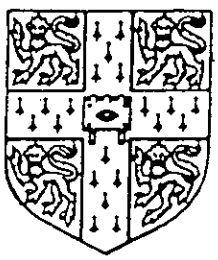
86

UNIVERSITY of CAMBRIDGE



Department of Earth Sciences

Cruise Report

R.R.S. Discovery 155

Two-ship seismic experiments in the Hatton Bank-Rockall area of the north-west U.K. Continental Margin

R.S. White

CRUISE REPORT

DISCOVERY 155

Two-ship experiments in the Hatton Bank-Rockall area of the northwest U.K. continental margin

R.S. White
Department of Earth Sciences
University of Cambridge
Bullard Laboratories
Madingley Rise
Madingley Road
Cambridge
CB3 0EZ

CONTENTS

OBJECTIVES

The main objective of this cruise was to investigate the structure of the continent-ocean crustal transition from Hatton Bank to the Atlantic on the northwest UK continental margin. The main techniques were: to shoot a grid of multichannel normal incidence seismic profiles to determine the thickness and shape of sediment and crustal reflectors; to run a number of two-ship synthetic aperture profiles (SAP) across the margin to image the deep structure and to measure lateral variations in velocity; to shoot a number of expanding spread profiles (ESP) along and across strke using large airguns or explosive sources to find the variation of velocity with depth; and to measure underway bathymetry, magnetic and gravity fields to help constrain models of the crustal structure.

Other objectives included determination of the crustal structure in Rockall Trough by an explosion ESP, to run a long two-ship synthetic aperture profile from Hatton Bank to Rockall Trough across Rockall Plateau and the Hatton-Rockall Trough, and to study the variations in crustal structure across small Atlantic fracture zones. The last objective had to be abandoned due to restricted allocation of seatime.

Following the abrupt cancellation in January 1985 of a planned Cambridge Ocean Bottom Seismometer and MCDSAS experiment off Sardinia, we added the deployment of OBS on the explosion lines to our programme.

BACKGROUND

This two-ship work was first proposed by us to the NERC in November 1981 and a revised version finally approved in April 1983. Seatime was initially scheduled for early summer 1984 using RRS CHALLENGER and RRS DISCOVERY. But snce the endurance of the CHALLENGER was insufficient for the cruise without an additional port call the RRS CHARLES DARWIN was allocated instead. Through the early part of 1984 the scheduled cruise dates were re-arranged many times, wth the final dates being in September 1984. Six weeks before the cruise was due to start it was postponed until summer 1985. In December 1984 the cruise was cancelled entirely by the NERC, but following protestations by us it was revived in January 1985. The final dates then remained essentially unchanged as May/June 1985, although in the last 10 days the embarkation port changed from Ardrossan to Falmouth to Govan and we eventually sailed two days later than expected due to the necessity of making repairs to the hull plating in dry dock.

NARRATIVE

The DISCOVERY sailed from Govan at 1800 (local)/137 on Friday, 17th May 1985, within a few hours of CHARLES DARWIN leaving Ardrossan. The port E-M log was calibrated by four runs along the measured mile off Arran, and then we steamed towards Hatton Bank in company with DARWIN.

Streamer Balancing

The multichannel array was streamed starting in the early evening and continuing through the night of Sunday 19th May (139). It was generally level though rather heavy. On the following day (140) we added 9 litres of oil to every section to bring the buoyancy up towards the 5 lbs per section recommended, and added 2 more depth controllers to give a total of eight. Section 3 was replaced and several hours spent fixing an open circuit. The array was deployed again by midnight (140).

Explosion ESP's and Associated Normal Incidence MCDSAS Profiles

During Tuesday 21 May (141) we shot the first explosive ESP1 with Darwin. Winds force 4 to 5 with a reasonably quiet array. We ran single-ship MCDSAS profiles through the night, meeting Darwin for ESP2 at 0824Z/142 on Wednesday, 22 May. Array well balanced except the front, which was a little deep and more noisy. All the ESP shots were successfully recorded using 90 sec record length and 5 minute triggers timed from the Cambridge clock. Both the Cambridge and Ship's DWM clocks were recorded on auxiliary channels of the Sercel, but the DWM clock jumped, or stopped, several times during the cruise and we eventually stopped recording it. Sea state remained reasonable, typically 4. After ESP2 we profiled through the night first along the profile ESP2 and then across to the north end of ESP3. We used the umbilical with four guns: 466 + 300 + 166 + 40 cu. inch at 1950 psi. With three compressors this could fire on an 18 sec. cycle, but no faster.

On Thursday morning (143) 23 May we turned south west into the line of ESP 3 and the array immediately became noisier. The wind had increased to Force 6, with an 8 foot swell from behind the ship, and this caused the array to become very noisy as the swell passed over and along it lifting it up. In general we found it to be much quieter steaming into the sea since the streamer was then held taught and did not tend to ride up with the swell. Most of the swell induced noise was low frequency, and acceptable normal incidence profiles could still be obtained with the 8 Hz low cut filter in. But this was too hard a filter for explosion sources, so the explosion ESP planned for this day was postponed.

In the early morning of Friday 24 May (144) the 466 cu. in. gun failed, and shortly afterwards a second gun on the umbilical stopped firing. Fortunately we were able to switch to an explosion ESP 4 while the guns were repaired. The fault was a worn shuttle liner in one gun, and a burst hose caused by abrasion of the high pressure air hoses in the umbilical against the supporting chain. Despite heroic efforts to protect the hoses this problem was to recur subsequently on the airgun umbilical. ESP4 became increasingly noisy as the weather worsened to approx. Force 6. In view of the poor weather we did not deploy the guns again, instead shooting an airgun ESP5 with Darwin in the early hours of Saturday 25 May (145). In the afternoon, we moved onto ESP 3 for a second attempt at the explosion ESP there with Darwin, starting at 1500z/145. But the

sea-state with a ten foot swell caused a lot of low-frequency streamer noise, so we commuted the line to a short one consisting only of twenty-three 2.1 kg charges. Through the night we profiled ESP 6, with the 8 Hz low-cut filters in, coming northwards along the line of ESP 3 on the morning of Sunday 26 May (146) for a third attempt to shoot the explosion line. This time we went ahead, observing good ground wave arrivals. But towards the end of the line the weather deteriorated.

Following the end of ESP3L we started to deploy the four-gun umbilical. During the deployment the weather worsened rapidly to Force 7 and gusting 8. At about 1420z Brian Barrett got a finger caught between the airgun support chain and a karabiner as the sea snatched at the umbilical. His finger was badly skinned and bruised, requiring penicillin treatment. By this stage in the fairly lengthy (1.5-2 hours) deployment procedure it was quicker to complete the airgun deployment than to retrieve it, so that we continued putting the guns out. We attempted subsequently to decrease the dangers inherent in deploying the airgun array and there were no further injuries. But the system should not be used again from Discovery in its present form.

During the afternoon of Sunday (146) the sea was too rough to turn so we continued head to wind until 1830z. We were then able to turn, profiling down to the northern end of ESP6 and receiving an airgun ESP6 shot by Darwin starting about midnight.

On Monday 27 May (147) we ran an airgun ESP7 with Darwin. Quality rather poor due to moderate seas, about Force 6. Ship to ship communications via the lab. radio had broken down so we reverted temporarily to the ship's radios on 2.246 MHz. Subsequently we found that the receiver side of our lab. radio had failed, but we were able to replace it with another Yaesu receiver whilst still using the lab. radio to transmit. A separate aerial aft was erected for the receiver.

During Monday night (147) the weather was better, with the sea down to Force 4, and we commenced a long normal incidence profile along the dip line of V08 across the centre of the survey area. Generally a good profile, though the weather deteriorated during Tuesday (048), with winds gusting 40 knots and a progressively noisier profile. The gyro log failed and was fixed during the line. Towards the end of the profile (2200/148) the 466 cu. inch gun failed, again due to abrasion through the pressure hoses. The streamer suffered no damage but one bird had come off its mountings and another lost one wing. The tailbuoy had lost its light and radar reflector.

Through the night we steamed to the start point of the next line and started to deploy the streamer at 1000z/149 on Wednesday 29 May. Work was delayed by a hydraulic leak on the Schatt davit and a water leak on the winch hydraulic pump. During the day we deployed the streamer, adding between 0 and 3 lbs lead weights to sections according to which we had found to be noisy over the preceeding few days work. Streamer and airgun deployment complete by 1900/149.

We profiled during Thursday 30 May (150). Streamer now well balanced and remained out throughout the remainder of the cruise. Sercel tape decks kept giving trouble due to overheating so during the rest of the cruise we kept an outside door open and watchstanders were often to be found wearing jackets and coats.

About 0100z/151 on Friday 31 May the ship's main engines failed, for about half an hour. The array dived rapidly, with the centre part reaching 250 feet, before restoration of the bow thruster gave enough way to hold the streamer up. Even when the streamer is positively buoyant it will dive when the ship stops suddenly, since it has considerable forward momentum. Power to the compressors was restored about 0400/151 as we commenced profiling the northern end of ESP1 (NI 1B). During this time the airgun umbilical drogue had become tangled around the streamer lead cable, but we were able to untangle it by reeling in the streamer a little.

Variable Offset Line V08

We turned onto the line just 5 minutes before the first shot, then recorded Darwin's explosive shots as we steamed northwestwards. Good arrivals, though weather deteriorated later with a swell of 40 to 45 foot, and winds over 30 knots. But since the swell was mainly on the beam, it did not adversely affect the streamer noise levels. Computer gyro log failed again for about 5 hours, and the forward trisponder fell off its mounting onto the deck. Both were fixed.

Airgun Expanding Spread Profiles

While waiting for Darwin to retrieve its OBSes we profiled airgun lines ESP5 and ESP10, then met Darwin on Saturday 1 June afternoon (152). The 466 cu. inch gun failed just before the end of our profiling, again due to an abraded hose, and we pulled it in during two-ship work with Darwin.

Through Saturday (152) and Sunday (153) we shot a sequence of four airgun ESP's with Darwin in moderate weather - in order ESP10, ESP5A, ESP6A, ESP7. Weather good by the end, with sea state 2-3. Were unable, despite considerable experimentation, to get our radio link to shoot Darwin's guns so they fired remotely from the Cambridge clock. Finished at 0130z/154.

Synthetic Aperture Profiles

Started the two-ship SAP's with Discovery leading at 0630z/154 on Monday 3 June. To match Darwin's array we deployed 1000 + 466 + 300 + 160 guns, with the 1000 cu. inch towed separately from the Schatt davit and the remaining three guns on the umbilical. This arrangement worked well. Depth of the 1000 cu. inch gun was adjusted to match Darwin's by measuring the bubble rise time to the surface. During the previous weekend we had competely rebound the umbilical hoses with sheathing and this proved sufficient to protect the hoses through all the subsequent five days profiling.

We successfully fired Darwin's guns via the radio link, only losing contact twice in the following 5 days due to stray tuning on Darwin's receiver. During those periods Darwin fired remotely.

The quality of the SAP's was extremely good due to fine weather (~ Force 3). The E-M log failed during Day 155 but was repaired after several hours. Completed four SAP's across the detailed survey between 0630z/154 and 1030z/156, then started on the long traverse across the Hatton-Rockall Trough, and Rockall Bank to Rockall Trough.

The 466" airgun failed again on Wednesday evening but we decided to continue without it rather than break the profile. Increased speed to 5.1 knots and firing interval to 19 sec. to complete line faster. Excellent data quality, fine weather.

Finished SAPs in Rockall Trough at 2230/158 on Friday 7 June. Ten disposable sonobuoys (new type) deployed by Discovery on line, of which only half worked.

Rockall Trough Lines

The final lines were shot in Rockall Trough over the same track: an airgun ESP, (ESP11), an explosion ESP (ESP12) and a normal incidence profile (NI11). Weather deteriorated during the final profile (1545z/159 - 0220/160), reaching Force 7, gusting 8 at the end. Airguns and streamer retrieved with no damage by 0545z/160 in Force 7, gusting 8 weather.

Passage to Falmouth

A good passage was achieved, reaching Falmouth by 2000z/161 on Monday 10 June. Average speed 12.5 knots. The entire ship's company was disgusted by an order from RVS that we were not to berth that evening but instead were to anchor offshore. There was no good reason stated for this. After 25 days hard work at sea there is no surer way than this to damage the esprit de corps of the ship's personnel.

I was particularly struck during this cruise by the low morale of the ship's officers in response to the forced redundancies of the purser/catering officers, the likelihood of forthcoming redundancies amongst other officers and the cancellation of most of this year's Discovery scientific programme. Since the first to leave are likely to be the most able people, I fear greatly for the future of marine science in the U.K. This is a sad thought at the end of an outstandingly successful cruise.

EQUIPMENT

Although we suffered numerous minor equipment failures, the hard work of RVS and IOS technicians ensured that we lost very little scientific data as a result. The new streamer and MCDSAS were a pleasure to use. The following comments are suggestions for, mostly minor, improvements to various items of equipment.

1. General

(a) The DMW clock stopped several times. I suspect that it needs a better, cleaner, power supply.

(b) The magnetometer needs a good davit fixed (probably on the port quarter) to hold it clear of the multichannel streamer. We jerry-rigged one, and restricted turns to 4 degrees per minute which was mostly satisfactory.

2. Sercel

(a) The tape drives need more cooling. It was certainly not hot on this cruise, but still they suffered from overheating at times. They might be unusable in Discovery's Plot in the Tropics.

(b) Firing Box. The firing control box worked well with its three position switch: "normal, alternate or noise". It would be helpful to have a fourth position added to make the start of digitisation a fixed interval (say 500 msec or 1000 msec) after the Sercel initialisation pulse. The reason for this is that when we were firing off our clock, or the remote ship was firing off theirs, there was a variable start-up time (typically 250 to 350 msec) from reception of the trigger signal to the time of the first digital sample. This will make analysis more complicated than it would be if we knew that the first sample was always at a fixed time after the clock initialisation pulse.

3. Multichannel Streamer

(a) Six depth levellers and depth sensors is too few for adequate control over the depth. A minimum of two more should be added (there is space in the depth control box for two more) and preferably more than two extra. More collars for the birds are needed. Though we had nine birds, we only had eight collars and one of those needed re-machining.

(b) BBC Header.

(i) Needs four digits for entering "shot spacing". At present it only has two available and we were often using 100 m shot spacing or more, so we could not enter it correctly.

(ii) It would be extremely useful to automatically feed the actual speed from the E-M log and the actual heading from the ship's gyro into the header for each shot instead of some nominal constant value we insert manually at the beginning of the line.

(iii) Can the BBC position number be made to keep incrementing while the header is being updated? At present it stops.

(c) Sercel or BBC Header. At present the only indication of the reel number is the sticky label we put on the outside. Could the Sercel or the BBC be made to write the reel number on

the tape header incrementing it as appropriate when new tapes are put on?

(d) The tail buoy needs a decent strong mast with radar reflector and photo-sensitive flashing light. The mast was lost during both main streamer deployments. The tail buoy otherwise tows well.

4. Airguns

(a) The four gun umbilical is dangerous to deploy from Discovery, and in any case is subject to continual damage from abrasion between the supporting chain and bundle of hoses and trigger leads. The airgun array must be re-designed.

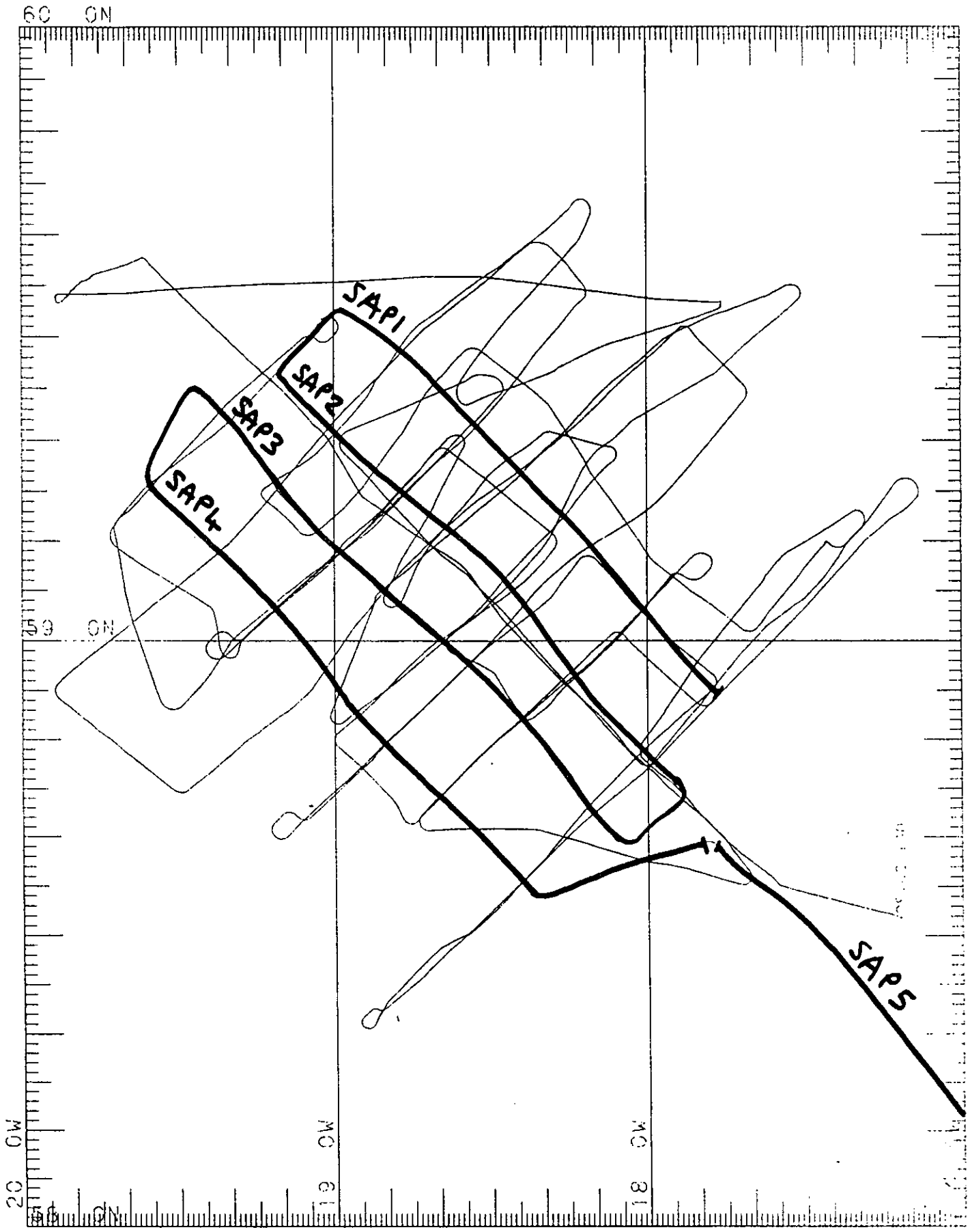
(b) It would be useful to have a davit on the starboard quarter from which a gun(s) could be streamed.

(c) The airgun array and air supply is by far the weakest part of the system. It should be upgraded if NERC are serious about supporting the high costs of multichannel seismic profiling and data processing.

(d) The airgun trigger delay unit works very well. Can we have a four-trace (or more) storage scope with which to monitor the shot instants? More sophisticated airgun arrays will require microprocessor-controlled shot instants to handle the gun firing.

DISCOVERY 155

Two-ship Synthetic Aperture Profiles, MCOSAS

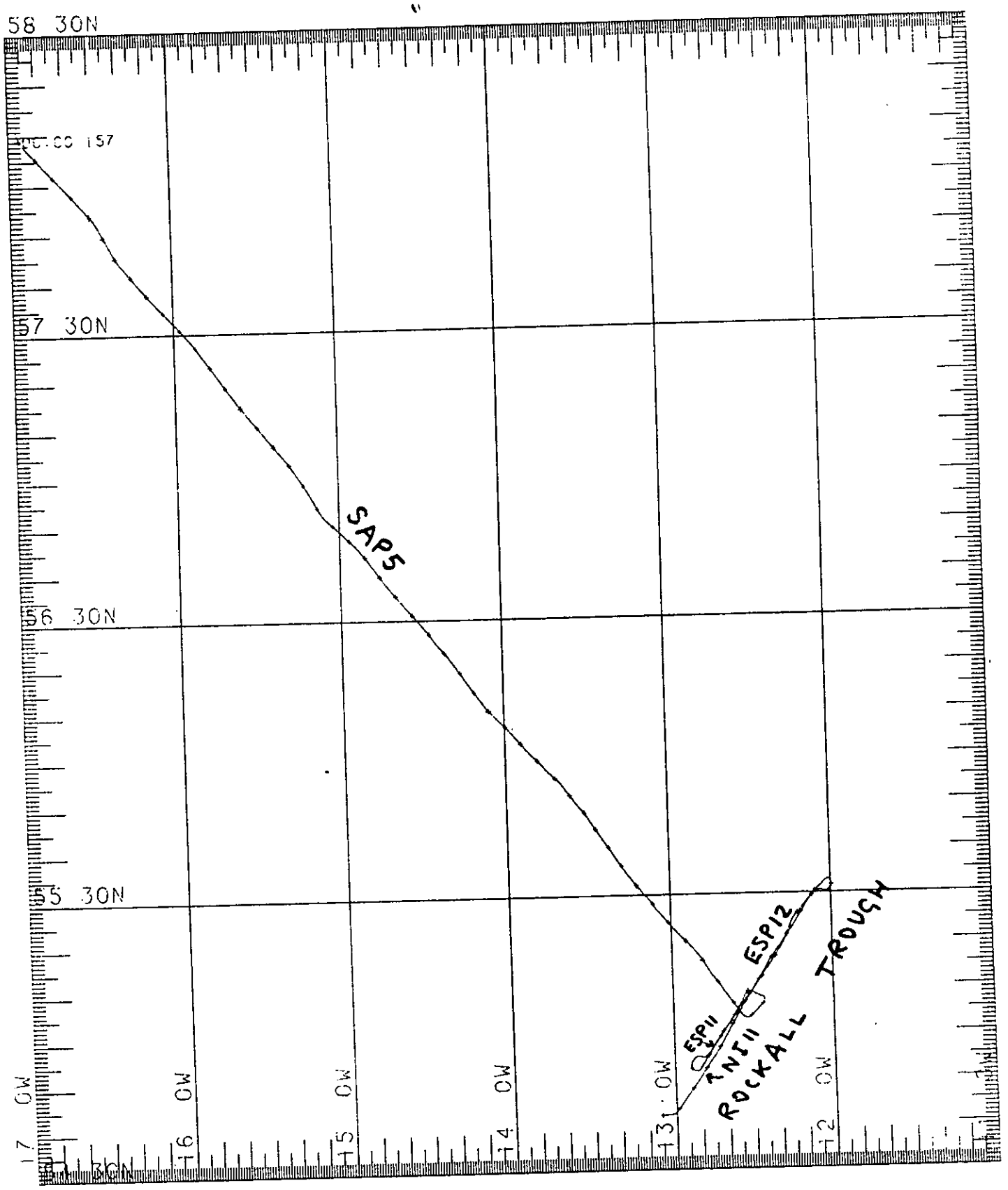


MERCATOR PROJECTION

SCALE TO 1:000000 (NATURAL SCALE AT LAT. 57.0°)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0.0N

DISCOVERY 155 (ROCKALL TROUGH)



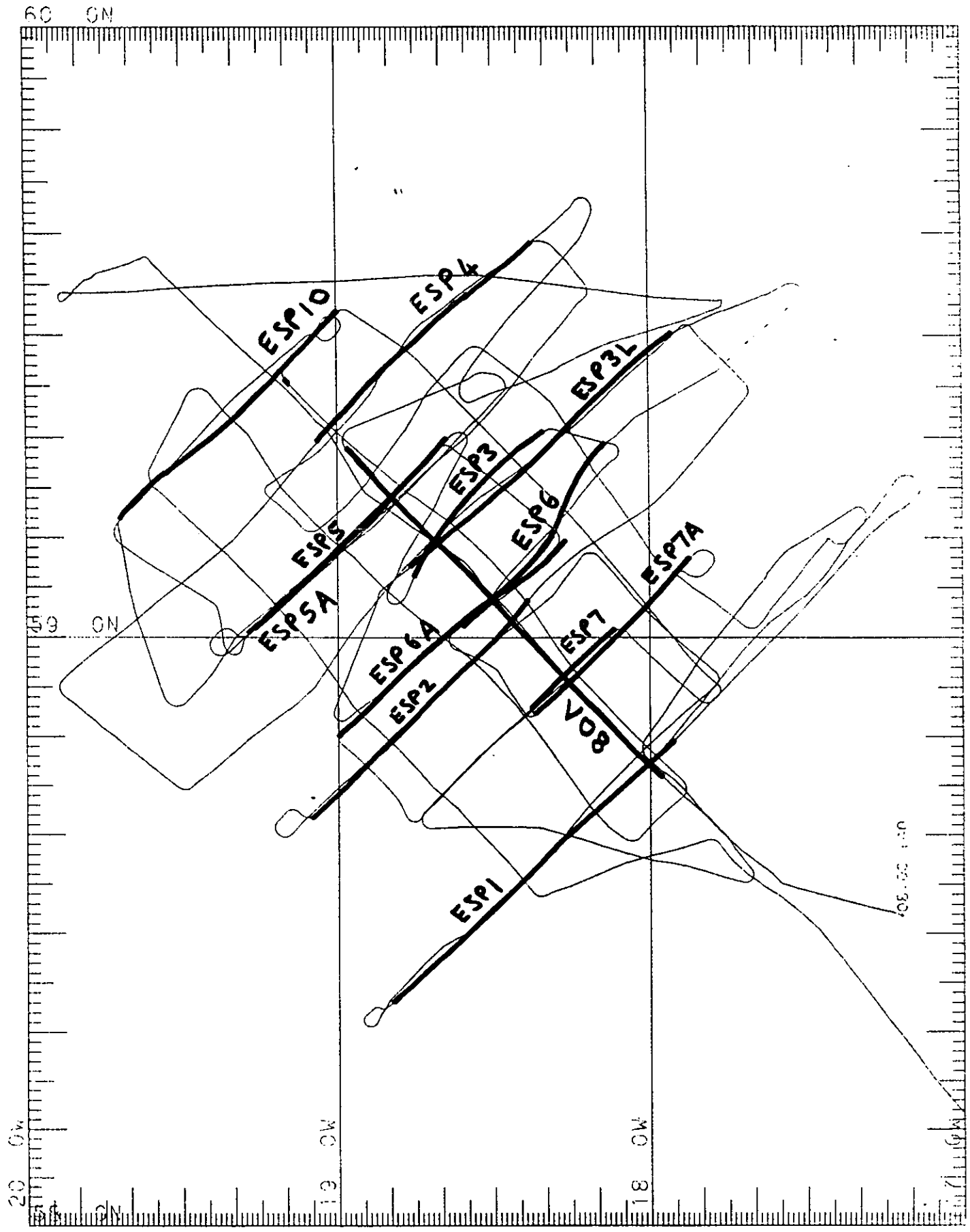
MERCATOR PROJECTION

SCALE 1 TO 2000000. (NATURAL SCALE AT LAT. 57.0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0.0N

DISCOVERY 155

Two-ship MCDSAS Expanding Spread Profiles and Variable Offset Profile



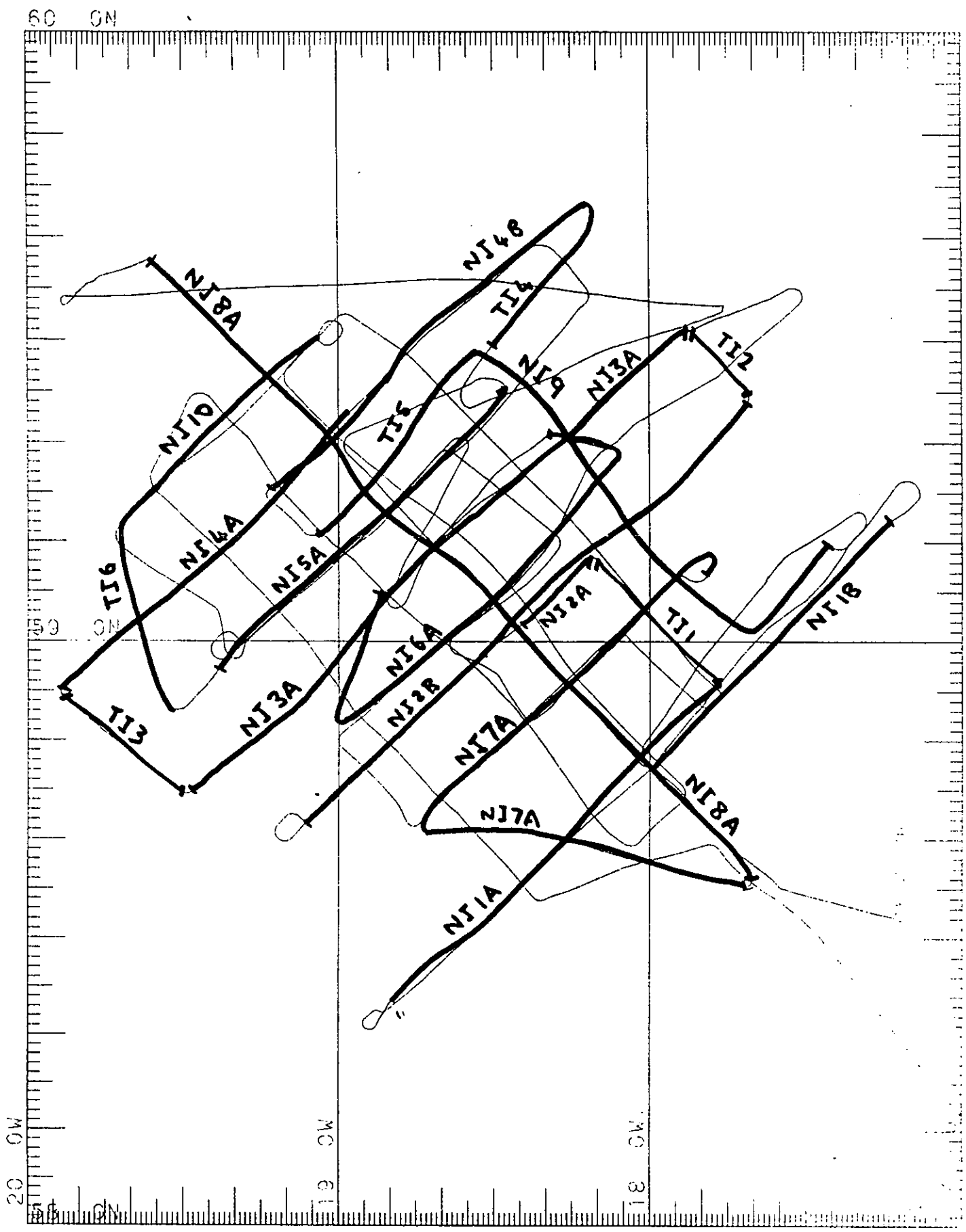
MERCATOR PROJECTION

SCALE 1 TO 1000000 (NATURAL SCALE AT LAT. 57.0°)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0.0N

DISCOVERY 155

Single-ship MCDSAS profiling



MERCATOR PROJECTION

SCALE 1 TO 1000000 (NATURAL SCALE AT LAT. 57.0)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 0.0N

APPENDIX I

Cruise Report of Proceedings

Ship. RRS DISCOVERY Cruise No 155

Cruise Dates (Inclusive, port to port) Friday, 17th May - Tuesday, 11th June, 1985

It is requested that the following aspects of the cruise may be covered in this report of proceedings for dispatch or delivery to the Director, Research Vessel Services immediately on return to port.

a) Main objectives of the cruise.
b) Geographical area. Reference stations or points in latitude and longitude.
c) Sea and weather conditions encountered.
d) Conduct of cruise, main problems encountered and success or otherwise of the programm
e) Equipment performance.
f) Ship performance.
g) Any recommendations.
h) Signature and date.

Brief comments are preferred but if necessary please continue on another sheet.

---

a) Main Objectives

The main objectives were to carry out a series of two-ship multi-channel seismic experiments with RRS CHARLES DARWIN to investigate the nature of the continent-ocean transition west of Hatton Bank, northwest U.K. continental margin. A second, shorter experiment was done in Rockall Trough to determine whether the crust there is oceanic or continental. Underway geophysical measurements and single-ship MCDSAS were also required.

b) Geographical Area

The main detailed survey was within the limits 58°30'N-59°35'N and 17°30'W-20°00'W. The Rockall Trough line was centred at approx. 55°00'N, 12°30'W.

c) Sea and Weather

During the first half of the cruise the sea was moderate, typically Force 4-6, often with a heavy swell and with occasional blows of Force 7 or 8. The MCDSAS was too noisy to be worth using above Force 5 or 6. The heavy swell affected the streamer particularly badly, especially when we were running in the same direction as the swell. About two or three days work were lost due to heavy weather. During the second half of the cruise we enjoyed rather better seas and recorded excellent MCDSAS data.

d) Cruise Conduct and Programme

The cruise was very successful and all the objectives were met. The lateness of departure from Govan (Friday instead of Wednesday), meant that we did not have as much time as planned to balance the streamer, and it was not until mid-way through the cruise on our third deployment that I was satisfied that we had it right. Some of the MCDSAS data from the first half of the cruise is as a consequence less good than it could have been. No major problems were encountered. We maintained good communications with Darwin and the time of both ships was

profitably spent. In total we recorded 1490 km of single ship MCDSAS profiles, 1000 km of two-ship synthetic aperture profiles, seven two-ship explosive lines and eight airgun expanding spreads. We ran over 400 km of magnetic tape through the Sercel MCDSAS.

e) Equipment Performance

We had a host of generally small problems and breakdowns, more perhaps on this cruise than is usual in my experience. The technicians worked splendidly to repair or to provide alternative systems, and very little scientific data was lost as a result of the failures. That this is so was due entirely to the dedication and hard work of the technicians aboard. The digital streamer and acquisition system was a pleasure to use after my earlier experiences with the ailing Geomechanique and analogue tape decks. The biggest and continuing weakness lies in the airgun source array. Even when the four-gun array provided by RVS is working correctly, it is quite inadequate by any commercial seismic profiling standards. But in addition it was difficult, and in heavy seas dangerous, to deploy and it suffered many breakdowns due to abrasion of the high pressure air hoses against the supporting chains. Rather little data was lost as a result of gun failure, because our joint work with Darwin left periods when it could be recovered and repaired. But it should not be used again in its present form, and a serious attempt should be made to upgrade the airgun source array if it is to be made compatible with the standard of the streamer and recording side.

The computer logging and data reduction system was excellent and we left the cruise with complete sets of all the plotted and merged data we required. Perhaps more importantly, due to the necessity of navigating two or three or more times precisely down the same lines, Kay Potter was able to provide the bridge daily with large-scale plots of up-to-date navigation tracks. All the bridge navigation was done on these plots which proved a most valuable aid.

Over the last decade we have come to rely increasingly on RVS technical support. This was particularly so on this cruise where we used very little of our own equipment. It is a pleasure to report on the professionalism and enthusiasm of the technicians who sailed with us. The success of this cruise is due in no small measure to their efforts.

f) Ship Performance

As with the RVS technical support, the ships services provided by the ship and its officers and crew were excellent. Breakdown on the outward passage of the alternator providing power for the compressors threatened to ruin our seismic profiling plans, but by a great deal of hard work the engineers stripped and repaired it. The compressors operated well throughout the remainder of the cruise and we lost no scientific time from this fault. The main engines failed once, for about half an hour, and we lost about 4 hours profiling before the compressors could be restarted. The loss was not serious as it occurred on a passage track.

3.

g) Ship Scheduling

This particular cruise has been subject to enormous scheduling uncertainty. Over the past two years since it was approved and funded by the NERC, the ship has changed from CHALLENGER to CHARLES DARWIN to DISCOVERY; successive dates changed frequently through the summer of 1984 before being postponed by a year six weeks prior to sailing; the cruise was cancelled entirely by the NERC in December 1984 and re-instated in January 1985; and the departure port changed from Ardrossan to Falmouth to Govan in the last two weeks. Some of these changes are inevitable consequences of marine operations. Others are not. I have written elsewhere about the enormous damage such vacillation in cruise scheduling is causing to the scientific community.

Even harder to understand as I sit in my cabin on DISCOVERY at anchor outside Falmouth at 8 pm is why the ship has not been allowed by RVS to berth this evening, but must wait until the morrow. After 25 days of working 24 hours per day in not particularly pleasant seas, the morale of 49 people and their attitude to the NERC has been considerably dented. Surely whatever, if any, minor financial savings accrued by not berthing in the evening are not worth the loss of morale engendered in the personnel by such actions.* It is the only sour point of an otherwise extremely successful cruise.

h) Recommendations

A full set of minor recommendations concerning the MCDSAS are in the main cruise report; none are sufficiently important to recite here since their main function is simply to make minor improvements. Methods for deploying multiple airgun arrays need to be redesigned to be safer to deploy and retrieve and less subject to damage during normal operation. If the multichannel profiling system is to come close to the routine standard available from commercial operators the airgun source needs to be considerably enhanced with more air available and the use of properly designed airgun arrays to give a good source signature.

Robert S White

14 June 1985

* Footnote

The logistics of having both ships arrive simultaneously on Tuesday morning caused unnecessary and annoying delays in demobilisation. Following telex orders received at sea we re-arranged our transport to arrive at 8 am on Tuesday 11th. In the event we didn't berth until past 9 am, and customs weren't cleared until after 1 pm. The limited crane time available meant that we didn't finish loading our lorry until very late in the afternoon. Had DISCOVERY berthed on Monday evening, much of this hanging around on Tuesday would have been avoided.

Appendix 2 : Cruise Statistics

Total voyage time : 589.7 hours = 24.5 days

Total station time : 485.5 hours = 20.25 days

Underway bathymetry, magnetic and gravity profiles : 5800 km

Multichannel Digital Seismic Lines

Normal incidence profiling	:	1490 km
Synthetic aperture profiling	:	1040 km
Explosive expanding spread profiles	:	Total 6
Explosive variable offset profiles	:	Total 1
Airgun expanding spread profiles	:	Total 8
Total digital tape useage	:	1074 (approx. 400 km of digital tape)

Appendix 3

List of main seismic lines recorded on Sercel

1. Normal Incidence Profiles

48 channel; 4 msec sampling; source (466 + 300 + 160 + 40) cubic inch airguns at 1900 psi; approx 50 m shot point spacing.

Identification	Tape Numbers	Start and End Times	No. of hours
NI1A	17-63	1835/141-0308/142	8.5
NI1B	514-534	0442/151-1029/151	5.8
NI2A	64-68	0649/142-0807/142	1.3
NI2B	77-120	1625/142-0450/143	12.4
NI3A	128-170	0649/143-2135/143	14.8
NI4A	177-195	0124/143-0808/144	6.7
NI4B	440-468	2359/149-0900/150	9.0
NI5A	552-570	2320/151-0626/151	7.1
NI6A	223-265	1820/145-0754/146	13.6
NI6B	274-285	2000/146-0000/147	4.0
NI7A	314-362	1219/147-0308/148	14.8
NI8A	363-427	0322/148-2240/148	19.3
NI9	483-513	1445/150-0015/151	9.5
NI10	581-592	1300/152-1717/152	4.3
NI11	1033-1074	1555/159-0220/160	10.5
TI1	50-63	0309/142-0648/142	3.6
TI2	121-127	0450/143-0649/143	2.0
TI3	171-177	2307/143-0124/143	2.3
TI4	428-439	2001/149-2359/149	4.0
TI5	469-482	1026/150-1438/150	4.2
TI6	570-580	0900/151-1300/152	4.0
			161

* NOTE. TI prefix are usually short tie-lines between strike profiles.

2. Synthetic Aperture Profiles

48 channel; 4 msec sampling; source [1000 + 466 + 300 + 160] cubic inch airguns at 1900 psi; approx. 100 m shot spacing.

Identification	Tape Numbers	Start and End Times
SAP1	651-688	0634/154-1748/154
SAP2	689-734	1748/154-0710/155
SAP3	735-780	0710/155-2235/155
SAP4	781-830	2235/155-1502/156
SAP5	831-1012	1502/156-2230/158

3. Explosive Expanding Spread Profiles

48 channel; 4 msec sampling; source 2.1 to 50 kg charges fired from RRS CHARLES DARWIN at 7 min. intervals; approx. 2100 m spacing.

Identification	Tape Numbers	Start and End Times
ESP1	8-16	1858/141-1613/141
ESP2	69-76	0824/142-1415/142
ESP3	219-222	1456/145-1758/145
ESP3L	266-273	0824/146-1428/146
ESP4	196-202	0824/144-1339/144
ESP12	1025-1032	0755/159-1408/159

4. Explosive Variable Offset Profile

VO8	535-551	1100/151-1950/151

5. Airgun Expanding Spread Profiles

48 channel; 4 msec sampling; source (3 x 1000" + 2 x 300") cubic inch airguns on RRS CHARLES DARWIN; approx. 300 m shot spacing.

Identification	Tape Numbers	Start and End Times
ESP5	203-218	0423/145-0940/145
ESP5A	606-624	0354/153-1142/153
ESP6	286-299	0012/147-0459/147
ESP6A	625-638	1202/153-1735/153
ESP7	300-313	0617/147-1103/147
ESP7A	638-650	2033/153-0149/154
ESP10	593-605	1851/152-0010/153
ESP11	1013-1024	0040/159-0404/159

Appendix 4

Table of Julian Day Numbers

	Date		Julian Day No
Sa	18	May 1985	138
Su	19	"	139
M	20	"	140
Tu	21	"	141
W	22	"	142
Th	23	"	143
F	24	"	144
Sa	25	"	145
Su	26	"	146
M	27	"	147
Tu	28	"	148
W	29	"	149
Th	30	"	150
F	31	"	151
Sa	1	June 1985	152
Su	2	"	153
M	3	"	154
Tu	4	"	155
W	5	"	156
Th	6	"	157
F	7	"	158
Sa	8	"	159
Su	9	"	160
M	10	"	161
Tu	11	"	162
W	12	"	163

Appendix 5

PEOPLE

Scientific

Bob White	Cambridge
George D. Spence	"
Mathias Joppen	"
Susan R. Fowler	"
Beverley F. Smith	"
Peter W. Carter	"
Graham J. Tiley	Birmingham
Adrian N. Bowen	Durham
David Teare	R.V.S.
Tony R. Cumming	"
Derek Lewis	"
David G. Booth	"
Richard Phipps	"
Brian Barrett	"
Kay E. Potter	"
Robin N. Bonner	I.O.S.

Ship's Officers

Michael A. Harding	Master
Pony Moore	Chief Officer
Terry Morse	Second Officer
Paul Peppler	Third Officer
Raymond Morris	Purser/Catering Officer
Ian R. Bennett	Chief Engineer
Thomas A. Rees	Second Engineer
Alexander Greenhorn	Third Engineer
Timothy Comley	Fourth Engineer
Kevin Sullivan	Fifth Engineer
Barry Smith	Electrical Engineer
Eric Rodgers	Radio Officer
Martin Harrison	Chief Petty Officer (Deck)

APPENDIX 6

GRAVITY METER READINGS

S84 (0.9967) (CHARLES DARWIN)

	METER READING (UNITS)	GRAVITY TRANSFERRED TO SHIP (mg)	
FALMOUTH	12322.6	981089.224	25 Jan 85
FALMOUTH	12323.6	981089.17	7 Feb 85
FUNCHAL	10997.5	979770.12	7 March 85
BARBADOS	9503.0	978279.89	18 March 85
BARBADOS	9508.6	978280.08	2 April 85
FUNCHAL	11007.2	979770.99	25 April 85
ARDROSSAN	12816.0	981575.16	14 May 85

S86 (0.9988) (CHARLES DARWIN)

	METER READING (UNITS)	GRAVITY TRANSFERRED TO SHIP (mg)	
FALMOUTH	12478.5	981089.224	25 Jan 85
FALMOUTH	12480.6	981089.17	7 Feb 85
FUNCHAL	11157.5	979771.7	7 March 85
BARBADOS	9664.2	978281.10	18 March 85
BARBADOS	9672.6	978280.00	2 April
FUNCHAL	11173.1	979771.7	25 April

S40 (0.9917) (DISCOVERY 154, 155)

	METER READING (UNITS)	GRAVITY TRANSFERRED TO SHIP (mg)	
FALMOUTH	9361.0	981089.588	Nov 84
GLASGOW	9868.8	981587.84	13 May 85
FALMOUTH	9361.0	981089.34	10 June 85

GRAVITY METER DRIFT RATES

METER S.40 (CAL. 0.9917) [METER INSTALLED IN GRAVITY ROOM OF DISCOVERY]

BASE TIE-IN WITH REFERENCE TO SHEETS (A) - (E)

FALMOUTH - GLASGOW Nov 84 - May 85

+0.032 mg day^{-1}

GLASGOW - FALMOUTH

+0.17 mg day^{-1}

FALMOUTH - FALMOUTH

NIL (Zero Drift) : Suggest using zero drift rate since MSG gravity base station at Glasgow is a bit suspect.

SHEET A

RESEARCH VESSEL SERVICES

GRAVITY AND MAGNETIC SECTION

GRAVITY BASE STATION

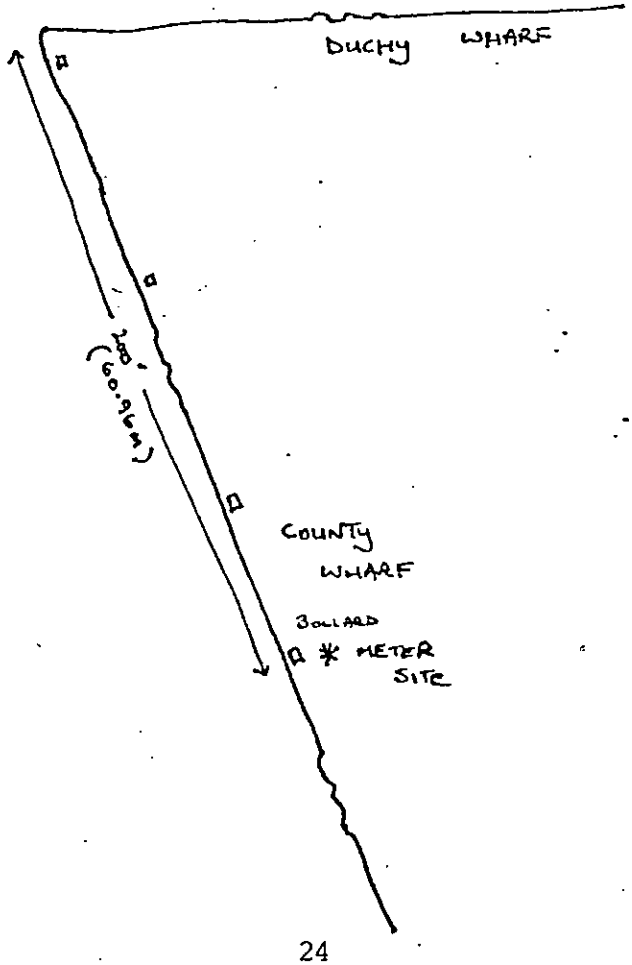
SITE DESCRIPTION:- COUNTY WHARF METER ON DISH, 200 FEET FROM DUCHY WHARF CORNER (FOURTH MOORING BOLLARD) 17·9 FEET ABOVE LOW WATER LEVEL

METER WORDEN 'PROSPECTOR' No. 769 MDL 112 DAL CONSTANT 0.08822
TIED TO TROON, CORNWALL FBM, VALUE 981026·651

NGRN 73

LATITUDE
050° 9·12′ N
LONGITUDE
005° 3·52′ W
METER NO WORDEN 769 MDL112
METER READING
CORRECTION FACTOR
0·08822
DATE/TIME
15th JULY '81
G VALUE: 981088·145 MG *
* NOT CORRECTED FOR EARTH TIDE EFFECT
OBS. STEVE JONES RVS.
PORT FALMOUTH CORNWALL

SKETCH PLAN:



E

GRAVITY BASE STATION

008 .30

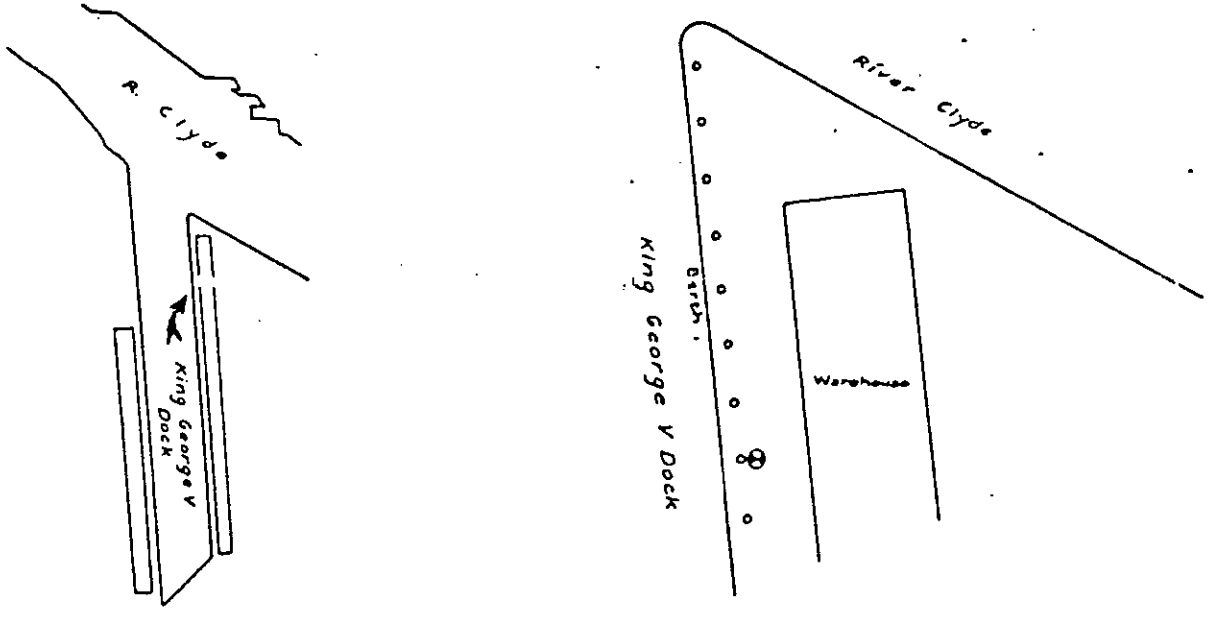
LAT. 55° 52'.25N
LONG. 04° 21'.05 W
CHART REF. BA 2007 (Plan C)
OTHER REF. NAVO 0039.13

COUNTRY/STATE UNITED KINGDOM - SCOTLAND
TOWN/CITY GLASGOW
STATION NAME KING GEORGE V DOCK
IGSN 71 g= 981 588.0 mgals

STATION DESCRIPTION

The station is situated at Berth 1 on the eastern side of the dock, 0.3 metres east from the eighth bollard from the northern end of the wharf.

LOCATION DIAGRAM



OBSERVATIONS/CONNECTIONS

Date	Observed by	Instrument	Ref. Station	Value	Δg	
0 JUN 74	NAVOCEANO	LRG - 76	008.29	981 588.0	+0.02	ABABA