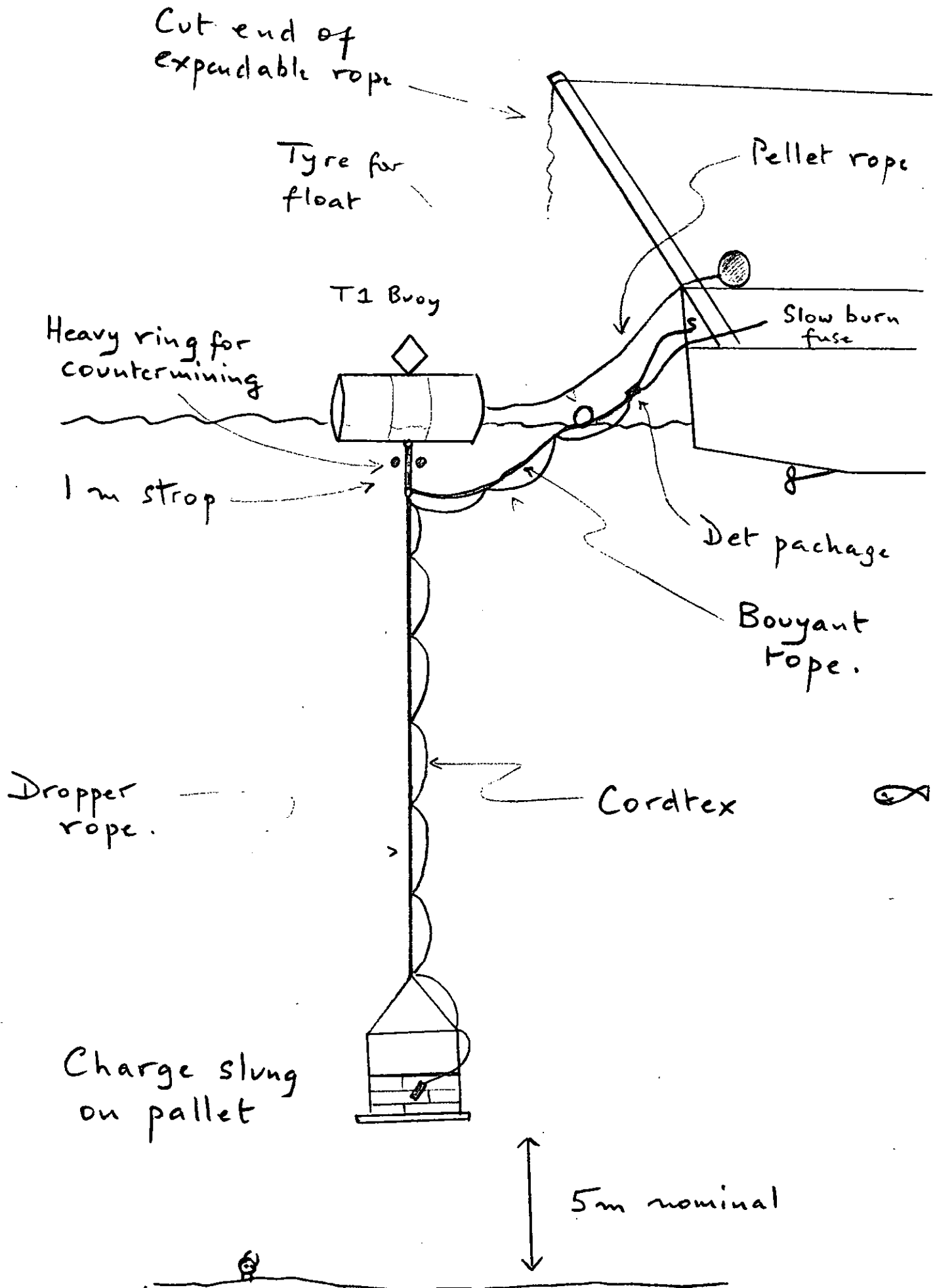


Diagram not drawn to scale

Puss mooring.

Floated charge rig

figure 3.



DEPARTMENT OF EARTH SCIENCES
UNIVERSITY OF CAMBRIDGE

Telephone (0223) 51686
Telegraphic address: Geophysics, Cambridge.
Telex No : 817297 Astron G

BULLARD LABORATORIES
MADINGLEY RISE
MADINGLEY ROAD
CAMBRIDGE CB3 0EZ

Thank you for recording the shots that we fired in the North Sea in July this year. An impressive number of teams were in the field recording our shots (list enclosed).

I am very interested in your data and would like to see it and discuss it with you during the next few months. Please don't throw any of it away! I will either come and visit you, or arrange to meet you if you are in the area, for example in London. I suggest that we exchange record sections as soon as they are ready. I would ask you to send me the typescript of any paper you write using the data before it is published, and I will do the same for you. I hope this is an acceptable arrangement.

I enclose a list of shot positions, times and depths and some explanatory notes.

Penny.

SHOT	SIZE kg	DATE	TIME BST HRS:MIN:SECS	POSITION		SHOT DEPTH m	WATER DEPTH m
				LATITUDE	LONGITUDE		
S1	125	18.7.80	20:02:19.910	56°49'59.219"N	00°54'11.394"E	92	92
F2	1000	19.7.80	17:03:35.905	56°14'33.226"N	02°11'26.792"W	47.5	53
F7	500	21.7.80	16:03:24.364	56°42'28.843"N	00°20'38.848"E	96.5	176
S2	75	26.7.80	13:02:07.043	56°53'52.424"N	01°15'38.683"E	94.6	94.6
S3	75	26.7.80	15:02:08.364	56°57'56.878"N	01°35'46.265"E	100.3	100.3
S4	75	26.7.80	18:02:10.706	57°02'13.893"N	01°56'59.928"E	92.4	92.4
S5	125	26.7.80	20:02:18.188	57°04'39.369"N	02°11'28.942"E	90.0	90.0
N2	500	27.7.80	06:03:12.262	57°21'26.944"N	03°41'43.647"E	58	65.2
N3	500	27.7.80	12:03:11.490	57°29'44.472"N	04°26'12.679"E	73	80.6
N4	500	27.7.80	19:03:12.038	57°38'38.648"N	05°17'40.619"E	83	101.5
N5	750	28.7.80	06:03:16.623	57°35'51.680"N	06°00'40.613"E	102	145

NOTES

TIME

This is in British Summer Time (GMT + 1) as recorded from MSF Radio (60 KHz) broadcast from Rugby. This is equivalent to Universal Time (UT1 ie GMT) but differs from Co-ordinated Universal Time (UTC, the Caesium standard) potentially by as much as 0.9 seconds (see Admiralty List of Radio Signals Volume 5). During the experiment the difference was about 0.2 seconds (UT1-UTC \approx 0.2 seconds).

If you used a different coded radio time signal there may well be a correction to make to our times so please contact me and we can try to figure out what it should be.

POSITION

Co-ordinates are derived from Decca Navigator readings which were sent to Decca Ltd for full correction and translation into latitudes and longitudes. Each point is said to be good to within 25m of true position.

SHOT INSTANT

This was calculated using the ship to 'charge-away' ranges derived from Decca positions, and the detonation depth. The buoyed charges (500 kg and over) have a well known detonation depth. Previous experience in the department indicates that the throwover charges all hit the sea bed before detonating, and there is no evidence to contradict this. Data from IOS Wormley for the area during July led to the conclusion that the water was virtually unstratified (ie mixed), with a mean velocity of 1.494 km/s.

There are three other independant estimates of the ship to 'charge-away' range, and the greatest difference between the four is 300 m. However, the shot hydrophone (towed 81 m behind the ship) and the hull geophone gave independant estimates of the shot instant for a given range. Using the Decca distances these gave agreement to better than 5 ms in all cases and so the Decca was chosen as the most consistent estimate.

Dr R E Long, Dept Geological Sciences, South Road, Durham
Tel Durham 64941

Dr D T Hopkins, Geology Dept, Reading University, Reading
Tel 85123 X7868

Dr P K H Maquire, Dept of Geology, University of Leicester, Leicester LE1 7RH
Tel Leics ~~50000~~ 554455

Dr A W B Jacob, DIAS, Geophysics Section, 5 Merrion Square, Dublin 2
Tel 0001 774321 Vivienne Ward 0001 875104

Dr A R Ritsema, Seismological Division, Royal Netherlands Meteorological Institute,
P O Box 201, 3730 AE de Bilt
~~030~~ 766911
070 31 30

Dr C W A Browitt, IGS Seismological Unit, Murchison House, West Mains Road, Edinburgh
Tel 031 667 1000

Dr M Warner, Dept Geophysics, Kings Buildings, University of Edinburgh
Tel 031 667 1091

Dr H I S Thirlaway, Atomic Energy Authority, Blacknest, Brimpton, Berks
Tel 073546 4111 X4293

Mr B Cassell, Dept of Geodesy and Geophysics, Madingley Rise, Madingley Road, Cambridge
Tel (0223) 51686

AND TEAMS IN NORWAY

DR F. GRAY, BULLARD LABS, MADINGLEY RISE, MADINGLEY ROAD, CAMBRIDGE