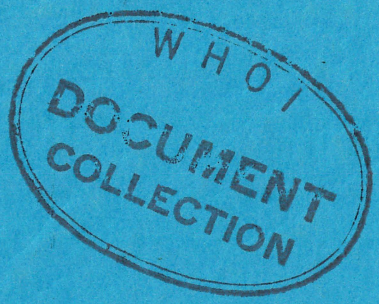


WOODS HOLE OCEANOGRAPHIC INSTITUTION

Reference No. 64-30

NARRATIVE OF CHAIN CRUISE #17, PHASE I
St. George, Bermuda, to Freetown, Sierra Leone
19 February - 22 March 1961

WOODS HOLE, MASSACHUSETTS

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts

Reference No. 64-30

NARRATIVE OF CHAIN CRUISE #17, PHASE I
St. George, Bermuda, to Freetown, Sierra Leone
19 February - 22 March 1961

by

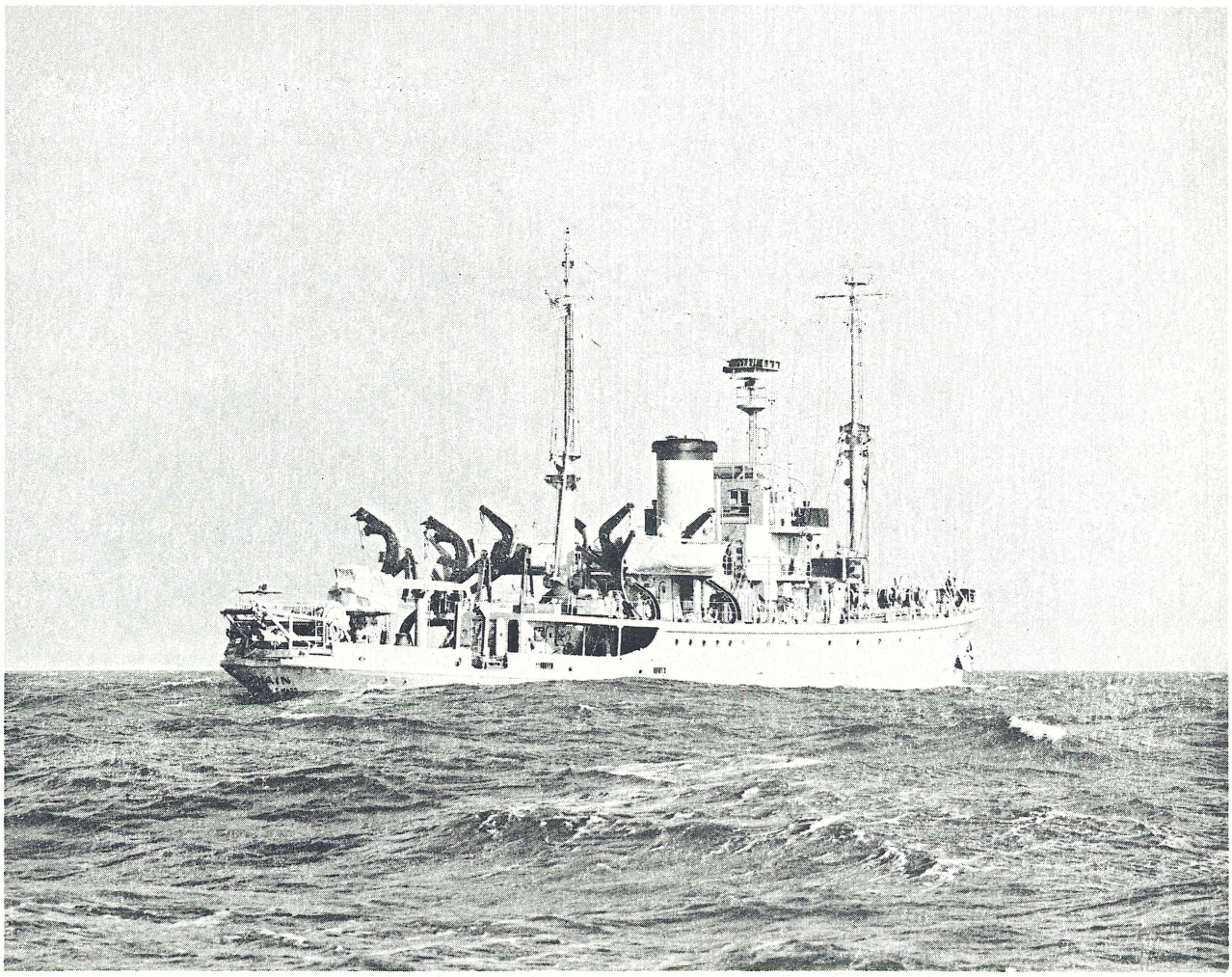
A. D. Voorhis and E. T. Bunce

June 1964

Submitted to the Office of Naval Research under Contract Nonr-2196(00)

APPROVED FOR DISTRIBUTION Richard H. Backus

Richard H. Backus
Deputy Chairman
Department of Geophysics



R/V CHAIN

TABLE OF CONTENTS

ABSTRACT

The journal of a cruise of R/V CHAIN from Bermuda to Freetown, Sierra Leone during February and March, 1961, is the basis of this report. Location of observations are given. The portion of the Mid-Atlantic Ridge lying along the equator was surveyed from 10° to 19°W, and new information concerning the slope and orientation of rift zones was obtained. A detailed bathymetric survey of the Romanche Trench was made. A continuous temperature-depth profile, from the surface to 100 meters, was made along the ship's track with a thermistor chain. Surface shear was measured with pitotmeters mounted on the chain (surface water velocity relative to the water velocity at the depth of the pitotmeter), to determine the strength and direction of the equatorial undercurrent.

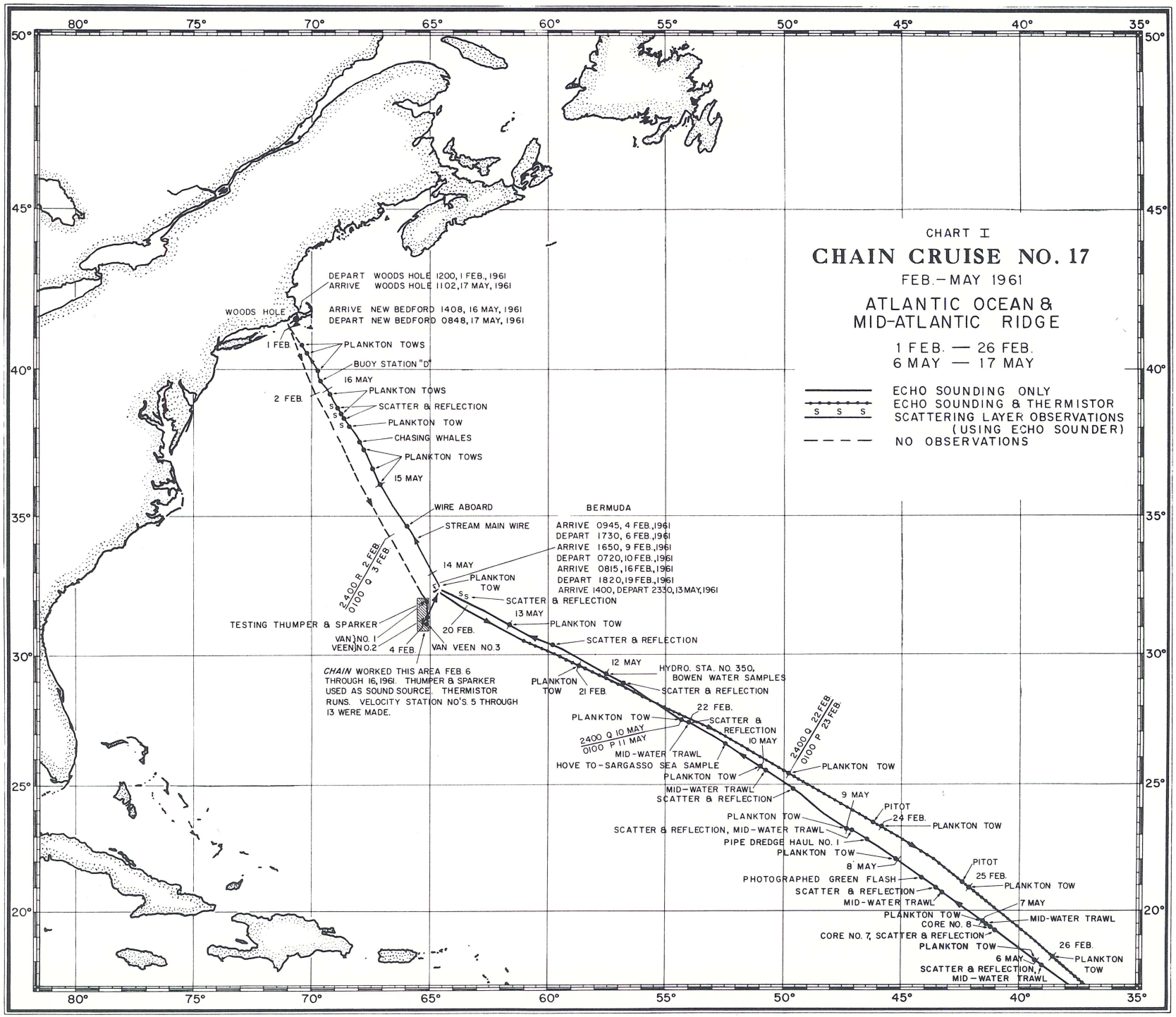


CHART I
CHAIN CRUISE NO. 17
FEB. – MAY 1961
ATLANTIC OCEAN &
MID-ATLANTIC RIDGE
1 FEB. — 26 FEB.
6 MAY — 17 MAY
ECHO SOUNDING ONLY
ECHO SOUNDING & THERMISTOR
SCATTERING LAYER OBSERVATIONS (USING ECHO SOUNDER)
NO OBSERVATIONS
DEPART WOODS HOLE 1200, 1 FEB., 1961
ARRIVE WOODS HOLE 1102, 17 MAY, 1961
ARRIVE NEW BEDFORD 1408, 16 MAY, 1961
DEPART NEW BEDFORD 0848, 17 MAY, 1961
WOODS HOLE
1 FEB.
PLANKTON TOWS
BUOY STATION "D"
16 MAY
2 FEB.
PLANKTON TOWS
SCATTER & REFLECTION
PLANKTON TOW
CHASING WHALES
PLANKTON TOWS
15 MAY
WIRE ABOARD
STREAM MAIN WIRE
BERMUDA
ARRIVE 0945, 4 FEB., 1961
DEPART 1730, 6 FEB., 1961
ARRIVE 1650, 9 FEB., 1961
DEPART 0720, 10 FEB., 1961
ARRIVE 0815, 16 FEB., 1961
DEPART 1820, 19 FEB., 1961
ARRIVE 1400, DEPART 2330, 13 MAY, 1961
2400 R 2 FEB.
0100 Q 3 FEB.
14 MAY
PLANKTON TOW
SCATTER & REFLECTION
13 MAY
PLANKTON TOW
SCATTER & REFLECTION
TESTING THUMPER & SPARKER
VAN VEEN NO. 1
VAN VEEN NO. 2
4 FEB.
20 FEB.
VAN VEEN NO. 3
CHAIN WORKED THIS AREA FEB. 6 THROUGH 16, 1961. THUMPER & SPARKER USED AS SOUND SOURCE. THERMISTOR RUNS. VELOCITY STATION NO'S. 5 THROUGH 13 WERE MADE.
12 MAY
HYDRO. STA. NO. 350, BOWEN WATER SAMPLES
PLANKTON TOW
21 FEB.
SCATTER & REFLECTION
22 FEB.
PLANKTON TOW
SCATTER & REFLECTION
2400 Q 10 MAY
0100 P 11 MAY
10 MAY
MID-WATER TRAWL
HOVE TO-SARGASSO SEA SAMPLE
PLANKTON TOW
2400 Q 22 FEB.
0100 P 23 FEB.
PLANKTON TOW
MID-WATER TRAWL
SCATTER & REFLECTION
9 MAY
PITOT
24 FEB.
PLANKTON TOW
PLANKTON TOW
SCATTER & REFLECTION, MID-WATER TRAWL
PIPE DREDGE HAUL NO. 1
PLANKTON TOW
8 MAY
PITOT
25 FEB.
PHOTOGRAPHED GREEN FLASH
PLANKTON TOW
SCATTER & REFLECTION
MID-WATER TRAWL
7 MAY
PLANKTON TOW
MID-WATER TRAWL
CORE NO. 8
CORE NO. 7, SCATTER & REFLECTION
PLANKTON TOW
26 FEB.
6 MAY
PLANKTON TOW
SCATTER & REFLECTION, MID-WATER TRAWL
80°
75°
70°
65°
60°
55°
50°
45°
40°
35°
50°
45°
40°
35°
30°
25°
20°

CHART I

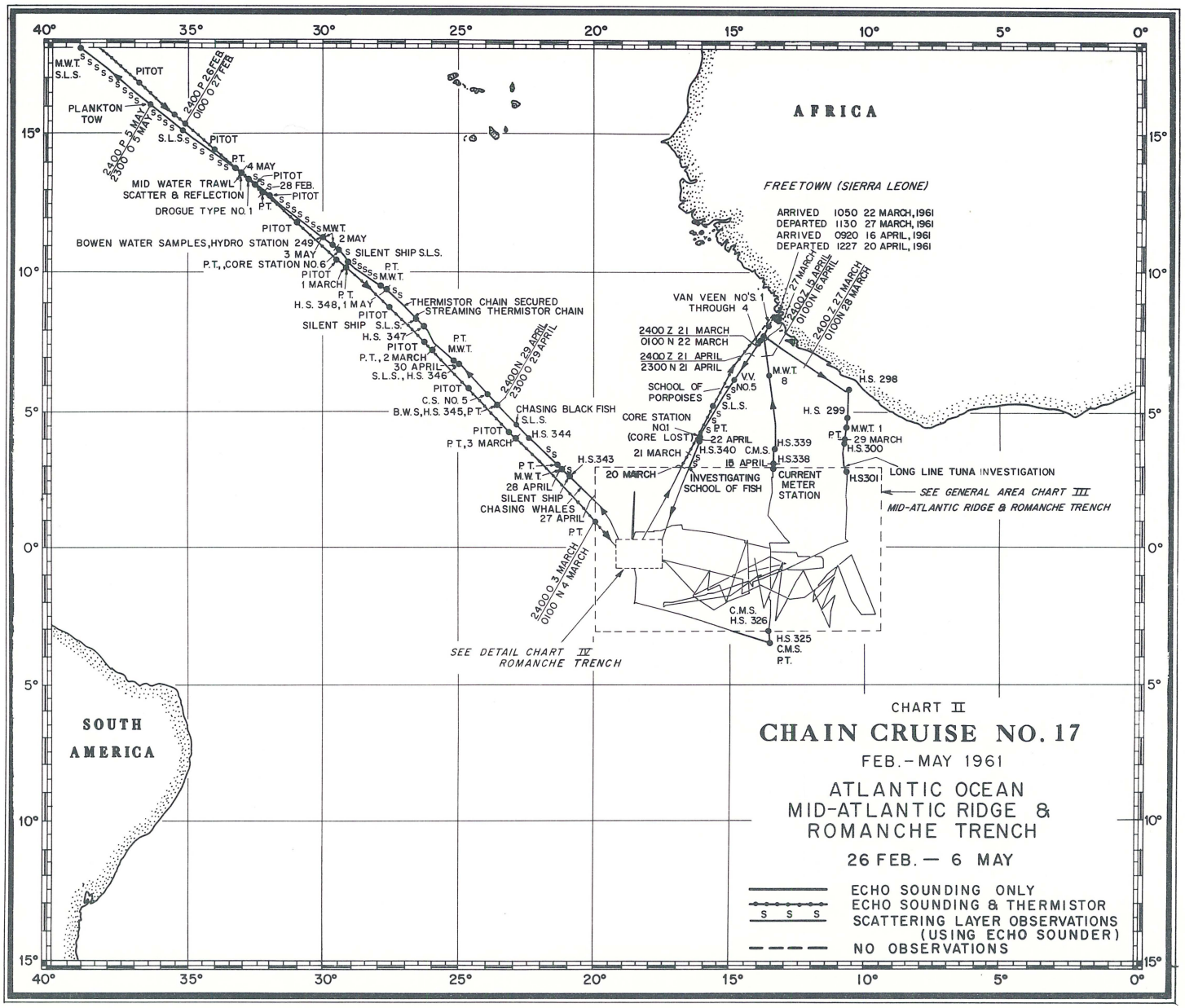

AFRICA
SOUTH AMERICA
FREETOWN (SIERRA LEONE)
ARRIVED 1050 22 MARCH, 1961
DEPARTED 1130 27 MARCH, 1961
ARRIVED 0920 16 APRIL, 1961
DEPARTED 1227 20 APRIL, 1961
M.W.T.
S.L.S.
PITOT
PLANKTON TOW
2400 P 26 FEB 0100 O 21 FEB
2400 P 5 MAY 2300 O 5 MAY
MID WATER TRAWL SCATTER & REFLECTION
DROGUE TYPE NO. 1
4 MAY
28 FEB.
BOWEN WATER SAMPLES, HYDRO STATION 249
2 MAY
3 MAY
SILENT SHIP S.L.S.
P.T., CORE STATION NO. 6
1 MARCH
H.S. 348, 1 MAY
THERMISTOR CHAIN SECURED
STREAMING THERMISTOR CHAIN
SILENT SHIP S.L.S.
H.S. 347
P.T., 2 MARCH
30 APRIL
S.L.S., H.S. 346
2400 N 29 APRIL 2300 O 29 APRIL
C.S. NO. 5
B.W.S, H.S. 345, P.T.
CHASING BLACK FISH
S.L.S.
H.S. 344
P.T., 3 MARCH
H.S. 343
M.W.T.
28 APRIL
SILENT SHIP CHASING WHALES
27 APRIL
2400 O 3 MARCH 0100 N 4 MARCH
SEE DETAIL CHART IV ROMANCHE TRENCH
VAN VEEN NO'S 1 THROUGH 4
2400 Z 27 MARCH 0100 N 15 APRIL
2400 Z 27 MARCH 0100 N 28 MARCH
2400 Z 21 MARCH 0100 N 22 MARCH
2400 Z 21 APRIL 2300 N 21 APRIL
SCHOOL OF PORPOISES
V.V. NO. 5
S.L.S.
CORE STATION NO. 1 (CORE LOST)
22 APRIL
21 MARCH
H.S. 340 C.M.S.
16 APRIL
20 MARCH
INVESTIGATING SCHOOL OF FISH
H.S. 339
H.S. 338
CURRENT METER STATION
M.W.T. 8
H.S. 298
H.S. 299
M.W.T. 1
29 MARCH
H.S. 300
H.S. 301
LONG LINE TUNA INVESTIGATION
SEE GENERAL AREA CHART III MID-ATLANTIC RIDGE & ROMANCHE TRENCH
C.M.S. H.S. 326
H.S. 325 C.M.S. P.T.
CHART II
CHAIN CRUISE NO. 17
FEB. - MAY 1961
ATLANTIC OCEAN
MID-ATLANTIC RIDGE & ROMANCHE TRENCH
26 FEB. — 6 MAY
ECHO SOUNDING ONLY
ECHO SOUNDING & THERMISTOR
SCATTERING LAYER OBSERVATIONS (USING ECHO SOUNDER)
NO OBSERVATIONS
40° 35° 30° 25° 20° 15° 10° 5° 0°
15° 10° 5° 0° 5° 10° 15°

CHART II

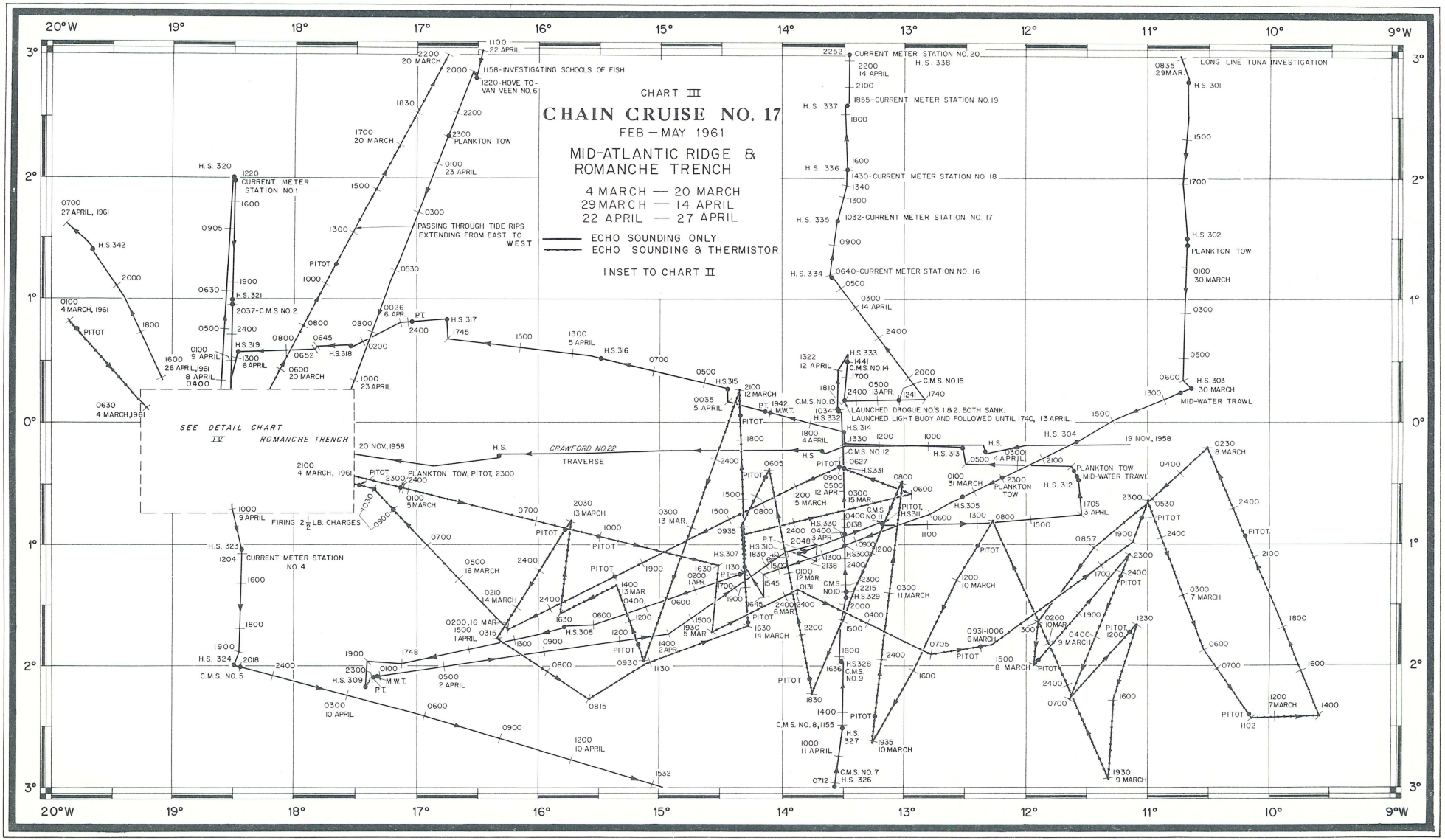


CHART III
CHAIN CRUISE NO. 17
FEB — MAY 1961
MID-ATLANTIC RIDGE &
ROMANCHE TRENCH
4 MARCH — 20 MARCH
29 MARCH — 14 APRIL
22 APRIL — 27 APRIL
ECHO SOUNDING ONLY
ECHO SOUNDING & THERMISTOR
INSET TO CHART II
SEE DETAIL CHART IV ROMANCHE TRENCH
CRAWFORD NO.22 TRAVERSE
CURRENT METER STATION NO.1
CURRENT METER STATION NO.4
CURRENT METER STATION NO.20
CURRENT METER STATION NO.19
CURRENT METER STATION NO.18
CURRENT METER STATION NO.17
CURRENT METER STATION NO.16
LONG LINE TUNA INVESTIGATION
MID-WATER TRAWL
PLANKTON TOW
PASSING THROUGH TIDE RIPS EXTENDING FROM EAST TO WEST
LAUNCHED DROGUE NO'S 1 & 2, BOTH SANK.
LAUNCHED LIGHT BUOY AND FOLLOWED UNTIL 1740, 13 APRIL
FIRING 2½ LB. CHARGES
1158-INVESTIGATING SCHOOLS OF FISH
1220-HOVE TO-VAN VEEN NO.6
20°W
19°
18°
17°
16°
15°
14°
13°
12°
11°
10°
9°W
3°
2°
1°
0°

CHART III

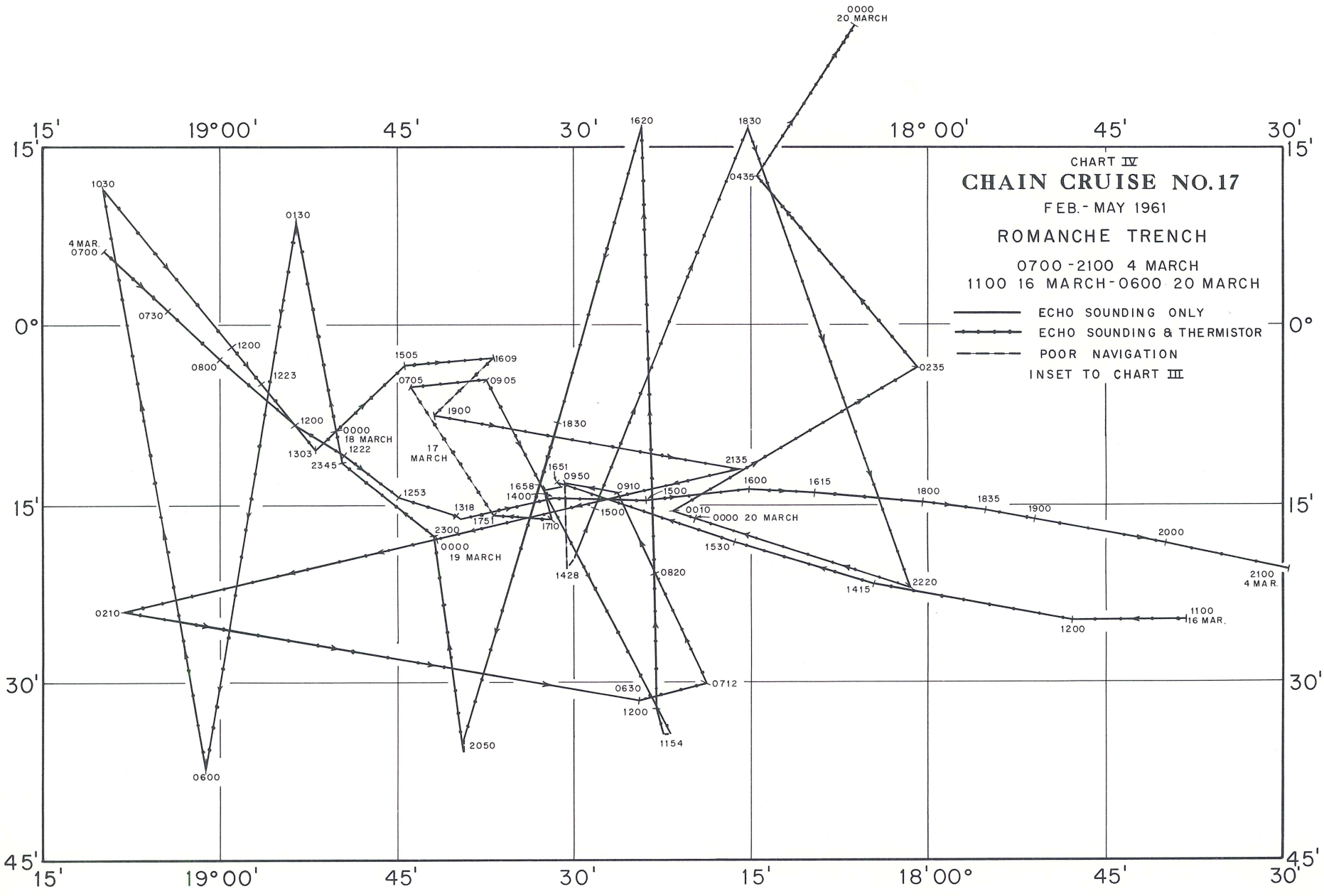


CHART IV
CHAIN CRUISE NO. 17
FEB. - MAY 1961
ROMANCHE TRENCH
0700 - 2100 4 MARCH
1100 16 MARCH - 0600 20 MARCH
ECHO SOUNDING ONLY
ECHO SOUNDING & THERMISTOR
POOR NAVIGATION
INSET TO CHART III
15'
19°00'
45'
30'
18° 00'
0°
0000 20 MARCH
1620
1830
0435
1030
4 MAR. 0700
0130
0730
1200
0800
1223
1505
1609
0705
0905
1900
1830
0235
1200
0000 18 MARCH
1303
1222
2345
17 MARCH
2135
1651
0950
1658
1400
0910
1500
1600
1615
1800
1835
1900
2000
1253
1318
1751
1710
1500
0010
0000 20 MARCH
1530
2300
0000 19 MARCH
1428
0820
2220
1415
2100 4 MAR.
1100 16 MAR.
1200
0210
0712
0630
1200
1154
2050
0600

CHART IV

INTRODUCTION

CHAIN Cruise17 was made in three phases, only the first of which is described here, the passage from Bermuda to Sierra Leone. The Research Vessel CHAIN departed St. George, Bermuda on 19 February and arrived at Freetown, Sierra Leone, thirty-two days later, on 22 March, 1961. The chief purpose of this phase of the cruise was to make a bathymetric survey of the Mid-Atlantic Ridge where it runs east-west along the equator from 10°W to 19°W. Such a survey would provide new information concerning the rift zones along the ridge (Heezen and others, 1964) and determine the maximum sill depths (Metcalf and others, 1964) for the possible flow of Antarctic Bottom Water across the ridge to the north. A knowledge of the location of these sills was necessary for the proper distribution of hydrographic measurements to be made in a later phase of the cruise. An additional bathymetric survey of the Romanche Trench (0°10'S, 18°30'W) was made to determine more accurately the location of its walls for dredging and the geochemical measurements to be made there in a later phase of the cruise.

Besides these surveys, several other projects were carried out. A continuous temperature-depth profile from the surface to 100 meters was recorded along the entire track of the ship by means of a towed thermistor chain. Forty measurements of surface water shear were made by means of pitotmeters mounted on the thermistor chain. The temperature and shear measurements along the equator quickly revealed the presence of an eastward-flowing undercurrent (Voorhis, 1961; Metcalf and others, 1962) similar to the Cromwell Current observed in the Pacific. Thirty-seven 100-meter drogues were set by C. Parker, some of which indicated a strong undercurrent at the equator. A plankton tow was made every day as part of a study conducted by H. Curl. Continuous measurements of dissolved carbon dioxide in the surface water along the ship's track were made, and these showed that the concentration along the equator was greater than that in the water north of about 4°N.

Throughout this leg of the cruise the Geon navigation system was tested by W. S. von Arx. Navigational fixes were provided by him at times when morning and evening star fixes could not be obtained because of overcast weather.

The track of the ship is shown in charts I to IV. Bathymetry and other information may be found in WHOI Ref. No. 62-9 (Bunce and others, 1962), from which the charts in this report are taken. Because of this they show the

track for all three phases of the cruise. The Appendix gives the station locations for the observations.

References

Bunce, E. T., M. C. Stalcup, and C. E. Parker (1962): Track charts, bathymetry, and location of observations, CHAIN Cruise #17, Atlantic Ocean - Romanche Trench, February 1, 1961 - May 17, 1961. WHOI Ref. No. 62-9.

Heezen, B. C., E. T. Bunce, J. B. Hersey, and M. Tharp (1964): Chain and Romanche fracture zones. Deep-Sea Res., Vol. 2, pp. 11-33.

Metcalf, W. G., B. C. Heezen, and M. C. Stalcup (1964): The sill depth of the Mid-Atlantic Ridge in the equatorial region. Deep-Sea Res., Vol. 2, pp. 1-10.

Metcalf, W. G., A. D. Voorhis, and M. C. Stalcup (1962): The Atlantic equatorial undercurrent. J. Geophys. Res., Vol. 67, No. 6, pp. 2499-2508.

Voorhis, A. D. (1961): Evidence of an eastward equatorial undercurrent in the Atlantic from measurements of current shear. Nature, Vol. 191, No. 4784, pp. 157-158.

JOURNAL

St. George, Bermuda, to Freetown, Sierra Leone, 19 February to 22 March, 1961

by A. D. Voorhis and E. T. Bunce

The Scientific party departing Bermuda for Sierra Leone was:

Voorhis, Arthur D., Chief Scientist

Arend, John
Bunce, Elizabeth
Chappelle, Edward
Farnum, Gregory
Green, Edward
Parker, Charles
Paulding, Bartlett (student)
Riegel, Richard
Savin, Samuel
Stalcup, Marvel
Stone, Richard
von Arx, William
Wilharm, Larry

19 February, Sunday. Departed St. George at 1900Q. No watches were set. Voorhis spent the evening repairing the surface temperature bridge. Von Arx took some star sights before leaving dock. Green started his continuous carbon dioxide sampling.

20 February, Monday. A staff meeting was held at 0900 and the following watches were set:

0000-0400	0400-0800	0800-1200
1200-1600	1600-2000	2000-2400
Riegel	Arend	Green
Stone or Bunce	Paulding	Savin

The watches are responsible for marking all instrument records and keeping the log of the PGR (Precision Graphic Recorder). Continuous recordings of surface temperature, of relative humidity (by wet and dry bulb), and of wind speed and direction were started. The echo sounding fish was put overside and seems to tow well at 12 knots in sea state 1. The PGR was started but we could record no signal from the fish; consequently the port hull transducer (with Edo 2) was used, but only fair recordings were obtained with it. Wilharm worked on Edo transducers 1 and 3 and one of the preamplifiers (designed by Caulfield), trying to find the source of the trouble; both port and starboard hull transducers are operative, but Edo 3 is not. The TC (thermistor chain) was put in the water and records were begun; five thermistors were inoperative. At midnight Stone made a plankton tow at 200 meters using the hydrographic winch. The captain felt it risky to leave the TC in while making the tow, so the chain was raised. Stalcup is taking two BT's daily, at 0000 and at 1200 GMT.

21 February, Tuesday. There are still unsatisfactory records on the PGR. Wilharm continues working on the Edo's. The thermistor recorder was recalibrated and gave satisfactory recordings. The TC was raised, two thermistors were replaced, and a new wire pair was used. A rack to hold the humidity sensor was built, and the unit was mounted on the port rail of the top lab. Stone made a plankton tow at midnight. At 1600 Stalcup started recording salinities for Worthington; he will be taking measurements every two hours.

22 February, Wednesday. Wilharm found a grounded connection in Edo 1 (used with the towed-fish transducer). The PGR is now operating well with the hull transducer, but not with the fish. Wilharm is checking the modifications of the Edo's made by Caulfield. The TC was raised and connections were made for three pitot tubes. Stone made a plankton tow at midnight. About 2200 a 20-minute recording was made of temperature fluctuations at thermistor 7. Clocks went ahead one hour at midnight (Papa time).

23 February, Thursday. One pitot tube was installed on the chain between thermistors 21 and 22. At 2130 a starborad box maneuver was made (10 minutes each leg), to measure shear with the pitot tube. Temperature fluctuation and TC profiles were recorded at the same time. Betty Bunce and

Arend find that echo sounding with the fish is only practical at speeds of less than 9 knots; at normal speeds (10 knots) the fish is useless because of flow noise (in sea state 1 or 2!). (Note: This performance of the echo sounding fish of the design used (Knott - Witzell) is unusual; normally the fish is somewhat noisier than a hull-mounted transducer, but it will give satisfactory records at speeds of 14 knots and in very rough seas.) Tests made with the ship increasing and reducing speed indicate a complete masking of the signal by noise at speeds of 10 knots or higher. The fish was brought aboard and secured. We got beautiful PGR recordings of ridge mountains. Plankton tow made by Stone at 2400P. We explained the echo sounding program and purpose to the scientific party and discussed some tentative plans for the bathymetric survey.

This day we sighted two tankers and one freighter, a few flying fish, and a plane taking magnetic anomaly measurements.

24 February, Friday. Routine echo sounding program. Voorhis and Parker worked on the TC harness, repairing a lead to the pitot meter; at 1800 it was working satisfactorily. Shear measurements were made in a box maneuver at 1800.

25 February, Saturday. Overcast and some rain squalls. Routine echo sounding. Minor PGR problems: channel-1 scale-line marker is useless except as a paper cutter, and one scale-line generator is sick already. Some scattering layer returns of an Alexander's Acres type. It would be better if the entire group could be persuaded that short-pulse echo sounding is best. A broken electrical connection was detected in the potentiometer of the pitot; another pitot was substituted but failed to work. Stalcup ceased taking salinity data, and the results he had obtained from 55°W to 40°W were transmitted to CRAWFORD. At 2400, while the TC was aboard for Stone's plankton tow, a new pitot was installed.

26 February, Sunday. Routine echo sounding. Interesting single echo (probably a large fish or whale) moving up through scattering layer, at shallow depths, apparently closing ship; seen about three times over a period of 50 minutes. Shear measurements were made with the pitot at 1250 and 2100. At midnight the clock was advanced one hour (to Oscar time). Two box courses were run. Plankton tow.

27 February, Monday. A near-surface thermocline is now shallow enough to appear on the thermistor record, with beautiful trains of internal waves. Two box courses were run. Parker and Chappelle released a drogue buoy in the morning and expect to do so every 10 hours. Plankton tow made. Tentative plan for a sill hunt revised slightly: plan now is to cross the equator at about 18°45'W, try going over the VEMA Cruise 12 echo sounding tracks across the Romanche Trench itself, and swing southeast on a long leg to about 12°30'W 2°S and then northeast to just north of the equator. This will give a good east-west tie line for survey legs which will be more or less southwest-northeast or southeast-northwest.

28 February, Tuesday. At 0100 we put the second pitot at the top of the TC. It is operating poorly, but probably well enough for measurements. At 1030 made shear measurements with both pitots. Wind drift was negligible. In the afternoon the gain of the deep pitot was increased, and there appears to be a hint of internal wave motion in its reading. This should be examined later. Made a long temperature fluctuation record with various thermistors, made a plankton tow, and did routine echo sounding. No celestial fixes for the navigator today, and no morning stars yesterday.

The PGR dropped dead in mid-afternoon. We eventually found a short in the main (selector) operating switch, which was due to lack of clearance on the control panel cover. We cannot close the cover with the present switch, and there is no spare of a smaller size aboard; the lid is now propped open and a large sign warns against closing it.

Schools of flying fish today for the first time. Trying to procure a blower from the engine room to cool the PGR, as the ambient temperature in the lab is quite high.

1 March, Wednesday. The shallow pitotmeter is still operating poorly. Temperature fluctuations at thermistor 22 correlate well with velocity fluctuations at the deep pitotmeter. The shallow pitot was completely useless at 1500. Made a maneuver in the evening for work with the deep pitot. At 2100 the 0.1°C isotherms on the TC records became excessively dark. New phototransistors were installed in the TC recorder, as well as a new servo chassis and amplifier chassis. Plankton tow at midnight; during it the TC was left out, to about 60 feet. BT's at 1200 and at 2400 GMT.

Our "patent" aquarium overflowed in the starboard passage to the main lab during the night; one jellyfish had plugged the drain. Bailing indicated.

At 0330 the PGR B+ power supply fuse blew, and a wait of 5 or 10 minutes was necessary before a replacement could be found that would not blow out. Suspecting that overheating was the trouble, the chief engineer and electrician rigged a blower behind the PGR Altec. Certainly, at least it stirs the hot air and it may help keep the ambient temperature down.

Six Wilson's petrels sighted, and more schools of flying fish. The petrels struck at the lure on the fishing line astern, during the slow-down for letting out the TC.

2 March, Thursday. At 0100 the TC recorder was finally operating satisfactorily. During morning and afternoon, fluctuations were recorded for comparison with the deep pitot-tube recordings. At 1630 the drogue schedule was changed to one drogue drop every two and a half hours, from 5°N to 2°S. Stalcup is recording in a log the hourly humidity, air temperature, surface temperature, etc., and some interesting trends are appearing. Passed through thunderstorms and rain in the evening; von Arx identified this as the intertropical convergence. Put the clocks ahead one hour to N (November) time. Made a plankton tow, with the TC out 60 feet. At 0100 the PGR B+ power supply fuse was gone again; depth recordings lost for about fifteen minutes. "Tunabird" sighted, and some type of shearwater.

3 March, Friday. At 0030 both pitots were removed from the TC for repair. During the morning a long temperature fluctuation sequence was made. In the afternoon Green reported that the surface water was supersaturated with respect to dissolved CO_2 and that the sea temperature had dropped approximately 1°. These facts probably indicate the presence of undercurrent. White-tip sharks following along port side, dolphins chasing a school of flying fish off to port. Glassy flat calm all morning, slight southeast breeze in the afternoon. The port side of the ship is hot enough to give a bake-oven effect. We made a plankton tow, again with the TC out 60 feet; this practice will be continued. So far on this trip we have been making engine turns for 12 knots. The captain suggests, in the light of our plans for the bathymetric work just starting, of the fuel supply versus the time remaining at sea, and of other matters, that we reduce the number to a more economical 145 turns and

make 11 knots; fine. Making course 105° for the contour "nose" shown on chart HO 6750-B. Correlation between our data and the chart is strictly coincidental. Rough topography, some small flat basins, and side echoes of the peak type (ridge type). Most of us are now taking salt tablets regularly; the ship is a big steel oven.

4 March, Saturday. At 0030 during the plankton tow we installed both pitots on the TC, between thermistors 3 and 4 and thermistors 21 and 22. At 0200 made a pitot maneuver and measured an undercurrent of 111 cm/sec in the direction 106°T. Mike Palmieri reports that the hydrographic wire for the plankton tow acted strangely, probably because of the undercurrent. At 0900 the ship stopped for line crossing ceremonies. PGR and CTR on stand-by. During the hove-to period the ship drifted west-northwest at about 1 knot. Parker put over a 100-meter drogue which proceeded to head eastward. Beautiful trains of internal waves were being recorded on the TC recorder; they can be studied for period and velocity, and direction can be got from the maneuvers. Unfortunately, because no pitots were in the water we did not observe the northern boundary of the undercurrent which we had probably crossed yesterday afternoon. However, our dissolved CO_2 and thermistor records may tell us where this was. Several white-tip sharks were sighted while we were hove-to, and one was hooked and brought aboard.

The ceremony was over at 1100; at 1130 we were under way on a course that was supposed to run down the axis of the trench, following the VEMA Cruise 12 track and charted soundings, and then southeastward. The ridge survey has been started. It is interesting that soundings do agree rather well (to within 10 to 20 fathoms) with those plotted on the VEMA track, considering the apparent steepness and rough topography as well as the difficulties of navigational control. Echo character very poor as we approached 4000 fathoms and greater; lose it in noise and side-echo structure.

5 March, Sunday. Continuous bathymetry. Two box courses for shear measurements and internal-wave analysis. At 0550 a fuse in the B+ power supply to the PGR blew. Total time this supply was down was 30 minutes, during which two more fuses blew (the supply is dwindling). This is a heat effect.

We are maintaining our course of yesterday. Bottom is very rough.

The lower lab becomes impossibly hot about noon. Most plotting work is therefore being done in the early morning, before sunrise. A school of tuna was sighted to port this morning. Very few flying fish the past two days.

At 1630 we changed course. Plan to make north-south legs across the base direction of 105°.

6 March, Monday. The depth at 0700 was about 980 fathoms. Side-echo of small peak we have been making for, which is shown on Chart HO 6750-B. Changed course to northeast for a long leg across the 2000-fathom curve on the north side of the area. Steplike topography: 1700-fathom mountains, then 2000-fathom mountains, etc. We are altering courses to survey this eastern side of the ridge.

7 March, Tuesday. Continuous bathymetry and two box patterns. Today is model-making day: Arend, Parker, Stalcup, and Bunce decided that the only sensible way of seeing what we are doing while we do it and making the necessary decisions is to build a model of the bottom from the soundings as we go. Promoted quarter-inch Lucite sheets from engine room for same.

8 March, Wednesday. Continuous bathymetry and two box patterns. Working in region at 10°W from 0° to 2°30'S, following idea that we may have found a sill area. As day wears on it becomes obvious that we are being led down a garden path. Found a plateau-type region whose depth is moderately constant, though topographically rough, at 2100 to 2200 fathoms. Having spent too much time on it, we decided to turn westward again, to define the west side of the feature at least as far as 3°S, making course turns of about 45° for this. The PGR blade-drive failed; has been giving trouble for past few days. Installed a new drive; Wilharm is working on the failed unit.

9 March, Thursday. Continuous bathymetry and two box patterns. We returned to our original survey plan after finding that our plateau is fenced off from any southwestern basin cold water by mountains to the west and southwest. It may be an isolated basin and part of the eastern section.

Another battery in the PGR amplifier (Caulfield's design) was replaced today; that makes four since we left Bermuda. The draining of current must be considerably more than we had estimated. Both battery and fuse stocks are too low for comfort, and we are going to need replacements before making the next two phases of the cruise.

Sooty terns have been around the ship the last two evenings. They circle us clockwise, then all change as if on signal, and go counterclockwise. Rain squall at evening-star time. We have been very fortunate so far in having had clear weather for our celestial fixes.

10 March, Friday. Continuous bathymetry and two box patterns. No good stars today but a Venus fix this morning.

During the rain squall yesterday, water reached the back of the PGR cabinet through a window open for air, creating a short on the terminal board of the B+ power supply. We need the air in there badly and will have to be faster at shutting the window when a squall hits. The survey of the eastern portion of the ridge is nearly completed, and no obvious sill area has yet been found. We are proceeding westward to survey a possible rift valley midway between the trench and the eastern portion of the ridge.

11 March, Saturday. Continuous bathymetry and two box patterns. Hot. Rain squalls. Star sights at 1800 (first in 36 hours). PGR blade-drives have a built-in trouble factor; we are repairing them not quite as fast as they are failing. Model taking shape nicely, as is the entire bathymetric picture.

12 March, Sunday. Three sperm whales, forty to fifty feet long, were sighted about a quarter of a mile away at 0633, apparently feeding. During the day we crossed the equator on a northward leg and measured a 3-knot undercurrent. The sea was practically glassy-calm all day; many slicks were observed, and large fluctuations in sea-surface temperature were noticed. Beautiful internal waves were seen on the TC recorder and were also noticed on the deep-pitotmeter record. It looks as if a plot of isotherms for this whole area would be very interesting. For instance, there is a marked widening of the isotherms along the equator, due to the undercurrent. Rain squalls between 0850 and 0920. Satellite observed at 1850, passing to southwest. Two box courses for pitot measurements today, two BT's, and continuous bathymetry all day.

13 March, Monday. At 0810 the bathythermograph was fouled in the thermistor chain; it was cleared with no damage by 0850; taking of BT's was terminated for this leg. Two box patterns were run. Continuous bathymetry. Now we're into a program of longish legs crossing north and south 2000-fathom curves, usually making 20° to 30° turns. Have identified a deep valley apparently trending southwest; we can see it plainly on the model and are beginning to get very confident in predicting when we will cross it on our different courses! Will the valley continue to trend southwest, or is it blocked off by higher topography? Time will tell.

Just after sunset we saw a ship to starboard, the first in two weeks, and spoke to her by blinker. Norwegian tanker outbound from Capetown. Science conference on survey schedule; we have just about one week of working time left. Are into double bottoms for fuel; figure on leaving the area for Freetown late the twentieth; this should give us three or more days in the trench itself, if all goes well.

14 March, Tuesday. Continuous bathymetry survey of mid-portion of ridge is about over. Soundings and a model constructed from them reveal that the most likely passage for 2100-fathom water from the southwestern basin across the ridge to the northeast is via a rift valley whose axis lies about 070° and 250°. One box pattern today. Continuing crossings of rift valley to southwest; also plan a short back-track to fill a now noticeable gap in data. Hindsight.

Interesting facts: average speed, star sight to star sight, since 4 March (line crossing and beginning of survey) has been 10.6 knots, distance so far covered (since 4 March) is 2700 miles, and first double-bottom tank was ballasted today (ship's lightness is beginning to be noticeable in the rolls).

Gyrocompass short caused all-stops for two very brief periods, the first since Bermuda except during the line crossing and BT tangle. Estimate we'll be at Romanche Trench in the afternoon of 16 March.

15 March, Wednesday. At 0600N we changed to westerly courses that will take us to Romanche Trench for the final part of the survey. Two box courses today. Weather overcast; rain squall at 1400. Very humid. Tremendous thunderstorm at 1630. The sea built up to state 3, with whitecaps just before

the storm arrived, and then was completely flattened by the rain. Storm activity lasted until about 1800. Had to secure top lab openings, but it was wetter inside (from humidity) than rain. Model indicates fair chance that antarctic water may come up through our rift valley and thence, by smaller rifts and clefts, go into the northeast basin. Only the hydrographic data on the next phase of the cruise can say whether this is true or not.

Evening conference to set up trench survey, buoy drop, and possible camera lowering. Have been checking CRAWFORD bathymetry (IGY) where possible, also available charts, etc. Some agreement, within navigational limits.

We know where we are with respect to where we were, pretty well, because we have been running continuously, there have been no stops between celestial fixes, and these fixes have been supplemented by fixes from the Geon. We believe we are good to within 2 to 5 miles on our navigation. Bunce has set up a shot-instant system and checked out the Sanborn recorder and amplifiers, for use with the radioacoustic buoy. We have six amplifiers, three of which are sick (for the record: still echo sounding on Edo 2 and the port hull transducer).

16 March, Thursday. Continuous bathymetry. Another surface-shear measurement in the afternoon. At 1810 we arrived over Romanche Trench where we had decided to set a buoy. Returned to region of deepest soundings of 4 March and made various courses and speeds, using VEMA Cruise 12 data and our own of 4 March to find pothole. Then various courses to determine east-west extent of the trench, for buoy anchoring. We hoped to anchor in a depth of over 4000 fathoms. At 1810 the buoy was overside, and reeling off of the anchor line began; at 2004 the buoy anchor was overside. We misjudged the set of the ship and the anchor was dropped in 2700 fathoms instead of 4000 because of excess drift to the northwest. Extra line was added in an attempt to get additional steaming time to the south toward the trench, but we didn't make it. Total anchor line was 36,000 feet (6000 fathoms). Waited two hours for the anchor and cable to settle. Von Arx got two fixes (00°10.55'S, 18° 31.1'W) for position of anchor over side. At 2200 we were under way to the buoy. At 2250 the buoy line was observed to foul near the ship's bow: all stop and TC in. The buoy line could not be found and was believed to have been cut. Parker thinks that with its extra-long cable and the undercurrent it has a long loop near the surface. Three buoys are on cable: a radio

acoustic buoy, a 1.5 sec flashing-light buoy, and an 8 sec flashing-light buoy with radar reflector. The ship lay hove-to the rest of the night, observing buoys. Since we are stopped and this is the first chance in three weeks, everyone goes fishing -- for sharks, squid, and anything that will bite. It is so hot, hove-to, that it is better to be on deck than below, or inside anywhere. By 0300, 17 March, we had caught as least nine sharks, all white-tip; the total catch today was fifteen sharks and many squid.

17 March, Friday. Got under way at 0700 to close buoy (300 to 400 yards). During the night the ship drifted to west of the buoy about 6 miles, which gave us some hope that its line had not been cut. All buoys on the polypropylene cable were lined up east-west, but the cable was observed to lie along the surface fore and aft of the buoy. Depth of water, 2420 fathoms. No stars or fixes during the night, and too hazy for morning star sights.

At 0905 we left the buoys and started our trench survey. Continuous bathymetry, the TC in. Decided to continue program on assumption that buoy is anchored, but to return for checks during bathymetric survey. At 1450 started to get radio bearings on acoustic buoy, which could be triggered satisfactorily; estimated range was about 16 miles for the first bearing. At 1850 we were abeam the buoy, but we are still not clear whether it is anchored or not. Dead reckoning from two fixes made by von Arx and from a star fix at 1800 gives us some hope that there is no buoy drift. At 2100 the TC was in the water. Fired three M-2 explosives, but got no signal from the acoustic buoy although the radio was triggered. Buoy had worked well on deck; trouble can be any one of several things, including sharks biting off hydrophone dangling below buoy. (Since our ship's radar is out of order we only have radio bearings and visual fixes on the buoys.)

18 March, Saturday. At 1110 a blackfish school to port; they seemed to stay in the same general region as we passed. A slick is here; sea state is 0 to 1.

Survey continues. At 1547 we were alongside buoy. Good fix obtained by von Arx, and buoy is anchored. A current past the floats was visible. Inspected area for floating polypropylene line; none seen. The line from the buoy is taut, at an angle of 30° from the surface. Departed buoy area for a short leg over the trench. At 1830 returned to buoy for final star fix: 00° 07.6'S, 18°40.6'W. Water depth there is 2390 fathoms.

At 1850 we departed the buoy area again, to continue our survey. At 1530 we fired five M-2's within 4 miles of the buoy and got no acoustic arrivals. Wilharm believes that the local static level is too high and the buoy preamplifier gain is not set high enough, if the hydrophone is still intact. Have abandoned use of the buoy for acoustic arrivals.

By 1200 we had steamed 3400 miles, plus or minus a few, since 1200 on 4 March.

At 0334 today the PGR took matters into its own hands: it blew a B+ power supply fuse (standard behavior at this hour these days); when this was replaced, with a magnificent flash of blue-white light it blew its main (20 amp) power fuse. Probably the bridge thought the top lab had blown up.

19 March, Sunday. At 1000 we stopped the ship on the eastern slope of the trench and started a camera lowering at 0950 (the only one made in our survey). Arend in charge, Savin on PGR, Riegel on winch. The camera started up from the bottom at 1005 and was on deck at 1430. We began in 4000+ fathoms, but the drift was such and the trench sides so steep that most of the pictures were made in 3700 to 3800 fathoms. (Locations, start and finish, were 0°14'S, 18°33'W, and 0°17'S, 18°35'W.) It was a successful lowering. We took one roll of black-and-white photographs and one roll of color. Under way at 1600 to continue our survey of the eastern area of the trench.

At 1030, before the camera lowering, the ship appeared to have struck a fish; a large fin was visible in the wake, weaving from side to side. Turned ship about to look for it but it had disappeared. We think it was a large basking shark.

20 March, Monday. At 0400 the survey of the trench was concluded, and the ship headed at 12 knots for Freetown. Two box patterns were made with the deep pitotmeter. At 0945 a defective plug in the PGR signal power supply let go; it was repaired and in operation again at 1000. Routine bathymetry. At 1830 we held a meeting and organized clean-up gangs and port watches for escorting visitors.

21 March, Tuesday. Routine bathymetry. A gull was sighted at 1715. At 1815 we could smell land.

22 March, Wednesday. TC hauled aboard at 0104. Plankton tow at 0300. Less than 20 fathoms of water depth at 0600. PGR secured. Land in sight at 0800. The bridge pit log reads 8015 miles. We are off the entrance to Freetown, awaiting a pilot.

Some statistics: 30 days plus 14 hours at sea, 4600 miles steamed from 4 March 1200 to 20 March 0400, 12 equator crossings.

APPENDIX

TABLE 1. Current measurements by means of 100-meter drogues

Drop No.	Tag No.	Time	Date	Lat.	Long.
		East Side of Mid-Atlantic Ridge			
1	10261	0927Q	27 Feb.	14°33'N	34°13'W
2	10262	1930	27 Feb.	13°28'N	32°49'W
3	10263	1045	28 Feb.	11°44'N	30°50'W
4	10265	1435	28 Feb.	11°25'N	30°30'W
5	10264	2030	28 Feb.	10°35'N	29°36'W
6	10266	0930	1 Mar.	9°07'N	28°55'W
7	10267	1530	1 Mar.	8°20'N	27°06'W
8	10268	2130	1 Mar.	7°33'N	26°15'W
9	10269	0910	2 Mar.	5°57'N	24°45'W
10	10270	1630	2 Mar.	5°00'N	23°48'W
11	10271	1900	2 Mar.	4°57'N	23°46'W
12	10272	2130	2 Mar.	4°17'N	23°05'W
13	10273	2400Q	2 Mar.	4°04'N	22°52'W
14	10274	0330N	3 Mar.	3°40'N	22°30'W
15	10275	0600	3 Mar.	3°25'N	22°15'W
16	10276	0930	3 Mar.	3°00'N	21°40'W
17	10277	1100	3 Mar.	2°40'N	21°31'W
18	10278	1300	3 Mar.	2°17'N	21°10'W
19	10279	1600	3 Mar.	1°56'N	20°49'W
20	10280	1830	3 Mar.	1°37'N	20°32'W
21	10281	2100	3 Mar.	1°15'N	20°10'W
22	10282	2330	3 Mar.	0°51'N	19°50'W
		Romanche Trench Area			
23	10283	0200	4 Mar.	0°37'N	19°39'W
24	10284	0430N	4 Mar.	0°20'N	19°24'W
25	10285	0700	4 Mar.	0°09'N	19°10'W
26	10286	0930	4 Mar.	0°00'N	19°00'W
27	10287	1106	4 Mar.	0°05'S	18°57'W
28	10288	1330	4 Mar.	0°15'S	18°32'W
29	10291	1830	4 Mar.	0°19'S	17°56'W
30	10290	0130	5 Mar.	0°59'S	15°20'W
31	10289	1130	5 Mar.	0°37'S	16°51'W
32	10292	1300	5 Mar.	1°00'S	15°12'W
33	10293	1800	5 Mar.	1°25'S	14°30'W
34	10294	0100	6 Mar.	1°24'S	13°49'W
35	10295	0600	6 Mar.	1°46'S	13°03'W
36	10296	1430	6 Mar.	1°25'S	11°43'W
37	10297	1930	6 Mar.	0°48'S	11°03'W

TABLE 2. Continuous recording of temperature structures at shallow depths by means of thermistor chain

Date	Time		Miles Towed
	Mid-Atlantic Ridge		
20 Feb.	1200	2400	136.5
21 Feb.	1420	2335	128.0
22 Feb.	0100	2351	260.0
23 Feb.	0205	2350	247.0
24 Feb.	0118	2352	249.0
25 Feb.	0118	2350	249.0
26 Feb.	0122	2350	237.5
27 Feb.	0158	2347	230.5
28 Feb.	0117	2400	250.5
1 Mar.	0100	2400	263.0
2 Mar.	0100	2400	256.5
3 Mar.	0200	2349	272.0
	Romanche Trench		
4 Mar.	0100	2350	189.0
	Mid- Atlantic Ridge		
5 Mar.	0100	2400	228.0
6 Mar.	0000	2400	234.0
7 Mar.	0000	2400	239.5
8 Mar.	0000	2400	253.0
9 Mar.	0000	2400	235.5
10 Mar.	0000	2400	240.0
11 Mar.	0000	2400	255.5
12 Mar.	0000	2400	243.0
13 Mar.	0000	2400	249.0
14 Mar.	0000	2400	248.5
15 Mar.	0000	2400	255.0

TABLE 2 (contd)

Date	Time		Miles Towed
	Romanche Trench		
16 Mar.	0000	1352	169.0
19 Mar.	1750	2400	63.0
20 Mar.	0000	2400	263.0
	Mid-Atlantic Ridge		
21 Mar.	0000	2350	275.0
	Approx. total number of hours	(577)	TOTAL: 6,419.5

TABLE 3. Measurements of Current Shear with pitot tubes on the thermistor chain

Date	Time		Location	
23 Feb.	2130	2208	23°33.5'N	46°06.5'W
24 Feb.	2130	2208	21°11'N	42°20'W
25 Feb.	1255	1321	19°36'N	40°09'W
26 Feb.	1232	1312	16°50'N	36°50.5'W
26 Feb.	2130	2205	15°43.5'N	35°35.5'W
27 Feb.	1032	1107	14°29'N	34°02'W
27 Feb.	2130	2207	13°11.5'N	32°32'W
28 Feb.	0200	0230	12°53'N	32°09.5'W
28 Feb.	1030	1106	11°51.5'N	31°02'W
28 Feb.	2130	2200 (GEK)	10°28'N	29°31'W
1 Mar.	1310	1350	8°37'N	27°23'W
1 Mar.	2130	2220	7°30'N	26°16'W
2 Mar.	1002	1050	5°50'N	24°41.5'W
4 Mar.	0130	0210	0°45'N	19°48'W
4 Mar.	1615	1655	0°16.5'S	18°11.5'W
4 Mar.	2300	2336	0°32'S	17°09'W
5 Mar.	1000	1036	0°56'S	15°31'W
5 Mar.	2016	2051	1°40'S	14°28'W
6 Mar.	0931	1006	1°51'S	12°23'W
6 Mar.	2015	2053	0°46.5'S	11°02'W
7 Mar.	1000	1037	2°25'S	10°10.5'W
7 Mar.	2200	2235	0°56'S	10°11.5'W
8 Mar.	1525	1555	1°59'S	11°53.5'W

TABLE 3 (contd)

Date	Time		Location	
9 Mar.	0015	0055	1°16'S	11°15'W
9 Mar.	1115	1150	1°45'S	11°08'W
10 Mar.	0930	1017	1°00'S	12°25'W
10 Mar.	2045	2121	2°25'S	13°14'W
11 Mar.	0955	1043	0°49'S	13°10'W
11 Mar.	1920	2000	2°06.5'S	13°46'W
12 Mar.	0630	0713	0°25.5'S	14°08.5'W
12 Mar.	1900	1944	0°03'S	14°20'W
13 Mar.	1015	1101	1°49'S	15°10.5'W
13 Mar.	2100	2146	0°52'S	15°47.5'W
14 Mar.	1640	1723	1°39'S	14°17'W
15 Mar.	0909	0957	0°20.5'S	13°32.5'W
15 Mar.	2020	2107	1°14'S	15°23'W
16 Mar.	1305	1352	0°24'S	17°51'W
19 Mar.	1750	1837	0°13.5'N	18°14.5'W

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Woods Hole Oceanographic Institution
Reference No. 64-30

NARRATIVE OF CHAIN CRUISE # 17, PHASE I, St. George, Bermuda, to Freetown, Sierra Leone, 19 February-22 March 1961, 25 pp. 4 charts.

Unclassified

The journal of a cruise of R/V CHAIN from Bermuda to Freetown, Sierra Leone during February and March, 1961, is the basis of this report. Location of observations are given. The portion of the Mid-Atlantic Ridge lying along the equator was surveyed from 10° to 19°W, and new information concerning the slope and orientation of rift zones was obtained. A detailed bathymetric survey of the Romanche Trench was made. A continuous temperature-depth profile, from the surface to 100 meters, was made along the ship's track with a thermistor chain. Surface shear was measured with pitotmeters mounted on the chain (surface water velocity relative to the water velocity at the depth of depth of the pitotmeter), to determine the strength and direction of the equatorial undercurrent.

1. CHAIN Cruise #17
2. Romanche Trench
3. Bathymetry
4. Seismic profiling

1. Voorhis, A. D.
2. Bunce, E. T.

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