I.O.S.

MV FARNELLA
CRUISES 8, 9/82

26 FEBRUARY - 26 MARCH 1982

GEOPHYSICAL STUDIES IN THE NARES ABYSSAL PLAIN AND THE KING'S TROUGH FLANK. RECOVERY OF TIDE GAUGES DEPLOYED IN DECEMBER 1981

CRUISE REPORT NO. 145
1983

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

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26 February - 26 March 1982

Geophysical studies in the Nares Abyssal Plain and the King's Trough Flank. Recovery of tide gauges deployed in December 1981.

Principal Scientist

J.A. Revie

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CRUISE OBJECTIVES

1. Leg 8

(a) To obtain GLORIA coverage of the distal part of the Nares Abyssal Plain as part of preliminary studies for the High Level Radioactive Waste Disposal Programme. The sidescan survey, coupled with seismic reflection and precision echo sounder profiles was to elucidate the structural trends of the basement, indicate areas of recent tectonics and provide details of active sedimentary processes in the area.

The survey would form a data base from which a selection of areas suitable for more detailed study could be made.

(b) To recover the seven tide gauges deployed during Farnella Leg 5.

(c) Passage GLORIA survey on Hayes and Oceanographer Fracture Zones depending on time available.

(d) If time permits, to lay one long term tide gauge.

2. Leg 9

Geophysical surveys of part of the south bank of King's Trough continuing the High Level Radioactive Waste Disposal Programme.

NARRATIVE

(a) Leg 8

Farnella sailed from Miami at 1100 hrs on Friday 26th February and started making passage at 12 kts to the position for the start of the GLORIA survey through the Vema Gap. The position was reached at 0800 hrs on 28th when the PES was deployed followed by the GLORIA vehicle and Port Magnetometer. Scientific watchkeeping commenced immediately and the survey was carried out at 10 kts along the track shown in Fig. 1. No sensible readings could be obtained from the magnetometer so after about an hour the Port fish was replaced by the Starboard fish but the results were equally bad.

At 0430 on 1st March a fault developed in the main gearbox oil cooler which needed immediate attention. The magnetometer and GLORIA vehicle were recovered and by 0530 the cooler was being worked on with the main engine stopped. The fault was repaired by 0700 and the GLORIA vehicle was re-launched at 0730 enabling the survey to continue from just after 0800.

At 1930 the point was reached for the start of the Nares Abyssal Plain survey. The SRP system was deployed consisting of the two section hydrophone streamer and an 80 cu in air gun fitted with a wave shape kit. At this time the PES fish which had been towing into the ship's side was recovered for inspection. Two broken fairing clips were replaced and the fish re-launched with no real explanation for its behaviour having been found.

The first line of the Nares A.P. survey was started at 2030 using SRP, GLORIA and PES. The weather was very favourable and the survey speed was fixed at 8.5 kts.

At this time there was some anxiety about the EM log which occasionally went through short periods of erratic readings. Cleaning the connections on the log, which was situated under the engine room plates, seemed to make matters slightly better.

The seven legs of the Nares A.P. survey were steamed more or less as planned in weather conditions which varied from calm to very calm and all the equipment was recovered in the latter conditions at 1900 on 4th March when we reached the end of the survey.

To reach Ponta Delgada on time we needed to average 11 kts allowing 3 hours per tide gauge recovery. It was decided to make passage to the furthest gauge G_5 with no equipment deployed so that the quickest route could be chosen regardless of territorial waters. After some small engine repairs to matters which had arisen during the latter stages of the survey passage was started for G_5 at 2115 - a distance of 1125 miles.

During the run south work continued on the Nares Abyssal Plain data and on 6th March the EM log connections under the engine room plates received some further attention. During this second day the weather turned slightly against us and the fresh easterly wind combined with high sea water temperature to keep the speed just under 11 kts. Luckily a favourable current kept the S.M.G. to just over 11 kts. The PES was deployed at 1900 on 8th March and watchkeeping re-started as we approached the position of G_5. Speed was reduced to begin recovery of G_5 at 0315 on 9th March. Due to a fault on the derrick topping lift motor, the PES was recovered and the tide gauge hoisted with the Schat davit and the 2½" nylon rope round the windlass whipping drum. The PES was immediately deployed again and passage to G_4 commenced at 0620. Adverse wind and current combined with high sea water temperatures to slow the ship and nearly 20 hours were needed to travel the 190 miles between stations. Recovery of G_4 presented

no problems and passage was resumed for G_3 at 0420 on 10th March. Arrival at G_3 at 0700 on 11th March was slightly ahead of 11 kt schedule but there had been no good satellite fix for 14 hours. It was decided to make an approach based on D.R. while we waited for a satellite fix to update the position, but the pinger switched on at the first attempt and the capsule was on board by 0845.

During the passage between stations, the PES was being used for development and tests of the automatic bottom tracking and digitising equipment. Also the magnetometer problems were sorted out and the fish streamed for tests. G_2 was reached one hour inside the 11 kt schedule and recovery presented no problems. The capsule was released at 0821 and onboard by 0952 on 12th March.

Passage to G_1 was completed at 0255 on 14th March. There were no problems locating and releasing the capsule but just at the time it was expected to surface, the ship was enveloped in a heavy rain squall and by the time that it had passed, the flashing light was spotted quite some way off. Recovery was completed by 0515 and passage set for A_7. The water temperature (and therefore sump oil temperature) had by now dropped considerably, making it possible for the ship to maintain nearly 14 kts and so build up some time for a further GLORIA survey on the Hayes F.Z. and also the time to lay a long term tide gauge. A_7 was reached at 1730 and released at 1800 on 15th March. The capsule was spotted in fast fading light and recovered by 1930.

Passage was continued at 14 kts towards Hayes F.Z. until 2330 when speed was reduced to launch the GLORIA vehicle for a passage survey of Hayes F.Z. The Port magnetometer fish was also deployed and the survey speed was 10 kts. The weather was flat calm for the duration of the survey which was terminated at 1800 on 16th March when the magnetometer and GLORIA vehicle were recovered and course set for last tide gauge position A_6. The position for A_6 was reached at 0315 on 17th March and the capsule was secure on board at 0450.

In the prevailing very calm weather conditions, it was decided that sufficient time remained to lay the long term tide gauge Y_2 in the preferred more southerly position which entailed an extra 65 miles on the distance to Ponta Delgada. A suitable water depth for Y_2 was reached around 0100 on 18th March. The tide gauge was launched on receipt of a good satellite fix just after 0200. A good signal was received all the way to the bottom and after another good satellite fix at 0410 the PES was recovered in readiness for passage to Ponta Delgada.

Before setting off on this passage the main engine was stopped for about 2 hours to change an exhaust valve, then in very calm weather a speed of at least

14 kts was maintained throughout the day. The engine was stopped again from 1800 to 1930 while a second exhaust valve was replaced. Ponta Delgada was reached in good time on the morning of 19th March and the ship docked at 0900.

The tide gauge party left the ship to return to U.K. by air and Les Sheppard left to return to America.

(b) Leg 9

It had been decided before arriving at Ponta Delgada to try to sail again in the afternoon to give extra time for the King's Trough survey.

Jon Campbell and Stefan Czyzkowski (Department of Environment) joined the ship.

Bunkers and some stores were taken onboard and the ship sailed at 1600.

In fine weather a speed of 14 kts was maintained to reach the position for the start of the King's Trough survey at 0930 on 20th March.

The PES, GLORIA vehicle, SRP (consisting of 2 channel streamer and 80 cu in air gun) and magnetometer were streamed in that order and the survey was started on the first line at 1030. In calm weather, the speed during the survey was 9 kts and the south flank of King's Trough was completed as planned at about 1800 on 21st March.

The next 10 hours were occupied by a detailed survey of proposed IPOD Site No. NA-3A. On completion of site survey at 0400 on 22nd March all scientific gear was recovered and course set for Ushant at 167 revs and 80% pitch.

An S.M.G. of 12 kts was required to reach Hull at 0700 on 26th March. Luckily we were able to make up some time before reaching the channel because in spite of very bad visibility during 25th March the ship entered the lock pits at Hull at 0530 on 26th March and berthed in William and Albert Dock at 0600.

ACKNOWLEDGEMENT

It is a pleasure to thank the captain and crew of the Farnella for their cheerful cooperation not only on Legs 8 and 9 but throughout the period of the charter. Their willing assistance and rapid learning of tasks unfamiliar to them added much to the amount of work which was accomplished. Mention must also be made of all the help received from the shore side of the J. Marr organisation without whose understanding assistance the voyage could not have been put together.

DEPLOYMENT OF SEA-BED PRESSURE RECORDERS

Seven 'Mark 4' bottom pressure recorders were laid in a line from a position southwest of the Azores to the shelf slope off Cayenne, French Guyana, in December 1981, and were recovered in March 1982. Their principal object was the third of a four-part plan to define the major harmonic constituents of the tides across the North Atlantic between Europe, Africa and the Americas. More particularly, the present line of recordings linked the southern part of the earlier IOS ocean tidal project, which covered the northeast Atlantic, to a region of maximum semi-diurnal amplitude on the South American coast, through a region where direct tidal measurements were completely lacking. In addition to these seven deployments, one of the recording units was re-assembled from the recovered equipment with new battery power supplies and laid in an 8th position, south of the Azores, to be recovered a year later. This was the second of a planned series of long-term recordings, aimed at exploring the low frequency spectrum of oceanic movement with later applications to satellite altimetry of the ocean surface.

The positions of the recording sites are marked in Figure 1 and their precise latitudes, longitudes and times of recording on the sea-bed are listed in Table 1. Positions A6 and A7 continue a series centred on the Azores, started on a previous deployment in 1980, while G1-G5 form a line normal to the Guyana coast, mostly following the mid-Atlantic Ridge. The new one-year site is denoted by Y2, and is close to an earlier site known as A4.

D.E.C.

RECOVERY OF TIDE GAUGE CAPSULES

All the capsules were recovered without problems. At each position the command pingers were switched on easily, usually after the first transmission, and then quickly released, in order to keep the station time to a minimum. Four of the capsules were released at night and located by means of their flashing lights. They were grappled and brought inboard on the starboad bow using the boom and windlass. The handling of the ship was excellent during this operation, especially considering the lack of bow propeller. During the recovery operation none of the capsules suffered any damage.

The condition of all of the devices was excellent with hardly any signs of corrosion. Of the eleven recording devices deployed, two partially failed to give results, the deep capsule at G4 had an immediate failure of one pressure sensor and the second stopped after 4 days. However, the auxiliary recorder appeared to

have functioned correctly. There was also a data recording/replay problem with the capsule at A7 that may yet be resolved. Again the secondary recorder appeared to function correctly. The records were translated from cassette to 9 track magnetic tape at sea using the GLORIA PDP 11/34 system. These were then edited, reformatted, and plotted on the Calcomp plotter before being rewritten on tape for further processing. This operation proceeded smoothly and will save much further processing at the laboratory. Further it enabled us to choose the system best suited for redeployment at position Y2.

R.S.

UNDERWAY GEOPHYSICAL SURVEYS

(a) Leg 8

Successful geophysical surveys employing GLORIA were completed at two tectonically and morphologically distinct areas on this leg.

The first survey was carried out in the vicinity of Vema Gap and the southern Nares Abyssal Plain as part of the High Level Radioactive Waste (HLRW) seabed study programme. GLORIA was launched at 1300/059 on the western approach to Vema Gap. Seismic reflection profiling (SRP) began at 000/061 using a single 80 cubic inch airgun fitted with a wave shape kit. All seismic data between 20 and 100 Hz were recorded on magnetic tape.

A 10 kHz precision echo sounder was operated throughout the survey. A dry paper digital recorder was run in parallel with the standard Mufax recorder. Useful sub-bottom returns and variations in surface reflectivity were apparent on the digital record that could not be discerned on the wet paper record.

GLORIA sonographs from the Vema Gap region reveal sediment lineations and broad bands of differential target strength suggesting textural rather than topographic variations in the surface sediments. These have been tentatively identified as turbidity current pathways. No similar structure can be traced onto the Nares Abyssal Plain.

Outcropping linear ridges trending ENE are common at the eastern and western limits of the plain. Subdued linear mounds, apparently related to basement highs, and with a similar trend occur elsewhere. These may represent buried ridges.

Several sediment-free, sub-circular targets ranging in diameter from 3 to 13 km have been interpreted as volcanic cones, some with calderas. They occur within the outcropping hills at the edge of the plain where they are locally associated

with disrupted basement.

The intervening sediments of the plain are flat lying with parallel sub-bottom acoustic reflectors. The sediments thin to the north and east where they overlie shallowing basement. Sediment lineations, generally parallel to the ridge trend, are very common in the western part of the plain, becoming rarer to the east. They have little topographic expression and their nature and origin requires further investigation.

All the gear was successfully recovered at 2300/063. No magnetic data was recorded throughout the survey owing to instrumentation problems.

The second survey was carried out on passage between tide gauge stations A7 and A6 along part of the Hayes Fracture Zone. GLORIA and the magnetometer were deployed at around 0100/075.

Highly variable, rugged topography in this region produced many very strong targets on the GLORIA sonographs. Basement ridges and lineations trending parallel to the spreading axis are truncated by a clearly defined smooth floored Hayes fracture valley trending ESE. A possible, second smaller fracture valley was found to the north of the Hayes Fracture Zone.

All the gear was successfully recovered at 2030/075 and course set for tide gauge station A6.

L.M.P.

(b) Leg 9

The two principal objectives of Leg 9 were to complete geophysical surveys of an area of the south flank of the Kings Trough as part of the continuing HLRW sea-bed disposal programme, and to obtain a GLORIA survey of a proposed IPOD deep sea drill site on the southeast margin of the Trough. Both objectives were attained successfully. The same geophysical equipment as described above for Leg 8 was used.

GLORIA sonographs from the Kings Trough flank are characterised by a series of strong linear targets, up to 25 km in length, as well as a smaller number of less regular features of variable reflective strengths. The linear features are predominantly narrow, orientated for the most part close to 010°, and are paralleled by several narrow linear shadow zones which are tentatively interpreted as discontinuous escarpments. Seismic reflection profile data from this cruise and Discovery Cruise 118 indicate the origin of the ridges as either basement

outcrops or basement controlled sediment ridges. A more uniform seafloor separates these features, although variations in surface morphology may be inferred from both subtle changes in reflection character in GLORIA sonographs and detailed bathymetric variations on echo sounder records.

Corrected magnetic anomaly profiles were obtained and await more detailed interpretation.

The close spacing of the IPOD survey enabled an 100% GLORIA coverage of the proposed site, revealing an almost featureless region covering approximately 80 sq. km apart from one small area of irregular reflection character. SRP and PES records indicate a more variable topography, underlain by a generally smooth basement.

S. McG.

ECHO SOUNDING DEPTH TRACKING AND DIGITISATION

During Legs 8 and 9 most of the major problems associated with depth digitisation have been solved, the least of which is putting a number to the position of a significant echo. Difficulties arise when:-

(a) the echo returns too close to the transmission and surface reverberation and a tracking window is drawn to the transmission,

(b) a side echo emerges requiring a rapid slewing of the tracking window if it is to attempt to follow the strongest echo. In contradiction the position of the window should not jitter around as the echo strength fluctuates and sometimes disappears,

(c) the echo moves through the transmission and the depth enters a new phase. The tracker can only find the relative position of the echo within a sweep and must make the necessary adjustment to display the absolute depth,

(d) due to watch-keeper intervention (changing a blade edge, changing the paper or switching the keying), there is a loss of synchronism or the echo sounder is "off-line".

In brief "PEST 82" tackles these problems in the following manner:-

On receipt of a zero depth trigger pulse a delay is started. At the end of the delay or if the delay required was zero a window of data is sampled. Simple binary automatic gain control is applied to compress 12 bits from the analogue converter into 8 bits for processing and to allow for echo sounder gain changes. If the samples fall within the transmission and reverberation clutter time-varied

gain is also applied to blot out the transmission and to ramp up the gain during the reverberation.

When sampling is complete the data array is then differentiated and smoothed to detect the rising edges of the signal. (This is actually achieved by correlation with a short rising ramp). The output of this routine is a series of smooth Gaussian-shaped pulses whose heights are in proportion to both the steepness and the ultimate height of each significant edge within the window. The next algorithm locates these peaks but first applies a linear weighting of zero at the ends of the window to one in the middle. The routine returns the amplitude and position (relative to the start of the window) of the largest peak and the amplitude and position of the peak nearest to a prediction (normally the centre of the window). The main program chooses between these two peaks and calculates the signed difference from the centre of the window.

This offset is added to the present delay value to shift the window position. Before this new delay is used it is passed through a digital filter and checked for out of range. (A delay greater than one sweep or a negative one is not allowable). As the delay is adjusted to fall into a 0 to 2 second range the machine's own phase value is incremented or decremented. The digital filter is also reinitialised to avoid the transient due to a discontinuous change in delay. Should the delay fall in a range where the window-centre would be in the middle of transmission clutter the processor goes into a gating mode search loop. If gating is on it will be detected by the presence of only one unmuted transmission during the gating cycle. Sampling can then continue during only the sweeps when there is no transmission but with time-varied gain not being applied. If the echo moves away from the clutter or gating is turned off normal sampling is resumed.

There are still a few problems to be dealt with. Although depths are available every 2 seconds no attempt has yet been made to fit a function to these figures so as to obtain a good value for the depth at 2 or 6 minute intervals. Advantage is not being taken of the information available when gating is on to check the phase. Switches for manual entry of depth have yet to be connected and although depths are printed locally every 2 minutes some change in the interfacing will be necessary for communication with a shipboard data logger. It is hoped that an immediate depth will be displayed on the tracker front panel and that a signal will be available to mark the position tracking window on the echo sounder.

C.G.F.

DATA LOGGING AND PROCESSING SYSTEM

The Data Logger developed an intermittent fault during the removal of the daily data tape for processing. This made it necessary to restart the system each time. Replacement parts were provided in Ponta Delgada for Leg 9; the fault caused minimal problems and all data was processed as normal. The Processing System produced track charts and annotated charts of the GLORIA survey areas and also from the recovery of the first tide gauge through to Ponta Delgada.

During the cruise the tide gauge data was displayed and edited from nine track tape. In addition Ian Vassie of I.O.S., Bidston developed a program for the plotting of tide gauge data using plotting software available on the processing system.

G.K.

GLORIA

(a) Leg 8

The GLORIA vehicle was launched in calm conditions at 1230 on day 059 and recovered at 2300 on day 063. A two second pulse was transmitted at 40 second pulse repetition period and once again the information was recorded on 4 channel FM recorders and also via the Camac system onto digital 9 track tape. No problems were experienced during the 107 hours of recording time and FM tapes and two digital tapes were recorded.

The next deployment of the GLORIA vehicle was at 0100 on day 075 for the passage survey of the Hayes F.Z. The vehicle was recovered at 2030 on the same day and this very short run produced no problems. The set-up was exactly as before although the terrain could hardly have been more different. A further 3 FM tapes and one digital tape were recorded.

J.R.

(b) Leg 9

The GLORIA vehicle was launched at 1100 on day 079 and produced a further trouble-free run until it was recovered at 0530 on day 081. Again the two second pulse was transmitted at 40 second pulse repetition period. Six FM tapes and one digital tape were recorded.

J.R.

SEISMIC REFLECTION PROFILING

(a) Leg 8

There were no mechanical breakdowns over about 70 hours of profiling. Twelve digital tapes were recorded. However, when these tapes were replayed it was discovered that despite a good monitor record the phase-locked-loop generating the digital sampling frequency had been unstable: the result - plus or minus one sample jitter on the recorded data. Since further jitter was being introduced on replay the immediate solution was to bypass the phase-locked-loop and take the sampling frequency straight from the crystal oscillator divider chain. A more permanent answer would be to choose an oscillator frequency that is divisible down to integer multiples of the 250 Hz minimum sampling frequency: 630 Hz would be suitable.

(b) Leg 9

No problems arose during the King's Trough flank survey. There were however too many tape errors for comfort. The digital transports return a tape error when on reading after writing the cyclic redundancy check code evaluates incorrectly. The cause of the problem is not well understood though certainly wear on tape guides does worsen the error rate.

C.G.F.

TABLE 1 TIDE GAUGE DEPLOYMENTS

Position Ref.	Latitude	Longitude	Depth (m)	Type	From	To
G5	6°59.6'	51°33.3'	3764	Mk IV	0700 Day 350	0700 Day 68
G4	9°59.1'	50°31.3'	4850	Mk IV & Aanderaa	1145 Day 349	0500 Day 69
G3	14°42.4'	48°50.4'	3527	Mk IV	0315 Day 348	1015 Day 70
G2	19° 0.4'	47°30.6'	3470	Mk IV & Aanderaa	0945 Day 345	1135 Day 71
G1	26°34.6'	43°57.6'	3600	Mk IV	0630 Day 342	0615 Day 73
A7	33°55.3'	41°11.5'	3372	Mk IV & Aanderaa	1400 Day 339	2000 Day 74
A6	33°59.9'	34°53.0'	3066	Mk IV & Aanderaa	0445 Day 335	0515 Day 76
Y2	33°59.3'	29°23.6'	3294	Mk IV	0445 Day 77	

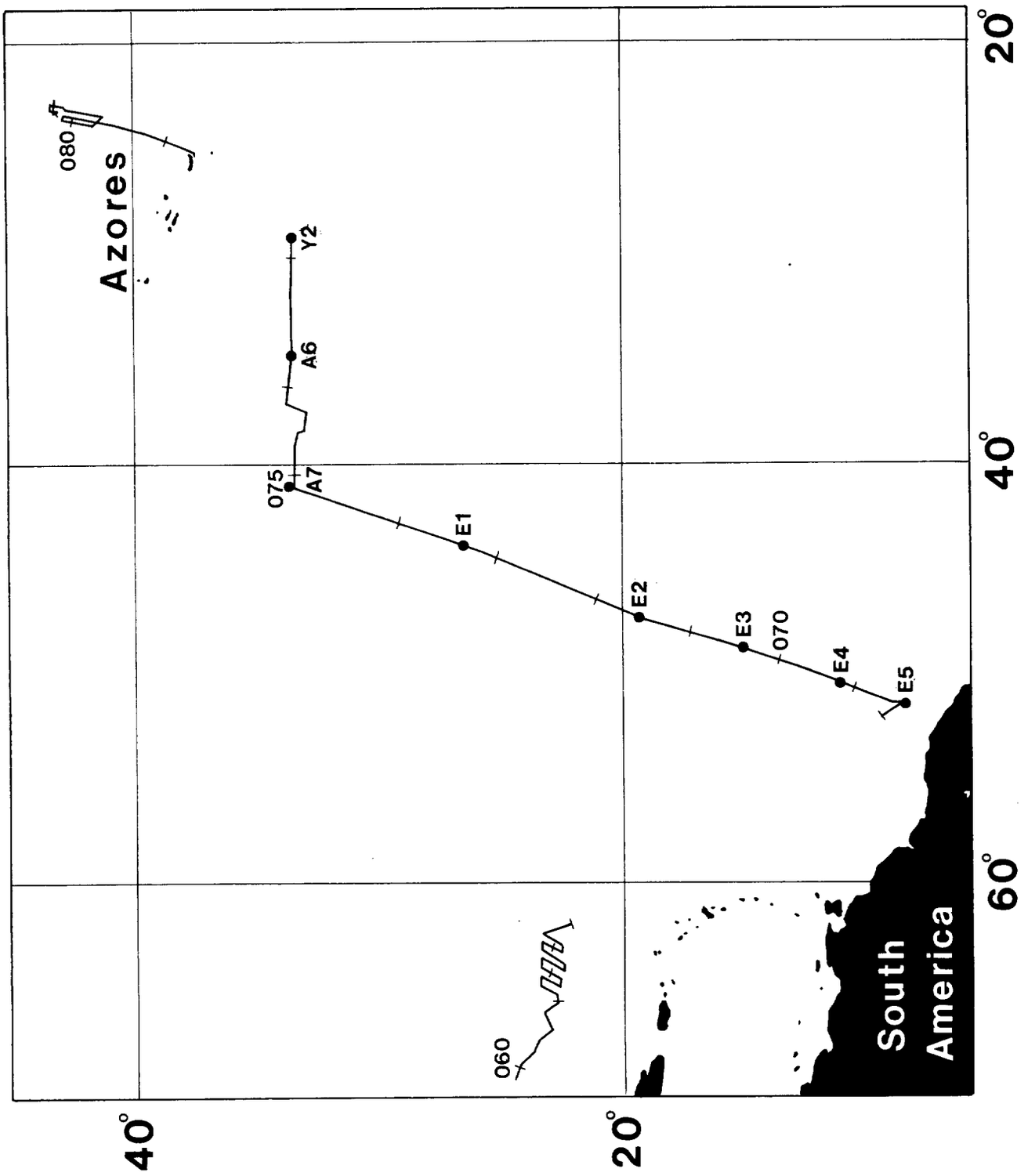

FIGURE 1 CRUISE CHART