BRAN 778:
RRS Bransfield
Scotia Sea
Geophysics
December 1977 - February 1978

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1. Introduction

The British Antarctic Survey's 1977-8 summer programme included 30 days aboard RRS Bransfield allocated to marine geophysics. For three previous seasons, Bransfield had acquired satellite-fixed magnetic data for the Birmingham University Geology Department group, but the 1977-8 season was the first in which considerable time above shortest passage time was made available, and in which a geophysical method other than magnetic survey was attempted. Since a similar arrangement is planned for the following three seasons there is considerable interest in such logistic and other difficulties as might have been encountered. For this reason, this preliminary cruise report is rather long and detailed.

The 30-day marine geophysics period was to start after the relief of the BAS base at Halley Bay at the end of December, and finish at South Georgia in early February. An additional call at South Georgia midway through this period was required by BAS, to which later was added an earlier call at the Signy I. base in the South Orkney Is. These base visits, within the geophysics period, were unfortunate from our point of view because they caused additional low-value passage time, but were unavoidable. The geophysics time was to be reduced if the Halley Bay relief was protracted.

NERC had provided Birmingham with funds for sufficient fuel for 30 days of one-engine steaming (a nominal 12 tons per day, providing a maximum speed of 10 kts). Two-engine steaming was rated at 20 tons per day and furnished 13 kts maximum. In addition, up to £13k had been made available within the 1977 refit for modifications to fit the ship for the expanded geophysical programme.

The major addition to previous seasons' capabilities was a seismic reflection profiling system with air gun source, but there was also a second satellite navigator and a standby echo sounder with towed transducer. The installation and performance of all the equipment is discussed in Section 4 below. In summary, although individual items did fail to work, the programme was not significantly impaired by equipment malfunction and, provided some modifications are made, the ship appears to be a perfectly viable platform for a programme of this kind. The ship's officers and crew were very friendly and co-operative, and base personnel gave willing and efficient help with watchkeeping.

The main objectives of the marine geophysical work lay in the northern Weddell Sea and southwestern South Atlantic. All were concerned with the tectonic evolution of these areas, as shown by the magnetic anomaly pattern produced by sea-floor spreading. In addition, reflection profiles were required in the northern Weddell and central Scotia Sea, partly for similar purposes but partly also against the day when further deep-sea drilling might be possible in circum-Antarctic waters, to examine the history of circulation and climate.

As the narrative (Section 2) describes, delays in Halley Bay relief meant that not all of these objectives could be pursued. The three surveys which were accomplished, however, all achieved their aims, so that to this extent the season may be counted a success. It remains to be assured that in future seasons a more realistic estimate will be built into the programme of the time required for Halley Bay relief.

2. Narrative

RRS Bransfield sailed from Port Stanley for South Georgia on 20th December 1977 but the magnetometer was not streamed until 22nd, in 48°W and more than 300 miles from the Falkland Is.. The line was an insignificant deviation from shortest passage, running along the southern margin of the North Scotia Ridge and Shag Rocks block, to Bird I. (ship tracks along which geophysical data were acquired are shown in Figure 1). After watering alongside at Grytviken (whaling station) the ship left South Georgia for Halley Bay on 26th December. Since the ship had been advised to make some easting to avoid pack ice, a useful magnetics line was agreed, running southwest across the eastern Scotia Sea to pass 10 miles south of Montagu I.; thence to 60°45's and 19°W to sample the anomalies on one side of the SW Atlantic spreading centre. The track then ran due south along 19°W to 69°S where pack ice was encountered on 30th December and the magnetometer had to be recovered. The line south from there represents an echo sounding profile only, the ship arriving off Halley Bay finally on 3rd January after having spent some time immobile in 7-8 oktas pack.

Base relief was made difficult by a 2 mile-wide region of rough, hummocked sea ice between ice-shelf and ship, and was not complete until 14th January. At one stage (5th January) the ship even left the Halley Bay area to attempt some geophysical work while ice conditions there improved. It was stopped, however, only 30 miles to the north by that same belt of thick pack jamming the shore lead which it had found difficult to negotiate earlier, and returned to the vicinity of the Base after only 12 hours away.

The ship left Halley Bay finally, late on 14th January. The same belt of pack ice still lay to the north, and although the magnetometer was streamed three times in the next few hours it did not stay out for long. Only when the ship reached open water in 70°S 23°W on the 16th January could the geophysical programme start in earnest. By now a revised ship's itinerary had been agreed, which included a 14th February arrival at Mar del Plata and calls totalling 4 days at Signy I. and Grytviken (twice). The two calls at Grytviken had additionally to be separated by about a week, at least. Thus, excluding unproductive passage time, only 19 days were left for the geophysics programme instead of the 30 days planned, the remainder having been consumed by the unavoidably protracted approach to, relief of and departure from Halley Bay.

It was decided to devote exactly 6 days between the two Grytviken visits to work east of the South Sandwich Is., to complete the examination of the SW Atlantic spreading centre started on the way to Halley Bay. This was a gamble, since much of that time would be used in getting to and from the work area and it was possible that more time would be needed in the event to complete the job; it was however all that could be spared. Secondly, the Signy to Grytviken passage was lengthened to 3½ days to permit an optimal reflection profiler line to be obtained across the central Scotia Sea. The remainder of the time, about 11 days, could be spent in the northern Weddell Sea. Because time was short, it was decided to use 2 engines for all of the time which was not to be spent reflection. profiling, despite the lower cost-effectiveness, in order to complete as much of the original programme as possible, and to cut reflection profiling time to the minimum necessary for tectonic (as opposed to palaeo-circulation) studies.

In the Weddell Sea, the first problem was to find the true orientation of the ridge crest/fracture zone system whose gross orientation had been shown by our existing data to run slightly north of east. Accordingly, ,a detailed magnetic survey was undertaken of the area centred on 66°S 30°W, on a section of the most prominent anomaly which would be clear of ice and seemed likely to contain a large fracture zone offset. The area was reached on 17th January and after 30 hours of detailed survey, in, poor weather conditions, it was obvious that the truth was less simple it seemed likely that a number of smaller fracture zone offsets existed, rather than one large offset. Nevertheless the reflection profiler was streamed and two crossings made to see if, despite this, some sub-sediment fracture-zone topography might be discerned.

Meanwhile, Bransfield had made contact with RV "Explora" whose chief scientist, Prof. Dr Karl Hinz, was aware of our pre-occupations. He reported that, on a direct passage across the Weddell Sea on the way to the margin near Kap Norvegia, his ship had passed over a sub-sediment elevation between 65°27'S, 26°59'W and 66°53'S 24°09'W, which might be of interest to us. The shape of this body and its extent away from this single track were unknown, but on the strength of the possibility that RV Explora might have run exactly along the top of a long narrow fracture zone ridge such as we were seeking, Bransfield headed across to 27°W. The first crossing of Explora's track on 20th January showed that the feature was indeed a narrow ridge, and had a typical small complementary trough, on its northern side. Over the next 3 days the ship followed the ridge northwestward, zigzagging repeatedly across it in ever-improving weather, until it emerged from beneath the sediment cover in the vicinity of 64°s 33°W. The exposed rough sea-bed topography in this area, whose ridgelike nature and orientation had been our second target in the Weddell Sea, was thus very satisfactorily shown to be only the exposed northern end of a fracture zone set extending far to the southeast. This is a very promising result, a real step forward in our understanding of Weddell Sea evolution.

To round off the survey, the next two days (23rd to 25th January) were spent in obtaining two long magnetic profiles parallel to but avoiding the fracture zone ridge, to attempt to find its age and the offset along it, with a further short reflection profiler traverse of the ridge at the southeastern end. By then it was time to head for Signy I., which was reached early on the 27th.

After 36 hours at the Base, the ship headed east, for a crossing in about 42°W of the S. Orkney trough, here abnormally shallow. The southern end of the profiler line was reached late on the 29th and the ship was at first able to obtain a good seismic profile at a speed of 7½ kts, using only 800 shp. The weather subsequently deteriorated, however, and the northern end of the line near Shag Rocks was completed at 2½ to 5 kts (still obtaining good data) and at up to 1700 shp!

The ship arrived at Grytviken on the morning of the 1st January and spent 24 hours watering before sailing southeast for the southwest Atlantic survey. The intention was to pass directly south of Bristol I. via 58°S 30°W, which would at least produce one useful line directly west of the S. Sandwich Is. on what would otherwise be a rather low priority passage to the area of real interest. Bad weather, however, made it inadvisable to alter eastward at 58°S 30°W and the existing course was maintained so that the ship instead Passed directly south oF S. Thule before altering (the Bristol I. line was eventually obtained on the return journey). There followed 2 days of magnetic survey of the area between the South Sandwich Trench and the most southerly known active spreading section of the SW Atlantic spreading centre, along lines sub-parallel to the track followed on the way to Halley Bay, and controlled also by the known distribution of earthquakes along the active plate boundary. A high degree of consistency was noted between anomalies on adjacent tracks, a promising sign for the eventual computer-aided deduction of age and spreading history of the region.

The ship returned to Grytviken on 8th February as scheduled and sailed next day for Mar de1 Plata. The magnetometer was towed to 49°W on a line very little different from the direct passage line. Before arrival at Mar de1 Plata the geophysical equipment, data, spares etc. were all stowed in the Dry Lab and locked away.

3. Cruise Statistics

A Port Stanley to. Mar del Plata

At anchor or alongside	17.4 days
Unusable passage time (wrong area)..	6.4
" " " (ice)	6.0
Geophysical data acquired	26.2
" down time (equipment failure)	0.0
Total- time	56.0 days

B

Total time charged to UBIRM	22.2
Unusable " " " " (ice)	2.4
Data acquired in charged time	19.8
" " on uncharged passage	6.4

C Magnetics

		hrs	km	kts
Port Stanley - S. Georgia	0045/356-0545/357	29	679	12.6
S. Georgia - Halley Bay	1820/36O-1045/364	88.4	2135	13.Ø
Halley Bay - Signy I.	0820/016-0350/027	-259.5	4433	9.2
Signy - S. Georgia	0000/029-0240/032	74.7	1032	7.5
S. Georgia - S. Georgia	1640/033-1200/039	139.3	2880	11.2
S. Georgia - 49°S	1500/040-0400/042	37	802	11.7
Totals and average		627.9	11969	1Ø.29

D Reflection Profiles

		hrs	km	kts
Weddell Sea	1830/018-0820/023) 6430/024-1030/024)	109.8	1222	6.0
Scotia Sea	172Ø/Ø29-21ØØ/Ø31	51.7	565	5.9
Totals and average		161.5	1787	5.98

4. Equipment

Most of the equipment discussed below (magnetometer, standby echo sounder and satellite navigation receiver, and almost all of the reflection profiler) was provided by the Marine Scientific Equipment Service of IOS, based at Barry, South Wales, and installed by them before the ship left Southampton. This equipment was maintained aboard ship by Chris Paulson of MSES with valuable assistance and advice on the mechanical side from Chief and 2nd Engineers. A watch in the lab. was kept mainly by BAS personnel on their way to or from a wintering base, and the equipment on the bridge(echo sounder, satellite navigator) was tended by the deck officer on watch.

A. Echo Sounder. The recorder and transmitter units of the ship's echo sounder were overhauled at MSES during the 1977 summer and worked well throughout; one hull-mounted transducer gave a much better signal than the other, but the reason for this is unknown, More important than the reliability, however, is the general signal-to-noise ratio, which was poor: in even moderate weather the echo was often lost, particularly in areas of rough bottom topography. Much of the bathymetry of the central Scotia Sea track, for example, will have to be obtained from the reflection profile.

In the previous season (1976-7) the sounder had failed early on and given no more data, and had an earlier history of unreliability. The MS 38 is no longer manufactured and the impression had been formed, rightly or wrongly, that Kelvin Hughes was no longer too interested in maintaining it. In view of this it was thought wise to borrow an additional MS 38 from MSES; the transducer for this system was in a towed fish and operated at 10.2 KHz rather than the 9.6 KHz of the shipboard set, so that the two systems were not compatible. The towed transducer was tried on the way to Halley Bay, suspended from the speed crane aft, but the noise from nearby engines and screw was much too great. After Halley Bay the transducer was tried again, towed from the forward crane, a position close to that of the hull-mounted transducers. There was still rather more noise (in fine weather) than on the hull-mounted unit, so that, while the towed transducer could have been used at reduced speed had the ship's set failed, we did not consider it worthwhile to keep it streamed routinely (brash ice and bergy bits being a further disincentive, and recovery in a seaway, promising to be hazardous).

Thus the ship's echo sounding capabilities are not strong; a fortuitous distribution of good vs. bad weather, flat vs. rugged topography, and profiler use meant that few data were lost this season, but another year the results could So much poorer. Essentially the ship's system (properly overhauled) is probably reliable, but has a poor signal-to-noise ratio, Short of buying a new machine (with the advantage of dry paper recording?) the best way of improving things would be to replace the steel of the ship's bull beneath the transducers with a flush fibreglass plate, as is done routinely in research ships. In Bransfield's case it would be necessary to reconcile this with her activities in ice, but this should be possible provided a suitable material and thickness were used. This would probably have to be done to effect a real improvement even if a new sounder were to be bought. In addition, it would be worth providing back-up for the present machine by converting the MSES recorder and transmitter to the frequency of the shipboard unit (and thus abandoning the idea of a towed transducer since as I understand this cannot be converted), and removing and checking thoroughly the two hull-mounted transducers while the ship is drydocked this summer.

B. Magnetometer. Installation and operation of the Barringer magnetometer was straightforward, as in previous seasons. The towed fish was generally streamed through the starboard beam or quarter fairlead, to keep it away from airgun and streamer leads (qv). The equipment was noisy at times, and gave a low signal on certain courses despite use of "omnidirectional" bottles. The entire lab. vibrated at full speed, and vibration frequencies could be seen modulating the precession signal envelope, but the cause of this was unclear; no fault could be found with fish or inboard units. Other noise was generated electrically, fluorescent light fittings close to the cable run being a particularly powerful source, Despite this noise, no magnetic data of any consequence were lost.

C. Satellite navigation. The poor reliability in previous seasons of Birmingham's single-channel Redifon receiver on the bridge persuaded us to supplement it for 1977-S. A (mostly) new Magnavox Z-channel set was made available by MSES at the last minute, and installed in the lab., but came without spares. The Redifon receiver's performance on the N. Atlantic crossing in October became unacceptably bad and a Redifon technician flown to Mayport, Florida, found corrosion by salt of the aerial. This was repaired and refitted, and a spare aerial. This was repaired and refitted, and a spare aerial dome flown to Valparaiso; the original repair was examined in Port Stanley but not replaced, and gave good results all the way to Mar del Plata in February. A computer fault which had developed on the way from Palmer Station in early December was cured in Stanley by a thorough check of earthing points and card seatings with Dick Kressman's help, and no further problems developed. One satellite (A = 7440.5) gave a consistently high number of 04 fixes with apparently good doppler data consistently being edited out, but the reason for this is unknown.

The Magnavox receiver worked well only until Christmas Day in South Georgia, when a front-end computer fault developed which could not be eliminated simply, and could not be repaired because of the lack of shipboard spares and of opportunities to send any out. It should be noted that, before this failure, the Magnavox receiver worked sufficiently well to demonstrate the adequacy of the aerial siting, atop a 30 foot mast on the helicopter deck.

D. Reflection Profiler. The profiler was made up of

1 Reavell SATC 7H compressor with diesel drive
1 large, 1 small Bolt airgun with firing box
2 x 2 channel Geomecanique hydrophone streamer on partitioned winch drum
1 Fortune 24-channel amplifier-filter set
1 12-channel tape pre-amplifier
1 Bell Howell 1" tape deck
3 Kemo filters
2 EPC flatbed recorders

The compressor and its diesel prime mover were located in a container sitting on wood blocks and wired down onto the starboard side of the main deck directly forward of the helicopter deck. Enough compressed air was provided to fire a 160 CU. inch-chambered gun once every 16 seconds at 1600 psi. The diesel engine used about 1½ gallons of fuel per hour, brought by lab. watchkeepers from a pump at the after end of the boat deck. Watchkeepers also checked oil levels periodically and drained liquid from the compressor chambers and reservoir bottle. Where the compressor was located, the ventilation louvres could not be exposed; sliding panels are needed to replace the existing hinges. Before use, particularly while at Halley Bay, it was considered advisable to run a ½ kw black body heater beneath the sump. Many small bolts were not fitted with spring washers and vibrated loose when the equipment was running.

The Geomecanique streamer winch was bolted and welded to the maindeck on the port side, directly forward of the helicopter deck. This permitted a clear run aft for either streamer, to the new wooden fairlead (although only the outboard streamer was ever used).. The fairlead is correctly located, and almost the correct shape. A little shaping and a few coats of a hard varnish will improve things and repair the gouges caused. by protrusions on the streamer.

The outboard streamer leaked oil on two occasions, once from a split at the forward end of the inboard spring section (a weak point because of the sharp bend which occurs there as the streamer is wound onto the drum), and once from a crack in the middle of the aftermost passive section (which could have been caused by expansion on a particularly hot day at Signy I). Both splits were repaired without any significant loss of data. The streamer was well weighted at the outboard end of the tow cable, and the deep towing of both gun and cable probably contributed much to the good record quality. It had not been at all certain beforehand that good quality reflection profiles could be obtained easily from so large a ship as Bransfield, because of the likelihood of a high level of ship-generated acoustic noise. In the event, the main difficulty was that the minimum power which the ship could maintain for long periods (800 shp) was sufficient to propel her through the water at 7 to 7.5 knots in calm weather, perhaps 4½ to 5 knots in a moderate head wind and sea; under both conditions acceptable records could be obtained. With minimal power and a stern or quarter sea and wind, however, the ship moved too fast, and poor records resulted. Given adequate weather forecasts, advance planning of a survey could probably circumvent this difficulty.

Only the larger Bolt airgun was used, and performed well with no part replacement needed. The gun towing wire was wound on a drum bolted on top of the port capstan, running outboard through one block on deck and a second on an adjustable beam extending outboard from the after end of the main deck, amidships. The air line and firing cable fed through the port quarter roller fairleads, which kept them separate from gun towing and streamer cables. On one occasion with a strong wind and swell from the starboard bow, it seemed that the magnetometer was periodically approaching the hydrophone streamer. The magnetometer, which was being towed through the starboard quarter lead, was recovered and restreamed through the starboard beam lead to increase the separation. While being restreamed, however, it tangled with the gun towing cable which lay well over to starboard (windward) as the ship was pushed downwind. It was untangled and restreamed without difficulty or damage, but the incident does point up the care needed when handling lines aft. To guard against tangles also, course alterations were made at a maximum of ten degrees per minute when the profiler was in operation.

The lab-based electronic part of the profiler worked well, without incident. One EPC displayed the data in a read-after-write mode, to check that data were being recorded properly onto tape.

E. Miscellaneous. MSES also provided an event marker, made by Chris Paulson, which gave 5-minute time marks for the magnetometer chart recorders, a 5-minute watchkeepers' "wake-up" buzzer, and a 30-minute marker for the profiler tape and EPC recorders. This worked well throughout.

Communication with the bridge via the telephone was adequate, and the gyro repeater provided a useful check on courses. A more permanent record, such as would be provided by a course recorder, would however be much more useful. It is surprising that a ship of Bransfield's size, capabilities and responsibilities does not have one.

5. Personnel and acknowledgements.

As mentioned earlier, we are grateful to the entire ship's company, particularly the senior deck and engineering staff, for their help and advice, and to BAS wintering personnel (and others) who helped with lab. watchkeeping.

A Senior Ship's staff

MASTER: S.J. Lawrence

MATES: J. Tolson, M.J. Burgan, R.C. Plumley, A.M. Reading

ENGINEERS: A.J. Johnson, S.E. Taylor, L. Buchanan, J.E. Shaw

ELECTRICIANS: H. Speakman, A.J. Parkinson

RADIO OFFICER: H.M. O'Gorman

CATERING OFFICER: E.A. Heathorn

EOSUN: G.C. Trevor

B BAS Watchkeeping Union

(i) Stanley to Halley Bay:-
C. Adams, W.A. Freeland, M. Gardiner, M.A. Howes,
S. Hutchinson, L. Irvine, T.A. Lachlan-Cope,
M.J. Leeson, B. Moore, G.D. Westmacott

(ii) Halley Bay to South Georgia
P.Edwards, T. Forsyth, B. Gardiner, M. Gardiner,
P. Hart, D. Hogg, I. Levack, H. Mathews, G. Morgan
J. Oliver

(iii) Soutb Georgia to Mar del Plata
S, Broom, D. Colville, T. Forsyth, B. Gardiner, P. Hart
N. Law, H. Mathews

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