I.O.S.

R.R.S. DISCOVERY
CRUISES 95 AND 97

25 October - 17 November
and 6 - 21 December 1978

Tide recording in the Tropical Atlantic and Equatorial Hydrology at 27½° and 32½° West Meridians

CRUISE REPORT NO.77

1979

INSTITUTE OF
OCEANOGRAPHIC
SCIENCES

NATURAL ENVIRONMENT RESEARCH COUNCIL

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ITINERARY

Cruise 95 :	Leave South Shields	25 Oct 1978	
	Call at Spithead	27 Oct	
	Off Cap Vert	5 Nov	
	Arrive Recife	17 Nov	
Cruise 97 :	Leave Recife	6 Dec 1978	
	1st tidal mooring	11 Dec	
	Arrive Recife	21 Dec	

SCIENTIFIC PERSONNEL

	Affiliation	Cruises	
D.E. Cartwright	IOS-B	95	Pr. Scientist
J.B. Rae	"	95,96	
R. Spencer	"	95,97,98	
J. Huthnance	"	95	
B. Hughes	"	95,96,97	
A. Kerr	"	95	
P. Foden	"	95,96,97	
D. Flatt	"	95,96,97	
J. McKinnon	"	95	
D. Grohmann	IOS-W	95	
R. Wallace	"	95	
G. Lodge	"	95	
P. Hartland	RVS	95,96,97	
L.M. Skinner	RVS	97	Pr. Scientist
J.M. Vassie	IOS-B	97,98	
G. Ballard	"	97	
C. MacDonald (Ms)	"	97	
K.P. Koltermann	DHI - Hamburg	95	
J. Harari	U. Sao Paulo	95	
R. Rizzo	U. Sao Paulo	97	

B. McCartney, J. Bunting, A. Braithwaite joined for nine hours on 25 October for E/M log calibration.

J. Legg (Ms), T. Crocker, P. Collins, B. Hart joined from S. Shields to Spithead for tests on sonar equipment.

SHIPS OFFICERS	Cruise 95	Cruise 97
Captain	M.A. Harding	J.J. Moran
Chief Officer	J.J. Moran	J.D. Noden
2nd Officer	S. Sykes	J.K. Seymour
3rd Officer	J.K. Seymour	C.J. Dixon
Chief Engineer	A.E. Coombes	C.P. Tottle

OBJECTIVES

1. To collect tidal pressure records from a line of stations between West Africa and Northeast Brasil, to be supplemented by tide gauge records from coastal ports and islands of both continents. The records were required not only for tidal boundary conditions for the North Atlantic Ocean, but also to define low frequency pressure waves with possible coherence across the ocean, of interest to the international FGGE exercise. (FGGE was strictly supposed to start in January 1979, but preliminary records were also valuable). IOS had also sent D.L. Leighton to Ascension Island just before the cruise, to instal a pressure recorder at the jetty there.

2. To record surface and deep currents at the Equator at about 32½°W, for comparison with pressure gradients measured simultaneously, again of potential FGGE interest.

3. To take CTD and current profiles from surface to 500m at two equatorial cross-sections, 1°N to 1°S along the meridians 27½°W and 32½°W, for definition of the undercurrent structure, for FGGE. All records of wind and surface currents (from Sat.Nav.) in the equatorial regions were similarly relevant.

4. To attempt recovery of a current meter mooring laid by Institut für Meereskunde, Kiel in December 1977 at about 33°N, 22°W. (Late addition to programme)

ALTERATIONS TO SCHEDULES

Cruise 95 had been planned for 20 October - 10 November, starting from the south of England, while Cruise 96 was to start by laying

the tide recorder at T7 (17°S, 14°W), to be recovered during the passage to Cape Town on Cruise 98. The seven days' prolongation of the refit at South Shields caused a corresponding slippage in the arrival date at Recife, and Cruise 96 had to be curtailed by omitting the detour to T7, thus restoring the original schedule of dates from Cruise 97 onwards. It was later arranged to lay the tide recorder at T7 during Cruise 98, and recover it in March 1979 from the French research ship JEAN CHARCOT.

However, although Cruise 95 finally had its originally allotted time span, (counting the effective start as from Spithead on 27 October), it had late undertakings to call at the German station (Objective 4) and to tension at least two new wires to more than 5000m. These duties effectively reduced the time available by about 36 hours, and more careful calculation showed that the FGGE objectives 2 and 3 (themselves a relatively late addition to the prgoramme), really required an extra 2 days for proper execution. Much time therefore had to be made up by steaming with three engines, and it was fortunate that the ship was never seriously delayed by weather. Nearly the whole programme was thus achieved without extended time, but we were unable to lay the three surface moorings near the Equator, since these needed more time for experimentation.

Thethree-engine working in the Tropics was a hard trial for the ship's engineers and crew, because the air-conditioning system was in poor conditon. In future cruises of this kind, involving high mileage in tropical waters, it would pay to allow a few days more time in the planning stages and to beware of additional commitments.

NARRATIVE - CRUISE 95

The annual refit at South Shields took a week longer than expected, causing all concerned to be kept waiting around the ship for several days at high cost in subsistence allowances, and radical changes to the plans for the future cruise schedule (see previous section). DISCOVERY finally got away from South Shields at 1100 on 25 October, but with several items of equipment, some for later cruises, still requiring adjustment before finally leaving UK waters at full speed. Extra personnel necessary for these adjustments raised the total scientist-complement at the start to 22, but this was reduced to 19 before midnight, so sleeping accommodation was adequate.

After turning trials off the Tyne entrance it was found that the main engines' cooling system was non-functional, and this necessitated four hours at anchor for repairs. It had been intended to calibrate the e/m log on the measured mile at Blyth during daylight, but this now had to be done in the dark, so orders were transmitted for the shore markers to be lit. On a first turn, the southern lights were obscured by haze, but visibility later improved, enabling a successful pair of traverses to be made at 10 knots. Ideally, the operation should have been repeated at other speeds, but time had now run out. Subsequent study of the sat. nav. currents showed that the e/m log had been well calibrated.

Dr McCartney and his two assistants left by the Tyne pilot boat at 2000, and DISCOVERY headed southeast. The Asdic trunk was soon lowered for acoustic tests, but hydraulic valves controlling its turning mechanism were found to jam when hard-over, a fault impossible to repair there and then. After some 90 minutes with the speed at 2½ knots, Mr Collins' team managed to get the Asdic pod in its fore-and-aft position and it was retracted into the hull for the rest of the night.

During the morning of 26 Oct, the worst of the Asdic valve - jamming problems were overcome, but acoustic tests were restricted to the fore-and-aft pod position for safety. The tests were carried out at speeds from 6 to 10 knots, and were terminated at 1400 in order to get some fast steaming with three engines. Some acoustic tests were continued after the pod had been finally retracted. DISCOVERY proceeded at 12-13 knots round the East Anglian coast and into the Channel. She anchored at Spithead at 0845/27, where the Director IOS and Mr Fisher paid a brief farewell visit by launch, some late stores were delivered, and the Asdic party returned to shore.

On leaving Spithead at 1000/27 in calm weather, the main objective was to cover the 3000 or so miles to the first tidal station T1 with the minimum of necessary delays. Three engines were therefore used throughout,with speeds averaging about 12½ knots, or 5° per day. However, instead of taking the shortest route, via Ushant, the ship headed for the Lizard and then at 244° as far as the shelf edge. This route was taken partly because the Captain had internal pains and could more easily have been landed at a UK port if they had not improved, and partly to give the scientists a sight of the ODAS data buoy on station. A straight course from the ODAS buoy to the German mooring then gave a less well worn track for the bathymetry than the usual one over Galicia Bank.

At 1400/29 we stopped in the Biscay Plain for the first tests of tide gauge acoustics by lowering on the old 4mm wire to 3500m. We had hoped thereby to save some time before 5500m was reached when the new wire could be wound on the electric winch under tension, since we had been assured that the old wire should be still usable. Unfortunately, the old wire parted on paying out at 2600m losing two sets of acoustic pingers. After this, we let the rest of it go.

On resuming course at 1600/29, regular watches were started on the Precision Echo Sounder and on the Salinity/Temperature recorder, which were kept up almost continually until the end of the voyage. Because of calm weather, the hull transducer was used at first, but the P.E.S. 'fish' was used from 7 November when a beam sea caused the echo from a rough bottom to become indistinct.

Transfer of new hydrographic wire to the electric winch drum was completed during 30 October, as well as some general tidying of various equipment on the forward deck and testing of the forward winch. On reaching depths greater than 5400m on 31 October, we stopped to tension the new hydro. wire and to test some pingers. These operations, together with some extra time needed for work on the ship's engines. took about 8 hours.

The German current-meter station at 33° 02'.8N 21° 56'.6W was reached at 1410/1 November. Some 5 hours were taken in attempts to contact it by AMF acoustic transmissions at a number of frequencies, with occasional listening for possible radio transmission from a surfaced float. Several positions were occupied within about a mile radius, without success. While still hove-to at 1645 we started to pay out the new CTD wire from the larger drum of the electric winch, for tensioning. The necessity to pay out very slowly in order to dig out 'buried turns', occasionally stopping-off to ease tension, prolonged the operation to 6 hours. The wire was tensioned to 5127m, and rewound over a layer of canvas, but the top 100 metres had to be cut away because it fouled the automatic brake. After a final search for the AMF acoustics, we got underway again at 2300/1 Nov.

At about 1905/2 a considerable surge on the ship's 240v AC supply set off alarms in the computer area, and all scientific equipment had to be switched off including the computer itself, while

damage was assessed. It was found that most sensitive equipment had been protected by cut-out fuses, and the only permanent damage was the burning out of transformers on the typewriters of the H.P. satellite navigators. A new typewriter was substituted on the bridge, and the burnt out transformers were later restored by re-winding. Normal logging was resumed by 2030/2, with a voltmeter fitted in the plotting room to be monitored by the watchkeepers.

3-5 November were passed in steady steaming at 12-13 knots on a 169° course, with a short intermission on the 3rd for testing shallow pingers, and some interruptions on the 5th due to engine trouble. On crossing 17°N latitude on the 5th, the magnetometer was launched to provide information requested by Dr. J. Jones of University College London for all passage work between west Africa and Brasil. The magnetometer, provided by RVS for the occasion, (I.O.S's own magnetometers were being safeguarded for a later cruise), seemed to function normally throughout the rest of the cruise, apart from the usual intermittent drying-up of the ink feeding to the pens, and some occasional trouble due to overheating of components.

While skirting the Sierra Leone shelf on 6 November, temperatures everywhere on board were unpleasantly high, with the sea at 29°.5 and the ship's air conditioning in very poor shape. There was a good deal of Sahara dust in the air. A fan was installed above the magnetometer in order to prevent overheating of its 'Phase Lock 2' components, diagnosed earlier. The Sat. Nav. system also gave signs of overheating; some time was spent by engineers injecting Freon into the bridge air-conditioner which is supposed to cool it.

The first tide-station T1 (10°06'N, 17°14'W) was reached at 2030/6 November with a satisfactory depth of 526m in the expected

position, and good satellite fixes. The capsule was launched without trouble, and a litte time was spent in testing the CTD system before setting off towards T2 at 2130.

During 7 November the rejection by the computer of a sequence of satellite fixes caused us to accept that currents up to 1.5 knots were normal in this area (in fact throughout our passage in the tropical Atlantic), so the customary rejection level of 1 knot was increased to 2kt. Back-logging over the last day or so then gave a consistent course between newly accepted fixes, and a consistent set of surface currents, mostly southeasterly. More serious failure of the 'Magnavox' satellite navigator on the 8th was eventually traced to an overheated component while the bridge air-conditioning was poor.

Both tide-stations T2 and T3 were displaced by about 1° from their planned positions because depths in the planned positions were found to be unsuitable or varying too rapidly. (The changes in position are of little consequence). T2 (6°4'N, 20°58'W) was laid 0900-1040/8th and T3 (3°8'N, 25°4'W) was laid 1540-1720/9th. T3 was in 4167m, the deepest site yet attempted with the IOS Mark 4 capsules - later proved to be successful. Full details of positions and times are summarised in the Table on page 33.

The north end of the first Equatorial Profile, EP1 - 1°N to 1°S at 27½°W - was reached at 0900/10 November. The operations, of FGGE interest, consisted of seven stations (9909-9915) at 20 mile spacing, at each of which the CTD was lowered to 500m and a bottle sample taken at a depth of suitably stable conditions, about 200m, then an Aanderaa current meter recording at 1-minute intervals was lowered to record at 20(10) 100(20)200(50)400, 500 metres depths with waiting intervals to allow for scans occurring while being lowered. The actual depth of

the meter was monitored by recording via the CTD cable to a printer on deck, and the wire paid out by metre-wheel accordingly. During these operations the ship was allowed to drift freely, except for occasional use of the bow thruster to keep the wire vertical, and the drift later added to the meter readings from the 2-minute computed log. Weather conditions were fairly constant on both EP1 and EP2, typically Force 4-5 at 120-150°.

Each station took about 2h when everything went well, but there were naturally some occasional faults which caused minor delays. Steaming between stations was done at about 10kt on two engines in order to give the engineers a chance to overhaul and cool off a little. The whole profile EP1 took 29 hours and ended at 1350/11 November, after which two hours were taken on some more pinger trials.

We left station 9915 at 1500/11 and resumed three-engine working back across the Equator towards tide station T4.

T4 (00°56'N, 29°17'W) was on the sea-mount of St. Peter and Paul Rocks, and was approached with some caution during the dark hours. A Brasilian chart (no. 51) giving detailed soundings up to 5 miles of the rocks was found to be more useful than any of the British Admiralty charts. The mount is in the form of a very steep ridge elongated along a line 075° away from the rocks. It was important to place the capsule on the crest of the ridge in 350-400m, and our first crossings of the ridge, about 3 miles ENE of the rocks, proved to be too shallow. After some further traverses, a section was found with minimum depth 351m, and with careful manoeuvring in a 1kt westerly current, the ship was eased up to this position and the capsule lowered quickly at 0615/12 November. The radar bearing of the north point of the rocks from the lay position was 255°, 4.38 miles.

On the 13th, noise on the echo-sounder associated with the E/S fish swinging close to the hull caused us to suspect that its fins were damaged. The fish (no. 6) was brought inboard and replaced by fish no. 2, but inspection of no. 6 showed no obvious damage. The effect was therefore attributed to the high speed (near 13kt) and the vagaries of the ship's steering. Some time was also spent on the 13th repairing the control system of the forward crane.

The planned position for tide station T5 was reached about 1300/13, and a suitable depth (3932m) found within an hour. The Mark IV capsule was launched by the forward crane at 1454, after a good satellite fix had been accepted (0°58'N, 35°34'W). The capsule reached the bottom at 1607, and the pingers were soon switched off and the ship underway on course 090° by 1650/13. No E/S or magnetometer watches were kept during the run to EP2 because the course was virtually the reciprocal of that already traversed from T4 to T5.

The second Equatorial Profile (EP2) - 1°N to 1°S at 32½W - was reached at 1130/14 November, and was conducted as a sequence of seven stations (9918-9924) similar to EP1. It had been originally intended to lay three surface current moorings and one deep mooring at the central part of this profile, but time limitations mentioned above made us reduce this to one surface and one deep mooring. The paying out of various sections of polyprop. rope and steel wire sections above the anchor for the surface mooring at station 9921, (Equator) was started at 0015/15. A pinger was attached pointing downwards in order to monitor height of anchor above the bottom. However, by 0330, with 3000m of cord out, it was found that the ship's drifting over a very uneven bottom had reduced the depth by 230m. Changing the lengths of the remaining strops would have taken another hour during which time

the depth could well have drifted to yet another value. Since time was running out and there was still another mooring to go, the PSO decided to cut the wire adrift at 0407 and resume work on EP2. Apart from the 3000m of cord and wire, the only important equipment lost was the bottom pinger.

The deep current mooring was made at station 9922 (32°29'W, 0°20'S), after the CTD and current profiles and after steaming about 2 miles to the south to allow for the ship's drift during the paying out procedure. Paying out, again with the anchor first, took from 1045 to 1455, by which time two good satellite fixes had been received, and the depth at 4340m was about right for the lengths of wire. The mooring was cast away at 1505/15, and left in satisfactory condition by 1520.

The remaining two profile stations were completed, with a short interruption while the CTD recorder was repaired, by 2220/15. The PES fish was then brought inboard, and a course set for Recife, resuming magnetometer, E/S and S/T watches with the hull transducer for echo-sounding, which was quite adequate in the calm sea conditions prevailing. The watches were terminated at 2400Z/16 November, when the ship had reached 5°22'S and was getting rather close to Brasilian shelf waters.

On approaching Recife on 17 November, the ship was met by a group of three naval gunboats which put on a great display of smoke, speed, circling round DISCOVERY, with personnel waving. Although not quite clear at the time what this represented, we were later told by a member of the Brasilian Hydrographic Department that it was an official welcome to Brasilian waters, in recognition of the agreement made with the Hydrographer at Rio de Janeiro for cooperation over the

current tidal programme, and exchange of data. (The scientists on Cruise 96 however were later refused permission to work in Brasilian waters - see Cruise Report).

DISCOVERY entered Recife harbour at 1400 (local time) on 17 November.

D.E.C.

NARRATIVE - CRUISE 97

The principal objective of this cruise was to recover the five tidal capsules and one current meter mooring that had previously been deployed on Cruise 95. The recovery was to be in order of their west longitudes starting from the most easterly site T1, at $10^{o}06.13'N$ and $17^{o}13.86'W$. Subsidiary objectives were to obtain records from the P.E.S, Magnetometer and S/T Fish. Because of the very large steaming distances between the tide gauge sites it was necessary to keep the ship's speed at its practical maximum for the major part of the cruise.

The ship sailed from Recife at 0915 (local time) on 6 December and a course was immediately set for the position of T1. This was estimated to be approximately 5 days steaming away. The magnetometer and S/T Fish were deployed and watches were started at 1600 hours when the ship was well clear of the immediate vicinity of Recife.

Work was started during the passage on cleaning and stripping scientific equipment for despatch from Capetown. The weather was very hot and humid and with a great deal of low cloud. After a day at sea some problems were encountered due to overheating at the stern gland; this was cured by the ship's engineers who rigged additional cooling hoses directly on to the gland. The ship proceeded on 3 engines and a favourable passage was made. During the early afternoon of 11

December the ship-borne release equipment and hydrophones were tested. The ship arrived on station at approximately 1900 hours and the command pinger on the tide gauge was switched on almost immediately. The capsule was recovered and brought aboard within the hour. The tide gauge was then washed down and stored in the aft rough lab and the ship put on a westerly course for T2.

The vessel made good speed to T2 and arrived on station at 2300 hours on the 13 December. During passage the capsule from T1 was stripped down and the data tape recovered. The capsule at T2 was released and recovered in just over 2 hours. Course was set immediately for T3 which was reached on the early morning of the 14 December. The tide gauge was again recovered very quickly and by 0430 hours the vessel was on course for T4.

During this part of the cruise the skies cleared giving very hot sunny weather with calm seas. The combination of good weather, favourable currents and very quick recoveries meant that the ship could be put back on 2 engines for the run to T4. The ship arrived on station at about 0600 on 15 December and the tide gauge was recovered within half an hour. This station was just off St. Pauls Rock and the ship's company had a very good opportunity to observe the rocks at relatively close quarters. A course was set for T5 and the station reached at approximately 1530 on 16 December. The command pinger was switched on almost immediately. Some experiments were then conducted with a spare release system, Mufax and Tadpole, to simulate the recovery set-up that would possibly be used on the JEARN CHARCOT in the New Year. It was not possible to release the capsule with this system and it was subsequently found that a connector on the Tadpole had flooded. The tide gauge was eventually released with the main release system and was brought on board within the hour.

The site of the current meter mooring was reached on the afternoon of 17 December and it was very quickly released. The complete mooring was recovered in just over 3 hours. During this time some light relief was obtained by the crew who managed to catch a medium sized shark from a line astern.

Due to the good weather and favourable circumstances pertaining to all of the recoveries, almost 2 days had been gained over the orignal program. A course was set to Recife passing close to Fernando de Noronha and some interesting echo sounding records were obtained in the vicinity of the island. During the passage time all of the tide gauge capsules and current meters were stripped, cleaned and prepared for future deployments. A preliminary examination of the data from both the tide gauges and current meters looked very promising although it was subsequently found that a logger fault was present on the capsule at T5. After a very successful series of recoveries the ship arrived at the Pilot Station Recife at 0900 hours on 21 December.

L.M.S.

Tidal pressure recorders - Cruises 95, 97

There were two main types of capsule deployed plus an experimental gauge of the Aanderaa type. The first, designated MkIII, consists of a forged aluminium sphere containing the data logger, acoustic systems, and batteries. The sphere also provides the buoyancy. The MkIII capsule was used at positions T1 and T4. The data logger has the capacity for a temperature sensor and two pressure sensors, these being a strain gauge type and a 600 metre Digiquartz sensor. Concern arose with the conditions prior to deployment due to the high humidity and temperature and the presence of considerable airborne sand off the African coast. However subsequent recovery showed everything had functioned properly. There were large temperature variations at position T4 (near St. Pauls rocks) which may affect the strain gauge performance, but both Digiquartz sensors worked well.

The second type of capsule, designated MkIV, was of a new construction. After tests on a prototype, four new units were built for this exercise. It consists of a 'Sea Data' logging system housed in an aluminium tube with its batteries. Corning glass spheres are used for buoyancy and the standard IOS release system for recovery. Three capsules were used at positions T2, T3, T5, T7. The capsule at T3 was at our deepest tidal recording position to date, 4200 metres. Each gauge had two temperature sensors and three pressure sensors. The capsule at T2 and T7 had a deep Digiquartz sensor, the remainder being strain gauge types. Unfortunately, the capsule at T5 developed a fault in its serial shift register shortly after deployment, with the result that only a temperature record was obtained. The other three capsules all performed well,

but the manufacturers of the digital clocks have since indicated that these may be faulty. This will be investigated during the data processing.

The new MKIV systems proved to be easier to use at sea and should take considerably less time to prepare for deployment. They also have a considerably increased capacity enabling more sensors to record parameters for longer periods of time if required in the future.

On recovery all the acoustic systems worked well and each capsule was located and retrieved remarkably quickly, some at night being easily located with their flashing lamp. It was pleasing to note that there was no flooding in any of the 26 sensors deployed. All the data were translated at sea, edited using the CAMAC system, and transferred to 9 track magnetic tape. Preliminary plots of the new data were then made. This required much preliminary effort for the MkIV system, as it was the first time the translater had been used at sea, however, the processing of the data should be quickly carried out in the future.

R. Spencer

Tidal pressure recorder - Cruise 96

As part of the programme of tidal pressure measurements in the Tropical Atlantic, undertaken during cruises 95, 97 and 98, it was also possible to deploy and recover a deep pressure recorder during cruise 96. This gauge was deployed in a depth of 2825 metres at position $6^{o}45.27S$, $34^{o}18.05W$, about 90 miles from the coast of Brazil. The gauge was deployed at 0242/22 November, soon after the start, and recovered at 1349/3 December, shortly before the end of the cruise, giving a record of 11.5 days.

The pressure recording system used was an integrated pressure and temperature sensor with frequency modulated signals being integrated every fifteen minutes and recorded on a modified Aanderaa data logger, all contained in a deep sea current meter housing. This gauge, together with a standard acoustic release unit and a deep sea current meter, was mounted within a small aluminium instrument frame, which was rigidly attached to a ballast frame by a pyrotechnic release mechanism. Buoyancy was provided by four Corning glass spheres held together in a circular frame and attached to the instrument frame by a three metre length of nylon rope. This arrangement was found very easy to prepare, deploy and recover, and had a fall rate of 1.26 metres/sec. and a rise rate of 0.86 metres/sec. The tidal record provided by this gauge has proved to be of good quality and has also provided very useful information for the evaluation of this type of tide gauge and of the sensor arrangement used.

J.B.Rae.

Tidal pressure recorder - Cruise 98 and 'Jean Charcot'

The MkIV tide capsule recovered from T2 was deployed at a site designated T7, position 17°04.2'S: 13°39.6'W, depth 2827m. T7 was a particularly important position on account of radical differences in computed cotidal maps of this area. The gauge also had an experimental Aanderaa type tidal recorder fitted to the frame. A more detailed description of the operation is given in the report for cruise No. 98.

The capsule was recovered from the French oceanographic ship JEAN CHARCOT on 25 March 1979. It was located immediately, both command pingers being switched on with the first transmission, and the complete recovery took less than 2 hours. Both capsules appear to have worked well and should provide good data.

R. Spencer

Current and CTD measurements

Investigations of the equatorial undercurrent were carried out by means of CTD measurements and by use of a profiling current meter arrangement. Both CTD and current profiles were taken down to 500 metres at stations between 1^{o}N and 1^{o}S along lines of latitude at $27^{o}30'$W and $32^{o}30'$W.

Current profiles were made using a modified Aanderaa meter, lowered on the 6mm hydrographic wire, to take measurements every 20 metres down to 200 metres, then every 50 metres down to 400 metres, and at 500 metres. This meter was arranged to sample current speed, direction, temperature and pressure each minute, and as well as being recorded internally this data was transmitted along the hydrographic conductor wire to a decoder and printer on the ship. The data was then converted to engineering units using a programmable calculator. By relating the current speed and direction measurement to the ship's velocity, as calculated from the satellite navigation system, the real current velocity was found. This system worked well and there was no evidence of tangling of the electrical connection between the freely rotating current meter and the hydrographic conductor wire.

CTD profiles down to 500 metres were also taken at each station using a Plessey 9400 underwater sensor unit interfaced to a 9040 shipboard recording unit. These two units are compatible in terms of temperature and depth, but the conductivity sensor of the 9400 has a full range output of 0-60 mmho/cm. as compared with 10-60 mmho/cm. for the 9040 underwater sensor. The 9040 system is nominally set up so that water at 34‰ and 20^{o}C records 50 mmho/cm. If the correct value of 47.9 mmho/cm. was used then calibrations carried out using the 9400 sensor unit, when corrected for zero and sensitivity, gave acceptable results. On each profile a calibration water sample and

temperature were taken at a suitable depth using a water bottle attached to the hydrographic wire immediately above the sensor unit. The conductivity of these samples was measured relative to sub-standard sea water of known conductivity using a Guildline salinometer. During the course of profiling work a fault developed causing interference between the measurement channels. This was overcome by replacement of a faulty component at the interface between the 9400 sensor unit and the 9040 shipboard unit, with no significant loss of data. On some of the later measurements there appeared to be a time-dependent drift of the conductivity channel, indicated by a difference between the down and up profiles. This has not yet been explained and will require further investigations in the laboratory.

In planning the cruise programme it was anticipated that two or possibly three moorings would be deployed in order to measure and define the equatorial undercurrent. These moorings were designed with the aid of the Shape program to support three current meters separated by 25 metres at a mean depth of 100 metres, in a total depth of 4000 metres of water. The current meters would be mounted between a surface Selco buoy and a 48 inch steel sub-surface buoy maintained at a depth of about 200 metres by a wire to the bottom ballast weight. To prevent either excessive wire tensions or unacceptable vertical cope of the sub-surface buoy this design required that the total mooring length be accurately related to the depth of water within $\pm$20 metres. Due to lack of time during the cruise it became apparent that it would only be possible to deploy one of these moorings, on the equator at 32^{o}30'W. Since sea conditions were good it was decided to deploy the mooring ballast first using the double barrel winch on the foredeck. During the course of deployment the ship's drift and the bottom topography were such that it was found

impossible to change the mooring design length quickly enough to ensure the correct length relative to the water depth at the time of release. Lack of time prevented a detailed bottom survey, and rather than risk loss of the mooring it was decided to curtail the deployment.

A deep sea current meter mooring was deployed at position 0°20'S, 32°30'W in a depth of 4340 metres. This mooring was designed for six current meters at depths of 500, 1000, 1500, 2000, 3000and 4000 metres, using a 48 inch steel sub-surface buoy to support 2000 metres of Kilindo wire and 2200 metres of polypropylene rope. The mooring was deployed ballast first using the double-barrel winch, and was recovered by acoustic release with no difficulty, giving successful records. However, the speed with which the anchor reached the bottom and the float reached the surface after release suggest that the float was near the turbulent layer in the top 100 metres.

J.B.Rae

Attempted recovery of German Mooring

This Kiel University mooring had been laid on 5 Dec. 1977. A first recovery attempt in May 1978 failed due to what was then thought a fault in the AMF ship-board unit.

DISCOVERY reached the position (33 03'N, 21 56 W) at 1430Z/1 November. An acoustic listening pattern within a 2nm radius of the position was carried out. As there were no contacts on the original channel of the recovery device, all other channels were tried as well. By 1600Z wire tensioning began which did not interfere with the acoustic search work. The course was followed on the VDU in the plot room and the pattern could thus be changed according to immediate needs. Using the IOS-pinger on the tensioned wire at depths of 5000m as a transmitter, the sensibility of the AMF hydrophone and ship-board unit was tested and found to be good. The search was abandoned at 305/2315 when the wire was inboard again and course resumed.

It is assumed that a battery failure in the underwater unit prevented a successful normal recovery. Another attempt by trawling for the mooring will be made in 1979 by RV METEOR.

K.P. Koltermann.

Surface Salinity/Temperature profiling

The fish was streamed at 1700Z/304 and recovered at 0000Z/321 after a run of 3800nm. During PES watches a regular check on a two-hourly basis was maintained and data from the chart recorder and the computer printout were entered in the Fish Log Book.

The performance of the fish proper gives no reason for remarks except that with the ship broaching in afterly winds and swell aeration increases the scatter of the data points. Generally this comparison should be read having in mind that we worked in tropical waters with temperatures in excess of 20°C.

For calibration purposes 66 seawater samples were drawn from the non-toxic tap in the bio-lab. Each sample consisted of two bottles, these in turn were used to determine the salinity with the Guildline Salinometer, with several readings per bottle so that a fairly representative average salinity for the sample could be achieved. The temperatures were compared with the ship's hull temperature, T_{hull}, which in turn was calibrated on two occasions with thermometer readings of NIO bottles at 4m depth.

The temperature readings from the fish show a linear offset of $-0.74 \pm 0.13^{o}C$ compared with T_{hull}, taking the computer printouts (fig. 1). The readings from the chart recorder, reread by one person to insure systematic reading errors, were $0.57 \pm 0.15^{o}C$ too high compared with T_{hull}. So there is a discrepancy of $T = -0.17^{o}C$ between chart recorder and printout. The individual temperature readings show larger deviations for the area on the Sierra Leone Shelf, where temperatures near 30°C were encountered. It is believed that a strong vertical temperature gradient, associated with intense fresh-water run-off from the river systems, causes these deviations

due to different sensor depths of the hull sensor and the fish. Furthermore on the first days of the cruise, when temperatures were around 20°C, the error is only about -0.39°C, maybe indicating a nonlinear calibration for the higher temperatures encountered. A plot was made to show the individual temperature deviations on a time axis. For all calculations, the printout data have been used.

The salinity comparison, naturally, shows more structure . Generally the printout data are by 0.326 ± 0.153‰ too low compared with the water samples. Here the offset between chart recorder and printout is almost negligible, the difference being 0.308 ± 123‰ and the offset S=+0.018‰ . A closer look at fig 3 (top) reveals a large scatter of individual data even for successive hourly readings, and the influence of marine growth on the salinity/conductivity sensor. The differences $S_{sal} - S_{fish}$ are as small as 0.080‰ for the first hours after cleaning the fish's head in fresh water with some added detergent. But within 24 hours the deviations increase to about 0.35‰ and more. After this a "long-term" stability seems to have established. This influence of marine growth naturally depends very much on the prevailing temperatures and, thus, the corrections given here can only be taken as examples of tropical waters. This same effect is seen in a plot, where one easily notes that for low salinities around 30‰ , as found again on the Sierra Leone Shelf, the deviations become very small. For oceanic conditions the salinities recorded by the fish are definitely too small by an undesirable amount. Table (1) shows the day to day variations of T and S.

Finally a remark must be made on an unexplainable observation during the cruise. Although frontal zones with associated temperature

and salinity jumps were encountered especially off the African coast, sometimes for short (ca.30min) or longer (ca. 6 hrs) periods sudden jumps occurred both on the chart recorder and in the print-out for temperatures and/or salinities. So far an explanation is only seen in temperature dependences of the electronics. These jumps have not been reproduced by any means. An investigation into this is advised. Furthermore, it is strongly advised to clean the fish at least daily, preferably twice daily.

A note on the recorded data should be added. Both the passages through coastal African waters and in squall areas during the oceanic work show numerous interesting features from the oceanographic point of view.

K.P. Koltermann

Table 1

Day	$(t_{hull} - t_{chart})$	$(t_{hull} - t_{print})$	$(S_{hull} - S_{chart})$	$(S_{hull} - S_{print})$	
304	-0.38	-0.39	0.349	0.369	
305	-0.32	-0.84	0.428	0.048	
306	-	-	-	-	
307	-0.43 ± 0.04	-0.60 ± 0.02	0.558 ± 0.145	0.449 ± 0.210	
308	-0.78 ± 0.27	- .093± 0.29	0.333 ± 0.037	0.358 ± 0.011	
309	-0.60 ± 0.11	-0.75 ± 0.09	0.334 ± 0.140	0.343 ± 0.128	
310	-0.55 ± 0.11	-0.70 ± 0.17	0.293 ± 0.185	0.172 ± 0.282	
311	-0.58 ± 0.08	-0.81 ± 0.07	0.256 ± 0.049	0.274 ± 0.053	
312	-0.63 ± 0.07	-0.81 ± 0.07	0.298 ± 0.045	0.321 ± 0.040	
313	-0.77 ± 0.226	-0.75 ± 0.12	0.200 ± 0.051	0.268 ± 0.404	clean
314	-	-0.76 ± 0.02	-	0.553 ± 0.027	
315	-	-	-	-	
316	-	-0.71 ± 0.04	-	0.553 ± 0.088	
317	-	-0.78 ± 0.03	-	0.417 ± 0.218	clean
318	-0.66 ± 0.13	-0.78 ± 0.09	0.105 ± 0.046	0.118 ± 0.059	
319	-	-	-	-	
average	-0.57 ± 0.15	-0.74 ± 0.13	0.308 ± 0.123	0.326 ± 0.153	

Bathymetry and Magnetometry

Echo sounding was carried out throughout both cruises 95 and 97 with manual logging at 6 minute intervals, (restricted on cruise 95 to south of 44°N and north of 5°S). The hull transducer was used in the early and later parts of cruise 95 where it gave good echos in calm seas, but PDR fishes nos. 6 and 2 were used at other times. At one stage, fish no. 6 had a tendency to swing towards the hull for no discoverable reason. The Mufax traces covered several features of potential interest to geologists, such as a central traverse of Papp Seamount (near 26°N, 20°W), traverses of Cayar Canyon and several other canyons off the west African shelf south of Cap Blanc, and much detail, some of it unmapped, throughout the Sierra Leone Rise, the St. Paul's Fracture Zone and Fernando de Noronha Rise. There were also many examples, especially in the Tropics, of dense scattering layers with diurnal migration, and fish shoals, of potential interest to biologists.

All bathymetric data west of 25°W from both cruises were plotted on standard scale sheets and given to the Brasilian hydrographic authorities at Rio de Janeiro.

A magnetometer unit, loaned from RVS, was deployed on Cruise 95 in most tracks south of 15°N, and throughout cruise 97, at the request of Dr. John Jones of University College London. Exceptions were the two equatorial traverses EP1 and EP2, where deploying the magnetometer fish between the stations would have cost too much time, and on the eastbound leg from T5 to EP2, where the track had already been covered in the westbound course to T5. From 00 to 06 hours GMT of day 320 the computer was accidentally not switched to logging magnetometer data; the data for this period is obtainable from the analogue chart roll.

On a few occasions, notably the morning of day 310, the magnetometer was observed to have a tendency to record at double scale. This was diagnosed as caused by overheating of a card known as "Phase Lock 2" in tropical conditions, and was subsequently avoided by keeping the uppermost rack exposed to air with a rotary fan blowing over it continuously.

D.E.C.

Work on forward hydraulic system

Installation of the Lucas 58 H.P. CPSV pump, with reservoir tank and associated valve control system was completed during the refit period. The new double barrel capstan and the hydraulic winch were also fitted.

During passage of Cruise 95 the valve pipework system of the main hydraulic power pack was completed and closed loop running tests carried out. The theoretical working pressures were obtained on main and auxiliary lines, although there was a noticeable drop in the speed output from the electric motor drive.

As it was found impossible at the refit to fund the installation of the connecting pipework between the new power pack and the various winch positions the "Double Barrel Capstan" had to be powered by the new diesel hydraulic emergency power pack. During run-up trials the reeling winch motor coupling sheared and damaged the hydraulic drive motor. Repairs were carried out and the mooring work was accomplished with manual operation of the reeling winch. The new emergency power pack performed well throughout the cruise, giving a static pull of 3400 lbs. on the drums of the double barrel capstan.

The forward hydrographic winch was not used on the cruise, but pull tests using the emergency diesel power pack gave a figure of 3400 lbs. at the barrel radius with an operating pressure of 3000 psi.

IOS Engineering Group

Sonar trials in North Sea

The following transducers were mounted on the stabilised platform:

Port Plate		Starboard Plate	
Front Face	Back Face	Front Face	Back Face
2 x 250 kHz 37 kHz	70 kHz	31 kHz	70 kHz

The 250 kHz transducers were mounted at right angles with one being used for transmission and one for reception to give a narrow beam. Echosounder records were obtained using these transducers and the telesounder electronics.

The 31 kHz and 37 kHz side scan systems were tested and a record obtained while the pod was extended. The new 31 kHz transducers which enable the 31 kHz beam pattern to be changed from a fan shape to one more suitable for echosounding were successfully tested.

The 70 kHz line and cone transducers were angled off the plate, one forward and one aft. They are intended for current measurement in deep water by doppler frequency change and were tested using a new transmitter and the 37 kHz receiver electronics. Doppler frequency changes of the bottom echo were measured while the ship was under way and records were obtained which gave a guide to the beam shape.

J.G. Legg

Computer engineering

The important requirements of the computer facilities were to provide accurate positions for the deployment and recovery of the tide gauges.

Live track and track charts of the ship's position during deployment were produced and these were subsequently used to aid recovery.

The Magnavox (bridge) computer system gave very little trouble and all recovery positions were within ½ - 1 mile of the deployment positions.

Routine data stored on the 1800 computer included all temperatures, wind speed and directions, magnetometry and temperature and salinity profiler data.

Each day both navigation and meteorological data were evaluated to provide a quality control check on the previous days data. Bad fixes were subsequently rejected and the navigation course up-date re-run. Considerable radio frequency interference was noted from radio transmissions and where possible this was edited out. Most of the engineering problems were caused by faulty air conditioning and erratic mains supply.

Dr. Vassie used the 1800 computer and front end PDP11 for processing the sea-data tapes and this was accomplished successfully with no hardware problems, except that on one occasion a parity error was detected.

P. Hartland

STATION LIST

Stations 9905, 9907, 9908, 9916, 9917, 9922 and 9925 were allocated to tidal pressure stations whose details are tabulated on the next page. Other station numbers allocated on Cruise 95 were as follows.

9904	33°04'N,	21°56'W	and vicinity - search for German mooring pinger tests, wire tensioning
9906	07°22'N,	20°57'W	CTD tests to 500m
9909	01°00'N,	27°30'W	Equat. Profile EP1.1
9910	00°41'N,	27°32'W	" " EP1.2
9911	00°19'N,	27°30'W	" " EP1.3
9912	00°01'N,	27°29'W	" " EP1.4
9913	00°20'S,	27°31'W	" " EP1.5
9914	00°40'S,	27°30'W	" " EP1.6
9915	01°00'S,	27°30'W	" " EP1.7
9918	01°01'N,	32°31'W	Equat. Profile EP2.1
9919	00°40'N,	32°31'W	" " EP2.2
9920	00°20'N,	32°31'W	" " EP2.3
9921	00°03'N,	32°28'W	" " EP2.4
9922*	00°20'S,	32°30'W	" " EP2.5
9923	00°40'S,	32°30'W	" " EP2.6
9924	01°00'S,	32°30'W	" " EP2.7

* Station 9922 also included the deep current meter mooring.

TIDAL STATIONS

Times given in columns 6-8 are GMT hours and minutes followed by 1978 day number

Name	Station number	Latitude	Longitude	Depth (m)	Scan O (GMT)	On bottom	Off bottom	Comments
T1	9905	10 06'N	17 14'W	527	1115/309	2051/310	2115/345	Mk.3 No.7 Guinea shelf
T2	9907	06 04'N	20 58'W	3650	1700/309	1021/312	0119/347	Mk.4 no.4 Sierra Leone Rise
T3	9908	03 08'N	25 04'W	4200	1700/312	1701/313	0423/348	Mk.4 no.3 Deepest IOS capsule
T4	9916	00 56'N	29 17'W	351	1030/315	0621/316	0825/349	Mk.3 no.17 St. Paul's Rocks
T5	9917	00 58'N	35 35'W	3800	1149/316	1607/317	1817/350	Mk.4 no.2 Pressure channels failed
T6	9925	06 45'S	34 18'W	2825	1400/286	0319/326	1232/337	Aanderaa TG 282-3 Brasilian shelf
T7	9933	17 04'S	13 40'W	2800	1230/365	2236/001*	0804/084*	Mk.4 no.4 Mid-Atlantic Ridge
E1	9922	00 20'S	32 29'W	4340	various	1507/319	1640/351	6 Aanderaa current meters

* 1979 day numbers

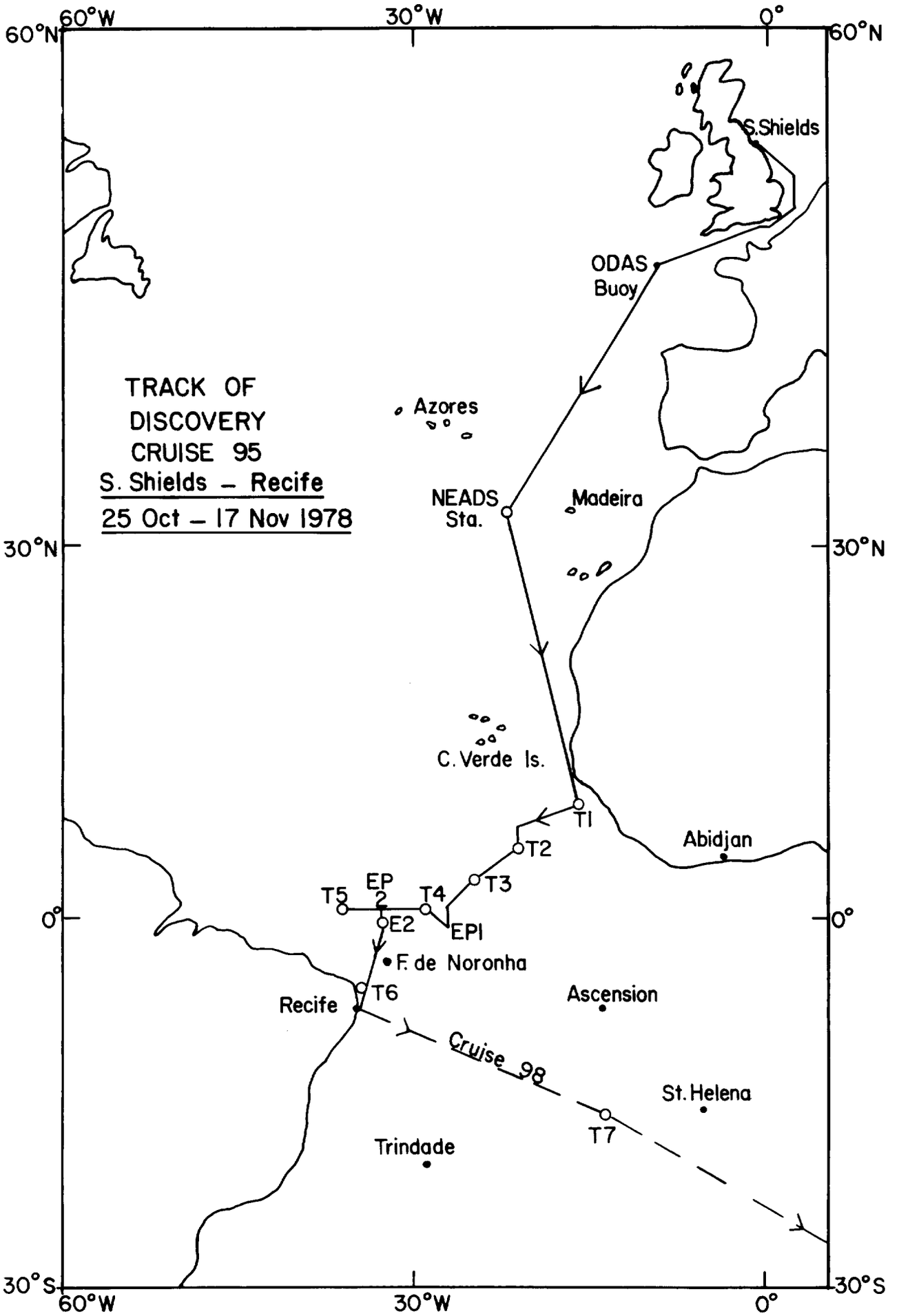
TRACK CHART

The chart on the following page shows the track chart of Cruise 95 and the positions of the tidal stations T1 - T7 and the Equatorial profiles EP1 and EP2.

T6 was laid and recovered on Cruise 96 for which there is a separate Cruise Report, and T7 was laid on Cruise 98, Recife to Cape Town.

The track of Cruise 97, when the tidal moorings were recovered in the same order as laid, consisted of a 'straight' line from Recife to T1 followed by straight tracks between the tidal stations T1 - T5, omitting EP1, and returning from T5 to EP2 only to recover the current meter mooring E2.

The map also shows the islands of Ascension, Fernando de Noronha and Trindade, all of which, together with Recife and Abidjan, had shore-based tide gauges operating during the same period.


60°W
30°W
0°
60°N
30°N
0°
30°S
S.Shields
ODAS
Buoy
TRACK OF
DISCOVERY
CRUISE 95
S. Shields – Recife
25 Oct – 17 Nov 1978
Azores
NEADS
Sta.
Madeira
C. Verde Is.
T1
T2
T3
T4
T5
EP
2
E2
EP1
Abidjan
F. de Noronha
T6
Recife
Ascension
Cruise 98
St. Helena
T7
Trindade