WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts

Reference No. 65-9

NARRATIVE OF CHAIN CRUISE #43
February - August 1964

by

S. T. Knott, E. T. Bunce, C. O. Bowin, J. B. Hersey, and
R. L. Chase

February 1965

In citing this report in a bibliography, the references should be followed by the phrase UNPUBLISHED MANUSCRIPT, which is in accordance with bibliographic practice.

This cruise was supported by the National Science Foundation under Grant GP-2370 and Submitted to the Office of Naval Research under Contract Nonr-4029(00) NR 260-101.

APPROVED FOR DISTRIBUTION J. B. Hersey

J. B. Hersey, Chairman
Department of Geophysics

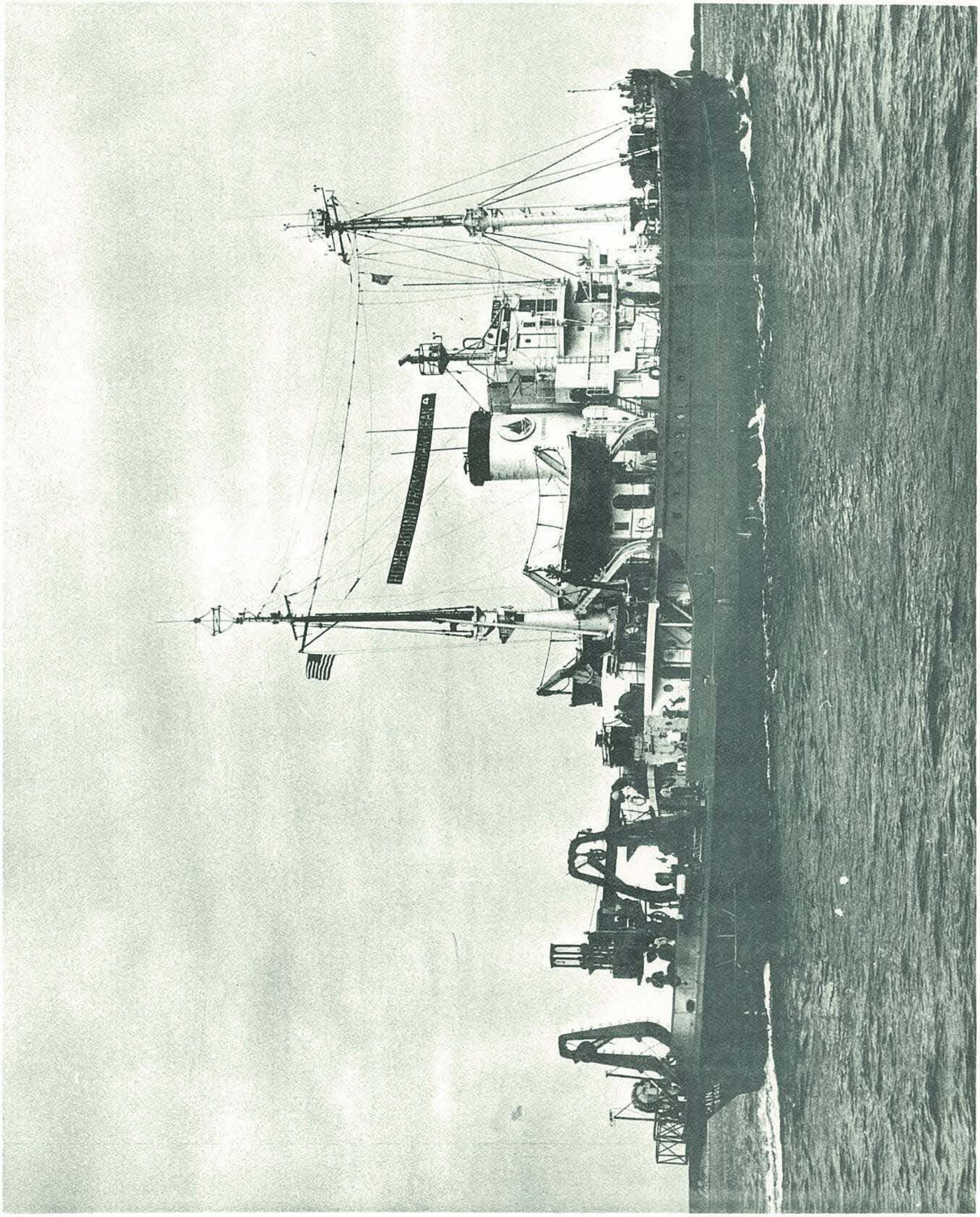


TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

ABSTRACT

On CHAIN Cruise 43, 15 February to 21 August 1964, geophysical and geological observations were made in the North Atlantic Ocean, the Mediterranean and Red Seas, and the Western part of the Indian Ocean, along the track Woods Hole - Ceuta (Spanish Africa) - La Spezia - Port Said - Aden - Victoria (Seychelles Islands) - Port Louis (Mauritius) - Victoria (Seychelles Islands) - Port Said - Beirut - La Spezia - Monaco - Plymouth (England) - Woods Hole. This report contains (1) a narrative of the cruise, (2) a list of stations, (3) statements of the scientific objectives of the cruise, (4) a summary of the geological and geophysical observations, (5) end-of-cruise reports on equipment and some phases of the research program, and (6) a selection of bottom photographs. WHOI Ref. No. 64-51 contains a detailed navigational plot of the entire cruise, including soundings and the locations of other observations.

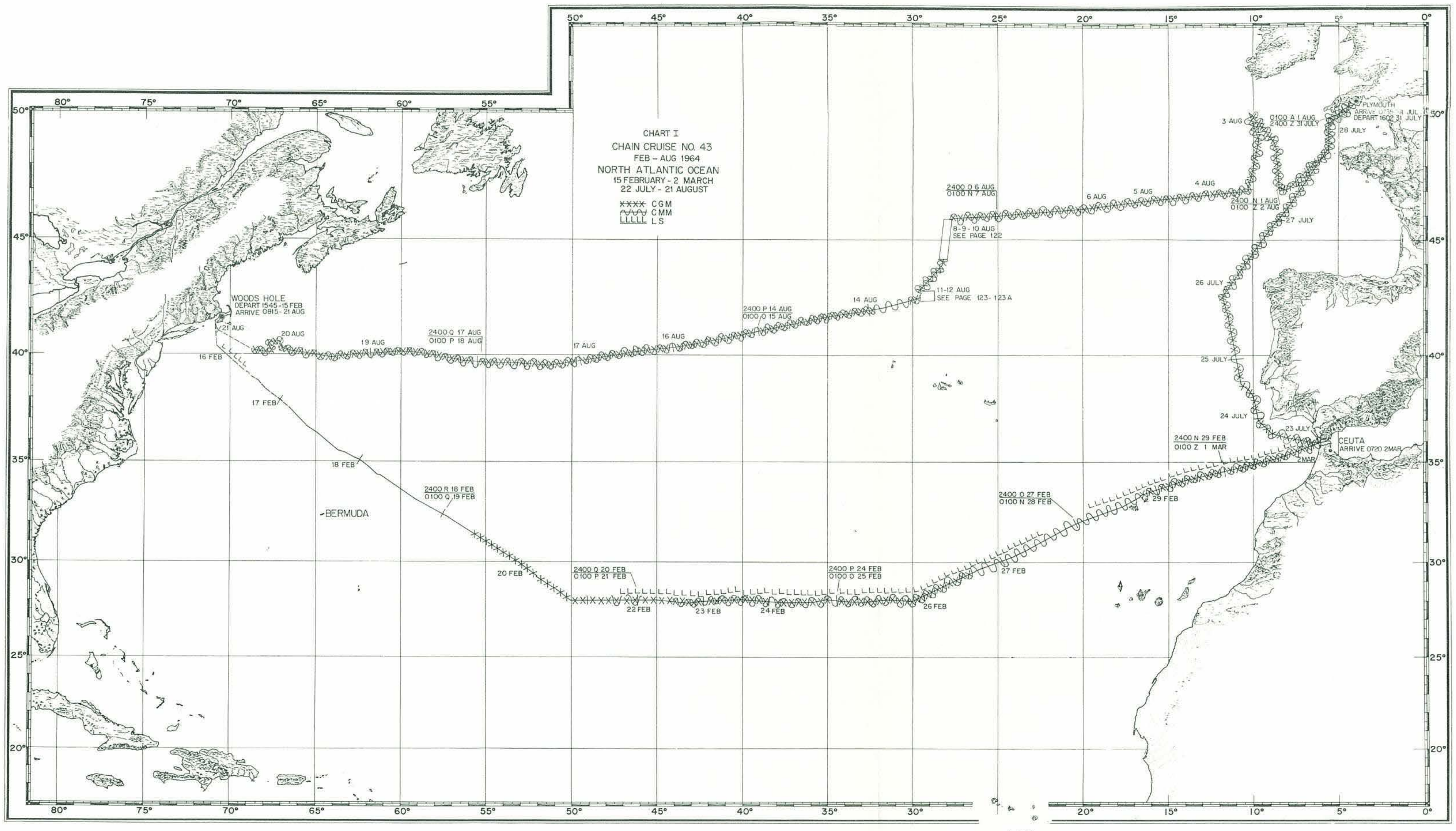


CHART I
CHAIN CRUISE NO. 43
FEB – AUG 1964
NORTH ATLANTIC OCEAN
15 FEBRUARY - 2 MARCH
22 JULY - 21 AUGUST
XXXX CGM
CMM
LLLLL LS
WOODS HOLE
DEPART 1545 - 15 FEB
ARRIVE 0815 - 21 AUG
BERMUDA
CEUTA
ARRIVE 0720 2MAR
PLYMOUTH
8 - 9 - 10 AUG
SEE PAGE 122
11-12 AUG
SEE PAGE 123 - 123 A
2400 R 18 FEB
0100 Q 19 FEB
2400 Q 20 FEB
0100 P 21 FEB
2400 P 24 FEB
0100 O 25 FEB
2400 O 27 FEB
0100 N 28 FEB
2400 N 29 FEB
0100 Z 1 MAR
2400 Q 17 AUG
0100 P 18 AUG
2400 P 14 AUG
0100 O 15 AUG
2400 O 6 AUG
0100 N 7 AUG
2400 N 1 AUG
0100 Z 2 AUG
16 FEB
17 FEB
18 FEB
20 FEB
22 FEB
23 FEB
24 FEB
26 FEB
27 FEB
29 FEB
2 MAR
23 JULY
24 JULY
25 JULY
26 JULY
27 JULY
28 JULY
3 AUG
4 AUG
5 AUG
6 AUG
14 AUG
16 AUG
17 AUG
19 AUG
20 AUG
21 AUG

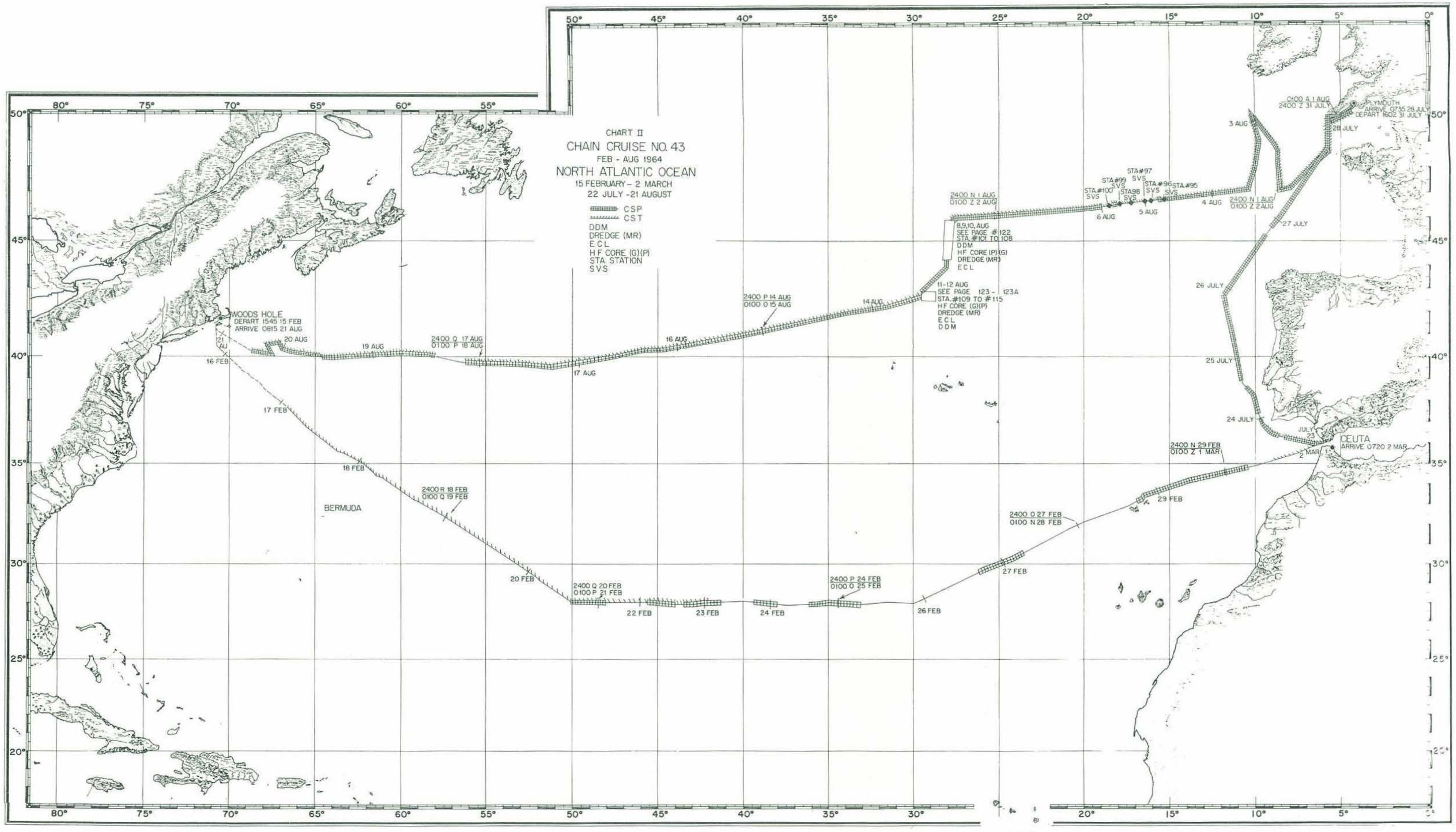


CHART II
CHAIN CRUISE NO. 43
FEB - AUG 1964
NORTH ATLANTIC OCEAN
15 FEBRUARY - 2 MARCH
22 JULY -21 AUGUST
CSP
CST
DDM
DREDGE (MR)
E C L
H F CORE (G)(P)
STA. STATION
S V S
WOODS HOLE
DEPART 1545 15 FEB
ARRIVE 0815 21 AUG
BERMUDA
CEUTA
ARRIVE 0720 2 MAR
PLYMOUTH
ARRIVE 0735 28 JULY
DEPART 1602 31 JULY
0100 A 1 AUG
2400 Z 31 JULY
28 JULY
3 AUG
4 AUG
2400 N 1 AUG
0100 Z 2 AUG
27 JULY
26 JULY
25 JULY
24 JULY
JULY 23
STA #97
SVS
STA #99
SVS
STA #100
SVS
STA 98
SVS
STA #96
SVS
STA #95
SVS
5 AUG
6 AUG
2400 N 1 AUG
0100 Z 2 AUG
8,9,10, AUG
SEE PAGE #122
STA. #101 TO 108
DDM
HF CORE (P)(G)
DREDGE (MR)
E C L
11-12 AUG
SEE PAGE 123 - 123A
STA. #109 TO #115
HF CORE (G)(P)
DREDGE (MR)
E C L
D D M
14 AUG
2400 P 14 AUG
0100 O 15 AUG
16 AUG
17 AUG
2400 Q 17 AUG
0100 P 18 AUG
19 AUG
20 AUG
21 AU
16 FEB
17 FEB
18 FEB
2400 R 18 FEB
0100 Q 19 FEB
20 FEB
2400 Q 20 FEB
0100 P 21 FEB
22 FEB
23 FEB
24 FEB
2400 P 24 FEB
0100 O 25 FEB
26 FEB
27 FEB
2400 O 27 FEB
0100 N 28 FEB
29 FEB
2400 N 29 FEB
0100 Z 1 MAR
2 MAR
80° 75° 70° 65° 60° 55° 50° 45° 40° 35° 30° 25° 20° 15° 10° 5° 0°
50° 45° 40° 35° 30° 25° 20°

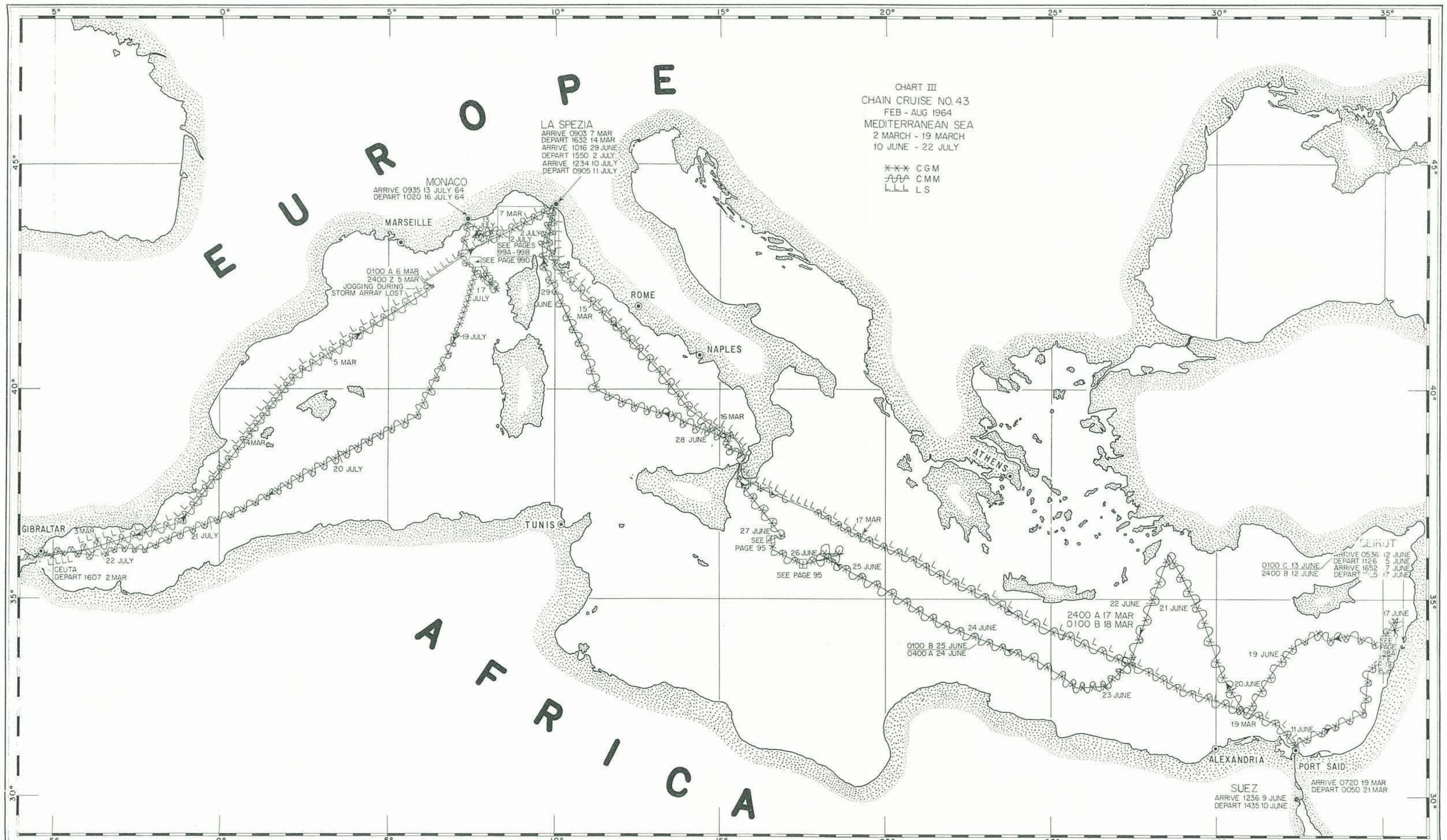


CHART III
CHAIN CRUISE NO. 43
FEB - AUG 1964
MEDITERRANEAN SEA
2 MARCH - 19 MARCH
10 JUNE - 22 JULY
CGM
CMM
LS
EUROPE
AFRICA
LA SPEZIA
ARRIVE 0903 7 MAR
DEPART 1632 14 MAR
ARRIVE 1016 29 JUNE
DEPART 1550 2 JULY
ARRIVE 1234 10 JULY
DEPART 0905 11 JULY
MONACO
ARRIVE 0935 13 JULY 64
DEPART 1020 16 JULY 64
MARSEILLE
ROME
NAPLES
ATHENS
TUNIS
GIBRALTAR
CEUTA
DEPART 1607 2 MAR
ALEXANDRIA
PORT SAID
ARRIVE 0720 19 MAR
DEPART 0050 21 MAR
SUEZ
ARRIVE 1236 9 JUNE
DEPART 1435 10 JUNE
0100 A 6 MAR
2400 Z 5 MAR
JOGGING DURING
STORM ARRAY LOST
2400 A 17 MAR
0100 B 18 MAR
0100 B 25 JUNE
0400 A 24 JUNE
0100 C 13 JUNE
2400 B 12 JUNE
SEE PAGE 95

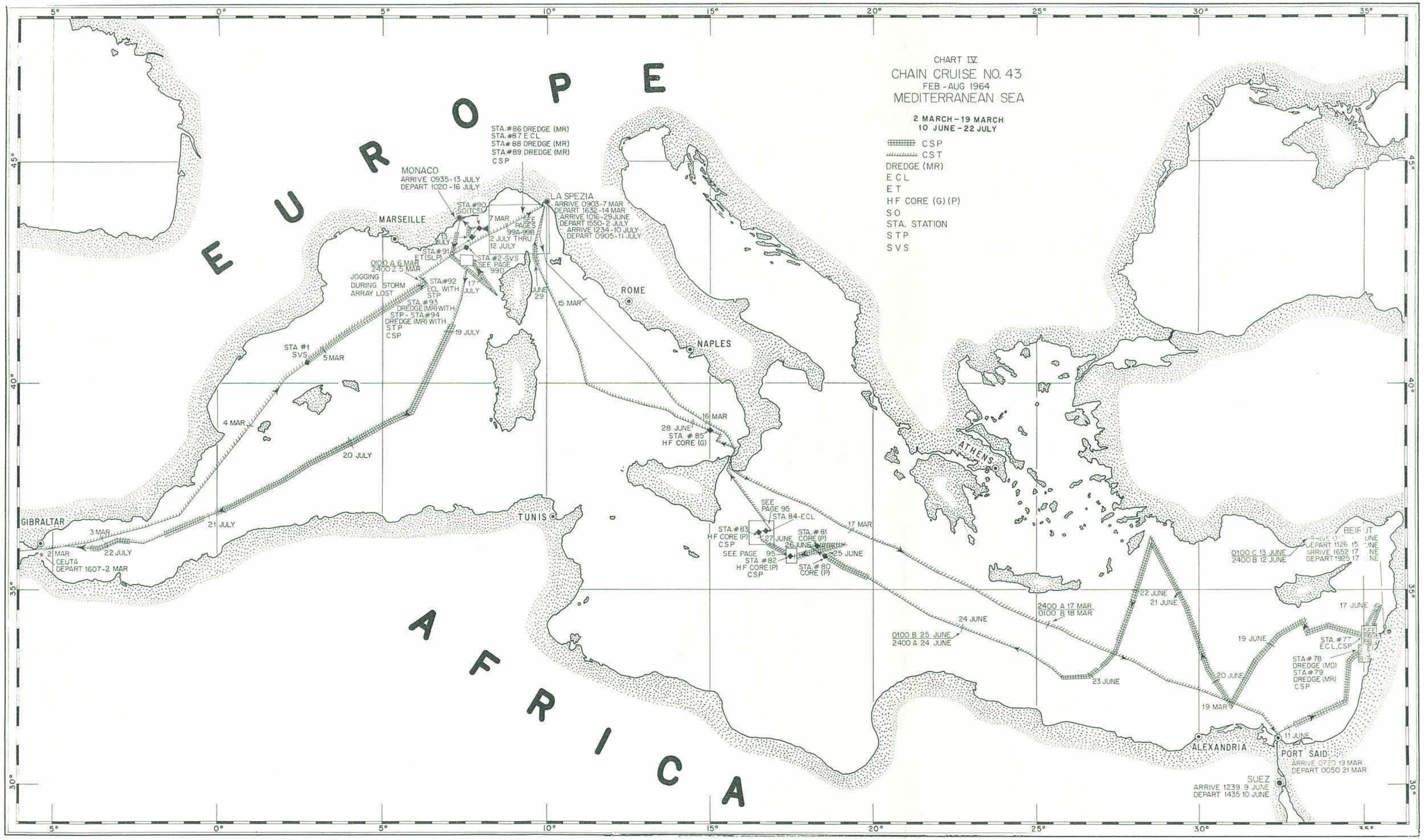


CHART IV
CHAIN CRUISE NO. 43
FEB - AUG 1964
MEDITERRANEAN SEA
2 MARCH - 19 MARCH
10 JUNE - 22 JULY
CSP
CST
DREDGE (MR)
ECL
ET
HF CORE (G) (P)
SO
STA. STATION
STP
SVS
EUROPE
AFRICA
GIBRALTAR
MARSEILLE
MONACO
LA SPEZIA
ROME
NAPLES
TUNIS
ATHENS
BEIRUT
ALEXANDRIA
PORT SAID
SUEZ

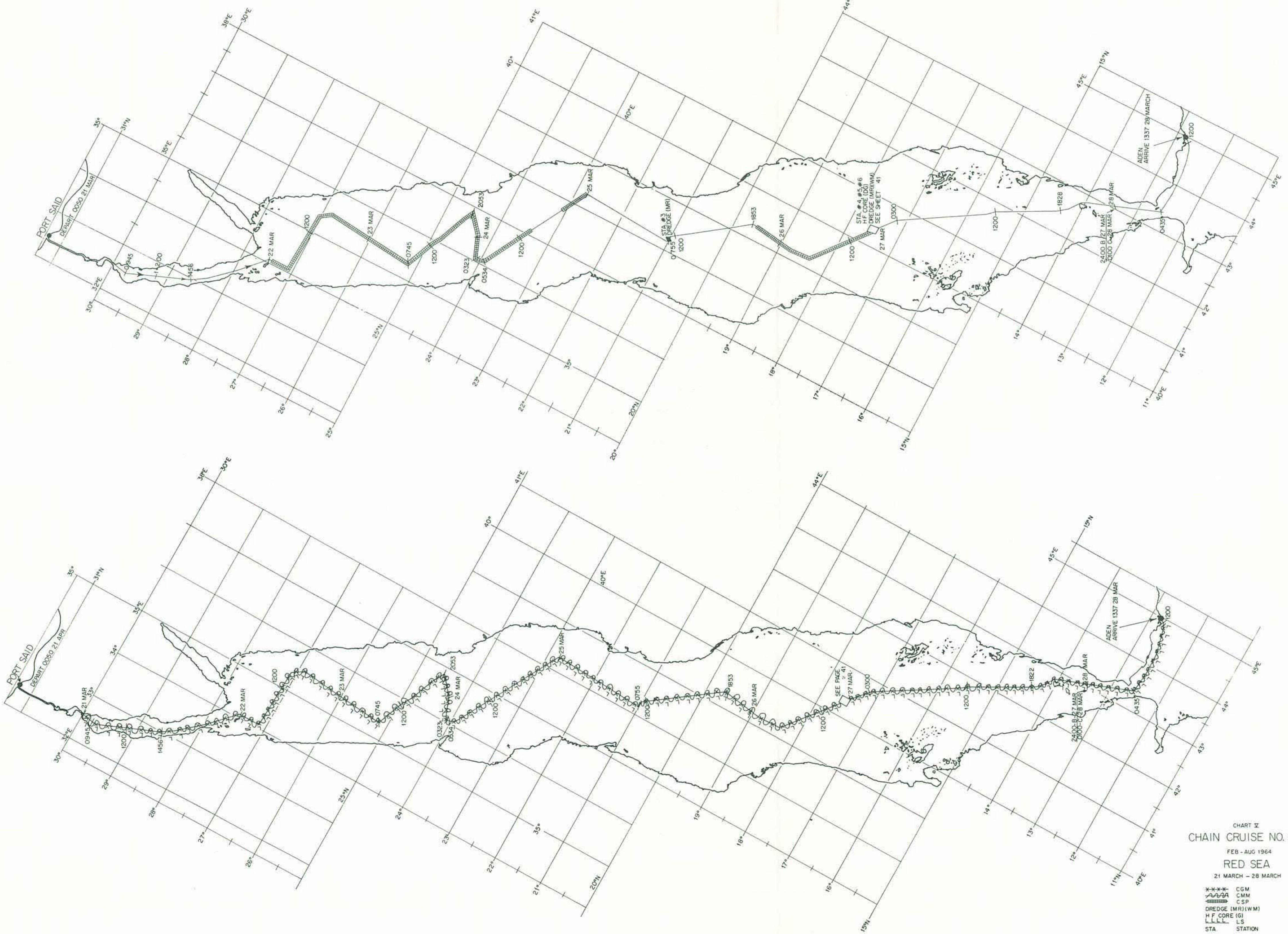


CHART V

CHAIN CRUISE NO. 43

FEB - AUG 1964

RED SEA

21 MARCH – 28 MARCH

CGM
CMM
CSP
DREDGE (MR) (WM)
H F CORE (G)
LS
STA STATION

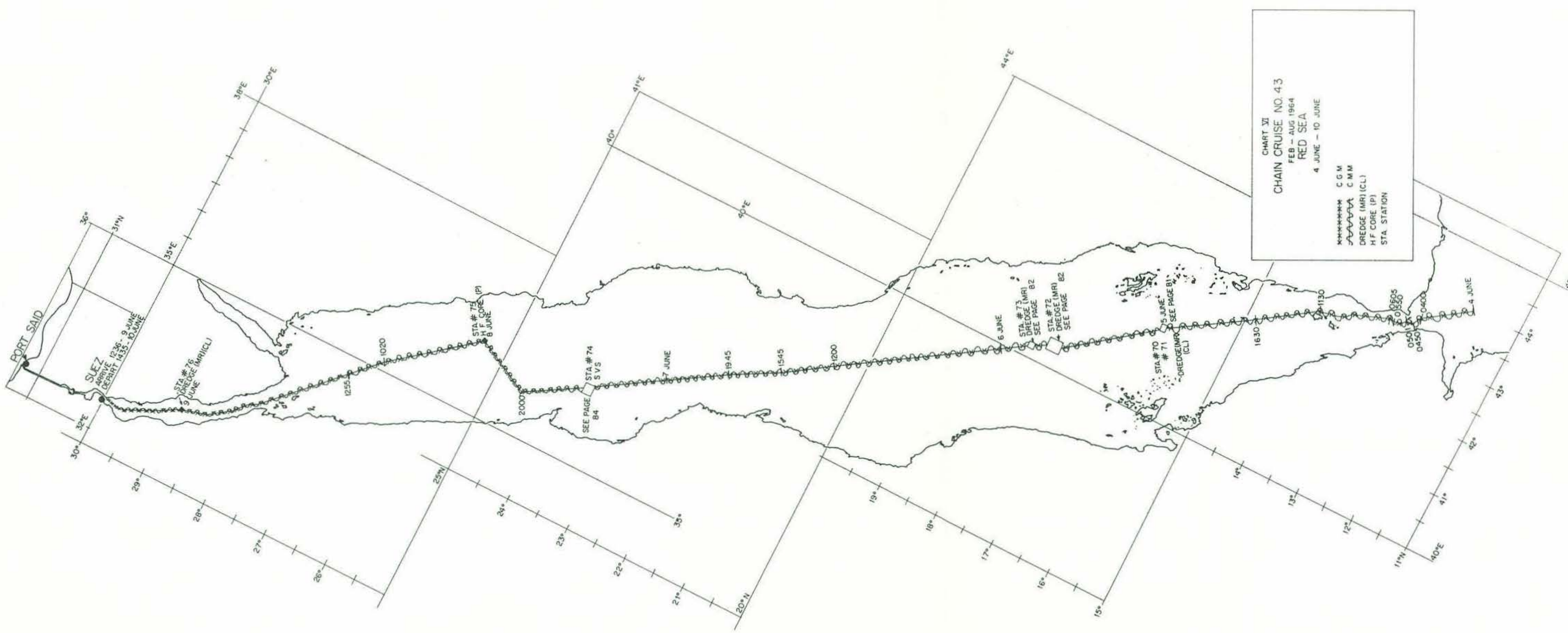


CHART VI
CHAIN CRUISE NO. 43
FEB – AUG 1964
RED SEA
4 JUNE – 10 JUNE
C G M
C M M
DREDGE (MR) (CL)
H F CORE (P)
STA. STATION
PORT SAID
SUEZ

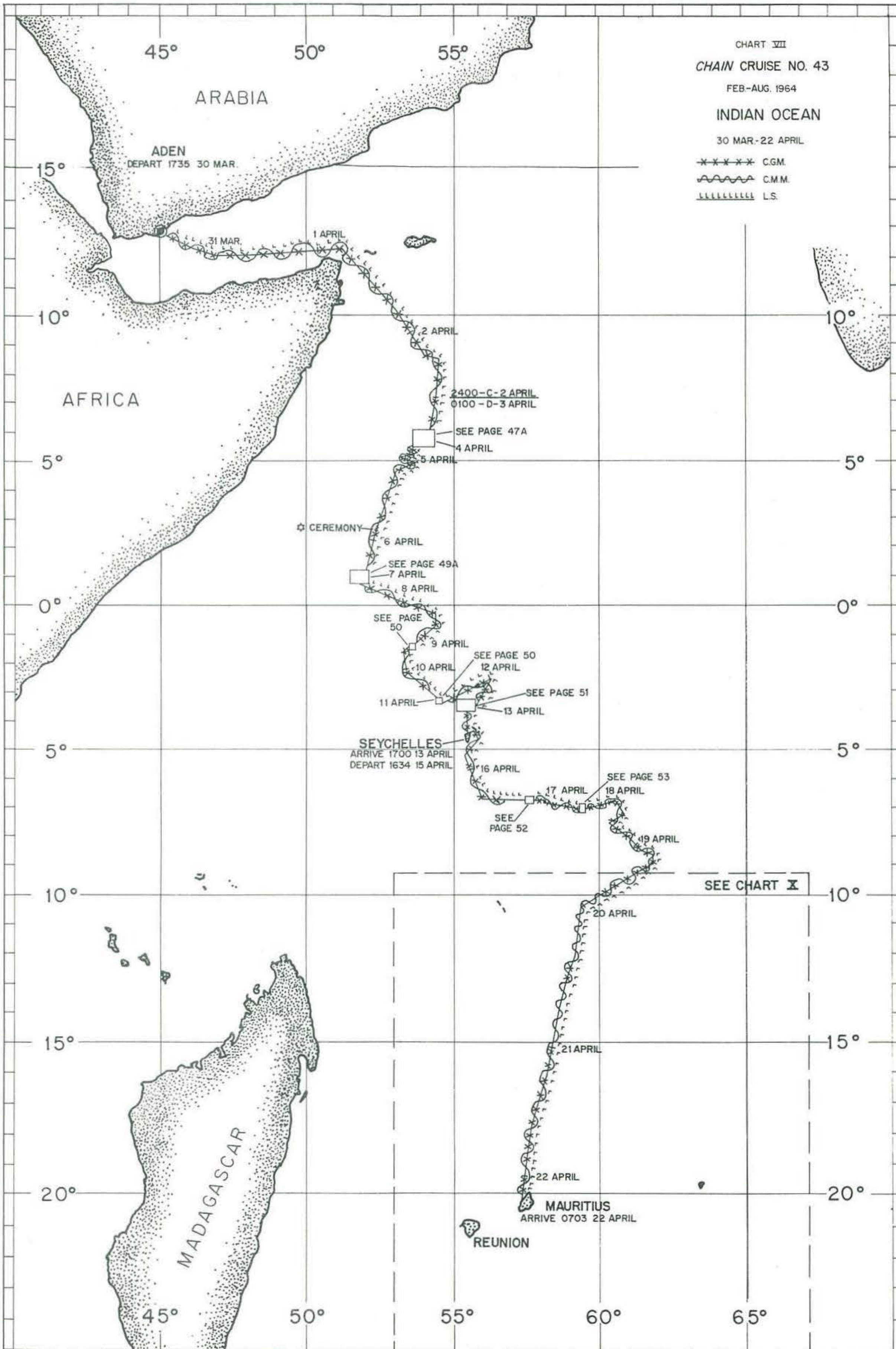


CHART VII
CHAIN CRUISE NO. 43
FEB-AUG. 1964
INDIAN OCEAN
30 MAR.-22 APRIL
C.G.M.
C.M.M.
L.S.
ARABIA
AFRICA
MADAGASCAR
ADEN
DEPART 1735 30 MAR.
31 MAR.
1 APRIL
2 APRIL
2400-C-2 APRIL
0100-D-3 APRIL
SEE PAGE 47A
4 APRIL
5 APRIL
CEREMONY
6 APRIL
SEE PAGE 49A
7 APRIL
8 APRIL
SEE PAGE 50
9 APRIL
SEE PAGE 50
10 APRIL
12 APRIL
11 APRIL
SEE PAGE 51
13 APRIL
SEYCHELLES
ARRIVE 1700 13 APRIL
DEPART 1634 15 APRIL
16 APRIL
17 APRIL
SEE PAGE 53
18 APRIL
SEE PAGE 52
19 APRIL
SEE CHART X
20 APRIL
21 APRIL
22 APRIL
MAURITIUS
ARRIVE 0703 22 APRIL
REUNION
45°
50°
55°
60°
65°
15°
10°
5°
0°
5°
10°
15°
20°

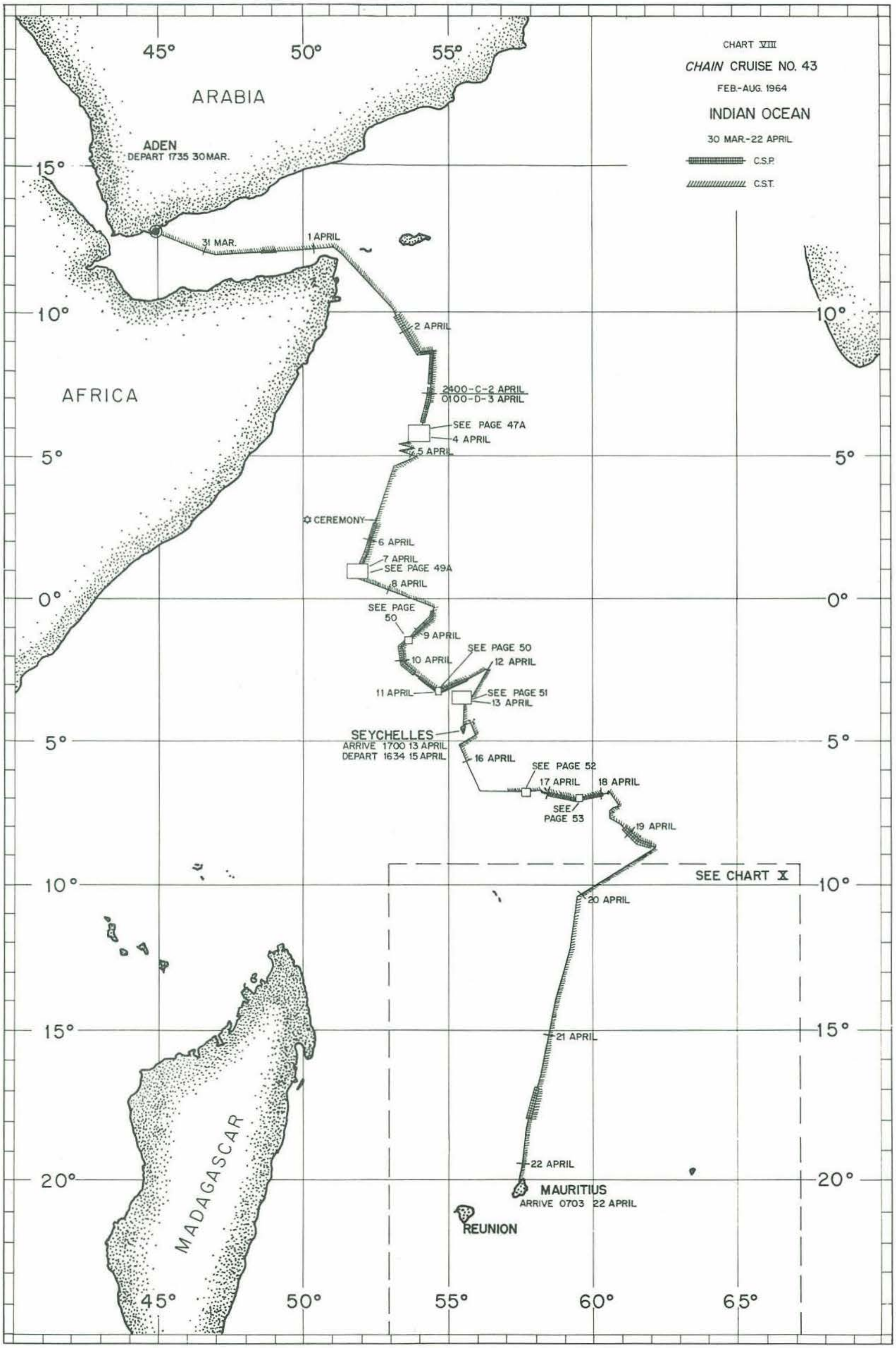


CHART VIII
CHAIN CRUISE NO. 43
FEB.-AUG. 1964
INDIAN OCEAN
30 MAR.-22 APRIL
C.S.P.
C.S.T.
ARABIA
AFRICA
MADAGASCAR
ADEN
DEPART 1735 30 MAR.
31 MAR.
1 APRIL
2 APRIL
2400-C-2 APRIL
0100-D-3 APRIL
SEE PAGE 47A
4 APRIL
5 APRIL
CEREMONY
6 APRIL
7 APRIL
SEE PAGE 49A
8 APRIL
SEE PAGE 50
9 APRIL
10 APRIL
SEE PAGE 50
12 APRIL
11 APRIL
SEE PAGE 51
13 APRIL
SEYCHELLES
ARRIVE 1700 13 APRIL
DEPART 1634 15 APRIL
16 APRIL
SEE PAGE 52
17 APRIL
18 APRIL
SEE PAGE 53
19 APRIL
SEE CHART X
20 APRIL
21 APRIL
22 APRIL
MAURITIUS
ARRIVE 0703 22 APRIL
REUNION
45°
50°
55°
60°
65°
15°
10°
5°
0°

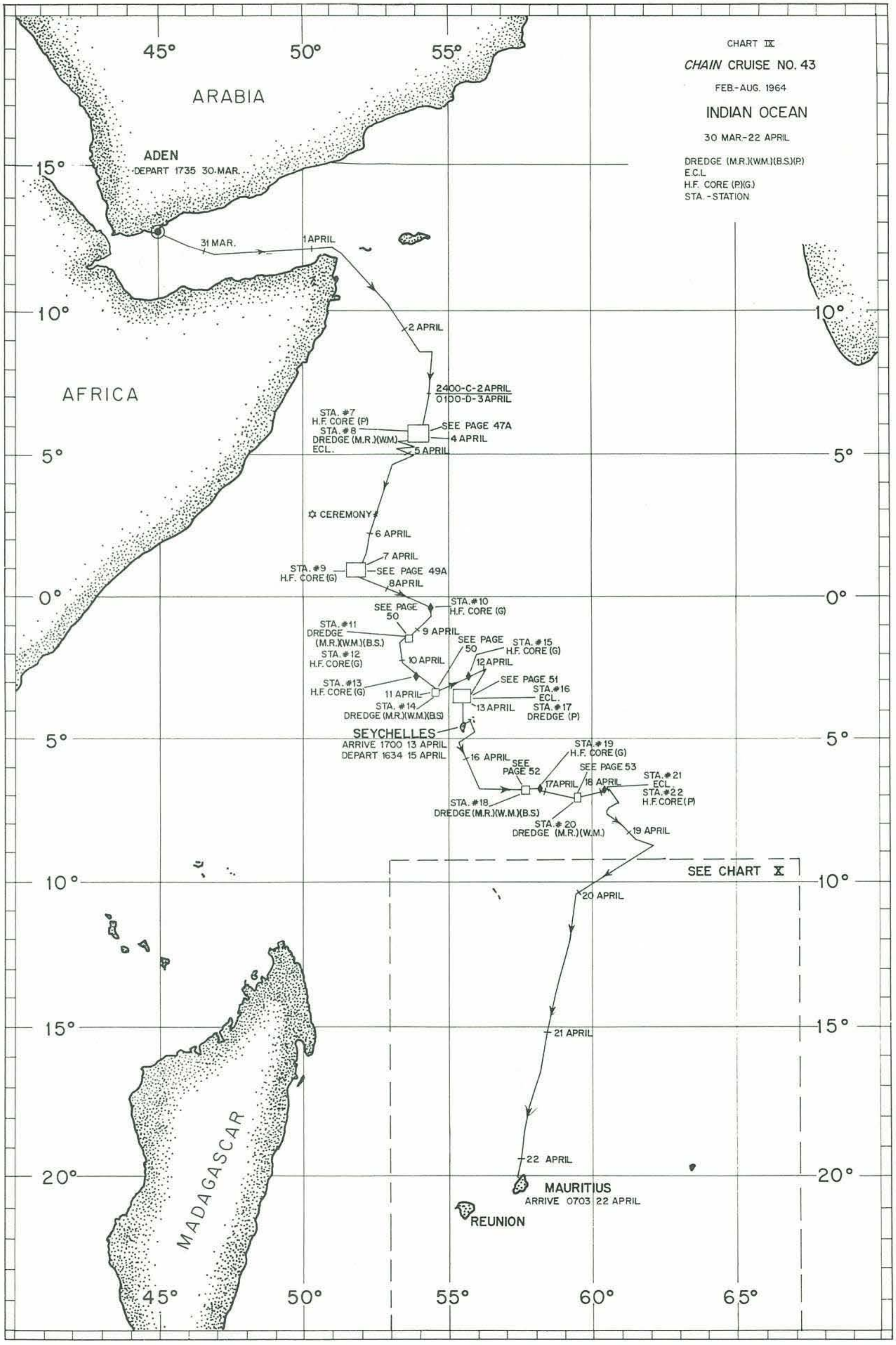


CHART IX
CHAIN CRUISE NO. 43
FEB.-AUG. 1964
INDIAN OCEAN
30 MAR.-22 APRIL
DREDGE (M.R.)(W.M.)(B.S.)(P.)
E.C.L.
H.F. CORE (P.)(G.)
STA. - STATION
ARABIA
ADEN
DEPART 1735 30-MAR.
AFRICA
MADAGASCAR
31 MAR.
1 APRIL
2 APRIL
2400-C-2 APRIL
0100-D-3 APRIL
STA. #7
H.F. CORE (P)
STA. #8
DREDGE (M.R.)(W.M.)
ECL.
SEE PAGE 47A
4 APRIL
5 APRIL
CEREMONY
6 APRIL
7 APRIL
STA. #9
H.F. CORE (G)
SEE PAGE 49A
8 APRIL
STA. #10
H.F. CORE (G)
SEE PAGE 50
STA. #11
DREDGE
(M.R.)(W.M.)(B.S.)
9 APRIL
STA. #12
H.F. CORE (G)
10 APRIL
SEE PAGE 50
STA. #15
H.F. CORE (G)
12 APRIL
STA. #13
H.F. CORE (G)
11 APRIL
SEE PAGE 51
STA. #16
ECL.
STA. #14
DREDGE (M.R.)(W.M.)(B.S)
13 APRIL
STA. #17
DREDGE (P)
SEYCHELLES
ARRIVE 1700 13 APRIL
DEPART 1634 15 APRIL
16 APRIL
SEE PAGE 52
STA. #19
H.F. CORE (G)
SEE PAGE 53
17 APRIL
18 APRIL
STA. #21
ECL.
STA. #22
H.F. CORE (P)
STA. #18
DREDGE (M.R.)(W.M.)(B.S)
STA. # 20
DREDGE (M.R.)(W.M.)
19 APRIL
SEE CHART X
20 APRIL
21 APRIL
22 APRIL
MAURITIUS
ARRIVE 0703 22 APRIL
REUNION
45°
50°
55°
60°
65°
15°
10°
5°
0°

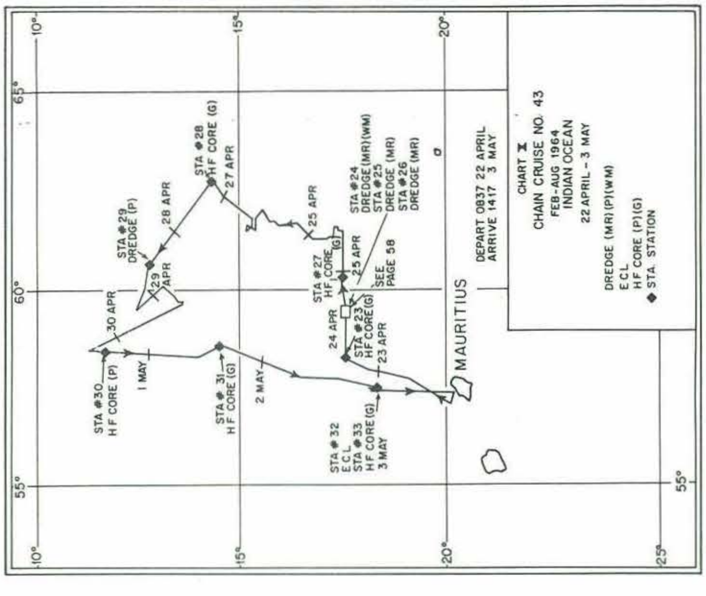
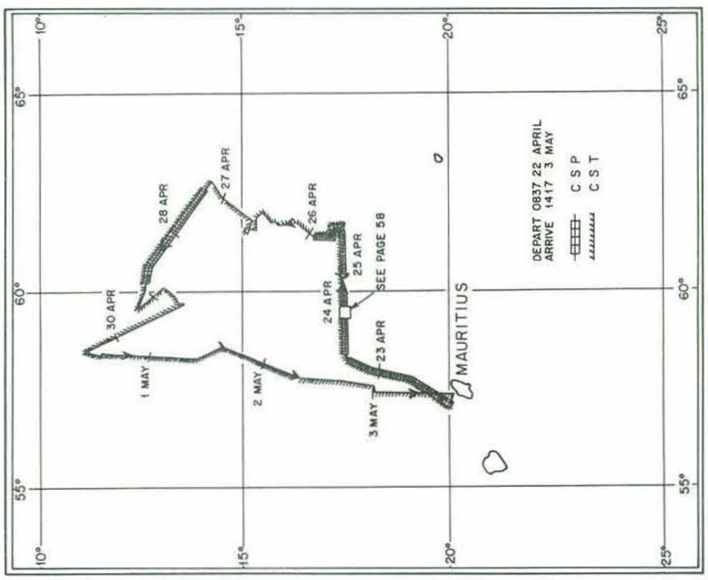
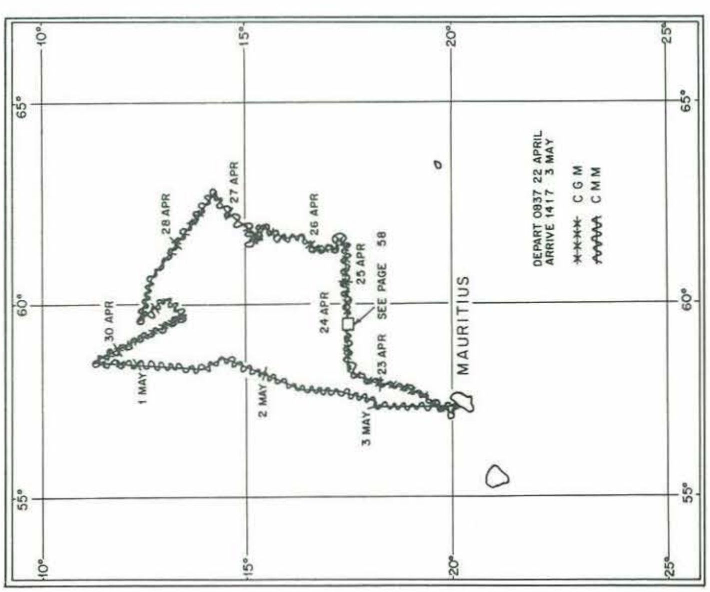


CHART X
CHAIN CRUISE NO. 43
FEB-AUG 1964
INDIAN OCEAN
22 APRIL - 3 MAY
DREDGE (MR) (P)(WM)
E C L
HF CORE (P)(G)
STA. STATION
DEPART 0837 22 APRIL
ARRIVE 1417 3 MAY
MAURITIUS
SEE PAGE 58
STA #24 DREDGE (MR)(WM)
STA #25 DREDGE (MR)
STA #26 DREDGE (MR)
STA #27 HF CORE (G)
STA #28 HF CORE (G)
STA #29 DREDGE (P)
STA #30 H F CORE (P)
STA # 31 H F CORE (G)
STA # 32 E C L
STA # 33 HF CORE (G)
STA # 23 HF CORE (G)


DEPART 0837 22 APRIL
ARRIVE 1417 3 MAY
C S P
C S T
MAURITIUS
SEE PAGE 58


DEPART 0837 22 APRIL
ARRIVE 1417 3 MAY
C G M
C M M
MAURITIUS
SEE PAGE 58

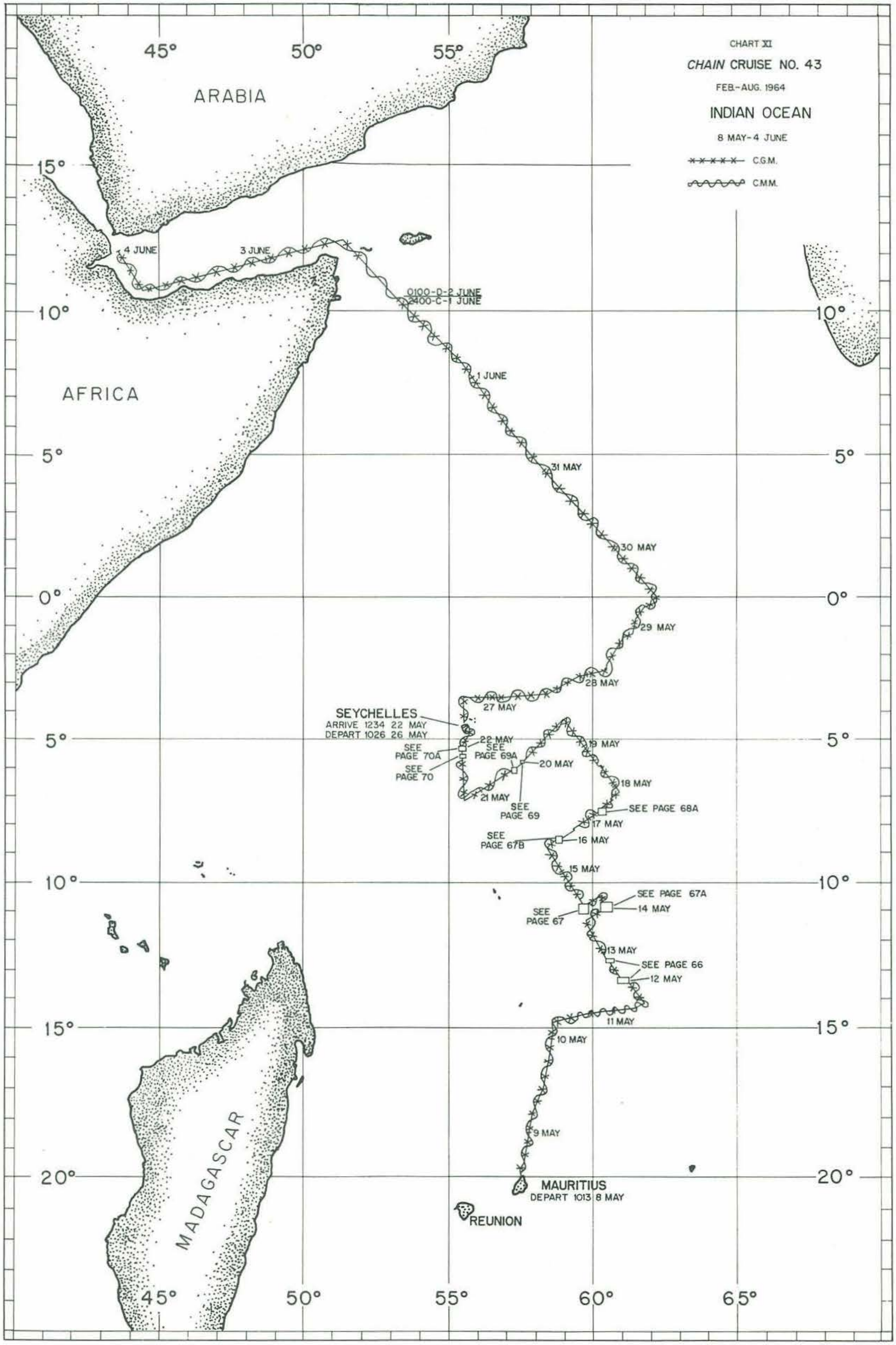


CHART XI
CHAIN CRUISE NO. 43
FEB.-AUG. 1964
INDIAN OCEAN
8 MAY-4 JUNE
C.G.M.
C.M.M.
ARABIA
AFRICA
MADAGASCAR
SEYCHELLES
ARRIVE 1234 22 MAY
DEPART 1026 26 MAY
MAURITIUS
DEPART 1013 8 MAY
REUNION
4 JUNE
3 JUNE
0100-D-2 JUNE
2400-C-1 JUNE
1 JUNE
31 MAY
30 MAY
29 MAY
28 MAY
27 MAY
22 MAY
21 MAY
20 MAY
19 MAY
18 MAY
17 MAY
16 MAY
15 MAY
14 MAY
13 MAY
12 MAY
11 MAY
10 MAY
9 MAY
SEE PAGE 70A
SEE PAGE 70
SEE PAGE 69A
SEE PAGE 69
SEE PAGE 68A
SEE PAGE 67B
SEE PAGE 67A
SEE PAGE 67
SEE PAGE 66
45°
50°
55°
60°
65°
15°
10°
5°
0°
20°

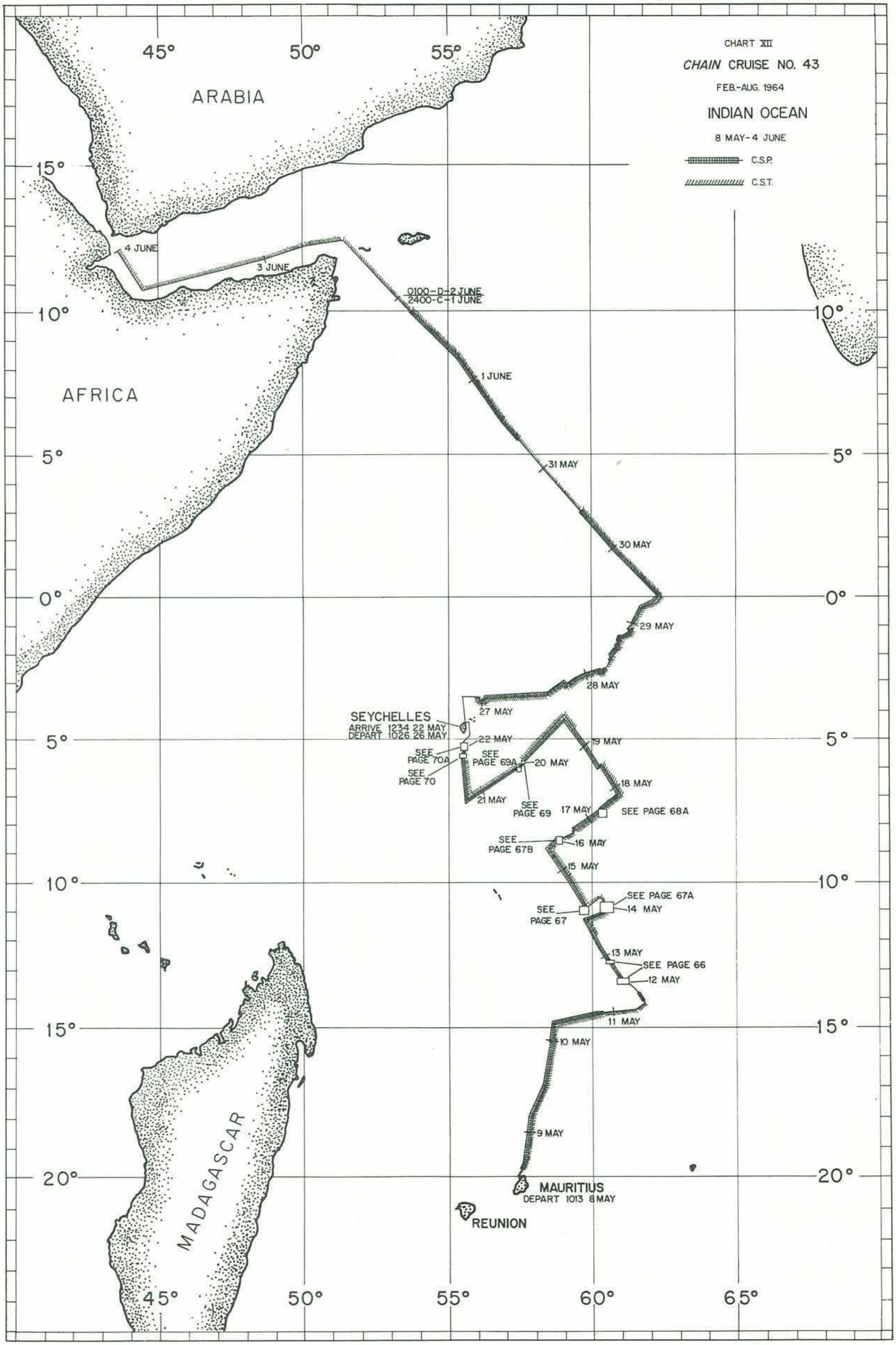


CHART XII
CHAIN CRUISE NO. 43
FEB.-AUG. 1964
INDIAN OCEAN
8 MAY-4 JUNE
C.S.P.
C.S.T.
ARABIA
AFRICA
MADAGASCAR
SEYCHELLES
ARRIVE 1234 22 MAY
DEPART 1026 26 MAY
MAURITIUS
DEPART 1013 8 MAY
REUNION
4 JUNE
3 JUNE
0100-D-2 JUNE
2400-C-1 JUNE
1 JUNE
31 MAY
30 MAY
29 MAY
28 MAY
27 MAY
22 MAY
SEE PAGE 70A
SEE PAGE 70
SEE PAGE 69A
20 MAY
21 MAY
SEE PAGE 69
19 MAY
18 MAY
17 MAY
SEE PAGE 68A
SEE PAGE 67B
16 MAY
15 MAY
SEE PAGE 67A
14 MAY
SEE PAGE 67
13 MAY
SEE PAGE 66
12 MAY
11 MAY
10 MAY
9 MAY
45°
50°
55°
60°
65°
15°
10°
5°
0°
20°

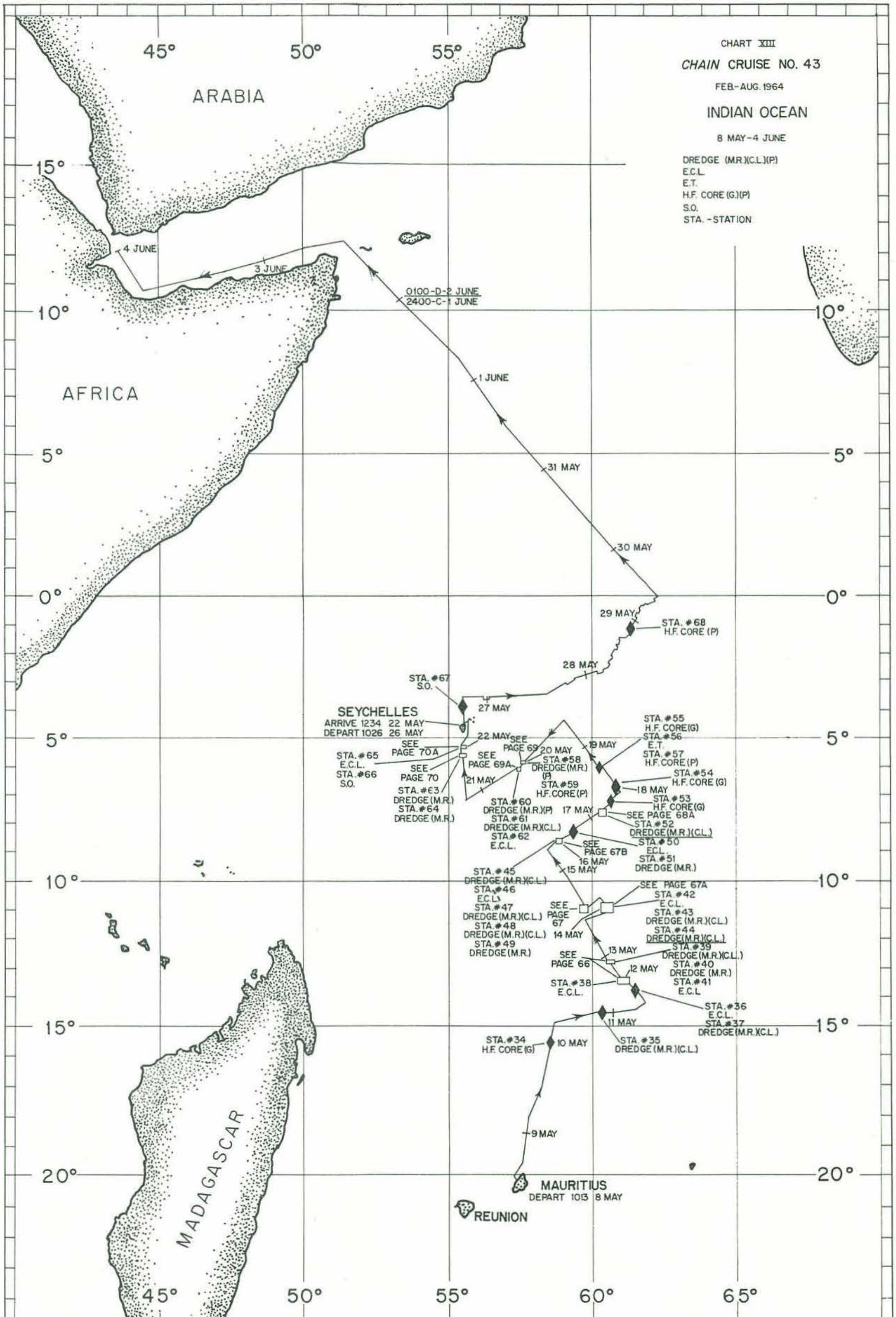


CHART XIII
CHAIN CRUISE NO. 43
FEB-AUG. 1964
INDIAN OCEAN
8 MAY-4 JUNE
DREDGE (M.R.)(C.L.)(P)
E.C.L.
E.T.
H.F. CORE (G.)(P)
S.O.
STA. - STATION
ARABIA
AFRICA
MADAGASCAR
SEYCHELLES
ARRIVE 1234 22 MAY
DEPART 1026 26 MAY
MAURITIUS
DEPART 1013 8 MAY
REUNION
0100-D-2 JUNE
2400-C-1 JUNE
STA. #68
H.F. CORE (P)
STA. #67
S.O.
STA. #34
H.F. CORE (G)
STA. #35
DREDGE (M.R.)(C.L.)
STA. #36
E.C.L.
STA. #37
DREDGE (M.R.)(C.L.)
STA. #38
E.C.L.

INTRODUCTION

Cruise 43 began on 15 February and ended 24 August, 1964. Work was done in the North Atlantic Ocean, the Mediterranean Sea, the Red Sea, and the Western Indian Ocean. The cruise was planned and executed as part of the International Indian Ocean Expedition (IIOE), a project to enlarge man's knowledge of the Indian Ocean from the standpoint of natural and physical science. The Woods Hole Oceanographic Institution's research vessel ATLANTIS II made one cruise in the Indian Ocean in 1963, and scientists from the Institution took part in the scientific program of the R/V ANTON BRUUN in the Indian Ocean. ATLANTIS II recorded total magnetic field intensity, but little other geophysical data was collected by WHOI personnel prior to the cruise of CHAIN.

The work done by those aboard CHAIN was primarily geophysical and geological, directed at an elucidation of the composition, structure, and properties of the earth's crust and upper mantle. In addition, acoustic studies were made of the sound-scattering layers in the ocean, the back-scattering of light from a laser by microorganisms in seawater was studied, the thermal structure of the ocean was recorded by thermistors mounted on the ship's stern and on a towing fish streamed astern, a comparison was made of the navigational accuracy of loran C and the GEON system of astronavigation, and profiles of the variation of the velocity of sound in seawater with depth were obtained with the velocimeter.

The main part of this report comprises the journals of the cruise written on board by the chief scientists. There are also summary charts of the ship's track, showing locations of the principal observations, a summary of geological and geophysical observations, a list of stations (Appendix A), the original plans for the cruise as outlined in technical memoranda internally distributed by WHOI (Appendix B), reports on some of the scientific techniques and equipment used during the cruise (Appendix C), table of personnel (Appendix D), a selection of bottom photographs (Appendix E), and summary charts showing the ship's track and areas in which scientific activity was concentrated. Detailed navigation charts including echo soundings will be found in WHOI Ref. No. 64-51.

The Chief Scientists were S. T. Knott (Woods Hole to Aden), E. T. Bunce (Aden to Mauritius), C. O. Bowin (Mauritius to Beirut), J. B. Hersey (Beirut to Plymouth), and R. L. Chase (Plymouth to Woods Hole).

Continuous seismic reflection profiles were recorded as a routine underway measurement during the greater part of the cruise. The sound source was a 10-kilovolt 100,000 joule Sparker (operated at 8.2 to 8.6 kilovolts), and the receiver was a linear array of hydrophones streamed 200 to 600 feet behind the ship. The profiles were recorded on two precision graphic recorders and on magnetic tape. Improvements in the equipment, made as the cruise progressed, allowed useful records to be obtained at speeds of up to 10 knots.

The Indian Ocean cruise is the longest research cruise yet made by CHAIN. The junior members of the scientific complement were, in the main, undergraduate and graduate students in the physical sciences. During the cruise they developed into a well-trained body of men. Relations between the crew and the scientific party were good, resulting in a happy ship.

SUMMARY OF GEOLOGICAL AND GEOPHYSICAL OBSERVATIONS

by Richard L. Chase

During the entire cruise, continuous measurements of water depth, total magnetic field intensity, and gravitational field were made with, respectively, a precision echo sounder, a Varian proton magnetometer, and a LaCoste and Romberg gravimeter. The gravimeter was secured when rough seas caused ship motions too violent for its suspension system or when a breakdown in the air-conditioning system allowed excessive heating of the electronics of the IBM computer. The echo sounders were used not only to determine bottom configuration but also, where necessary, to study the oceanic sound-scattering layers and fine subbottom layering in the sediments of abyssal plains and sediment ponds.

Atlantic Ocean

The Atlantic Ocean was crossed twice. During the eastbound leg (Woods Hole - Ceuta) a crossing of the Mid-Atlantic Ridge was made at 28°N between 50°W and 30°W. Bathymetry and measurements of total magnetic field and gravitational field were continuous. Seismic reflection profiling was intermittent.

Continuous measurement of backscattering of laser light by plankton in surface seawater was made with an apparatus designed by Frederick Spilhaus and operated by W. S. von Arx.

During the second crossing (Strait of Gibraltar - Plymouth - Woods Hole) four continuous seismic profiles were made of the European continental shelf and shelf-slope boundary between Spain and Cornwall, in part along the lines of seismic refraction shot in 1962 by R/V CHAIN and HMS DISCOVERY II (Bunce, et al. , 1964).

Five velocimeter lowerings were made in the eastern North Atlantic. Eight crossings were made of the median valley of the Mid-Atlantic Ridge between 42°N and 45°N. A detailed topographic, magnetic and gravimetric survey was made of a ridge on the eastern flank of the valley at 42°30'N. One heat flow measurement was made east of the valley in this area. Vertical change in total magnetic field intensity was measured in two places, and four successful dredge hauls and two camera lowerings were made.

A continuous seismic reflection profile was recorded on the run from Europe to the median valley of the ridge at approximately 46°N and from the ridge to the North American shelf at 40°-42°N. Three crossings of the North American continental slope and shelf-slope boundary were made at 68°-69°W, 40°-41°N off Nantucket.

Sea temperature was recorded continuously by two thermistors, one at the base of the bow stem, the other in a fish streamed 20 to 40 feet below the surface from the stern.

Mediterranean Sea

The Mediterranean Sea was crossed twice. During the outbound crossing (Ceuta - La Spezia - Port Said) only underway measurements were made.

On the homebound crossing (Port Said - Beirut - La Spezia - Monaco - Strait of Gibraltar) 42 days were spent in the Mediterranean. The ship's activities and findings during this leg of the cruise were as follows.

Eastern Mediterranean Sea

(a) a detailed seismic reflection survey made on the continental shelf and slope of the Levantine coast outside the territorial waters of Lebanon revealed the form of several structural units in the subbottom.

(b) The structure of the Nile Delta was revealed by two CSP profiles of the northern part of the delta (north of the 100-fathom line).

(c) Several transits were made across the abyssal plains and the east-west graben which lie in the area between Cyprus, Rhodes, Crete, and Egypt.

Ionian Sea

Underway measurements were taken across the abyssal plain, and piston cores were obtained to further study of sediment layers detectable on CSP records.

Tyrrhenian Sea

(a) Heat flow measured at one station near Stromboli was subnormal.

(b) Underway measurements were made across the Tyrrhenian basin.

Ligurian Sea.

Underway measurements were made on a grid of east-west and north-south lines west of Italy between La Spezia and Elba for investigation of subsurface geologic structure. Metamorphic rocks, dredged during this operation from Santa Lucia Bank in the northwest part of the gridded area, are similar to those found on Cap Corse, to the south, and in the Appenines, to the east.

In the Ligurian basin, underway measurements were made along seismic refraction lines which had been shot during CHAIN Cruise 7. Coral was dredged from a slope which is the surface expression of a north-south fault running approximately along the boundary of the abyssal plain and the Italian continental rise. Subbottom structure was investigated in an area around the Monegasque Buoy Laboratoire.

Algiers-Provencal Basin

Continuous seismic reflection profiles recorded on a course south of the Balearic Islands from Monaco to the Strait of Gibraltar showed many structures resembling buried seamounts or intrusions rising close beneath the sea floor in the northern part of Algiers-Pronvencal Basin.

Red Sea

Outbound for the Indian Ocean in March, the ship spent seven days in the Red Sea. Six times at successively lower latitudes, the ship passed more or less obliquely across the central part of the sea. The crossings in part coincided with seismic refraction lines shot in 1958 by the research vessels VEMA and ATLANTIS (Drake and Girdler, 1964). Dredging with rock dredge and permanent magnet in the southern part of the sea over strong linear magnetic anomalies yielded only minute magnetic spherules. Attempts to measure heat flow failed.

Homebound in June, the ship spent five days transiting the Red Sea. Underway measurements were made up the center of the southern part of the sea, and one oblique crossing and one heat flow measurement were made in the northern part of the sea. Limestone, bearing fossils identified as freshwater and continental pulmonate gastropods by Dr. W. A. Berggren of Oasis Oil Company, was dredged from the central deep of the Red Sea at 16°N.

Indian Ocean

In the Gulf of Aden during the outbound transit underway measurements were made on a course which cut obliquely across the central rift zone. On the homebound transit a course was made south of the central zone, parallel with the Somali coast.

Sound from the Sparker (seismic reflection sound source) penetrated 2 sec (two-way reflection travel time) into a sequence of flat-lying sedimentary strata beneath the Northern Somali Basin. The profiles showed clearly the lensing of sedimentary strata on the continental rise south of Socotra.

A number of crossings were made on a zig-zag track over Owen Ridge, a south-southwest-trending feature which appears to form the eastern boundary of the Northern Somali Basin. Alkali gabbro was dredged from the southern slope of the ridge.

An oblique seismic reflection survey was made in the Somali Basin south of Owen Ridge.

Managanese nodules were dredged from one of a series of parallel ridges which run north-northeast from the vicinity of the Amirante Trench to the area of Mt. Error in the Carlsberg Ridge.

Underway measurements were made during seven crossings over the Seychelles-Mauritius Ridge. Rough seas encountered here made the recording of gravity intermittent. Seismic reflection profiles and echo soundings show that the northern part of the ridge lacks a flat top and is composed of almost flat-lying strata. From the Saya de Malha Bank southwards, in contrast, the ridge has a flat top, below which subbottom layering is not evident on seismic profiles. Relatively strong magnetic anomalies associated with this section of the ridge suggest that it is composed here, at least in part, of volcanic or igneous intrusive rocks. Of twenty-five dredgings made on the top and flanks of the Seychelles-Mauritius Ridge and Seychelles Platform, nine yielded limestone or calcareous sand, which contained forams identified as Recent by Dr. Berggren. The remaining dredges were hauled up empty or lost.

On the run from the Seychelles to Socotra an investigation was made of the strike of magnetic anomalies over the southwest flank of the Carlsberg Ridge.

REFERENCES

Bunce, E. T., S. Crampin, J. B. Hersey, and M. N. Hill (1964): Seismic refraction observations on the continental boundary west of Britain. Jour. Geophys. Res., v. 69, pp. 3853-3863.

Drake, C. L., and R. W. Girdler (1964): A geophysical study of the Red Sea. Geophys. Jour., Roy. Astron. Soc., v. 8, pp. 473-495.

Fahlquist, D. A. (1963): "Seismic refraction measurements in the western Mediterranean Sea". PhD. thesis, Massachusetts Institute of Technology.

Woods Hole, Massachusetts to Aden, Aden Protectorate
15 February - 28 March, 1964

by Sidney T. Knott

15 February, Saturday. CHAIN Cruise 43 began on a brisk sunny Saturday, 15 February, 1964. Departure had been planned for 1500 and, considering the logistics of a six-month expedition, it is remarkable that we were only forty-five minutes late in leaving. The last line was cast off at 1545 and the sea buoy out of the Woods Hole harbor on Vineyard Sound was passed at 1555.

The scientific party on board is:

Knott, Sidney, Chief Scientist

Aldrich, Thomas
Birch, Francis
Carlisle, Donald
Dow, Willard
Friedberg, Jeffrey
Goulet, Julien
Grant, Carlton
Lynch, Frank
Martin, Barry
Porter, Charles
Powers, Patrick (IBM)
Salisbury, Matthew
Scott, David
Spilhaus, Fred
Stillman, Stephen
Ungar, Edward (IBM)
Vogt, Peter
von Arx, William
Waldon, Colin
Wilharm, Larry
Witzell, Warren

The afternoon was spent lashing down equipment and stowing a few additional supplies. Just prior to dinner I called the scientific group together, in order to point out some of the general habits desirable aboard ship. The main points I touched upon were watches, relief for meals, lifeboat and other emergency drills, seating arrangements in the mess hall, ship cleanliness, and the like. After dinner, until about 2000, all hands continued to lash down and protect the gear. The main hatch of the lower lab and the ammo locker hatch both leak.

Perhaps for this cruise the ammo locker should be called the geologists' storeroom, as there are no explosives aboard; the seismic reflection studies planned depend upon two electrical sources, the underwater spark and the Boomer, both of which are driven bythe power source designed by Caulfield.

Julie and I had some trouble keeping water out of the sparker-cable tube. We wrapped the rag stuffing at the end of the tube with canvas, and got soaked doing it.

At 2102 we began a pass over of the gravity range, steaming 180°T at 70°54'W from 40°38'N to 40°26'N. Then at 2204 we changed course to 130°T, heading to the east of Bermuda. Night plans are simply to steam as fast as is practical on heading 130°T.

Gravity (Barry Martin) reports a good run on the range without need for adjustments of the spring tension during the run.

Examined the computer system bible, and can see I've lots to learn! Tomorrow starts at 0600.

16 February, Sunday. Sea has become extremely rough - high winds, generally in Gulf Stream; more than 50% of the men seasick. Had short school session from about 0830 to 0930 and assigned watches:

Gravity

0000-0400 1200-1600	0400-0800 1600-2000	0800-1200 2000-2400
Vogt	Goulet	Aldrich

Top Lab

0000-0400 1200-1600	0400-0800 1600-2000	0800-1200 2000-2400
Friedberg	Dow	Birch
Grant	Salisbury	Carlisle
Lynch	Stillman	Scott
Porter	Waldon	Wilharm

Overall Snapper

Witzell

Leaks are continuously a problem in the lower lab, main lab, and top lab. Lower-lab problem is in the main hatch and small hatch in it. We rigged a canvas gutter for main hatch lead 1st night, so that water drained to sink in lower lab, and then covered small hatch with canvas; this covering did not leak. Most troublesome leak is a cracked weld in deck where sparker cable pipe was installed. Finally made a compression seal, braced under bulwark. Main lab: a waterfall coming down from auxiliary silent-ship generator room right over pit log through the inter-lab cable duct. Whitey Witzell and Barry Martin made a convas chute to carry the water over the pit log to a big wastebasket, which had to be emptied about once an hour. Water backs up the scuppers on the port and starboard sides of the main lab as the ship rolls. Top-lab doors leak badly.

Seas running high, 30 to 40 feet as measured by Bill von Arx -- a full gale. Have altered courses with wind to make as much way south with as much comfort as possible. This is a large storm system engulfing the whole northern part of the North Atlantic.

This evening, just after dinner, about 1815, smoke was detected coming from after steering by Matt Salisbury, who informed Steve Stillman, who called bridge immediately. Fire of unknown origin started back there, mostly burning plastic coffee cups of Styrofoam. Horrible acrid smoke - science luckily had provided for this cruise adequate passageway for access aft, especially useful in this rough weather. Crew at first had some trouble with oxygen breathing apparatus. Steve Stillman apparently has had training, and helped them get checked out as they prepared to go down to the fire. Electrician Fred Grace was first into the fire before the apparatuses were working. How he stood it, I don't know. Dave Scott was down there for a long time, tending lifelines and hose. Again, don't know how he controlled his breathing. I was down several times rigging lights and, later, a Modine for exhaust blowing, and I choked up immediately. Everyone was retching to some extent. Salt water through a spray nozzle was used; water damage to some of the gear stowed there was unavoidable. Fire luckily didn't get to paints or much other flammable material, wires on overhead crisp, and place black as pitch from the heavy smoke. Fire was brought under control in about an hour. Scientific staff helped clean out a lot of the burned debris, and secured for the day. The ship was maneuvered into the wind during the time of the fire, to ease working conditions on the afterdeck. Little time was lost, luckily.

17 February, Monday. At 0000 tried to start the watches. Lew Lynch is sick; Whitey Witzell, Chuck Porter, and myself are in top lab. At 0135 the watch became Whitey, Butch Grant, and myself, and shortly I went below. Mainly trying to get people accustomed to simple bathymetry with PGR. Able to steam at 14 knots with the seas, although it is very rough. Ship is remarkably steady, considering everything. Port bow transducer seems the best. We slowed to 12. 5 knots later in morning.

Computer is only occasionally on line, and we are trying to insert data to get some idea of its operational capabilities and limitations.

Rearranged racks holding the Gifft echo-sounding transceivers and automatic travel-time measurement system; the latter is to be used as the primary means of inserting bathymetric information into the computer memory. Wilharm and I discussed and simplified chassis interconnections. If gear keeps running, it will probably do the job. At 1353 asked bridge to make best course and speed toward 28°00'N, 50°00'W.

At 1400 put PGR 1 on 400-fathom scale while all scientists had school on the data-logging system in the main lab. Barry Martin held forth.

At 1545 rough seas continue.

At 1605 setting up forward PGR as slave. Aft starboard PGR will be master. Forward PGR tentatively called No. 2.

NOTE: The times indicated on data taken today as "Queen" should be "Romeo".

Colin Waldon has been tending the bow thermistor recorder and indoctrinating various watch-standers. Some students shaping up quite rapidly, some not. This afternoon almost everyone feeling better and able to stand watch.

18 February, Tuesday. The setup for the two PGR's described above is not satisfactory. Propose a change to make the forward one the master and to use a sweep to get overall picture and scattering layer; the after PGR can be high-resolution.

Afterdeck still too set for any rigging. Seas still running high.

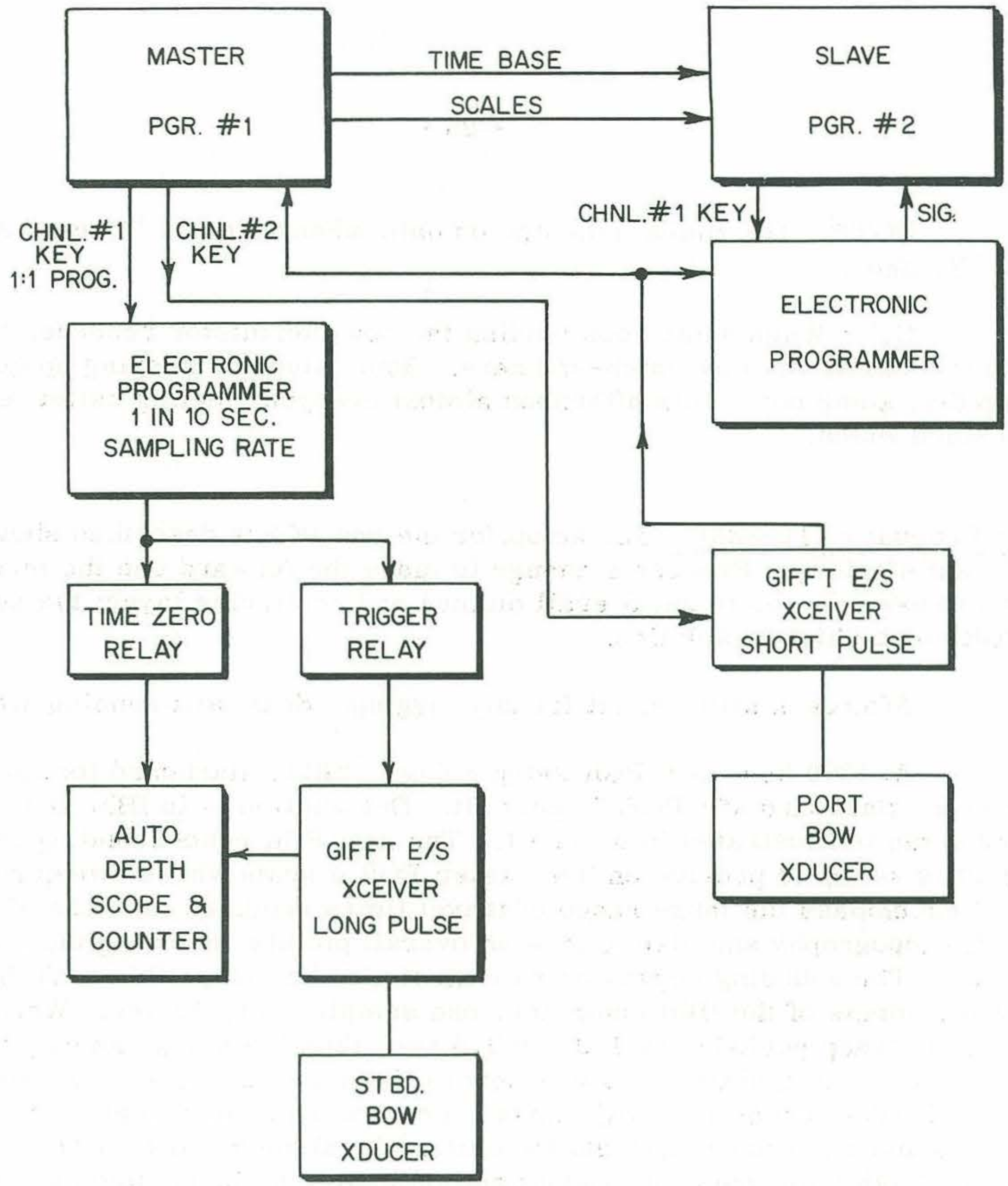
At 1300 have new PGR setup going: PGR1, starboard forward; PGR 2, starboard aft; PGR 3, port aft. Description is in IBM memory, and setup is illustrated in Figure 1. The new PGR echo-sounding arrangement is set up to provide on the master PGR a scale whose sweep period will encompass the large range of travel times required in areas of rough topography and also to give an overall picture including the scattering layer. The sounding repetition rate must also be compatible with the requirements of the IBM computer, one sample every 10 sec. When the master sweep periods are 1.25 or 2.5 sec, then the slave can be programmed conveniently to display several high-resolution sweep speeds. Two different echo-sounding transceivers are used, one to give long pulses and a narrow bandwidth for better signal-to-noise with the automatic depth measurement readout and in scattering layer studies, and the other to give short pulses and wider bandwidths for use in high-resolution echo-sounding studies.

At 1700 conversion of PGR's was finished.

At 2400 finally, officially, in Queen time zone.

19 February, Wednesday. At midnight the PGR electronic programmers are the major subject in the training of each watch as it comes along, for the programmer is the sampling time control of the auto depth system.

Not much sleep again tonight. Boy, I'm getting pooped: about three hours of sleep per day so far.



MASTER SWEEP PERIOD:
1.25 OR 2.5 SECS.

ELECTRONIC PROGRAMMER:
AN 8 OR 4 COUNT TO OBTAIN 10 SEC.

SLAVE SWEEP PERIOD:
0.125 OR 0.25 SECS.

ELECTRONIC PROGRAMMER:
A 5 OR 10 COUNT

FIGURE 1. The 12-kcps sounding system used to facilitate on a continuous basis observations of the scattering layer, the overall bathymetric picture in rough terrain, and automatic depth measurement for the computer and high-resolution recordings of bottom echoes in areas of sediment ponding.

Damn it, I wish weather were better, or there were more time. Sohm Abyssal Plain very interesting. Many small seamounts, volcanics perhaps, rise up and out of bottom abruptly and are gone in minutes; then the flat bottom again. Still rigging at every moment possible, to get Sparker and array ready. Have asked Matt Salisbury to take over the bathymetry daily plot. Good steady man.

Occasional "thermal fronts" are indicated by data from the bow thermistor.

IBM on again, off again, and not routinely in operation, owing to high sea states and typewriter difficulties.

Whitey rigged humidifiers on all top-lab PGR's.

Sparker still inoperative; about 0130 it seems we have lost our chance for sparking in the abyssal area.

20 February, Thursday. Still rigging Sparker and array at crack of dawn.

About 1100 made first tow test of spark cable, hold-down fish, and electrode.

About 1300 slowed to rig array tow; Maggie (the magnetometer) is being towed already.

At 1400 testing underwater spark system - trouble in key circuit. Checked out panic system and finally figured out key circuit design. Very simple, once circuit was found.

At 1600 array noisy, but recording on four-channel Crown. Will try to improve noise problems as soon as possible.

At 1730 the sparker quit: thyratron trouble and relay trouble.

Spent most of night modifying a 0. 25 amp fuse assembly in the insides of the new four-channel and two-channel Crowns in top lab. What a miserable place to put this fuse. Also trying to find source of other relay troubles in the four-channel Crown relay power circuits. Crown fixed, but so far signal-to-noise problems have prohibited good CSP records.

21 February, Friday. Some time after midnight the Sparker was back in operation.

IBM intermittent, getting tired like me. Hope soon to have a few more hours of sleep. Can't possibly log everything, but I know I've been busy!

At 0900 lengthened array tow.

Hauled in Sparker electrode so crew could get plywood out of hatch. Weather has improved. Sparker back in operation about 1120, but it died again at 1613. Willy and I found that the relays designed for 110 volts a-c were driven by 440 volts and were therefore burned out. We spent hours - more hours, that is - looking for circuits in the drawings. Rather confusing. Found only two spare relays; need two. Willy, Barry, and Whitey took over to make repairs and let me sleep.

At midnight Willy and Whitey suggested that, since the Sparker was again in operation, I send a night letter to WHOI requesting more spare relays, which I did. I had previously sent a radiogram suggesting that David Caulfield meet us at Ceuta.

Made PGR 2 the slave and PGR 3 the master for CSP.

The Mercedes deisel motor generator for the Sparker ran out of fuel, and it took us some time to find engineer, fuel, etc. , and to restart it. Deisel started at 0525, and sparking was resumed about ten minutes later.

Hard to determine decent filter settings for the CSP work. Noise is strongest in the spectrum just where one would expect the best CSP results -- very near to 100 cps, - a band from about 75 to 150 cps.

22 February, Saturday. At 0600 still here in top lab! Hit sack and passed out. No one disturbed me till noon. Six hours' sleep seems good for a change.

About noon array quit; actually it must have been out of operation for some time. Checked in at top lab after lunch and found array very noisy with snaps, crackles, etc. Sounded like a salt-water leak. Pulled in cable. (I wish I weren't the only one that seemed to check these things.)

The cable entry ahead of preamplifier was full of water under pressure. I believe the cause of the leak was the thin-wall construction of the preamplifier case, which distorts easily, and screw holes, which sheared the O-ring seal. Cleaned, washed, and dried connectors and restreamed the array. Signal-to noise ratio better than before. Amazingly, the seawater short didn't stop the signal when the connectors were flooded, although the system was very noisy; this is probably because the transistor preamplifier has such a low impedance output. Trying two Allison filters in cascade peaked at 100 to 110 cps. The noise problem today is obviously different from that of yesterday. Most likely reason is a difference in tow speed.

The slave PGR monitoring a low-frequency band of 37. 5 to 75 cps is not very effective, although we occasionally get some good recordings.

Increasing ship's speed slowly, to see how well the array will work. Up to 10 knots at 2100; CSP records still look good, Incidentally, we must steam at an average of 10 knots to meet our schedule at La Spezia and later ports.

23 February, Sunday. Coming up west side of Mid-Atlantic Ridge. In very early morning the array quit again. All was dry. Transistors at input preamplifier apparently overdriven by the high impulse of the directly received sound of the spark discharge. Repaired the array (replaced transistors). The day had plenty of work, but exactly each bit of it is hard to recall. With subsequent tests the array was finally in business in the late afternoon, 1700. We had missed the rift valley, unfortunately.

24 February, Monday. About 0230 I found noise in the array again. This failure and the last have been associated with trying to tow at 10 knots. This time the transistors were quiet if not touched, but very noisy if made to vibrate at all. Dow and Grant believe that they were vibrated loose right inside their little cases.

Willy made further modifications in the preamplifier, which I believe included a limit circuit and the use of a more rugged transistor.

At 2330 we're steaming at 9 knots, and once again I'm going up to check noise level.

We started painting various fixtures in the top lab, to make our home happier; shelves over plotting table and the mast were first candidates.

Hope array goes through night. First thing tomorrow I expect we will have to haul in the spark electrode for checking and haul in the array to increase speed and make more distance. We are slightly behind; if we made 10 knots from here to Ceuta our arrival would be late Monday, 2 March, rather than early that day, as scheduled. Also want to change back to a longer array cable to see whether tow noise decreases; this means perhaps two hours of rigging, although we are getting better at it each time.

25 February, Tuesday. Secured Sparker and array about 0915; they are working okay, but we need to get on and make up for some lost time.

A two-channel Crown has been used to tape excerpts of sediment ponding and scattering layers, as received with 12 kcps echo-sounding gear. Sediments are being observed with short pulses about 0.2 to 0.5 msec and scattering with about 5.0 msec pulses. We are now on the east side of the Mid-Atlantic Ridge. Bathymetry continues and magnetometer and gravimeter are working. Light-scattering measurements with the laser have been made continuously by Spilhaus and von Arx. Bill von Arx is having trouble with the generator which drives his geon stable table gyro. Hope he can get parts in Italy before the time comes to evaluate Geon in relation to Loran C.

Rerigged array with longer cable, hopefully to give us better signal-to-noise ratio at high speeds; 9 knots is still about the best we can do, if we wish to tolerate very poor records.

Started spectrum analyzer. Hope to swing it into action tonight or tomorrow, to show students and to use it for (at least) guiding our choice of filter bandwidths on the CSP.

There has been some difficulty in getting the outputs of both the Varian and the WHOI magnetometer systems into the computer.

Wish I could get the "auto depth", the automatic travel-time measurement system, working better. It's far from automatic right now.

Both Wilharm and Martin are working on the magnetometer problem; it appears to be one of a proper choice of Hewlett-Packard counter and its associated machine language. When through with that, they'll tackle auto depth again.

Underway at 14 knots since this morning. Figuring from 1700, if we advanced at an average of 10 knots, we would arrive Ceuta mid-evening of 2 March. I am going to pass up CSP until we reach the abyssal plains to the east of Great Meteor. One can gain more confidence in 10-knot work and evaluate one's signal-to-noise problems better in areas of smoother topography. This rough topography has not been conducive to good records. Noise isn't the only problem: you just move so fast there is little chance to examine the sediments in valleys before the next ridge appears.

Top and main labs received more paint and look a lot neater for the effort. This is called "physical therapy". I hope we can help make this a really proud ship.

26 February, Wednesday. In the morning, steaming at 14 knots; echo sounding continuing, with tapes of sediment valleys. About 1300 slowed and put out array and spark. Two magnetometers were towed, both Varians for a comparative test, then one was pulled in. Heavy swell makes it difficult to tow deeply.

Willy Dow made test of speed versus tow noise about 1700. Notes in PGR log refer to screw noise, but I believe the noise is primarily cable strum. These were rough, rather preliminary, checks played by ear. I don't think Willy took down any data. Continued at 8 knots, 100 rpm.

27 February, Thursday. Early morning still profiling. Secured at 0830 to steam again at 14 knots to head for Madeira. Echo sounding as usual. Heavy seas have made it impossible to run gravity, and disk packs were shut down because the heads were not tracking properly, so all logging is manual and magnetometer output is only on the Varian recorders.

28 February, Friday. Still at 13 to 14 knots. Heavy swells. About 1100 sighted Madeira. Automatic depth tracks up slope and down dale; best we've seen yet. The inclusion of optional modes of signal discrimination --

e. g. , optional integration constants - and optional modes of operation, in case the PGR programmer breaks down, will see this job well on the way to completion.

At 1600 started CSP again. Figure we can get about 30 more hours of this before high-tailing into Ceuta. This will mean we have obtained only abyssal-plain data in this area. Shelf will have to be examined on the ship's return out of the Mediterranean.

Still don't have clearance for Ceuta.

29 February, Saturday. At 0020, PGR 3, the CSP master, broke down; blade-lifting solenoid shorted to ground, which blew out the fuse to the clutch solenoid power supply, a power supply used for several purposes. Found also at this time that an earlier watch-stander was confused by interequipment hookups and had used for the tape's time-base information a 60 cps signal from a source other than the master PGR. Don't know how long this has been going on, but it is fairly recent, for I have been playing back tapes in the main lab without difficulty. I find a serious noise problem at Allison settings of about 75 cps times 1. 4 (105 cps) and lower. The Dimock, or WHOI, real-time spectrum analyzer is working; shows among other things the high response of these Chesapeake-type array receiving systems at about 5 kcps. Really haven't found the spectrum analyzer to be truly a good means of finding "windows" in the noise spectrum.

Incidentally, we are doing CSP at 10 knots (through the water, but 9 knots over the ground), so we may be able to cover more ground than expected. At about 1000 we slowed from 125 to 110 rpm and later from 110 to 100 rpm. At 1115, not too impressed with improvements in noise level; going back to 10 knots.

The gravimeter has been tested and used periodically during these days of moderately heavy swells, to see whether it can be operated reliably. Now gravity measurements are on line and have been operational since last evening, but the output is still a very wavy trace. Magnetometer is working, bow thermistor has been operational almost continuously, and auto depth has been operational off and on as watches become more familiar with it.

At 1115 tried to ping the array for the first time this trip, and not too successfully. Later, in afternoon, system was made to work better by adjusting filter bandwidth. I think it is still marginal.

Continuing CSP and echo sounding. CSP is taped continuously on the four-channel Crown magnetic tape recorder; samples of echo sounding of sediment ponds and other sections of interest are taped on the two-channel Crown.

1 March, Sunday. In early morning setting up CSP again, using the master PGR no. 3, and slave PGR no. 2, expecting a continuation of the relatively good records which had been appearing. Also set up a schedule of alternate 10-knot and 8-knot steaming, to compare noise and signal problems at these speeds. Not particularly happy with results, because overall noise level increased gradually, indicating that we may be having more preamplifier trouble. Hauled in Sparker and array after breakfast, for we had to get to Ceuta and maintain our ETA. Steamed at full speed, while echo sounding and towing the magnetometer. Computer on again, off again; checking programs, because swells made the use of random disc magnetic memory somewhat risky, for it is said that the magnetic recording heads will scrape the discs.

2 March, Monday. Shortly after midnight we hauled in Maggie, for it was felt there would be too much traffic to contend with in the strait.

Strait of Gibraltar: rain-squally and foggy; it is very choppy and uncomfortable. Echo-sounding, laser, and bow thermistor observations have been nearly continuous on the crossing and are continuing here.

Ceuta anchorage early morning, about 0600. Pilot said he knew nothing of our agent, which was a curious thing. Later find out, thanks to the post office, that "Gomez Martinez" is not the agent, but his new street address.

Liberty until 1500. Ceuta remarkably clean city, pleasant people, Spanish and Arab or Moroccan.

A little after 1600 we were underway again. Carl Bowin has joined, brought many items which had been requested of WHOI during first leg. He made a gravity land station on the dock; see his log. I'm not sure of his opinion of status of IBM, gravity, and magnetic observations of the Atlantic crossing. However, Barry was glad to hear from Bowin that gravity records of the past few days, although wavy, were okay, for he had taken considerable time and trouble trying to prove them so and had never been completely happy with the results.

Maggie (Varian) put out. We are not always notified in top lab when gravity is working. Communications need improvement.

Plan to steam east to deep water and make a test station with the velocimeter system for Stillman and Dow. Then to proceed northeast between Spain and the Balearic Islands and continue CSP from there to La Spezia.

Have had several discussions with Carl on better use of the IBM computer.

3 March, Tuesday. Echo-sounding data are automatically fed to computer when asked for by main lab. Automatic travel-time system is working well if programmed correctly. Echo soundings are being taped as before. Early this morning, about 0445 to 0600, tape recordings were made when porpoise squeals were predominant. Computer is on, then off; computer programs are being checked by Carl Bowin and the IBM people.

Didn't stop for the velocity stations, because Dow and Stillman weren't ready. It has been overcast but not rough; hope the sea stays this way until La Spezia.

4 March, Wednesday. Auto depth working well when required. Early morning checking out velocimeter system with synthesized signal. Stopped about 1000 for test station (Station 1); test successful. About 1130 magnetometer, Sparker, and array in operation as we head for La Spezia. Estimate that we will not have to run at more than 6.5 knots during these observations.

Two hydrophone arrays are aboard; both are Chesapeake type in having Chesapeake transducers and following somewhat the original design. One, however, has a short (about 20-foot) oil-filled tail, the other a long tail (about 50-foot). The long-tailed array was used during the Atlantic crossing on the first leg of CHAIN 43. We used the short-tail array, obtained fairly poor records, and changed back to the long-tail array about 1800. Made some noise checks and continued on. The long-tailed array appears to be the better of the two.

5 March, Thursday. Some good records! Low frequencies still missing. Hope the weather holds. Late morning getting rougher, records still fair.

At 1500, computer and gravity not working. Getting ROUGH. Hope to pass Gulf of Lion today. Calmer weather should show up.

After supper looks as if we have a bit of a blow. Secured Sparker electronics and hauled Maggie in, as we slowed the ship. Really wild out now. Should have hauled all gear in earlier. Intensity of the storm has increased very rapidly. Tried to retrieve array. All hands soaked. Fantail pooped several times - four or five feet of water - no one hurt. Decided to tow long-tail array through night.

6 March, Friday. Wind shifted westerly; we are now heading for Spain again, steaming into the wind, Hope to haul in array, then sparker fish, which we could not handle last night.

At first light, as we were trying to reach the retreiving line to the fish which held the array cable at tow depth, the after guy to the tow boom rigged on the port quarter parted. This brought the tow fish and associated cables abruptly into the side of the ship just ahead of the port screw. The port screw had been stopped, but in bringing in the hold-down fish we found the array tow cable was parted, actually about where the cable might have struck the propellor. At any rate, the array and about 750 feet of cable were lost. Two possible causes exist, that described above and another, less plausible: that the cable became entangled in the screw during the night as we jogged into the storm. If this had happened, however, the powered screw would probably have wound up the cable and carried the boom away. We all got soaked. This mistral is as bad as the Atlantic storm in the first days of the cruise. So rough last night that all but echo sounding shut down and only a small watch was set, for security.

At noon the seas had become calm by comparison. Sun out, beautiful day. Gravimeter, magnetometer, echo sounder, and bow thermistor all in operation again. Splicing two short cables for long tow for future use with the short-tail array. Full speed while the weather is good, heading for La Spezia.

About 1630 we made velocimeter station 2. Travel-time and velocimeter frequency measurements (period) are being fed to the 1711 computer.

Magnetometer in and out. WHOI - ORE unit tried, but not as good as Varian. Back to Varian after station.

7 March, Saturday. Arrived La Spezia and tied up at the Italian naval base. We were asked to med-moor, but we were able to argue the point and tied up alongside so that we could handle gear astern.

Through the previous day and night following the mistral, the ship people found the radar scanner inoperable. It was troublesome in storm at the Gulf of Lion. Had been overhauled in Woods Hole. Requests have been initiated for assistance from Sperry upon our arrival in La Spezia.

Expected to see Betty Bunce and Dick Chase on dock, but customs problems indicate something like three or four hours for clearance to join ship or land. Expect to see also Eldredge Moores, a geology student of H. Hess, and Siegfried Plaumann, a German scientist of Dietrich's group, whose main interest is gravity. The APL group under Stickney also joins here.

Dow, Grant, Witzell, Lynch, Scott, Spilhaus, Stillman, and Ungar depart here. Dave Scott is delaying his departure to assist in in-port details of radar repair. He has been good company on the crossing.

Plan to rerig the array tow off the back port side of the thermistor winch frame and to remove the port quarter boom rig, which became unmanageable in the Gulf of Lion when we lost the array. The hold-down fish is to be fixed so that it can be lowered and the array tow point can be moved up and down the tow cable as desired. Montgomery, the day man, can assist.

Examination of radar-scanner gear box shows teeth of hypoid gear drive completely gone in over 180° of hypoid, chewed by pinion beyond repair.

Scott has found Sperry representatives both Italian and American on the new Italian cruiser ANDREA DORIA. They will visit when the cruiser comes to port this afternoon. Three Sperry men arrive.

T. D. Allen and Roberto Frassetto and others visit from SACLANT. Arrange meetings and social plans. Visits by their people on CHAIN and by those of us having business at SACLANT.

At naval base it is difficult to do anything. Scott and Skipper are trying to get to the commercial dock below Hotel Jolly, Molo Italia.

8 March, Sunday. CHAIN scientists and ship's officers entertained SACLANT in Lerici. Went to Carrara marble quarries afterward.

Meanwhile, no parts available in Italy or elsewhere in Europe. Complete new pedestal required. No hypoids can be made in this part of Italy. Pedestal to be shipped from U. S. A.

10 March, Tuesday, to 14 March, Saturday. We shifted to the commercial dock, got crane on barge, removed radar antenna assembly. Wilharm departed; more details in communication log.

On Saturday Alden Cook arrived with antenna pedestal assembly which we assembled with the Italian Sperry representative. Installation supervised by Chief Engineer. Eventually tested, checked out, and we waved good-bye to La Spezia and Dave Scott and Alden Cook. After an agonizing delay in obtaining repair parts for the radar, we finally broke loose from our coffee grounds and headed for Aden at 1630.

Because of the delay in departing La Spezia, the schedule for port stops is a problem and may yet be altered. The plan now is to steam as rapidly as possible to Port Said, gaining a day or two by straight steaming, and then to reduce our stay at Aden. If all goes well, we will again be on schedule. To be on time is of no value to my leg of this cruise, but I hate to see the scheduled time in the Indian Ocean reduced any more than it is now.

We are echo sounding, hoping to catch some sediment records of superficial sediments. Magnetometer is being towed and gravimeter is in operation. Bow thermistor temperature measurements will be made if we can adapt an odd-sized paper to the recorder.

Sun came out this afternoon for the first time in what seems to be years.

Saw little of Italy. Roberto Frassetto, Bob Westerfelt, Tom Allen, the Winelands, and others offered their hospitality. Visited SACLANT, short trip to marble quarries, but not enough else to write home about.

Communications difficult in La Spezia, adding to the frustration of delay: radiograms become telegrams and are delayed, local telephone is very slow in getting connections, transatlantic telephone is very poor. Scientific party was not continually on liberty, but I tried to permit as much liberty as practical, with due consideration to work on board and the length of the cruise ahead.

15 March, Sunday. The scientific party on board from La Spezia to Aden is as follows:

S. T. Knott, Chief Scientist

Aldrich, Thomas
Birch, Francis
Bunce, Elizabeth
Carlisle, Donald
Chase, Richard
Friedberg, Jeffrey
Goulet, Julien
Martin, Barry
Moores, Eldredge
Pfuhl, Helmut (NASL)
Plaumann, Sigfried (Geol. Surv., Germany)
Porter, Charles
Powers, Pat (IBM)
Raitt, Howard (NASL)
Salisbury, Matthew
Stickney, Warren (NASL)
Vogt, Peter
von Arx, William
Waldon, Colin

Steaming at 13 to 14 knots. Maggie and gravity, bow thermistor, laser, various bathymetry studies, and scattering layer, morning to night. Off Rome seas are roughening. Overcast, rain, but occasional clearing. New recruits Stickney, Raitt, and Pfuhl are seasick. Geon evaluation has not as yet started, because of mal-de-mer.

Steaming at 13 knots. Typewriter problems make it look as if the bridge unit may have to be used as a spare, because another was not shipped to us at La Spezia. Gravity and magnetics. Echo sounding, with concentration on scattering layers during periods of morning and night migration, at 12 kcps and 5 msec pulse length. Using the impulse echo-sounding transmitter in between times. Bow thermistor is being used again, however, because no recording paper was at La Spezia; there is a makeshift rig, an attempt to use narrower paper. Automatic depth system okay. Later in day, because of roughness, secured both gravimeter and magnetic memory discs of the computer.

16 March, Monday. Made up a new top-lab patch panel, to facilitate making the various interconnections between echo-sounder transceivers and the transducers.

Early morning, Strait of Messina. Scattering layer stopped abruptly on our approach. Rather strange. Maggie was hauled in for passage of straits. Looks as if southern Mediterranean is going to be warmer. Clear weather appears to the south. It's been far from a sunny blue Mediterranean to date. Same system going as before. Later became rough again.

17 March, Tuesday. All data are now being plotted daily; gravity, magnetics, echo sounding. Scattering layer observations, laser, Geon, bow thermistor, are listed in the continuous observation log. Fire and boat drill today. Colin has continued his efforts with thermistor winch. This, unfortunately, is difficult to get at very often, for there has been so much need to train for work on other systems that people are occupied rather continuously. But Colin is managing to get a number of cable units into the thermistor chain. Meteorological recorder not in use now, and we have not been able to repair it.

18 March, Wednesday. Same observations as before: sediment ponds, scattering layer, echo sounding, bathymetry, gravity, magnetics, laser, Geon evaluation, and bow thermistor, off and on. Apparently, "coolie hat" protective covers on bow echo-sounder transducers rattle at high speed. Betty is photographing echo-sounding scattering-layer records. Roberto Frassetto will get copies.

Starting to cross Nile Delta; impulse echo sounding shows some layering.

19 March, Thursday. We have arrived, Port Said anchorage, about 0500. Maggie aboard. Water has become quite muddy. Wonder what the laser is doing. Anchored 0713. Hootenanny tonight.

20 March, Friday. What has seemed to be a long wait ended this mid-morning. We joined a convoy as the last ship (number 16). (We are actually number 15 1/2, because they could fit a "half-ship" in a berth also occupied by a dredge at the first bypass.) We entertained and helped the surveyor who had to measure ship, etc.; data on board (i. e., ship's papers) are based on shape of the ship in 1960, I believe, and therefore caused some embarrassment and extra work.

Mr. Redda, the surveyor, is a very cooperative, informative, helpful, and intelligent person.

Mr. Rashed A. H. Thabet from Suez Canal Authority Research Laboratory is aboard and will ride to first stop, Al Ballah. They asked us to try echo sounding to see if we can check sediments. Very flat country. Port Said is a clean and new city, from what we can see. Fishing fleet operates out of here, small boats have good-looking lines, lots of shear. I am told Dr. Ahmed Ammar, the director of the laboratory, was not able to join because he had to rush off to Cairo. Our delay in arrival apparently threw their welcoming plans for a cocked hat.

Echo soundings with the impulse echo sounder. Records are fair. Obvious change in sediments leaving Port Said area. We waited at Al Ballah, or first bypass, for convoy to come from south. Lots of traffic. Never seen so many ships at once in one line except in wartime convoys. Canal is in excellent shape and appears very well managed. Delay at Al Ballah means we pass through rest of canal at night. Too bad, would have liked to see Bitter Lake, etc.

Dr. Ahmed Ammar visited us this evening at Al Ballah bypass. Very engaging fellow, of middle age. He is director of the Suez Canal Authority's research lab in Ismalia. Presented Betty with a beautiful pin. We visited and talked of our work and his, Bill von Arx, Betty, and myself. Very fine evening. Gave him several reprints. He had already given us several on his work on research in canal area.

21 March, Saturday. Sent soundings to Dr. Ammar from Suez via pilot. There were three pilots. First one was an interesting chap. A lot of interest in our work and good company. Suez boat crew and their "bum" boat supplies on fantail. No other "bum" boat activity - very well controlled.

Passed Suez at 0800. Echo-sounding records sent with pilot to Dr. Ammar.

At Suez there are great ridges of mountains to the east and west. We can see those to the west easily; what a sight, like a side of the Grand Canyon. Sediment layers. Very arid, but beautiful. Must steam to Red Sea, can't CSP inside territorial waters (12 miles). Echo sounder looking at superficial sediments; gravity, Maggie, laser, as before.

In Red Sea at 1900; the array is over the side, but starter motor battery for the Mercedes motor generator is flat. Delayed CSP to about 2330.

22 March, Sunday. First CSP profile Red Sea shows sediment bedding -- occasionally vivid textbook examples -- apparent intrusions or volcanics, then later, in rift area, much less penetration and very disturbed bottom (Figure 2).

23 March, Monday. Same observations as before, but still struggling to make some sense out of signal-to-noise problem on array.

Spent much effort today trying to derive best tow depths from using the quarter-wavelength approach. Tow depth of the array is unpredictable. A change in depth at tow point (the hold-down fish) of 5 feet upwards or even less makes the array come up so near to the surface its depth can't be measured with the pingers. A small downward adjustment causes the array to tow at about 40 feet. Extremely critical.

Have added a rope tail on array, to calm its vibrating soul. A small improvement, but may work.

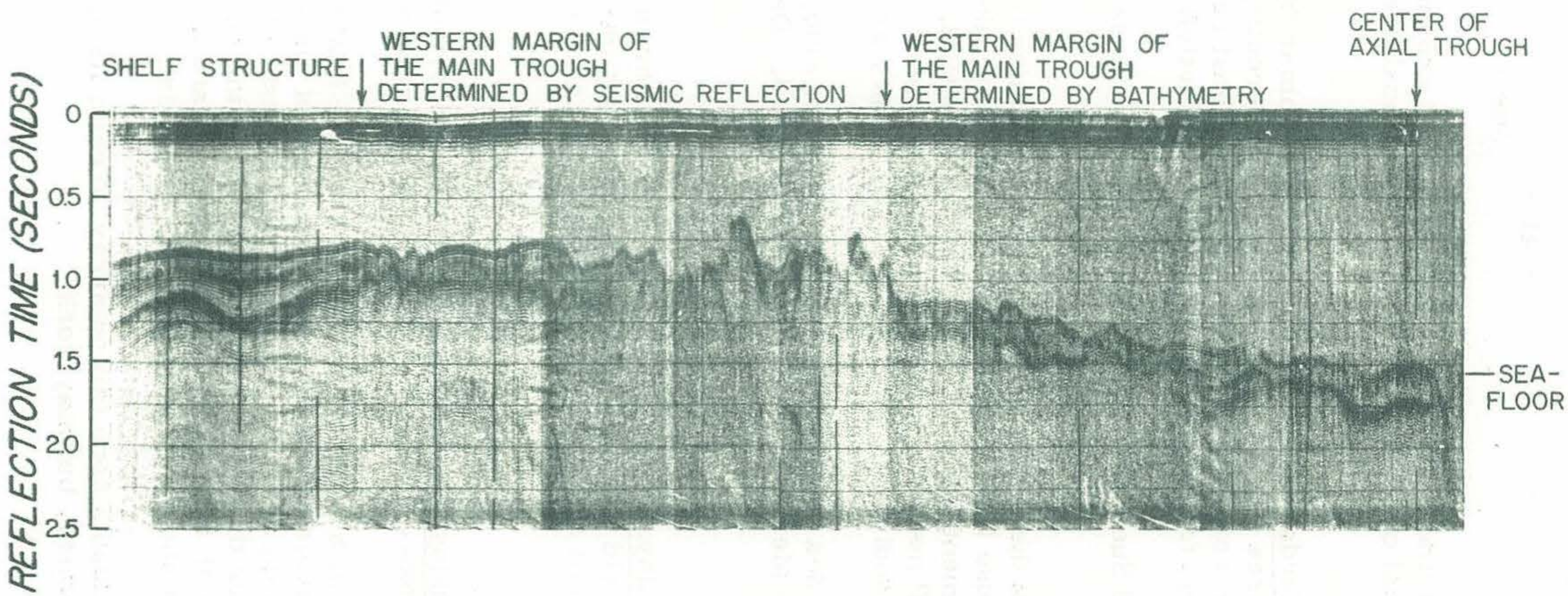


FIGURE 2. Continuous seismic profile record showing the typical change in subbottom structure from the west side to the rift valley of the Red Sea.

24 March, Tuesday. Mediterranean data all plotted in a series of continuous profiles: distance versus magnetics, gravity, Bouguer and free-air anomaly, and bathymetry. Atlantic data are now 50% or more completed, and Red Sea data are up to date day by day. No word on permission to land on St. John's Island. Dr. Ammar was going to look into the matter for us; he volunteered to help find out whether there was any obvious problem in obtaining permission.

This morning three UAR destroyer-escorts were, by coincidence, tracking us as we approached St. John's to occupy one of the ATLANTIS/VEMA refraction stations. (We had already scratched the possibility of landing, and just as well, for time is short. Every day in the Red Sea cuts into Indian Ocean time, for ETA Beirut seems too unalterable.) The old refraction station line runs right toward the island, so perhaps the DE's wondered if we were going to land in spite of no word. Our plans already were to divert before we reached the 12-mile limit. For a moment it looked as if we might have our array in their screws as we made a gradual turn to eastward. The DE's asked us by blinker who we were. When advised, they wished us smooth sailing. They later in the day practiced gunnery shooting toward the island and apparently used several rounds of hedgehog or depth charges. Interesting sounds on the tapes. If the island is used as a gunnery range, one certainly would want the word clearly that it wasn't to be used for gunnery on visiting day.

Air conditioner failed late morning. Those with fans were happy! Had to shut down gravity, computer, magnetometer, Sparker, owing to heat. Took this time to run some measurements of the spectrum of the received noise from the short-tail array (Chesapeake type) at various speeds and with different cable lengths. Results are in PGR log no. 2 for this cruise.

Find that by using a 600-foot cable (375,500, and 600 feet are the lengths used in these tests) the point at which noise peaks in the spectrum shifts to a frequency higher than that which is found with the shorter cables. The longer cable reduces noise in the lower frequencies, where we need to work. Seems that the addition of the tail has the same effect.

Looks to me and Frank Birch as though tension in tow cable is way to shift spectrum, because both the longer cable and the tail do this.

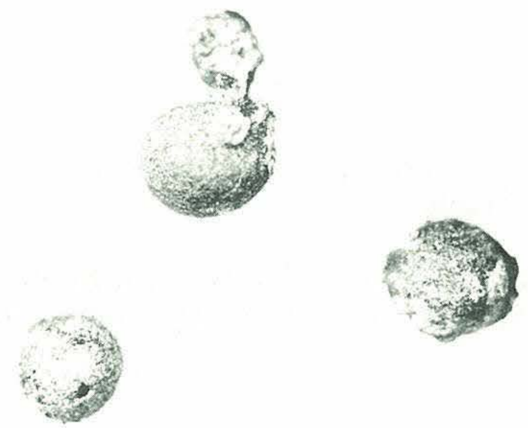
I decided to permit Pat Powers to remove the bridge typewriter, to use it for spare parts for fixing the more important stations in top and main labs.

25 March, Wednesday. Dredge at about 0800. No rocks; very little else, less than teaspoonful of tan muddy sand.

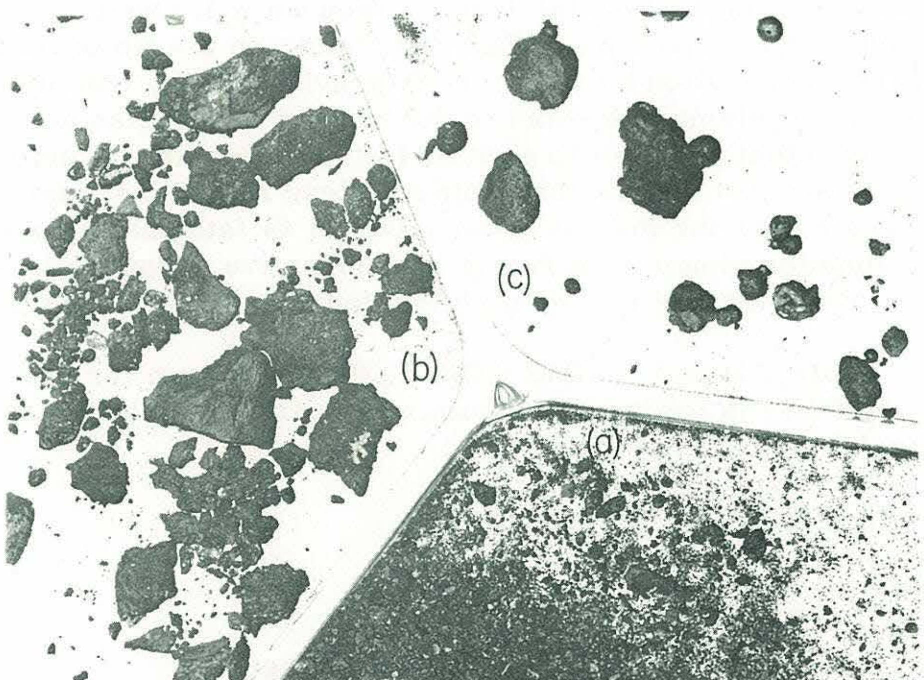
A brief comment on data collected during the first part of CHAIN Cruise 43. Most of the data that have been collected are good and, despite interruptions, tapes are good, at least those we have played back, and all have been monitored carefully. We may not be able to do all we wish here: things of interest, such as the sediments and their stratification in the valleys either side of the Mid-Atlantic Ridge, seismic reflection and the like here in the Red Sea and earlier, scattering-layer studies. These have just had to be caught on the fly, but what has been done I think has been worthwhile. I still hope that in general the operations are becoming sufficiently routine for these younger folks to take over. I think we are in good shape; some gripes about long hours, but they are tapering off. I think the students are beginning to see the results and value of their labor, because they show far more interest in different aspects of the work than they did.

26 March, Thursday. This day is noted for the following. First, a dredge lowering -- the dredge was lost, the shear pin broke, then the chain pulled free, and the connection to the bag broke, but the pinger returned okay. Then, a heat probe -- penetrated into sediments enough for one probe to be buried, but Frank had recorder trouble. This lowering was Station 4. Later, Station 5, a heat probe -- an 8-foot core was obtained. Then, Station 6, a dredge with a heavy magnet added, to obtain magnetic material as the magnet dragged over the bottom -- nothing obtained in the dredge, although we had a good strike; about half a cubic centimeter of magnetic material was collected, some of it in the form of spherules about a millimeter in diameter and a lot of it like dust, possibly spherical under a medium-power microscope. See Figure 3.

27 March, Friday. After the last station, close to midnight, we broke off all studies requiring slow speeds of advance. Estimate we will be in Aden about 1200, 28 March. Scattering-layer studies may be worth examining further. Sent signal to HMS SHEBA requesting the berth where the HMS OWEN had docked, so that we might make shipboard gravity check-outs in the same location as OWEN did.



12.5X MAGNIFICATION



3X MAGNIFICATION

FIGURE 3. Magnetic particles and spherules roughly sorted according to size and shape. Top: large spherules. Bottom: (a) small angular and spherical particles, (b) large angular particles, and (c) large spherical particles. Dredged on Station 6 in the Red Sea.

28 March, Saturday. Entering Aden about noon. Will berth at British naval facility in OWEN's berth.

Stickney, Raitt, Pfuhl, Moores, and Knott will leave. Vacquier, Cook, Hess, Feden, Johnston, and Tasko join here.

Aden, Aden Protectorate to Port Louis, Mauritius
30 March - 3 May, 1964

by Elizabeth T. Bunce

30 March, Monday. We departed Aden at about 1730, waved off by Bud Knott and Ted Gelinas, who are going home. Our initial course is to the southeast, out of the coastal waters, then we will change to a heading of 090° to make for the area of Cape Gardafui, on the tip of Africa. The PGR was in operation by 1800. Both gravity and the computer are having electronic problems. A short in the EM log circuit has not helped matters. This is eventually traced to a ground in the main-lab circuits, affecting precision a-c EM servos for computer dead reckoning, and other areas. Put Maggie over the side at about 1900, in 44 fathoms of water. Trying to use impulse pinger, but find it is inoperative, apparently a result of the a-c problems and tied up with the general main-lab malaise.

Made a signal to HMS SHEBA, thanking them for their courtesy and hospitality in letting us remain at Admiralty Dock for our entire stay in Aden.

Scientists aboard are:

E. T. Bunce, Chief Scientist

Aldrich, Thomas
Birch, Francis
Campbell, John
Carlisle, Donald
Chase, Richard
Cook, John (S. W. Res.)

Feden, Robert
Friedberg, Jeffrey
Goulet, Julien
Hess, Frederick
Johnston, Alexander
Martin, Barry
Plaumann, Siegfried (Geol. Surv., Germany)
Porter, Charles

Powers, Patrick (IBM)
Salisbury, Matthew
Tasko, Edward
Vacquier, Victor (Mar. Phys. Lab.)
Vogt, Peter
von Arx, William
Waldon, Colin

Watches were reorganized:

8 - 12	12 - 4	4 - 8
Carlisle	Chase	Birch
Feden	Porter	Friedberg
Waldon	Campbell	Salisbury
Vogt	Goulet	Aldrich

Vic Vacquier will be around during the 4 to 8, Sig Plaumann also, in the gravity lab. Others have no watches, but are available when needed. John Cook will probably work during the 4 to 8 on science in which he is interested.

Now the typewriters are out.

Everyone turned to this morning, before sailing, and restaged afterdeck. Hauled core and dredge gear out of ammo (now storage) locker, moved assorted equipment we will not be needing for a while, and generally reorganized for the work of the next leg.

It now appears that the source of the post-sailing electronic problems is the high moisture content of the air -- resulting in shorts and grounds throughout the labs. This is in spite of the air conditioner and directly due to carelessness in closing outside doors and keeping them closed while in port. Most particularly, it comes about from working parties' loading stores and equipment. Something to think about, because it will be worse before it is better in the tropical climate.

31 March, Tuesday. With the watch change at 0800, and with fairly deep water now, we started organizing for sparking. Assorted problems due to land gremlins (electronic type) promptly appeared. The array appeared intermittent, eventually traced to condensation in the tow-cable connector. Tow noise, unbearable. We are on the fish and faired cable rig, as in the Red Sea, so this is hard to believe. Next problem, the newly installed sparker tip refused to spark -- we found that the tape had flowed over the tip, because of heat on deck. We may have to go to an ice water bath when the electrode is on deck for any length of time.

Eventually unsnarled all the usual post-port-stop problems and the profiler records began to make sense. We are steaming along latitude 12°09'N in the Gulf of Aden. About 0.65 sec penetration, a fairly thick section, layered, probably sediments. It is unfortunate that the major tow noise is in the region of 40 to 110 cps, right in the reflection frequencies, so that I am not really proud of these data. Cannot get ship's speed above 7 knots and see reflection with the present tow. Some changes will be made, soon.

Added problem: some piece of computer-associated electronics put a high-voltage transient across the a-c line in the main lab and burned up an a-c box and, apparently, the EM servo for speed tracking. More of the condensation-caused trouble?

<u>1-2 April, Wednesday and Thursday.</u> During the night we passed between the Island of Socotra and the tip of Africa, not profiling, but trying to get into the Indian Ocean and start the major program of the cruise. We are now making for the area in the eastern section of the Somali abyssal plain (about 10°N) where the Heezen chart indicates a seamount. Vic is anxious to survey this from the point of view of magnetic field intensity, Dick from the point of view of dredging rocks, myself because of the probably interesting structures related to the plain, and so on.

Sparker operating, and we are short-pulse echo sounding. The latter with Gifft, since we still are having problems with the impulse pinger. About 0300, in 2500 fathoms, we began to see evidence for bottom penetration and stratification with the echo sounder, followed in three quarters of an hour by definite penetration, two layers, having about 2 fathoms' separation. The farther south and east we go, the more definite and deeper is the surface stratification, although not so well defined as that of the Nares Basin of the Atlantic. At the same time that we observe this shallow layering, we are beginning to see penetration on the sparker profile. Up to 1.75 sec of what appears to be a moderately thick section of horizontally layered sediments. Comparison with the VEMA profiles of this plain, with which I thoughtfully provided myself through Mark Langseth's kindness, indicates same order of penetration that their explosives produced (See Figure 4). I have a grin from ear to ear, according to the top-lab watch. And why not?

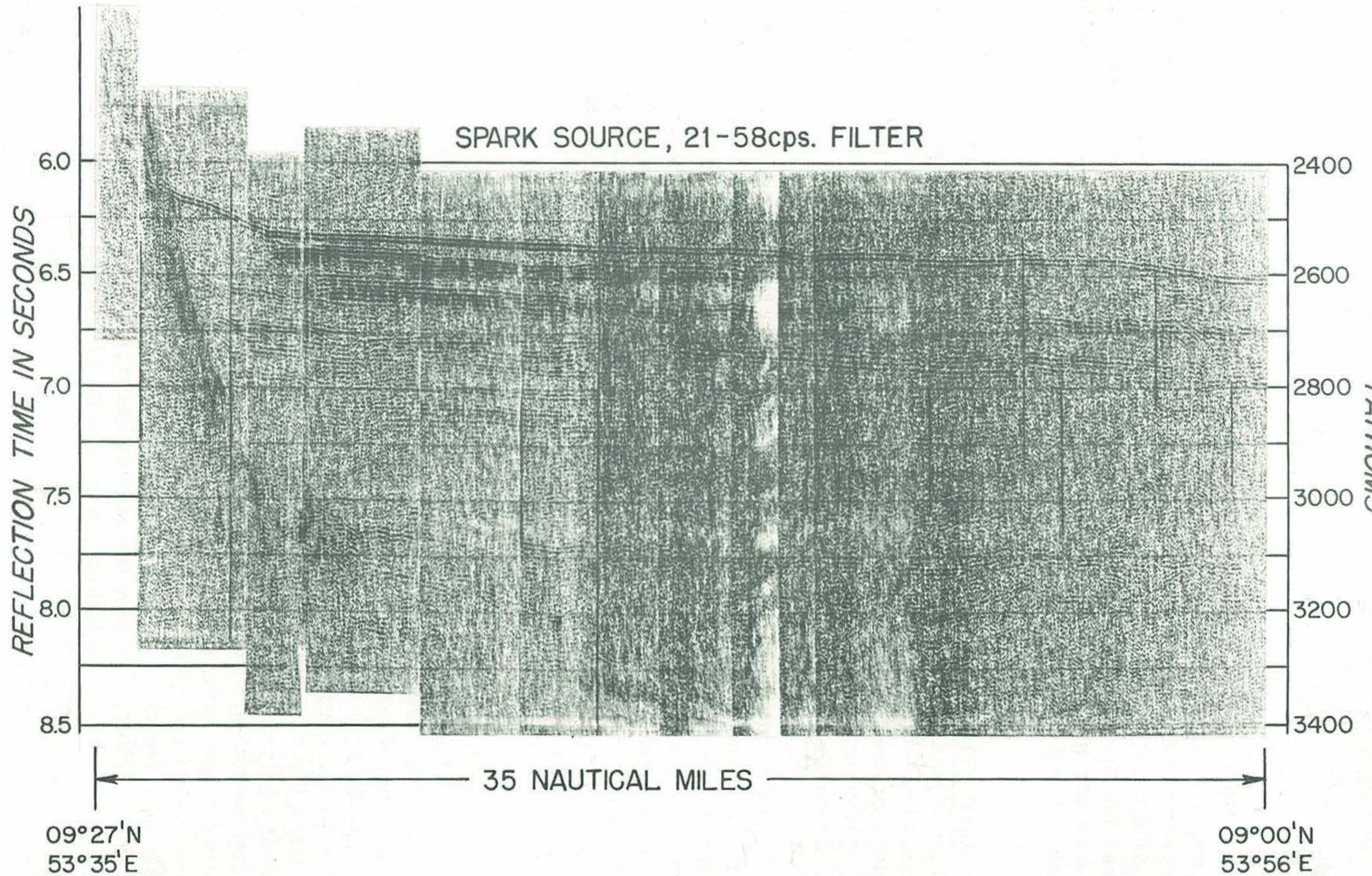


FIGURE 4. Somali Abyssal Plain reflection profile.

Both types of penetration continue as we steer course 180° to the region of a hilly feature near 54°10'E, 06°05'N. We have given up trying to reach the eastern margin of the plain in this northern sector. Our original plan was to make for the hills on the boundary of the plain, and the linear feature along it, but this could occupy us for another week, at the rate we are going, and I think we can investigate the relationship farther south with no damage to our program.

2-3 April, Thursday and Friday. Just before altering course to the eastward to investigate a hilly feature, we noted that the depth of penetration and the record character have been changing slightly. Either the sediments have thinned or the basement has shoaled, but the latter is now only 1.5 sec below bottom. The bottom stratification has remained about the same, 5 to 6 fathoms and possibly three distinct reflectors.

Of course, we chose this area in which to have sparker problems. Eventually rooted out the trouble, a cold-solder joint and thus no ground on the overvoltage meter. Apparently the joint became intermittent and then let go, causing our first failure. The second failure was more exotic, the meter-relay control misbehaving. Had to replace this, finally. Guess we will have to cable for another, since there were but two aboard and we cannot trust the one we have replaced. Of course it is possible that the relay trouble was due to the intermitting of the cold-solder joint, but I would hate to go on that assumption for four more months.

Continued sparking into the early afternoon, at which time we crossed a "peak" at 1500 fathoms. No real stir of interest by the magnetometer recorder, which is, incidentally, sitting beside the PGR in the top lab, but we decided that it would be valuable to survey the shallow hill and possibly to dredge it. Laid out courses designed to cross to the base of the hill, swing back to west and recross at another angle. Here our data and the contours shown on OWEN charts parted company. We had covered only about five miles on the 290° track when we again crossed a high elevation. Suspecting that there is a ridge trend, but still thinking that we might have an elongate single feature, we changed course to the southeast since, if it is a ridge, we should recross it on this course but, if a single feature, we should not find it so well resolved. We did cross a high elevation, and now the survey became even more interesting. We believe we have established the existence of a ridge trending about 047°, having abyssal-plain structure to both northwest and southeast. This leads us to the further conclusion that the three hilly features seen to the southwest on the chart are part of this ridge, and that it (the ridge) possibly extends to the fracture zone to the northeast.

We will dredge and photograph the steepest section of the ridge and will core and make heat flow measurements on the plain at the base.

4 April, Saturday. At 0130 we turned south for a final crossing of the ridge and an attempt to see whether it is possibly a doublet -- there is some slight evidence that this is possible. Meanwhile, the back-deck crew has been working furiously to get the piston core rigged for heat flow. We would like to have the long-core capability in this plain. At 0330 we were far enough out on the plain (2710 fathoms) so that we should not drift back onto the slope during the coring interval, so we hove to for Station 7, our first in the Indian Ocean. The core was back on deck about 0730, after a few educational mishaps. (This was the first piston and long core for all but two people.) Apparent penetration of the order of 27 feet, core bottom 12 to 15 inches of black sand, then fine gray clay to top of second liner, first liner has about 18 inches of tan grainy ooze, possibly foraminiferal. The heat flow was not an unqualified success. Birch suspects the value, attributing it to some peculiar jump of the instrument.

Underway at 0747 to select dredge site: CSP indicates possibility of cropout, perhaps two, above 2000 fathoms' level. Started dredge down with ship in 2600 fathoms, near base of the slope, which is fairly steep. Three hours of nothing except trying to keep camera near bottom. When camera time completed, continued dredging. No hits until ship in 1700 to 1800 fathoms when, as we were hauling the dredge up slope towards us, came a real whack on the tensiometer, 4750 pounds. Dredge aboard at 1647, rocks in chain bag. Lost the magnet suspended below the bag, lost the mud sampler on the bail, lost the weak link. Have a lovely assortment: mud, possible compacted mud with black "insertions", volcanic ash (?), and basaltic-type rock.

Underway at 13 knots after this station in order to investigate the relationship of the ridge trend we have been following to the next hill to the southwest. Many attempts to name our first intensively studied site in the Indian Ocean, resulting in "Mistaken Mountain" (later changed to "Owen Ridge"), since it is not a mountain along, but part of a larger, more extensive structure.

Following the diversion to the southwest we will continue on a more southerly course in the abyssal-plain region.

Tomorrow (Sunday, 5 April) has been set as the day of the Line Crossing. Planning for this ceremony has been proceeding in, around, and over all the other activities aboard. It is now clear that we will still be north of the Line, but we have to set a date, so this will be it. Doubt that it will really worry any of the Pollywogs that they will "cross" earlier. In fact, it may be a relief.

During the dredge station our ardent fisherman, Al John (Junior Oiler), caught and brought aboard a 6-foot white-tip shark on 20-pound test line. Some kind of record, we are sure. Shark is a female. Two remora attached to the head, one we have pickled for Backus. Magnificent sunset scattering layer tonight, all recorded on tape as well as PGR.

5 April, Sunday. Our efforts in reconnaissance and ridge-running continued through the night. Did very nicely; slightly double ridge, crests of 1500 and 1800 fathoms, dropping off to abyssal plain of 2700 fathoms' depth on each side. Second hill in line to the southwest along the ridge is higher than the first. We measured 1020 fathoms and are not at all certain that this is the peak itself. Could not stop to investigate its structure, we'd be here for the duration. I believe this establishes the ridge beyond reasonable doubt and that we can probably extrapolate the structure farther to the southwest to the next hill or mountain. It would be interesting to have enough time to investigate the extent in both directions. In fact, it would be interesting to have time to do all the things that are interesting, on all the cruises. Of considerable importance is the fact that there are no obvious magnetic excursions associated with any of the ridge and peak topography we have so far seen. Vic does not find it simply interesting, but moderately infuriating.

Once we were back on the Somali plain, made course for what we hoped would be a nice uniform bottom and sub-sea floor structure. Here we will anchor a buoy and make oblique reflection profiles.

At 1315 everything secured for the Line ceremony. Usual horseplay and haircuts, also complete revolt by the ex-Pollywogs following their initiation. They dunked all the Shellbacks. Hilarious performance, suitably preserved for posterity by Bill von Arx, at least up until the dunking crew arrived on the bridge.

Today also unveiled another CHAIN "first", the swimming pool. And a second, Neptunia Regina, reigned over the ceremony, the chief scientist. Topped off the festivities with a cookout on the fantail, then back to work.

Underway at 1700, everything operating. Sparked through the night on a southerly course. Penetration of 1 to 1. 5 sec to the major reflector. The latter, far from flat and featureless, would, at intervals, come up and form hills rising 100 to 200 fathoms above the bottom plain. Definite evidence on both PGR (echo sounding) and CSP records that these are sediment-covered, so we did not try dredging. No startling magnetic differences associated with them, either. At some locations, and particularly during these hilly excursions of the deep reflector, there appear to be reflections below this surface, quite rough and irregular. Perhaps these represent structure within the layer. It is interesting that at least thus far the reflections have not been particularly reverberant in nature as compared with those observed in the outer-ridge region of the Atlantic. Is this due to structural difference of the basement, or composition, or thickness of the overlying material, or surface topography?

Saving the worst of the day for the end. At 0814 today we lost the thermistor chain, in toto. Bob was lowering the chain prior to installation of another section of the new sensors. He had completed 50 per cent of this in previous days. Ship gave a lurch as though we had hit a mud bank which in 2700 fathoms of water I found slightly ridiculous. First word from the fantail was that the chain was gone. Recap: ship at 12 knots, tow fish just above water surface, chain being lowered; winch began free running. Bob put diesel in neutral and fast reverse, no good. Pieces of fairing and parts of new gear waiting for installation on winch platform flew all over the deck. After the loss, we found that the starboard drive chain had broken a link, throwing all the strain on the port chain. Since the winch had a differential gear in its axle, the port chain alone was unable to take up the strain and stop the winch. That is all.

<u>6-7 April, Monday and Tuesday.</u> Preparing for buoy launching and anchoring. Present reflection data show thin sediment layer about 0. 1 sec below bottom, flat, then deeper reflector at 1 sec depth. Had initial trouble with radio buoys. All the trouble turned out to be "cockpit" type. No one remembered that the transmitter-hydrophone connection is a mercury switch and the hydrophone has to be in normal position, nose down, to activate it. Ah well, it was good training in troubleshooting.

Marker buoy away at 1645, paying out line for anchor. Water depth 2709 fathoms, uncorrected, which means that we will use one 3000-fathom reel of line for the mooring, plus about 100 fathoms spliced on. Anchor over at 1756. Got sparker and array back in water and started operations. Buoy radio did not turn on. Fritz made trip in Zodiac boat and turned it on. Seas moderate, Fritz not happy with small-boat motion. According to the Geon fixes, the buoy probably anchored at about 1900. Geon a blessing, since the rest of our navigation is celestial and dead reckoning.

The radio receiver is fairly noisy with static and bursts of high frequency, but at least no other traffic as in the more well-travelled Atlantic. We made several short oblique reflection runs while getting set up, then one long reverse, 12 miles each way. All at pretty dead slow speed for high-resolution recordings and close-shot coverage.

Retrieved buoys at 1500 (7 April). As soon as this operation was completed, we started a heat flow measurement in the same location, using the gravity core. Penetration of 57 inches, gray and tan muds. A normal heat flow value on preliminary analysis.

Underway at 1820 toward a point 0°, 54'00"E, to cross the eastern edge of the Somali plain into the rougher, topographically speaking, area of the linear feature extending north from Madagascar. We plan to profile the whole section, thus correlating the structure, then core, heat flow, and possibly dredge. The latter program will be played by ear, depending on structures revealed by the profiler. There are five working days left in this area, as we are due in Seychelles 13 April.

Surface water temperature today, according to the bow thermistor reading, reaches 85.1°F. Air conditioners are working hard, we have added Modine coolers in the lower lab for the Sparker, in main lab for computer, and in the geology lab just to be able to work since it is not on the regular air-conditioning circuit.

At 2309 this evening we crossed structure shown by the profiler, apparently the edge of the abyssal plain. An abrupt topographic rise from 2700 to 2640 fathoms is followed by a section of moderately rolling topography and then a return to almost abyssal-plain water depth.

We have been using the Varian magnetometer electronics and the WHOI fish with success. The last Varian fish was investigated and somewhat mangled by sharks. The cable was leaking with resultant wicking throughout. This also possibly due to shark bites.

8 April. Wednesday. The automatic meteorology recorder unit has fallen ill. Problem is mechanical, not electrical. The recorder in itself is not driving properly, it needs a new drive cable among other parts, and there are none aboard. We cabled interested parties requesting that parts be sent to Mauritius. No shipments will meet us in Port Victoria, no mail ship at this time.

Daily scattering-layer studies at sunrise and sunset have continued except when topography or shallow bottom penetration were of primary importance. Interesting to note that the scattering layers have become thicker and more numerous with increasingly warm surface water.

Heat flow station this morning in 2580 fathoms. Good station. We used the gravity core and obtained an 8-foot sample. A frigate bird sat on the fantail rail and admired our work as we put profiling gear over the side after the station.

Present sparker count is 112,553 shots. We have had to cut back both tip and tape on this electrode, some irregularity in the way it is burning back. New tip in another 10,000 shots, if this one holds up that long. Profiler presently shows 1. 25 sec to basement, a good reflector at 0. 50. This is a highly reflective area, we can detect B_2, second bottom reflection, audibly. Water temperature up to 86. 5°F at 1915. Nice blobby-looking scattering layer, quite thick.

Heading back toward Somali Plain on course 235°, crossing section shown on Heezen chart as ridges. For the first time, a rough, reverberant basement reflector, only 0. 25 to 0. 40 sec deep. Topographic relief of 50 to 100 fathoms, made of low rolling basement-formed hills, sediment-covered.

9 April, Thursday. Having made it to bed at 0130, was roused at 0500, to dredge. We will dredge a part of one of the ridges. It shows some relief and also possible outcrops near 2000 fathoms. Dredged about four and a half hours with no hits, if we define hits as tensiometer readings greater

then 3000 pounds (above wire weight). We did see several smaller bites and nibbles, indicating we were dredging. Brought up chunks of manganese and manganese nodules, some small spicules on the magnet, but no spheroidal material. Made gravity core and heat flow station after the dredge, about 1 mile south of its location and toward eastern side of ridge (have a 10-foot core of the same gray and tan muds as before, and preliminary heat flow value of 1.58).

From here we are making for the Seychelles area, heading generally southeasterly toward the northern section of the Seychelles platform. All systems in good shape except the aforementioned weather recorder. It is in operation, but has to be nursed.

Heavy rain squalls started at about 1600 this afternoon. Floods in the top lab as a result. Water came through and around the doors as if they were open. To add to the confusion, we were rolling fairly well and the exhaust ducts for the air conditioner were dumping water into the lab, right on top of the after electronic racks, and into the profiling PGR's. Watch turned to with swabs and buckets, grabbed extra help to rig Pliofilm raincoats for the equipment, but we had about two inches of water sloshing around for a while. A mess. Echo-sounding PGR decided to throw a helix during this operation. At the same time we heard faint porpoise noises on the array.

<u>10-11 April, Friday and Saturday.</u> Profiler record at 0330 (10 April) shows apparent small fault zone, about 200 fathoms. We have been seeing about 0.50 sec penetration, with some hints of structure in the basement. Made heat flow station in the morning, but only got one probe into the bottom, and no core. Impulse pinger shows hints of shallow penetration every now and then.

We decided to dredge a moderately steep-appearing slope west of the Seychelles and brought all the gear aboard in preparation. Then could not find the same slope as we maneuvered for position to put the dredge over. The Sparker had indicated a very small chance of basement cropout on the steeper slope, and nothing we crossed afterward looked as promising. Attempted dredge anyway, along the slope and to the northeast. No rocks, and only two inches of mud in the bail sampler. Some interesting currents encountered in this region.

We also took this opportunity to change the spark electrode. The one replaced has 40,884 shots, is possibly good for a while longer, but this is an excellent time to make the change. Underway about 0300, to bed 0500. The records this morning are really beautiful, to say nothing of interesting. Penetration of 0.50 to 0.75 sec, basement hills rising above sea bottom, sediment (or at least layered material)in the buried valleys.

Made heat flow station in this type of structure in the afternoon. Cored 10 feet of café-au-lait-colored ooze. We have seen the same type of ooze at the very top of at least two other cores.

Ran into all kinds of problems with the profiling equipment when we got underway from this station. Sparker malfunction that turned out to be a loose wire on the Variac controlling the charging current. An array intermittent found to be in the deck plug connector between the array tow cable and the top-lab cable. Nice records once we got untracked.

A moderately uniform basement surface, at 0.65 sec, above this another layer that is patchy in appearance at 0.05 to 0.15 sec below bottom. If one attempts to correlate these reflectors with DISCOVERY refraction data, one can postulate that the basement reflector is the top of the 6.6 km/sec material in this region. My goodness. Although DISCOVERY stations are south of us, the extrapolation is not too far-fetched.

We are now running northeast, onto the plain indicated north of the Seychelles. By "plain" I mean the region of uniform bottom topography shown on the OWEN charts. Tomorrow we will dredge and photograph the slope coming up from this plain to the Seychelles, also pipe-dredge for bottom samples.

<u>12 April, Sunday.</u> After our tour onto the plain north of the Seychelles slope, we came back up the slope to within radar range of Dennis Island. Dennis is the large island to the east of the passage into Mahé and is the only one with enough elevation, out this far, to be useful for navigation. CSP shows two reflecting horizons, both rising with the surface slope. Selected a steep section of the slope, north-facing, to dredge and photograph. One camera transport did not operate. Since this was a camera lowering without dredge, we waited for pictures before lowering the rock dredge, and took a pipe dredge in the interval. Pipe dredges are fun; down, grab, and up, loaded. The load consisted of white clay, and white calcareous sand

containing coral fragments and also small dark (black?) fragments of, possibly, rock. The developed camera film shows cobbles, some ripple marks, no large rock nor indications of cropout. Changed our plans, and instead of lowering the rock dredge we made a high-speed bathymetric and magnetic survey of the slope area.

13 April, Monday. Concluded survey at 0500, underway into Port Victoria, Mahé Island, Seychelles. Ran Maggie into 20 fathoms' depth, where we brought it aboard, too many coral heads leering at us. Anchored off harbor at 1133, to await shifting of small vessel in our assigned dock space. Raining in torrents, top lab leaking. Ship cleaned, polished, and ready for visitors.

15 April, Wednesday. Departed Mahé at 1630, Vic Vacquier waving us off. Bob Tasko is also departing here, by Philco liaison plane to Mombasa, kindness of the satellite tracking station commander and Philco. Everyone had a delightful time here, it was hard to leave but not too bad, since the ship will return on the leg from Mauritius to Beirut.

We are operating bathymetry, magnetometer, and gravity, along with the underway temperature and meteorological observations. The bottom is extremely uncertain, coral heads and shoals dot the passage we are taking to the southeast, so that we will delay profiling until we have enough water to make certain we do not leave the array or Sparker wrapped around a pinnacle.

Made course southeast for Coetivy and Fortune Banks, intending to cross out of the shallow area north of them, at about 6°40'S, thence make course 090° for the possible abyssal plain west of Vema Trench. Crossing a long 20-fathom slope interspersed with shoals and pinnacles, then a drop-off to about 100 fathoms of water. No magnetics of interest along this course, nor on the drop-off of the slope.

16 April, Thursday. All set up to profile in the early morning, and what a day resulted. Mercedes, which is the sparker source generator, came up with extremely unstable voltage. The voltage regulator is completely burned out now, having been on the verge for some time. A new one will meet us in Mauritius, but that is three weeks away. Meanwhile, we are

having trouble even getting it started, its batteries drained flat and ours will not take the load. So we will have to wait while charging the others. Everything in the top lab is affected by land gremlins. Apparently, some of our guides and their tourists played with patch cords in demonstrating various equipments, and the results are somewhat confusing, to say the least. Finally, the real blow, the air conditioner had to be shut down at 1000. The GM diesel has sprung a leak. Immediately the computer, gravity meter electronics, and magnetometer electronics are out, since transistors cannot take the heat, and it takes no time for the temperature to increase to thermal (computer danger point) without air conditioning. Even with Mercedes inoperative and sparker bank off in the lower lab, temperature is pushing 100 °F in less than a half-hour.

Bathymetry and temperature measurements still operating. Crossed what appeared to be a relatively steep slope on echo-sounding data and decided to dredge, since everything else is temporarily kaput. Could not find same steep slope when we reversed, so settled for something less. No results. The conditioner on and then off again intermittently from mid-afternoon on. Crossing a fairly uniform bottom surface at 800 fathoms, in late evening, on which we took gravity core and heat flow, even though shallow for the latter. Core apparently laid itself horizontally on the bottom, no results.

Air conditioner on again at 2200. We will attempt sparking when lower-lab temperature allows, since Mercedes is also operative again.

17 April, Friday. By midnight we were cooled down enough to put profiler into operation. Added 150 feet of tow cable, putting array about 700 feet astern. Beautifully quiet records for the first two or three hours of operation, then array noise began building up. Nothing spectacular in the way of reflectors, 0.75 sec penetration with two layers below bottom. We are crossing Seychelles-Mauritius Ridge, to the east, north of the Saya de Malha Bank. Topographic relief of the order of 100 to 200 fathoms, but neither abrupt nor steep. Attempting to correlate these reflection records with ARGO refraction data, north of our line, is difficult owing to differences in water depth ranging from 800 to 1000 fathoms.

Decided this afternoon that we would try dredging some of the bottom structures, just dragging dredge along bottom, up hill and down dale, to see what, if anything, we can find. Results - nil. Pretty strong current set in this region, better than a knot to the southeast, 8° off the course line. At end of the dredge attempt we sparked again. Structure changed from that prior to dredging. One thick reflector that gradually differentiated into two, these separated by a quarter-second. Very faint hint of something 1 sec deep, but this could be an electronic artifact. I can detect on the scope, I think, a reflection at that time interval every now and then, but no permutation of filters will write any more clearly on PGR record.

At 2200 the bottom has started deepening from its 2000-fathom level, perhaps we are approaching the hoped-for abyssal plain. Here we will take camera, core, and heat flow stations, along with intensive short-pulse echo sounding to investigate possible turbidity current deposits, then turn south for the western terminus of Vema Trench. So far we have not observed any shallow bottom layering as we crossed from the Seychelles to this area. The profiler shows less than 1 sec penetration, and neither gravity nor magnetics has reacted to any structural changes that we can see.

I finally lost patience with our tortoise-like approach to the plain area and altered course to east-northeast to cut a narrower angle, this at about 2230. By a half-hour later we finally seemed to have emerged from the hillocky topography and to be on something resembling a plain surface, though nothing so uniform as the Somali plain nor the Nares of the Atlantic. Still have bottom roughness of the order of 16 fathoms. No traces of bottom layering and little penetration with spark source.

18 April, Saturday. Shortly after midnight we secured all overside gear and lowered camera to look at the bottom. Fris Campbell ran this lowering, under the supervision of Alex Johnston, for his initial venture. Very smooth operation all around. While the camera snapped away on the bottom we rigged the piston core for heat flow. Using 30-foot core barrel, since I am of the opinion that to make a first try with the longer rig, without the outrigger completed, and with no evidence for shallow layering, is foolish. We are also rolling rather heavily, which adds to the complications of handling the big corer, and the group has had but one previous experience with it. The whole party was finished at 0800, when the big core came aboard. We have a lot to learn about its proper retrieval and perhaps now the lectures on tag lines will be absorbed and used. We did not immediately put the sparker over, but steamed farther on the east-northeast heading, and

promptly ran into hilly terrain. This, according to our chart (preliminary Indian Ocean chart by Heezen) should not start so soon. Positive information to add to our observations earlier on lack of penetration, slope coming down to the west, and nonuniformity of bottom topography. Altered to west-southwest to come back on plain for Sparker run to the south. Never did get back on plain surface in spite of a search pattern, topography remains hilly. We put the Sparker over and again saw little penetration, then as we ran to the south we found gradually increasing separation between bottom and reflector. Small hills and large-scale features appeared, and then the major reflector differentiated into two horizons. Of the three reflectors, the deepest is the most reflective, at least at the frequencies of observation on the master PGR, that is, 20 to 65 cps bandwidth at the moment. It also appears this way on the scope, which is looking at the flat or unfiltered return. Interesting. Absolutely nothing else to be seen on the scope, flat or filtered. John Cook agrees with this observation. Incidentally, today we installed new first-stage transistors in the array preamp. This change appears to have helped considerably from the point of view of noise buildup. The noise has not increased so markedly since the start of this profiling effort.

We may have a new complication in our lives, not to do with equipment. One of the seamen had a paint or metal chip in his eye and the Doc is not happy with the progress of treatment. He and the captain are investigating treatment facilities in the Seychelles, which are nearest to us, and in Mauritius. With this in mind I am trying tonight to replan our work but so far am not worrying others of the party. We may not have to break off, and alarums and excursions benefit no one.

The pictures taken on the lowering this morning are good, both cameras ran. The piston core was a bust. Core catcher broke off and drove all the way up into the second barrel. We collected a total of 8 feet of ooze, possibly globigerina.

Presently steering course 142° to make good 135°. Interesting current set. We are also finally heading for the western fringe of the Carlsberg Ridge and for Vema Trench. Our hopes of achieving rocks from deep layers lie in this area. Sometime close to midnight a Geon fix informed us that we had gone through a current change, necessitating steering 130° to make our 135° course good. Current set is almost 180° in the opposite direction. It would be interesting to figure where we would have been by morning star time without Geon for this information.

19 April, Sunday. A series of minor errors in our running plot in the top lab has led to our getting too far west, apparently we are already west of the section of abyssal plain that we have been trying to find in order to work to the south along its axis. The confusion did result in some interesting profiler records, however: i. e. , the change from single reflector to three separate reflectors, the deepest being fairly uniform.

We were on our corrected course to the east-southeast when I was called into conference by Skipper and Doc. Ron Stire's eye definitely requires treatment either by an ophthalmologist or with equipment we do not have aboard. Facilities at Port Victoria, Mahé, are inadequate. The only decision to make is to head for Mauritius, full speed. This is three days' steaming for us. Secured sparking. All other underway observations continue.

Re-evaluation of program in committee results in cable to Woods Hole suggesting changes in this and next leg to avoid losing correlation of data in this area. It would be nice if we could have a bit more time, also.

We will have to eliminate our planned program in Vema Trench, since we cannot possibly get back that far north in the time we will have left and it would not make sense to try. We will probably work along and across the Seychelles-Mauritius ridge north of Mauritius, then hope the next leg can pick up our pieces.

Some interesting results when we shut down Mercedes this morning for the first time in five days. A fuel injector line broke, and the Chief had to make a new one.

We are crossing Saya de Malha bank tonight. It certainly comes up with a rush to the 600-fathom level. Very flat-topped where we crossed, from 20 and 40 fathoms deep. Impulse pinger on, to look for possible detail of bottom. None evident, very hard material. We are rolling moderately to heavily in the swells on this course and in shallow water. All deck and lab gear well secured, though I suspect a few thought I was an alarmist when we broke out the working parties for this when we started our full-speed run. Now they know. The ship is so little inclined to behave roughly that we all tend to become careless in lashing gear.

John Cook is happily working on reflectivity studies, with no profiler in operation. Photos are being processed, navigation and all science plots brought up to date, some instrument-refurbishing, and data analysis. The time will not be wasted, indeed.

20 April, Monday. Gravity meter went out of business at 2200 last night. Roll was too much for it. Computer still bearing up, as are Maggie, bathymetry, temperatures, and weather recorder. We are now back in trade wind territory. The weather clear, bright, and cooler. Fantail is pretty wet, but we have managed to put a new spark electrode on the cable. Ship has been logging between 13 and 14 knots. We received a boost from the current last night while crossing Saya de Malha, then lost it, now apparently we are in another one favorable to our course. Seas diminishing this evening, to the extent that we started measuring gravity again just 24 hours after the initial shutdown.

The Doc started dealing out antimalarial pills tonight. Mauritius is listed as possibly epidemic this time of year.

21 April, Tuesday. A combination of unexpected speed of the ship and inability to get in and out of Mauritius in the middle of the night has given us some scientific time prior to going in to drop Ron at the hospital. Needless to say, the Sparker was put in the water immediately. We have not diverted from course for Port Louis, but will profile along the west flank of the Seychelles-Mauritius ridge en route. We are making 8 knots and the tow is reasonably quiet. Noting spectacular in the realm of penetration. Ship rolling moderately, occasionally heavily, in southeasterly swells.

22 April, Wednesday. In Port Louis harbor entrance close to dawn. Pilot boat met us, but there has been, as probably could have been expected, confusion. Agent did not really understand cable announcing why we were coming in, he has laid on fueling, etc. All straightened out in a half-hour or so. We anchored, unsnarled getting mail out to the ship, inquired as to the possibility that some of the more critical equipment shipments might have arrived early, which they had not, and were away again by 0830.

At 0845 we had the Sparker and array over, in the harbor passage, heading for the southwest corner of the Seychelles-Mauritius ridge. We plan to cross this southern section of the ridge, south of Cargados Carajos, then look at the eastern flank on a northerly and northeasterly track. Next, cross the ridge to the west, north of Nazareth Bank, recross it to the east between the two banks, and finally investigate the trenchlike feature north of Mauritius shown on Heezen's preliminary chart.

23-24 April, Thursday and Friday. This morning we made a gravity core and heat flow station in the basin west of the Seychelles-Mauritius ridge, about 2000 fathoms deep, on a relatively flat plain surface. Some very thin and patchy penetration shown on echo sounding. Retrieved a 4-foot core of cream-colored clayey ooze, the top 8-10 inches containing many specks of black material, possibly volcanic ash. Since we are not too far from Reunion Island this might be a source of ash. Only the bottom heat probe went in, and one lead of the system was broken sometime during the station, so we probably did not obtain a good value.

Following this effort, we started across the ridge. Gradually shallowing bottom, with some spectacular rises as we approached the top. At 400 fathoms there is a definite notch effect in the reflection profile, and some evidence for cropout. We continued to work toward the top of the ridge, into 190 fathoms' depth, where we decided to reverse our course and dredge the 400-fathom level. We lost the first dredge, got the second dredge almost to the surface when the last remaining chain link apparently let go, and so did it (this occurred as we removed the pinger).

Chase and I decided we would make one more attempt. We hung the third dredge up in the rock, but after a tense few hours, we managed, by maneuvering the ship on the wire, guided by PGR and tensiometer, to retrieve what was left of it. In the remains of the chain bag were one 6 by 8-inch piece of limestone-coral and one somewhat strange sea beastie. The latter I finally persuaded into a jar of formalin to bring home to Backus. The entire series of misadventures lasted from 2300 to 0620. Interesting to note attrition rate of itinerant bodies on fantail. By the time we brought the final and only dredge aboard there were four: Chase, Feden, Friedberg, and Bunce. Decided to remain in the general area of the dredging for morning star sights, then to steam east again. Star sight put us in approximately the same position as that when we reversed course the night before. Put Sparker over, started work. Ran slave PGR on 500-fathom sweep while in this shallower water to look at possible subbottom reflection horizons before second bottom arrival. Two such reflectors observed. We can actually hear 10 to 12 multiple bottom returns and are writing 3 or 4 of them. In depths of 1000 fathoms or greater on the eastern side I believe we can see up to 1 sec of penetration.

By 1939 we were across the ridge. We hove to for heat flow station on the east side of the ridge, water of 2000 fathoms' depth, more or less, the bottom fairly uniform. We will continue to the east tonight to inspect the general trends on this side of the ridge as compared with those to the west. We have a new problem: the ship speed is reduced to 4 knots, port propeller shaft is locked while the engineers work on broken reduction lube oil line below it. Locking one shaft means no more turns than for a maximum of 4 knots on the other. Good thing we have two.

<u>25-26 April, Saturday and Sunday.</u> Beautiful birthday cake produced by Kal for the chief scientist. Latter unfortunately delayed in top lab and never did see it in its full glory, but it tasted just as good.

We are crossing a region of small ridges and valleys, trying to play the information on the Heezen chart by using our celestial and Geon navigation and echo sounding. Either the chart has some misconceptions or we are lost. I prefer the former interpretation. The control tracks for the chart in this region are few, and I do not believe our navigational error is that bad.

The profiler is not yielding elegant data but we are in an interesting area, geologically. The bottom seems to be absorbing a major portion of the energy, and the reflectors may be appearing in higher frequency ranges than we have been using. Some data at 65 to 100 cps, but this shift could also be due to 60 cps problem. I am spending much time on the scope and check filter in an attempt to set up best filters at this time. Penetration of the order 0. 50 to 0. 75 sec, but it sometimes requires a bit of imagination to see the deeper horizon.

At this time (26 April, 2000) we have not had a star sight for 24 hours. None this morning, none this evening. Overcast and raining cats and dogs. Fairly rough seas riding on a heavy swell. No specific bad weather forecast for this area, however.

Profiler records are suffering from the ship's rolling. Sparker rising and falling ten to fifteen feet, which does not help. We cannot, at the moment, decide whether we are east or west of the intermediate ridge shown between the Seychelles-Mauritius ridge and the sourthern portion of the more extensive abyssal plain that we investigated before our run into Mauritius. Decision made to make series of northeast-northwest tracks to try to resolve this matter.

Trials and tribulations somewhere around 0100 Sunday; PGR 1, the echo sounder PGR, decided its sweeps of 400, 200, and 20 fathoms were sick. Put echo sounding on PGR 2, normally the CSP slave, and attacked Number 1, finding a sheared pin in its magnetic clutch. The troubleshooting process was somewhat slowed by having had about three hours' sleep in the past twenty-four, not exactly conducive to clear lucid thinking. With PGR 1 back in operation, Number 2 promptly packed up its paper drive. This was a simple matter to fix, once we located the trouble. The drive roller had gotten off center because of a loose screw. Fixed it. Then the PGR 1 blade lift jammed, which took more time to locate and fix. Meanwhile the silly typewriters had managed to cause a shutdown of the entire computer. Pat Powers (IBM) finally ironed out the computer problem, but not that of the typewriters. Something fundamental is causing that particular illness.

This morning (Sunday) we are back on normal ship propulsion. Chief and crew have done a magnificent job under trying conditions.

The weather has definitely worsened, wind has hauled to the northwest, seas whitecapped and running ten to twelve feet, modulating the normal southeasterly swell.

Scientifically, we ran into some array noise problems, but located them, we think, in the array-to-top-lab patch connector. Took the bull by the horns and cut the cable back and put on a complete new connector. It seems to have effected some reduction in the noise, and certainly in the sporadic-intermittent contact effect of hydrophone 5 in the array.

We are still chasing topography along the ridge, and aiming for the southernmost part of the abyssal plain. Great excitement early Sunday afternoon. Dick thought he had found an isolated seamount. I claimed it just a high segment of the eastern series of ridges along the main ridge, southeast of Nazareth Bank. We agreed to settle the matter by boxing the area, which would yield the required information as to isolation or extension. It turns out that I am correct, for once. We locate ourselves on the eastern rim of a part of the ridge. Once again we head northeast for this ever-retreating plain.

Another conference on progress and plans. In this sea state we will have trouble holding a camera in position and also in handling the piston core. So we will not try camera-lowering unless weather moderates, and we will use gravity core for the heat flow we plan soon. We have hauled the

the Sparker gear aboard, we need a little time and we can make a few more knots this way. The back deck is a mess, the ship's motion has allowed the hydraulic leak in the thermistor winch to spew fluid all over the afterdeck and, mixed with sea water, this is a menace. We are coping with the situation, using detergents and brushes.

Gravity down again as of 2200. Just got the typewriters back today, and now the IBM Disc-packs have to be shut down. Sea state too much. Water is sneaking in here and there: main hatch is dribbling into lower lab every now and then, and some was coming in port after door of main lab until Fritz and I took a hammer to the dogs, which fixed that. It also means using only the starboard door for a while.

27 April, Monday. Not a good day, weather still making up. In the pearly dawn we made a heat flow station, using gravity core. Rolling fairly heavily at times. Put the profiling gear over as soon as we finished this. The array was, of course, easy to handle, but the high lift necessary with the crane to get sparker fish over resulted in some uneasy moments as we rolled down to port. Records look good even in the sloppy weather. Penetration of 1 to 1. 75 sec. Course now west-northwest to cross the Seychelles-Mauritius ridge north of Nazareth Bank. Things went smoothly until an a-c ground showed up on the board at 1100. Electricians chased it to a top lab circuit the first try, where it turned out to be the bridge a-c box tied to one of our lines. With that fixed, there was still a ground showing. This turned out to be one of the Variacs for the PGR steam pots, which was shorting to the PGR rack. It had shifted position because of ship roll. During all the troubleshooting of the main board we lost power twice for a total of one hour. The afternoon was fairly calm sciencewise, but not weatherwise. Goodly amount of water coming on the fantail. In late afternoon one of the torrential squalls of rain hit us. Water literally poured through the closed top-lab doors, and the exhaust ducts, even though fixed since last downpour, could not carry off the additional load and they decanted into the lab. Even with our almost permanent raincoats on the electronic racks, there was so much sloshing on the decks that one PGR arced. This because the amplifier a-c connection just above the base was under water (this connector is in the back of the cabinet, and we were concentrating mop-up efforts elsewhere). Of course this was the master PGR, so we kept it running for sparker key and did all recording on slave until we could dry out the contacts and get the amplifiers back into operation.

Seawater depth fairly constant, 1600 to 1800 fathoms. All operations in good shape except that our speed is reduced owing partly to sea state since the array tow noise is excessive with heavy rolling and some following seas.

28 April, Tuesday. We crossed toward the shallow flat top of the ridge during the night and at 0500 were in 800 fathoms, near the western side of the ridge. In the shallow-depth water on top of the ridge we plan a pipe dredge to sample surface materials. Brought all overside gear aboard without incident until the sparker tow fish, in swinging aboard, pushed its nose against the hull. Broke up the fiberglass a bit, but nothing that cannot be repaired. Interesting-looking spark electrode. It is split, as though there might be a metal flaw. This is the same tip we had tape flow problems with when we left Mauritius, and it may be that this caused the splitting, rather than a poor piece of brass.

We put the pipe dredge over on the flat 200-fathom top of the ridge, jogging into wind and seas during the station. When the dredge and pinger were just halfway to the surface on the way up, ship stern carried over wire, the wire catching between propeller guard and propeller. We could not have done this if we had wanted to, of course. The result was disastrous for the dredge and pinger. We could lower the gear, but wire had just enough tension so that we could not raise it. Discussed getting line around wire below the wheel, but this would require a man over the side, and by this time the wind and seas had increased considerably, gale force or better, and I could not see it. So we cut the wire. Poor old pinger sank to the bottom where it bleated pathetically as we got underway on port screw, until certain we had not any remnants in starboard screw, and finally faded out astern. We have not had a chance, during this relatively short time period, to replace the sparker electrode, so we will get on course slowly and without the Sparker. It also seems a good idea to leave this fairly shallow area, the seas build up beautifully here. Gravity has been down since 0330, incidentally. Put Maggie over, put thermistor fish over (echo-sounding fish with thermistor) and brought it back aboard, as it was fairly obvious that we would be wearing it if we left it over. Secured array, we thought, but while working on spark electrode suddenly noticed the array tail sneaking through a freeing port along with large amounts of water. It could not have gone too far, but would have suffered a few bruises in the process. So we relashed that section somewhat further from temptation. Taking green water over fantail in following seas. Actually a very nice day but for the wind and seas. Making courses for echo-sounding survey of this section of the ridge. Bow transducers are now a bit noisy and starboard hull transducer almost useless in the sea noise.

29 April, Wednesday. At 0500 the bridge took over control of ship; so ends our attempt to salvage some science during this weather. We, on our 140° course, had been slamming harder as the night wore on and the seas built up. Still have operative echo sounding, Maggie, bow thermistor, and weather data. Ship altered course to 205° from our 140°. We were trying to trace the edge of the ridge and also follow 400 to 2800 fathoms break, meanwhile gradually slanting southeast toward the area where we want to recross ridge to the east, between Nazareth and Cargados Carajos banks. Possibly made a few miles during the night but neither bottom nor Maggie indicated much change. We are also down in speed to 70 turns, now that we are heading up more into the seas. Went to 180° course after not too long a time. Rolled 35° a couple of times, the rolls averaging about 20° as it is. The echo-sounding records could be used for wave measurements, the noise and the quenching are so regular. The patterns are really repetitive. About 1400 the latest Mauritius weather announces that there is a "moderate tropical disturbance" named Jessie, radius affected 90 miles. If we assume we do not know where we are within 10 to 15 miles (and this is optimistic, since we have not seen a star for about two days and have been occasionally hove to on station), then pursuing my southeast course we are right in the lady's path. In fact, we have probably found this little girl, since we are sure that it is our weather report that gave them (Mauritius) the information necessary to define the storm.

Dinner a rather messy affair, as food, drink, and chairs slide around. To say nothing of people being decanted from their chairs. Nice thing about being Chief Scientist, one is well wedged into a corner. Now that we know for sure what we have for weather, we can try to make our way out of it. Course altered to the northwest, toward what should be the edge. Once we clear the storm area, we hope to be able to work back to the southeast. Eternal optimists.

The weather is definitely moderating as we steam northwest. Will maintain this course certainly until morning stars (hoping we can see some) and then find out where we are. Still hopeful that we can get in our easterly ridge crossing, another dredge, a couple of cores and heat flow, and a camera lowering with the big camera.

30 April, Thursday. We started south again at 0600, having obtained star sights. The sun came out this morning, also. A long swell and spindrift from white caps, but nothing compared to the past two days. Right after breakfast we hove to for heat flow. Obtained a good core, nearly 8 feet of whitish creamy ooze. Frank says a very dull and a routine value for the

heat flow. Jessie has supposedly increased speed to the south, we are trailing after her. In the afternoon we were forced to slow down to about 5 knots to get out of resonance with the periodic long swells that cause shuddering of the ship. This we do not favor when we think of that repaired lube oil line under the port shaft. We were able then to put the thermistor fish in the water again. Swapped the array tow fish to the Sparker, seems we have no fiberglass aboard that we can find and this is the easy way to repair sparker fish. The new electrode is now ready for use as well. We are seeing some shallow penetration with the impulse pinger in this region, in the plain lying west of and parallel to the Seychelles-Mauritius ridge at 2200 fathoms.

The seas are not too rough, but the swell is really tremendous. Have had to retrieve thermistor fish again, it was acting like a giant yo-yo. We are still steaming for our ridge crossing point, on course due south now.

1 May, Friday. Star sight to star sight we have managed to make but 60 miles. Pitching heavily at times and scooping masses of water sometimes to bridge height. Still trying to squeeze science into the remainder of our time. Gravity has been down most of the past 24 hours. The computer had to be secured last night. Put the 85-foot hoist back in the water this morning. Maggie still operating, as is bathymetry, although the latter records are still fairly noisy.

2 May, Saturday. Weather is apparently moderating, although seas are running high enough to make hove to work somewhat of a problem. We have also found sparker cable damage that we cannot cope with on this course in this sea state, since deck is too wet. Not much alternative as to the course, we must return to Mauritius, which is slightly southeast, and we are still hopeful of making that west-to-east crossing of the Seychelles-Mauritius ridge, which also necessitates a southeasterly heading to reach the crossing point.

By late afternoon it is very obvious that another crossing is out, there is not enough time. It is apparent, however, that we can squeeze in another core and heat flow measurement on this western side of the ridge and, if the weather continues to moderate, a camera lowering. We have been able to get up to 10 knots, although the long-period swell occasionally dumps us heavily.

At 1700 we made a camera lowering. The ship rides nicely hove to, taking a heavy roll every now and then, but nothing stupendous. We are also taking a fair amount of water on the fantail, via the A-frame rail break, but since most of us have not had dry feet for five days, this is minor. Pinger on camera quit when about 400 fathoms down, so brought it back on deck and repaired it. Station concluded at about 2300. Camera not an exact success, one case flooded, some of the external wiring mangled. Looks as if it was lowered too fast and the trawl wire wrapped it up. Suspect we may be lucky to have gotten off this lightly. Gravity core over as soon as we had the camera off the trawl wire. This lowering completed at 0140 Sunday. Obtained 5-foot core.

We are out of time. Maggie and 85-foot hoist put over, we are off to Port Louis.

3 May, Sunday. Docked at Port Louis 1400. This ends the second leg of CHAIN Cruise 43.

Port Louis, Mauritius to Beirut, Lebanon
4 May - 12 June, 1964

by Carl O. Bowin

4 May, Monday. Arrived at Mauritius from Nairobi via BOAC flight 167. Ed Ungar (IBM programmer) and Donald Farnsworth (new First Assistant Engineer) were on same arriving airplane.

W. von Arx, R. Chase, and S. Plaumann departed this afternoon by airplane for London, Australia, and Hanover, Germany, respectively.

5 May, Tuesday. Betty Bunce left by plane for Cambridge, England, at 1300. Collected four samples of basaltic volcanic rocks from three localities on the island of Mauritius. It rained all afternoon and prevented me from collecting more samples and being able to observe better the local geology.

6 May, Wednesday. I worked on the gravity meter, Pat Powers reassembled the speed servo, and Ed Ungar tested and improved the Cal-Comp plotter program. Difficulties with the radar set were being worked on, and the deflection coil was found damaged.

In the evening I and five others from the CHAIN visited Dr. and Mrs. Fougère and their daughter Andrée in Curepipe: a delightful evening was passed.

7 May, Thursday. Barry Martin left for Johannesburg about 0300 en route to Woods Hole, for termination of his employment.

Today the deflection coil was worked on by a local motor-winding shop; the rewound coil was delivered back to CHAIN about 2300.

A new output typewriter was installed in the main lab and a new table for it was built by six local carpenters: one had an auger, one had a saw blade, one had a screwdriver, two looked on, and a foreman visited three times.

Continued working on gravity meter and computer. Ran KHI determination and KAC program. Ungar tried twice to compile our main real-time program, but both times it exceeded the size of core (about 63,900 locations). About 0300 (8 May) the radar set was fired off.

8 May, Friday. Left Mauritius dock at 1013 (last line aboard). The scientific party is as follows:

Bowin, Carl, Chief Scientist

Aldrich, Thomas
Birch, Francis
Campbell, J. Frisbee
Carlisle, Donald
Cook, John
Feden, Robert
Friedberg, Jeffrey
Goulet, Julien
Hess, Frederick
Johnston, Alexander
Porter, Charles
Powers, Patrick (IBM)
Salisbury, Matthew
Ungar, Edward (IBM)
Vogt, Peter
Waldon, Colin

Watches were set:

0000-0400	0400-0800	0800-1200
1200-1600	1600-2000	2000-2400
	Top lab:	
Salisbury	Carlisle	Campbell
Friedberg	Waldon	Porter
Feden	Birch	Hess
	Main lab:	
Goulet	Vogt	Aldrich

While CHAIN was getting underway, Waldon, Birch, and Cook began preparing the Alpine eel array. After lunch it and the Sparker were put overside, and proved operational. A leaking line next to the starboard screw forced engineers to secure it, and we then proceeded northward at about 4 knots to compare the eel array records with records obtained 22 April with the WHOI array. The eel appeared slightly the better, and about 2030 the ship speeded up to 10 knots. We were still getting subbottom penetration; however, the water was still shallow (about 400 fathoms).

The fan in the gravity meter failed (it needed oiling) and was fixed by Aldrich.

The new output typewriter takes more than 1 minute to put out a 5-minute block of data; therefore, when fixes come in, the fix information may replace the last typed line of the 5-minute data.

9 May, Saturday. We are able to steam at 8 or 10 knots and still obtain useful CSP records. A speed of 8 knots, however, appears to be the fastest practical with the present arrangement for towing the sparker cable; at higher speeds the spark electrode rises close to the sea surface. On the track north of Mauritius the Alpine eel appeared to produce a slightly better record than the Chesapeake array at the same towing speed and sparker voltage.

Gravity and magnetics are doing well. We have laid out a track for three crossings of Nazareth Bank.

At 2300 a heat flow measurement was attempted (Station 34). Core barrel hit sideways: no result.

10 May, Sunday. Seas have been becoming rougher, and about 1644 we had to secure the gravity meter. We continued to CSP, measure magnetic field, and do bathymetry, but rough seas and much rolling caused concern for the Sparker rigging and about 2100 we pulled in the Sparker and array. We then made a dredge haul in 31 fathoms of water (Station 35). We let out 75 fathoms of wire, recorded five or six small tensiometer readings (about 1000 pounds), and obtained several pieces of coral (some with red algae) and many pounds of pieces of shell, coral, large round forams, and some scaphopoda. Algae were moderately common.

After the dredge lowering we proceeded with only the magnetometer and bathymetry operating, profiling part of the time at 9 to 9. 5 knots.

11 May, Monday. About 0400 we passed over the eastern edge of Nazareth Bank, well before we expected to, from the charts. Neither the captain nor the chief scientist was awakened, so a dredge was not made; Alex Johnston says, however, that seas were rough and it was very windy, so it would have been dangerous to make any lowerings.

At 1000 we put the sparker and array back in the water and got the gravity meter running.

About 1425 the ship stopped for a camera lowering (Station 36) to a bench (in 1100 to 1300 fathoms) on the east side of the Mascarene ridge. The camera unit failed to operate. We then lowered the dredge, with a canvas bag inside the chain bag (Station 37). Tensiometer readings were to 4900 pounds; the dredge returned with white silt and mud, probably mostly carbonate material.

We proceeded to cross obliquely the Mascarene ridge and, after appearing to cross the center of the the ridge (about 720 fathoms), retraced our track for about 20 minutes and lowered the same camera rig as before in about 760 fathoms at about 2310 (Station 38). The camera returned safely and all appeared to go well. The developing unit in the portable lab on the 01 deck, however, has cracks in some of the plastic tanks, and since the film could not be developed immediately, we lowered the dredge (Station 39) without benefit of bottom photographs.

12 May, Tuesday. The dredge did not give large tensiometer values, only to about 2500 pounds, and since a bottom penetration was obtained with the pinger on the way down, we expected the dredge to be empty or to have some mud. It returned to the surface considerably tangled. But, seven or eight or nine rocks were caught in the chain and canvas bag. Most were white carbonate(?) sandstone, not well consolidated; there were also three black-coated(?) porous pieces. No mud was brought up.

Put out the sparker array (Alpine eel) and magnetometer fish. Finally to bed at 3 a. m.

My room telephone awoke me at 0930. Bob Feden described layering cropping out on a scarp on the west side of the ridge we had crossed during the night. The CSP records looked very good, so we agreed it was a good spot to dredge. Turned ship around and brought in Sparker, array, and magnetometer, then lowered the dredge (Station 40). During lunch the dredgeing was finished; when about 200 fathoms of wire had been pulled in, however, the cable caught in the starboard screw. It could be seen lying across the screw by viewing from the deck under the A-frame. We rigged up the underwater TV camera; after several trials it worked well when fastened to the trawl wire and lowered to within 8 feet or so of the screw. The crew tried turning the latter by hand but could not move it more than one-eighth of a turn one way and one-sixteenth the other. Began to prepare the hydrocrane for lifting the cable out and away from the screw, when it came free by itself. Colin Waldon was refastening the TV camera to the wire, and it injured his thumb: a sprained ligament or broken bone. Dredge and pinger were by now back on the sea bottom, and when all the cable had finally been brought to the surface we found that the dredge was gone: a weak link and a shackle had broken and the pinger had slipped down the cable but was, fortunately, stopped by the shackle. About six frayed parts on the cable were found while the dredge was being brought up. These were cut off the cable (about 715 fathoms) after trailing the bad section off the stern.

A new Fiege fitting was put on the end of the cable and the ship was maneuvered in an attempt to locate the scarp we had been dredging. Found the scarp, but in a place about 100 fathoms deeper than where the dredging was. Lowered the camera (Station 41) and, to avoid snagging the cable on the screw again, we photographed while moving downslope. During the photographing, the bottom rapidly dropped away from the camera. Alex was able to keep the camera following the scarp by playing out cable, so pictures of this feature should have been obtained. When the camera returned to the surface, a frayed and splintered section of the cable was found (some strand wires were twisted) about 8 feet above the Fiege fitting. This really alarmed the people on deck, who expected to see the cable part and the camera rig plunge overboard. The camera, however, its lights still flashing, was secured.

While CHAIN was on these last two stations, Powers worked on the typewriters (logging and output) and Ungar worked on the new computer program (several program bugs were found). Slowly the new program is getting its kinks ironed out. Tried to test the spring tension controller part of the program, but the bugs prevented a satisfactory test.

Put Alpine eel array, Sparker, and magnetometer fish in the water and set a course for the west side of Saya de Malha.

13 May, Wednesday. After breakfast, examined the broken portion of the trawl winch cable with the captain and chief engineer. All along the cable, worn spots are observable and many outside strands are abraded halfway through or more. About 0930 the ship was slowed to 4 knots, array and magnetometer were pulled aboard, and the winch wire was streamed. Cut off about 100 fathoms of cable, put the array and magnetometer out again, and went to a speed of 8 knots.

Arrived at the western slope of Saya de Malha Bank and traversed it up as far as about 40 fathoms, at its top. Reversed course and hove to in about 400 fathoms of water, but the wind blew us upslope; we had wanted to photograph the bottom going down. Moved to a depth of about 800 fathoms to photograph going upslope, but we were now being sent downslope. Moved ship to 600 fathoms so we would be okay either way. Lowered camera (Station 42) and all went well. Alex and Fris immediately began developing film in the portable darkroom lab on the 01 deck. The photos showed mostly rippled sand, but some rocks were noted in it and abundant rocks reported to have been photographed near the end of the lowering.

We had difficulty finding a steep place to dredge. Eventually lowered in about 800 fathoms (Station 43). When the dredge was on bottom, the bottom rose only about 60 fathoms in 20 minutes; no tensiometer readings were over 2700 pounds. Brought the dredge to the surface: it was empty. Searched for a more rugged spot; crossed a canyon, and decided to try that (Station 44). I went to bed, giving word to wake me at the end of the dredge operation. The pinger frame returned highly damaged, but the pinger was still pinging (photos are in top-lab notebook). Dredge contained branching plant or coral with three pink crabs on it, other plant material(?), and several white limestone clasts (most of these did not look freshly broken but they may have been abraded and rounded by the chain bag). Dredge and pinger probably had been dragged on bottom for about a mile. The cable was frayed about 150 fathoms above the dredge, and between the dredge and the frayed spot there were marks from rubbing against limestone. We had to cut off about 250 fathoms of the cable.

14 May, Thursday. After the dredge was aboard, I described to the bridge and top-lab watches a track plan for a simple survey of this portion of the west scarp of Saya de Malha, to be made between the approximate depths of 40 and 1700 fathoms. Finally went back to bed, about 0500. The magnetometer was put out and the gravimeter was on. Alas, we learned a bitter lesson in the difficulties of communication. After the first turn of my intended survey of the scarp, the top-lab watch waited for 1700 fathoms to be recorded. The base of the scarp was passed at about 1450 fathoms and the bottom dropped only gently, but the watch continued to wait for 1700 fathoms. Twenty-six miles out across the gentle plain they travelled, before finally requesting the bridge to turn for the next leg (without having reached 1700 fathoms). I awoke at 0930 and called the top lab, to learn we were on our way back to the scarp. Too much time had been lost to continue the survey, so we changed course to N 25 W and had the Sparker and array put overside. I went back to bed and slept until 1145.

At 1330 I talked with Ed Ungar about programming difficulties and the advisability of his remaining until we reached Beirut; he agreed to stay.

At 1430 I met with Frank Birch, Bob Feden, John Cook, and Peter Vogt, to discuss cruise plans for the remainder of this leg. Decided to concentrate on the ridge between the Seychelles and Saya de Malha banks and do dredging where indicated by CSP and PGR. Also planned three heat flow lowerings in the plain northeast of the ridge, to examine a seamount shown on Heezen's map, if it turned out to be magnetic, and to use any remaining time in dredging the side of Seychelles Bank.

The remainder of the day we continued CSP, gravity and magnetics measurements, and bathymetry.

Fris Campbell printed some of the photos from Station 41, and the outcrops shown really made Feden and myself unhappy that the dredge had been lost during Station 40.

15 May, Friday. About 1830 the ship turned from an approximate N 25 W course to a northeast course for another crossing of the ridge linking the Seychelles bank with Mauritius. A steep scarp was found on the southwest side of the ridge, and the CSP records showed subbottom layering that might be cropping out on this scarp. Reversed course and put a dredge over (Station 45). The camera rig was not ready, so we decided to photograph after the dredging -- especially since so far we have not been able to dredge and photograph the same area because of the ship's drifting and the inadequacies of dead reckoning navigation.

The dredge touched bottom at about 1000 fathoms after a long period of our trying to reach the scarp. A little later 4000, 5000, and 6000 pounds of tension were registered. We let out cable, and the tension dropped to a steady 3000 pounds, then rose to 5000 or so, then jumped to 8000. More cable was let out: back to 3000 and 4000 pounds. Tried to maneuver the ship without tangling the wire in screws. Then there was a jump in tension to 10,000 pounds, followed by a drop to 2000 and 3000 pounds. The pinger was for a short time on the bottom, but soon came free; it returned to the surface in fine condition, but only half the weak-link and the safety chain from the dredge returned to light and air.

We lowered the camera as soon as the ship was again over the scarp (Station 46). However, the bottom during photography proved to be gentle. The camera was returned to surface and negatives were immediately processed. Several frames showed rock outcrops. Prints were made and examined for about two hours; they showed outcrops of whitish rocks (probably limestone) and rippled sand. We decided that samples of these rocks for dating might be very informative, and so maneuvered the ship to try for the area of the camera station again and put over our last dredge aboard (Station 47). Only small bites were got, however (the greatest tensiometer reading was 3800 pounds). The echo-sounding bottom beneath the ship continued to rise during the lowering, but the bottom where the dredge was kept dropping away from the pinger. About 0140 (16 May) the dredge was safely returned to deck empty, although many of the rings on the chain bag were bright and shiny from being dragged through sand.

16 May, Saturday. I went to bed at 0200, leaving word for Feden to keep dredging and to wake me if the dredge was lost.

Station 48 was another dredge lowering. Again there were difficulties in determining the bottom. Got bites of 5000 and 6000 pounds, and the dredge was immediately raised. The pinger frame had been damaged (but not irreparably) and the dredge bag was empty.

When the pinger frame had been fixed, a dredge again was lowered (Station 49). Again it returned empty.

I woke up at 0930; the ship had been underway for nearly an hour with gravity and magnetic instruments operating, and was proceeding to the crest of the ridge (course 050°).

Put the Sparker and array overside, but Fred Grace (ship's electrician) was working on lights on the A-frame, so we could not begin sparking immediately. We therefore slowed to 4 knots, so as not to miss much ground with CSP. Fred finished his work on the A-frame but, when we fired up the Mercedes engine, the starter lever broke. Finally "hot-wired" the Mercedes, began sparking, and profiled for about 40 minutes. The records showed horizontal layering and about 0.75 sec penetration. Pulled in Sparker, array and magnetometer, and prepared for a camera lowering, probably to be followed by a dredging on the flat crest of this ridge. The camera was lowered (Station 50), and the photos showed much organic activity: fishes, plantlike animals(?), burrowings(?), and tracks(?). On the negatives some of the bottom appeared gravel-covered.

Lowered the dredge with a new canvas bag with an expanded-metal bottom (Station 51). No strong tensions were recorded, and the dredge returned to the surface empty.

Put out Sparker, array, and magnetometer, and proceeded on course 055° to the northeast side of the ridge.

Alex displayed on the tables in the messroom a photomosaic of the bottom from camera lowering 6 (Station 38); it showed rippled sand and an outcrop of limestone, and fragments of branching coral appeared to be common.

17 May, Sunday. About 0030 we arrived at the northeast scarp of the ridge. CSP records showed the layers to drop over almost parallel to the scarp. Since only one dredge was left and the pipe dredge that the ship's engineers are working on would not be ready for a day or two, Feden and I decided not to work on this slope but to wait for a deeper and more interesting scarp on this side of the ridge.

About 0400 I was awakened and told we had crossed the deeper scarp. Turned ship around but it took until about 0800 to relocate scarp.

Lowered the dredge (Station 52) and dragged it for more than an hour. Never did encounter a scarp: the ship drifted in a manner to miss it. Dredge returned to surface with only four small rock chips: oolitic limestone, fragmental limestone, limestone of uncertain character, and a greenish-black chip with a weathered partial coating. The black rock appears to be a volcanic rock.

Put Sparker, array, and magnetometer in the water and continued on course 055°.

At 1400 I watched a demonstration of oxygen-breathing apparatus and tried out the OBA equipment.

Took second and last malaria pill.

We made a heat flow station (Station 53) at suppertime. Obtained only partial penetration but, from the core length and mud smears, Birch thinks he has a fairly good measurement (about 0.8 μcal/cm^{2}sec). After this we put out Sparker, array, magnetometer, and thermistor fish on the 85-foot hoist.

Alex and Fris displayed a mounted photomosaic from Station 46 showing two limestone (?) ridges and two depressions. Rocks show horizontal bedding. Figure 5 reproduces this photomosaic. However, this is only a portion of the complete mosaic obtained from the photographs of this lowering.

18 May, Monday. During the early morning Frank Birch supervised another heat flow measurement (Station 54). The core barrel did not penetrate the bottom and so no measurement was made. Continued sparking and taking magnetics, gravity, and continuous-temperature measurements, on course 322°.

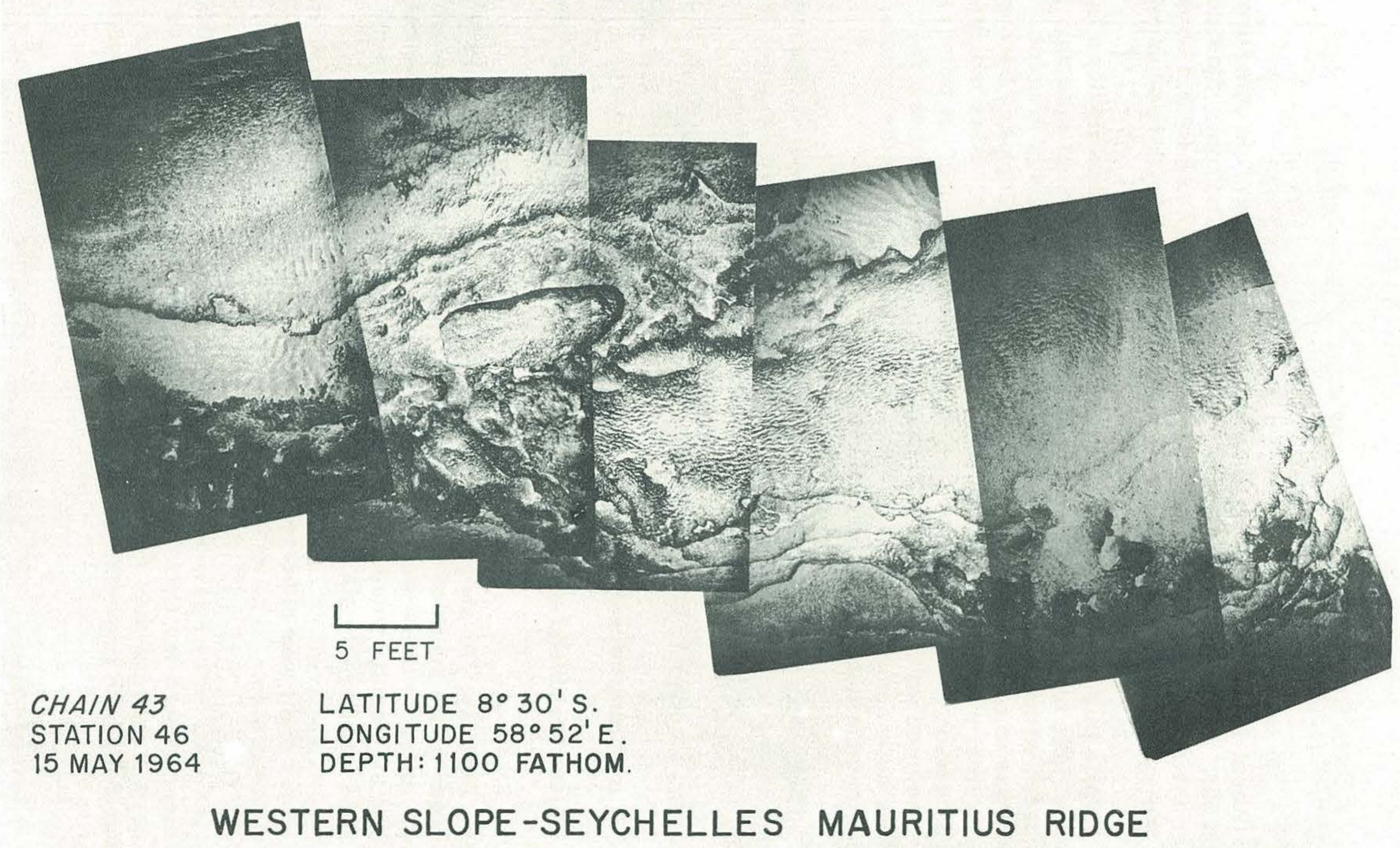


FIGURE 5. Portion of a mosaic of underwater photographs: the western slope of the Seychelles-Mauritius Ridge at 8° 30'S, 58° 51'E; water depth, 1100 fathoms.

About 1100 we arrived at the next site for a heat flow measurement (Station 55). The core barrel again did not penetrate bottom. To find out whether the fault was with the gravity corer or the bottom in this abyssal plain, we took the trouble to prepare the piston corer (with two barrels).

While this was being done, a pinger was turned upside down (after an extension cable had been made for holding the battery right side up), placed on the trawl winch wire, and lowered (Station 56) about 400 fathoms. Our purpose was to calibrate the measurements that John Cook has been making during ordinary station lowerings with the same pinger. Alex mounted a camera case on the wire, to test the case under pressure. A third camera will be mounted on the underwater camera rig and focussed at 6 feet; it will therefore be in focus when the camera rig comes close to the bottom, allowing details to be better recorded.

The piston core with heat flow outriggers was lowered (Station 57). Obtained 10 feet of white mud core, but the recorder failed to work during its time in the bottom and therefore no measurement was made.

Had a cookout, and I found why everyone enjoys them.

Three sharks were caught during stations 55, 56, and 57.

After Station 57 we continued on course 322° with all gear streaming.

19 May, Tuesday. At about 1230 we passed over a small seamount with steep sides to the south of some abyssal hills. We decided not to dredge it, however, because there were only about 16 hours left for stations before Mahé and the results would probably shed little light on the nature of the Seychelles and Saya de Malha ridge.

Last night was reported by one of the crew to have been the halfway point of the cruise.

At 1400 today I gave a talk about what we are doing in the Indian Ocean to all those aboard the CHAIN that were interested. There appeared to be more crew members than scientists present. From some comments made afterwards by both crew and scientists, it seems that such talks are worth while.

20 May, Wednesday. About midnight we decided to dredge the fairly flat bottom near the crest of the Seychelles and Saya de Malha ridge. We had hoped for a scarp on the northeast side of the ridge, but such was not encountered. The northeast slope was a continual gradual slope, the subbottom layers approximately paralleling the sea bottom.

Lowered a new pipe dredge, fashioned from an old condenser tank which was christened "Big Digger (we hope)" by Earl Montgomery (deck engineer), who smashed a bottle of scotch (water with coke for color) against her side. This dredge was Station 58. No significant tensiometer readings were obtained, and the dredge was returned to the surface empty. We had attempted to close the bottom of the dredge with a burlap bag in order to collect sand and mud, but this effort was not successful.

We then decided to try a gravity core. We rigged a core without heat flow recorder and lowered it to the bottom (Station 59). It returned empty and with its lip bent. The damage to the lip may have happened on deck before the lowering. We put out all gear except the thermistor fish, and I went to bed about 0230.

About 0400 a scarp on the southwest side of the ridge was found. The new pipe dredge was lowered (Station 60) and brought back about four pieces of an organic calcareous structure and some coral. Abundant foraminifera were found stuck to the burlap bag in the bottom of the dredge.

A rock dredge was then lowered (Station 61). After a long period of only small tensiometer readings, the dredge became caught on the bottom. Tensions of 6000, 7000, 8000, and 9000 pounds became common. Joe Morse (Third Mate) brought the ship around 180° and finally, after three times registering 10,000 to 11,000 pounds, the dredge and pinger came free of the bottom. Apparently it was the cable that had hooked itself on the rocks below. The pinger frame was damaged but not severely so. The dredge contained only small white limestone pebbles, caught by the expanded metal, some branching coral fragments, and one small pebble of granite.

We lowered the cameras for Station 62 at the same location. Three cameras were used, but the one focussed for close-ups failed to operate. Condensation, due to the film's having been loaded in the air-conditioned main lab and remaining for many hours in the camera on deck, made the film stick to itself and resulted in improper feed. Lost about a third or a half of the pictures in the other two cameras.

21 May, Thursday. Passing Platte Island about 1300 - a low tree-covered island.

Discussed underwater TV with Fred Hess. Told him of my interest in using it to get continuous mosaics of the sea bottom. He suggested putting the camera on a controllable fish and using sonar ranging to avoid cliffs.

Found a steep northward-facing scarp north of Platte Island with CSP evidence of outcropping of horizontal layers. We stopped for a dredge, but the wind set was unfavorable and so we put the gear back over and proceeded north.

Passed over scarps on the side of Seychelles Bank and then turned the ship around for a dredging. The cable on the hydrocrane broke while we were pulling in the Sparker, and the ship drifted during this time. We could not find a scarp but made a dredge anyway (Station 63). Some bites, and the dredge returned with several limestone rocks with manganese coating (one a foot long) and some fragments of branching coral

I went to bed and Feden carried out another search for a scarp and then supervised a dredge lowering (Station 64). Dredge returned empty.

22 May, Friday. During station 64, about 0200, Aldrich woke me up because of gravimeter cross-ham trouble. We took the plastic case off the gear train and tightened the clutch, after which the ham worked well. I returned to bed at 0415.

About 0530 Johnston made a camera lowering (Station 65) on the Seychelles Bank. All three cameras worked well.

About 1000 we lowered a towing fish with the TV camera and a 100-watt bulb into about 22 fathoms of water (Station 66). The fish towed well and the camera was steady enough for easy viewing; the current was about 1 knot NW. First we drifted, then put about 1 knot on the screws. The bottom was coral and could be first seen about 4.5 fathoms from it. The experiment was successful, and we will try again when we leave Mahé. Using the fish was my idea, Colin built the camera and light attachment, and Hess built the sealed light unit and spliced our two lengths of TV cable together.

Arrived at Mahé Island, Seychelles, and were anchored off Port Victoria. Arrangements were made for an hourly launch schedule to take people back and forth.

22 to 25 May. At anchor, because a British naval ship, LOCH LOMOND, was at the dock. At 0800 the morning of 25 May we moved to the dock for fueling; the LOCH LOMOND had left the pier about 0600 on 24 May to participate in a search for a missing fishing boat carrying a couple of tourists from Southern Rhodesia.

26 May, Tuesday. Finished refueling. Finally this morning, just a half-hour before the 1000 sailing time, our agent obtained a sheet of steel plate for dredges and some hose for the Modine exchanger. Sailed about 1020.

About 1330 we put the TV camera overside (Station 67). This time a steel boom was added, with a rope, weights, and cloth flags in view of the camera; a bucket dredge (large tin can) was attached to the rear of the towing fish. We were in a squall during the lowering, and the light at 30 fathoms was very low. The fish hit bottom at least twice; upon its return to the surface, the rope to the pail dredge was found to be broken near the fish.

We lowered the TV camera again (Station 63) with a new pail for a dredge. The light was very low and the TV monitors were not acting perfectly; we could not get more than a very blurred view of the bottom. The pail returned empty.

A new electrode was taped up, and gear was put over the side. The Mercedes failed in a brilliant flash of light! The ship's electricians put the Sparker on a 30 kw generator.

The mercury cell in the gravity meter beam recorder was bad and had to be changed, so we put in new cells that had been calibrated when we were staying at anchor off Port Victoria.

I figured we have about eighteen and a half days of work to do in the fourteen days before we land at Beirut.

27 May, Wednesday. Tested the spring tension controller program several times, but it always put the averaged beam trace into large oscillations. I began trying my hand at writing a new controller program.

Began making some jogs to determine the alignment of magnetic anomalies. We are practising for some large anomalies, discovered by the OWEN, which we are heading toward.

The program for accounting for the gravity meter's transient response following spring tension changes appears to work very well, judging by values recorded before, while, and after the controller program is operating.

28 May, Thursday. During the night several jog patterns were run to determine the trend of magnetic anomalies. The WHOI fish failed (there appears to be an intermittent open in the Dacron strength-member cable), and a Varian fish and cable were put over the side in about half an hour by Tom Aldrich and Peter Vogt.

Cal-Comp plotter is working very well; particularly, it brings to light the occasional mistracking of water depth by the computer smoothing equation.

The Mercedes ran all night and was worked on this morning for a while; the shorted coils were isolated and disconnected, and it ran fairly well all day today.

We made another test of Bernstein's (IBM Engineer) spring tension controller program; the beam trace still oscillates, but it does well on changes of course. I wrote out my program, and Ungar made a flow diagram for it.

This afternoon I used the CHAIN's swimming pool; very nice.

At 1900 the ship hove to for a heat flow measurement (Station 68). Birch and Feden rigged a piston corer from a small core unit. Apparently, there was some recorder difficulty while the core barrel was in bottom, but some values probably can be obtained. The barrel had about 2 feet of brown clay with forams(?).

In the evening I received a message from Neptunus Rex indicating the dress and activity requirements for miserable unwashed Pollywogs on tomorrow's crossing of the Equator.

29 May, Friday. According to computer dead reckoning, we crossed the Equator at 0841. Ungar and I filled the roles of scurvy slimy Pollywogs, and by 1400 became glorious shellbacks. During ceremonies ship continued science at 8 knots.

In the evening, a telegram from the Director, WHOI, forwarding information that permission from the UAR government had been obtained for us to land on St. John's Island in the Red Sea. Acknowledged permission by telegrams to the Director and to Dr. John Clark, U. S. Embassy, Cairo.

30 May, Saturday. A heat flow station (Station 69) was made about 1000. Birch decided on this site because it is the most remote from our last station that we will be able to occupy in the Indian Ocean. Obtained a good core of brown mud, and the measurement of heat flow appears to be good. Boat and fire drill during station.

After this station the Sparker gear was left aboard and we proceeded northwest at 13 knots. There just is not enough time to do continuous CSP.

During the day I talked with all the scientists, to learn of their geological backgrounds so that we should decide what might be achieved on the visit to St. John's Island. In the evening I posted a list of my decisions, as follows: geology, Bowin, Feden, Campbell (coastal study); planimetric map and field assistants, Vogt, Hess, Friedberg, Salisbury, Waldon; photography, Johnston.

In the afternoon Hess was busy building a nonoptical sighting transit for swinging horizontal and vertical angles.

Ungar compiled a Loran C program in the evening. He will try compiling a new real-time program tomorrow.

31 May, Sunday. About 0530 this morning we reached 5°30'N, and the Sparker and Alpine array were put over the side for CSP.

We inflated the Zodiac boat and inspected it for leaks; the valves leak slightly, but this is believed to be repairable.

At 1330 I held a meeting of the St. John's Island landing party, announcing a change of plans; since learning from Birch, Porter, and Salisbury that Moores (Research Associate, Princeton University) has a geological map of the island, it is not necessary that we try to make a planimetric map of it. The landing party is now as follows: Bowin assisted by Salisbury, Feden assisted by Vogt, Campbell assisted by Miner (crew in charge of landing boat), and Johnston (photography).

We checked out WHOI's and Feden's walkie-talkies; both pair use nearly the same frequency, so we are in luck. I worked on writing up the talk I gave at Victoria, Seychelles.

Had another cookout on the forward deck, a very pleasant change.

1 June, Monday. We are continuing on our course for the passage between Socotra and Somali, sparking and taking gravity and magnetics measurements and temperature measurements from the fish on the 85-foot hoist. We have usually been going at 8 knots, but in the earlier part of the day we were sparking at 10 knots. I expect to stop sparking about 0300 on 3 June, when we will have to travel at 13 knots to have 6 hours for dredging in the Red Sea and 8 hours for a landing on St. John's Island and be at Suez on 9 June.

I tried out the spring tension controller program I designed a few days ago. There were about three program bugs that had to be found before a good test could be made. The program proved to be unstable, for it did not anticipate that the slope may have changed as a result of a spring tension change or that the sign of the average ten-minute slope may be different from the sign of the present instantaneous slope. I devised a slope correction that, hopefully, will improve the program.

About 2000 the Sparker failed: appears to be a short in the cable. Pulled in the sparker fish and found the electrode burned back (no tape) as far as the aluminum fitting, which is damaged. It will take about twelve hours to repair it, so we pulled in the array and increased the ship's speed to 13 knots. The sparker cable and electrode will be worked on tomorrow.

Feden and I decided to spend extra time dredging several spots in the Red Sea which, hopefully, will afford some valuable information pertaining to its origin.

2 June, Tuesday. Montgomery (deck engineer) described a scallop dredge to me, which sounded good for digging into the bottom but not for freeing itself from rocks if caught. I thought of adding a chain with a weak link to a movable, rather than a fixed, bale. Chief Engineer gave approval for Montgomery to begin work on this and also on another pinger frame.

In the evening Ungar recompiled a real-time program incorporating changes in my spring-tension controller program. We finished computing and checking the basic program about 2300 and decided to wait until the morning to test the controller program.

3 June, Wednesday. The computer program ran all night in the new filtered manual mode. It appears to work well as long as operators change the spring tension only at the beginning of the minute during which indicator lights are on.

Ran my spring tension controller program and it failed: it becomes divergent oscillatory. I now realize why. The program assumes that a given spring tension change will be completely effective before the next minute, finds the slope and position have not changed sufficiently, and makes another spring tension change, and so is unstable. At present I am trying to devise a better controller program.

During the day Montgomery and Alfred John (Junior Oiler) finished building the dredge designed yesterday, and this evening Feden helped them put on a chain bag (fortunately, the one Feden had fitted perfectly, being 3 feet across).

This evening Montgomery gave me a haircut (a badly needed trim around the ears).

4 June, Thursday. We entered the southern end of the Red Sea about 0500 this morning, having passed over an interesting trench or canyon in the Gulf of Aden between 0050 and 0200.

Examined, with Bob Feden, the PGR and CSP records and T. D. Allen's (of SACLANT) magnetics, gravity, and depth measurements, looking for good places to dredge. We decided to dredge where there is a high north-facing scarp with a depth of 648 fathoms at its base. The dredge may encounter limestone composing a depressed portion of a limestone bank lying at shallow depths on both sides of a channel. We shall reach the site about midnight.

In the morning we passed the islands of Zugar and Al Hanisk. Through binoculars there appear to be basic (dark) volcanics, and in many places traces of lava flows can be seen. The flows are approximately horizontal or gently dipping, usually with broad shallow undulations. Locally along the coast there are beaches, and for a small distance inland there are dunes and windswept sand. Zugar is much the higher island and appears to be a large volcano with many satellite cones of various sizes. This island is probably Upper Tertiary and/or Recent.

In the afternoon Fritz Hess and I examined the old sparker cable. We found an intermittent open at the end of the stiffener, actually a little before the end, where the wood stiffener had broken. Some salt water was found in the cable near the broken spot and also under the electrical rubber tape about 3 inches back from the outside end of the aluminum stock. We cut off about 10 feet of the electrode end, saving it for later examination, and about 15 feet of the other end, slit open the cable, and removed the braid. We threw the rest of the old sparker cable off the stern of the ship. The cable was old and fatigued, the canvas cover in poor condition, and the Chief Mate wanted to paint the remaining part of the deck on which the cable was stowed.

In the early evening we passed several small islands, commonly with steep cliffs at the shoreline. They appeared to be layered volcanic ash deposits remaining from former volcanic cones. They are buff-colored with what appears to be a black hard (case-hardened) outer surface which is broken away in places. Farther away are two black, nicely shaped "cinder" (?) cones, which are probably Quaternary.

A school of porpoises played by our bow for a while.

5 June, Friday. About 0030 we lowered the dredge (with canvas bag with expanded-metal bottom) over the side (Station 70) on a north-facing scarp near the southern Red Sea. Had a 2500-pound bite, and the dredge returned with several rocks. The largest of the rocks are limestone with fresh worm tubes, fossil scaphopoda, and other unidentified forms; there were also some small pieces of coal.

We lowered the dredge again (Station 71), but it was only a short time on the bottom, when the pinger failed and we had to return it to the surface. I went to bed about 0200. After breakfast some mud was found in the creases of the canvas bag, and we saved it as a sample. There were also a few pieces of coal and a small hardened mud ball.

About 1100 we reversed course, pulled in the magnetometer and 85-foot hoist, and prepared for a dredge station, but we lost our scarp in the process of turning. Tried several course changes and spent until 1400 looking for a dredge site, when a moderately good slope was found. We let down the new dredge (Montgomery and Bowin's), but the slope did not behave as expected during the lowering (Station 72) and the dredge returned empty.

We steamed around, looking again for a slope, gave up, and proceeded on our original course at 13 knots. A fairly good scarp was found after about an hour's run at full speed. Made a Williamson turn, which worked well, and conducted a dredge lowering (Station 73). During preparations for the lowering, the 10 kva power source's inverter failed: a fuse had blown because of dirt on the transistors in the floating oscillator circuit. Several diodes were ruined during this failure and while the inverter was being checked. Hess and Aldrich worked on the problem and got the inverter going again. The dredge on station 73 had one 1000-pound bite after the pinger was on bottom. It returned with three small pieces of silicified tuff(?), cemented tuff, breccia(?), and a scoriaceous volcanic rock or piece of slag from a coal-burning ship.

After this station we put over the magnetometer fish and 85-foot hoist, and proceeded at full speed on course 328° for St. John's Island. Plan to be there at 0600 on 7 June. Figure 6 shows a portion of the Cal-Comp digital plotter record obtained while we were heading to St. John's Island.

<u>6 June, Saturday.</u> Tom Aldrich designed and built a display unit for the top lab which will indicate an automatic water depth mistrack (i. e. , that the computer used the same smoothed water depth value for five consecutive minutes) by a flashing red light and a buzzer. It will also indicate with two additional lights whether the sense switch is set for manual or automatic water-depth determination.

Made a tour of the scientists' quarters with the Captain, the Chief Steward, the ship's doctor, and the Room Steward. Improvement is desired in several places.

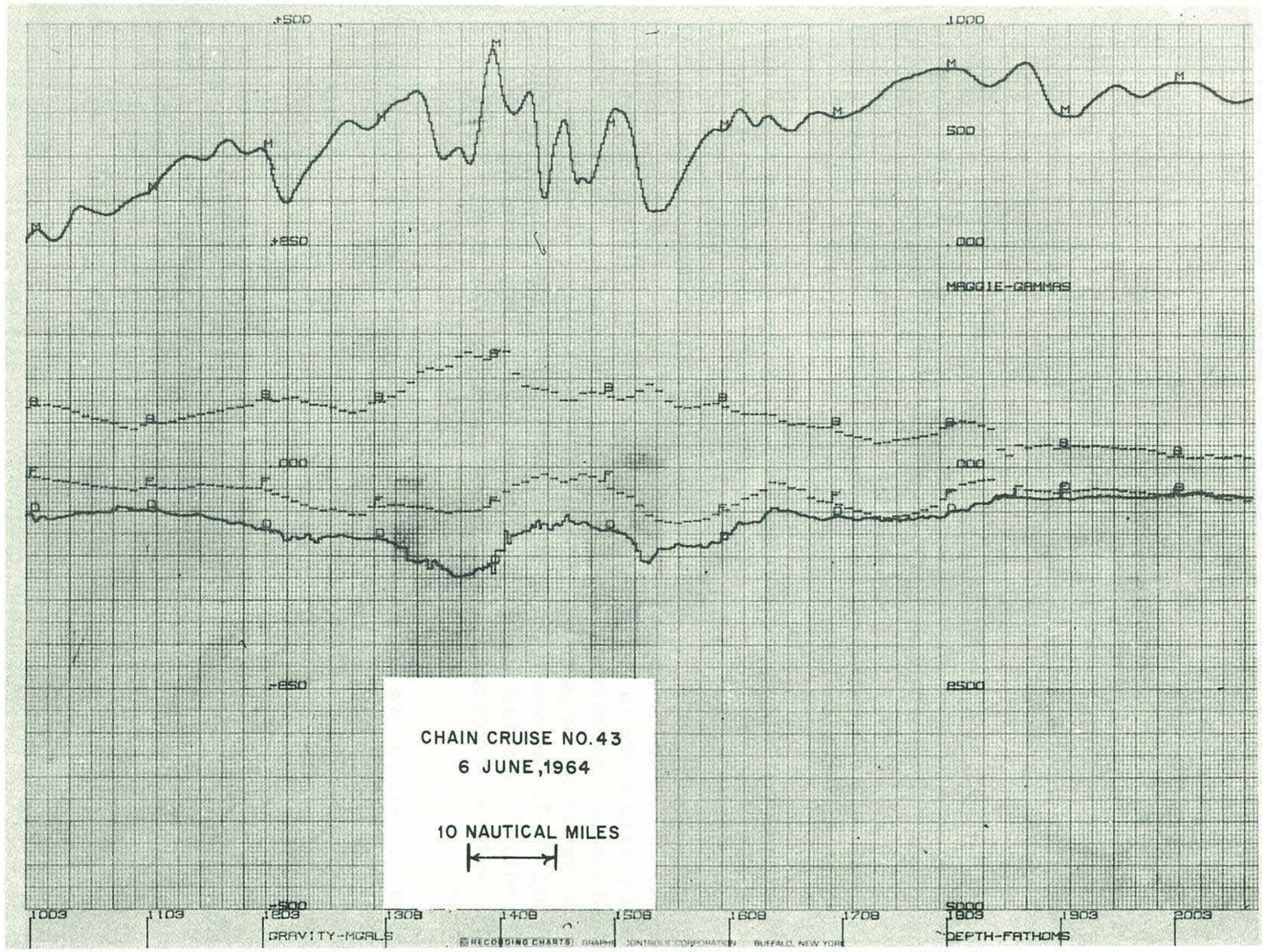


FIGURE 6. Portion of digital plotter record obtained in Red Sea south of St. John's Island. M = total intensity magnetic field, B = Bouguer gravity anomaly, F = free-air gravity anomaly, D = water depth.

Colin Waldon got several top-lab people who have had easy watch periods lately to reorganize and clean up the lower lab and magazine areas.

I defined a spring tension controller program, mod 2, which utilized predictive equations; checked the integration and equation development with John Cook and explained the procedure to Ed Ungar. After dinner Ed began writing this program in SPS.

At 1500 we had a meeting of the St. John's landing party, at which we discussed the supplies and equipment needed, procedures on landing, and the collecting and designation of outcrops and samples.

The captain and I discussed a signal code (by means of flares) which could be used in case the walkie-talkies did not operate.

7 June, Sunday. Awoke at 0430. Calvin Karram, First Cook, made breakfast at 0500 for the seven men of the landing party. At 0530 the island was being approached, and I examined it with binoculars and decided on a plan of investigation. About 0600 we were on our way to St. John's. Arnie Miner (boat man), Feden, and I were in the fiberglass skiff with the outboard motor, pulling behind us the Zodiac with Campbell, Johnston, Vogt, and Salisbury in it. We encountered shallow water over the barrier reef and then headed for the stone pier. The water was shallow, but with the motor up Feden pulled us to shore while he walked along the stone pier. We pulled the boats ashore and anchored them, and unloaded the gear and carried it to a ruined building, one of two standing about 200 feet inshore. Kept communications with CHAIN via Feden's walkie-talkies. CHAIN left for work (velocimeter lowering, Station 74) beyond the twelve-mile territorial-water limit. We split up into two parties, Campbell, Johnston, and Miner walking north to examine the coastal limestone, and Feden, Vogt, Salisbury and myself walking southwest to the old mine tailings and tunnels at the base of the north slope of the highest peak on the island. At the old mines we again split up, Feden and Vogt going south around the mountain and then to the top, and Salisbury and I going west to the crest of a ridge leading northwest from the highest peak. Matt and I then proceeded northwest along the crest, thence north along a valley, and eventually reached the head of the alluvial fan near the ruins. We reached the ruins about 1230. Rock samples had been collected by all parties. Had some water and fruit cocktail, and then boarded the boats and headed back to CHAIN. CHAIN got underway at full speed about 1430.

I took a nap, and then enjoyed the cookout. Captain advised me we would arrive Suez about 0100 on the ninth. This was not in keeping with the telegram advising visiting Egyptian scientists of our arrival about 0800. The ship changed course, to arrive at a 1200-fathom hole in the Red Sea for a heat flow measurement.

8 June, Monday. Arrived at deep water about midnight, and Birch and Feden did a heat flow lowering (Station 75). The bottom was apparently too soft, and although the core barrel and trigger weight penetrated it, the trigger did not release. The heat flow measurement was not entirely successful, because the temperature was off the thermistor scale; heat flow probably very high (greater than 2 ?).

In the morning we unpacked the rocks from St. John's and compiled all our stations on one map. We selected rocks for exhibition at the discussion period, set for 1530 to 1630 today.

I sent a radiogram to Clark at the U. S. Embassy, Cairo, advising him that the St. John's work was completed and asking him to extend our thanks and appreciation to the UAR government.

Our discussion took place; I gave a talk and showed the rock samples in the officers' mess. Feden gave a second brief talk. The meeting had an extra usefulness for those who had visited the island, in that it helped to consolidate our various thoughts.

During the early evening, as we passed into the Gulf of Suez, I looked for Mount Sinai; 'twas in vain, for higher mountains block the view.

Captain advised me we are still about three hours early, so we planned a dredge station for about 0045 in the center of the Gulf of Suez.

During the afternoon and evening Ungar and I tried my new spring controller mod 2 program. We found three programmer bugs, and I had left out a term in the equation for predicting a future beam position value. Ungar is trying to find another program bug, but so far without success.

9 June, Tuesday. Feden conducted a dredge lowering early this morning (Station 96) in about 27 fathoms. The dredge was on bottom for about fifteen minutes, when tension increased. We returned it to the surface and found it heaped full of mud and shells. It took Feden the remainder of the station time to clean the bag and dredge.

Arrived at waiting area, Suez, about 0820. Two pilot boats have come up to so far (1040). Still have no idea how long we may have to wait. No word on the visiting scientists.

Spring tension controller program is still being worked on by Ungar and still has bugs.

Moved to staging anchorage very near entrance to Suez Canal, and received word that we would join a convoy tomorrow morning.

In the early afternoon the American Consul in Suez came aboard CHAIN with his Egyptian assistant and two visitors who will join us for our transit of the canal. One of the visitors is Richard Helgerson, Press Attaché of the U. S. Embassy, Cairo, and the other is Dr. Anwar Abdel Aleem, Director of the Oceanography Department, University of Alexandria. The rest of the day was spent showing these gentlemen around the ship and enjoying many hours of discussion with them.

10 June, Wednesday. We made the transit of the Suez Canal. The top and main labs calculated the ship's speed by noting CHAIN's passage past the kilometer markers (in arabic numerals).

We tried out the spring tension controller mod 2 program twice, and found some of the errors to be in my equations.

CHAIN completed the canal passage about 2200, let off visitors, canal pilot, and electrician. When the water depth reached 100 fathoms, we streamed the magnetometer fish and put over the Sparker. The thermistor in the 85-foot hoist was flooded and was not put in water.

11 June, Thursday. Ungar made a change in the spring tension controller program so that the slope correction portion could be tested. We made two tests today and the controller worked, but it caused oscillatory

excursions of the average beam. We tried a four-minute averaging period, and the program worked better (amplitude of oscillation was smaller) but the horizontal accelerations are small. The difficulty lies in the computer program's not knowing enough about the trace of the average beam; the two end points are not sufficient and intermediate information is needed. Ungar and I timed the important phases of the computer program.

We are sparking over the slopes north of Egypt and at the southeast end of the Mediterranean Sea. Had a fairly good view of Jaffa and Tel Aviv.

12 June, Friday. The Sparker unit failed at 0047. The thyratron high-voltage fuse was replaced, but when the unit was restarted a loud pop and a flash from the ignitrons caused cessation of CSP for the remainder of this leg. After this trouble, the sparker cable and array were brought aboard. At 0430 the magnetometer fish and the thermistor fish on the 85-foot hoist were pulled in as we approached the harbor of Beirut, Lebanon. PGR and Gifft secured at 0530. Arrived dockside, Beirut, at 0600.

Beirut, Lebanon to Plymouth, England
15 June - 28 July, 1964

by J. B. Hersey

15 June, Monday. After many little problems and delays we started about 1130.

The party on board is:

Hersey, J. Brackett, Chief Scientist

Aldrich, Thomas
Campbell, J. Frisbee
Carlisle, Donald
Fahlquist, Davis (Tex. A&M)
Feden, Robert
Friedberg, Jeffrey
Goulet, Julien
Halunen, John
Johnston, Alexander
Porter, Charles
Powers, Patrick (IBM)
Ryan, William
Salisbury, Matthew
Vogt, Peter
Waldon, Colin
Whitmarsh, Robert
Wilharm, Larry
Winfree, Arthur
Yates, Michael

We made a brief series of courses near the harbor while echo sounding and recording gravity. We continued this work throughout the day, extended it over the Lebanese slope beyond the three-mile limit. I regret that we had not made advance arrangements so that we could work freely within territorial waters. Professor George is intensely interested in the sounding, as is Mr. Boulos, who especially wished to have it done. During this day we did all that was reasonable to do with soundings.

16 June, Tuesday. Camera station (Station 77) was made between 0100 and 0330. It was only fairly successful, but does show several acres of mud flat with various animal holes.

In the early morning hours after 0300 first the magnetometer and later the seismic gear were streamed, and recordings were started on a systematic grid of tracks paralleling the coast of Lebanon but approaching no closer than 3.5 miles. This work was continued throughout the day. There was much trouble with the precision drive of PGR 1 (Precision Graphic Recorder). Part of the day, soundings were taken from the CSP (Continuous Seismic Profiler).

17 June, Wednesday. Have found three general types of structural unit along the Lebanese coast. The lowest is an unknown rock with a rough upper surface; we see little or nothing below this. Next above, in deep water, is a layered sequence that fills depressions and may be unconsolidated sediment. In shallow water ($<$ 200 fathoms) there is overlying the first rock a series of subparallel beds, apparently lithified sediments, which form banks along the coast and possibly extend well inland. At least one sizable magnetic anomaly was recorded. The gravity profiles appear to follow topography expectably.

This morning we attempted dredging on a bank which appears to be formed by an outcrop of the deepest rock. The results were much fine dark-green mud, many shells of great variety (including a few small murices), and three or four coral bank fragments. No rock seems to have been freshly broken, despite evidence of a 5000-pound tug on the tow line.

Later another dredging was made where I supposed the layered bank-forming sediments might crop out, but it was curtailed for lack of time. It netted a few chunks of firm dark gray clay.

We returned to Beirut at high speed, reaching dockside about 1700. Wilharm joined ship, and our five guests departed. After some visiting with various Lebanese friends including Professors Bridgewood and Raben, we left for sea at 1925.

Set the usual watches and started echo sounding, CSP, gravity, magnetics, and temperature measurements after passing the three-mile limit. Proceeded on a westerly course, 270 at first and 280 after 2140, according to a track plan designed with the help of Bill Ryan.

Until midnight the passage was made over a gradually deepening floor (980 fathoms by midnight), under which a single complex reflector extends; I believe it to be the same one we charted near Lebanon. The delay to this feature after the bottom reflection becomes gradually less, but there are no other major complications in the structure.

We continue to have trouble with PGR 1, on which we record 12 kcps echo soundings. For the most part we have not made good recordings of these, since I prefer to have good CSP records on two PGR's. Wilharm repaired the automatic depth circuit and had it operating again by mid-evening (there is no entry in the log to this effect).

18 June, Thursday. There were only underway observations today, consisting of CSP, gravity, magnetics, and temperature measurements at the bow and on the fish of the 85-foot thermistor chain. Echo sounding was spotty and sometimes altogether unsuccessful because of technical difficulties with the recorder. Gross water depths are available from the CSP recordings, but detailed information about bedding at shallow depth below bottom is largely lacking. If anyone especially wishes the latter, he may be able to extract it from such records as we have. During this period we did cross an abyssal plain.

The control cables for rotating the hydrocranes had broken as we were working in the Red Sea or the Gulf of Suez; we obtained some substitute cables in Beirut. Today, about 1600, we moved the sparker suspension from the crane to the stern chock on the starboard side, so that the crane could be repaired; at a speed of 7.5 knots the suspension seems to work very well there, perhaps better than over the side. During the late afternoon there was the repeated nuisance of circuit breakers' shutting off the PGR controlling the Sparker - no great problem, but some data lost.

Our base course took us about 40 miles south of Cyprus. We made a single zig-zag sharply to the north, to within 20 miles of the island, intending to make a small survey of the narrow abyssal plain there, but we have lost so much time in various minor breakdowns that I elected to confine the work to a single pair of crossings. Baxter wanted to satisfy a point about a sound transmission measurement he had made in this vicinity.

At 1600 we turned to course 240, heading toward the central portion of the Nile Delta. We may have recrossed the abyssal plain between 1740 and 1825, as the depths were about 1360 fathoms (unreduced). Later the bottom shoaled and became uneven (the bumpy topography characteristic of much of the eastern Mediterranean) between 980 and 1200 fathoms. About 2315 the bottom fell away to depths of about 1400 fathoms but it was still uneven. This latter change is the beginning of a grand piece of structure that appears to be a huge graben formed at least in the rock that has been giving the strongest and most persistent subbottom echo (of course it may well have far more deep-seated causes than this). Within this apparent graben there are faultlike features of smaller dimensions and prominences, which are largely buried by presumably later sediments. The crossing of this feature was completed at 0248 on 19 June.

19 June, Friday. This is the day we ran up onto the Nile Delta.

The CSP worked well until after I decided to alter course to the northwest and head for Rhodes. The shackle holding the Sparker had been sparking mildly during the day, but toward nightfall it became worse. I decided to stop and pick up the Sparker: it needed a new electrode, which was installed. When back in the water it wouldn't discharge; we found it was not triggering. The fault was traced to a cold-solder joint in the trigger chassis in the lower lab. Next, the condenser bank would not charge on every other charging cycle. Wilharm felt this was caused by bleeding in an ignitron; it was. This interruption started at 2026 and lasted until after 0100 on 20 June. I decided to hold position, as we were still rather high on the slope from the Nile. The CSP recordings of the passage upslope to the Nile show a compound ridge system apparently damming the sediments from the delta; at the shallow depths these sediment are arranged like shingles on a roof, but the deeper layers persist beneath them. On the second and downslope passage the shingle structure was apparent again, but we did not cross the ridge system - at least not obviously.

The gravity meter was out of operation during much of the night because of troubles with the HAM's (horizontal accelerometers). Aldrich was able to deal with these troubles, and the meter was back in operation at 0339.

The magnetometer, which was changed at the departure from Beirut, has been most satisfactory so far and has been recording on the 100-gamma scale. Several obvious anomalies have been noted, one of which correlates with the huge grabenlike structure reported yesterday. We do not have complete daily summary plots of our data, and nothing makes this more evident than trying to compare magnetic, gravity, and seismic data. I am encouraging the top-lab watchstanders to make such plots.

20 June, Saturday. All day was spent on a long straight passage north-northwest from the Nile Delta toward the island of Rhodes. We passed over about 10 miles of abyssal plain between 0955 and 1115 and beginning at 1500, over a complex structural feature, displayed on the CSP, where it looks very similar to the grabenlike feature crossed two days ago. This discovery, which appears never to have been made on previous cruises, has captured our attention. Many of us would like to spend much more time on it, but I feel we can give it at best one day more.

Magnetic anomalies seem to me incessant, in contrast to what we found on part of the passage to the east, where there were longish stretches of rather uniform regional change.

The gravity data have been satisfactory and should, of course, be quite helpful in the interpretation of the structure revealed by the CSP.

On the technical side, Fahlquist and Waldon are nearly ready to install the array cable on the 85-foot chain. The fins have been specially adapted for the purpose, and the fairlead for helping the cable make the sharp bend near the fish has been borrowed from the Sparker installation. We plan to replace the Alpine eel array with the Chesapeake array and install the gear on the chain tomorrow.

Johnston and Wilharm prepared a combination of two Edgerton-modified Edo transducers as a suspended echo-location system. One transducer is to be part of a standard pinger, and the other will be a receiver fed to the ship through the Schlumberger cable. By the end of the day the unit had been assembled but not tested. The first use I plan to make of it is to look edge-on at the scattering layers.

We have tried unsuccessfully to look at the scattering layers by means of the Sparker and an Edo. We see something that could be volume reverberation, but we cannot be sure.

About 2200 we altered course from 335 to about 328, to head for the center of the abyssal plain south of Rhodes.

21 June, Sunday. The run toward Rhodes from the Nile Delta on course about 328 was completed, and at 1103 course was altered. A base course of 200 was held for the rest of the day. Between 1753 and 2042 the Sparker was stopped, the magnetometer hauled on deck, and the Alpine array exchanged for the Chesapeake array. My intention had been to fasten the array cable to the 85-foot chain to control the depth of the array, but the combination of 60 cps power-line crossfeed and excessive noise from the screws made this seem unwise. The next several hours were consumed in chasing power-line pickup, but to no avail. Some improvement was achieved, and at times the signals appeared quite clear. This possibly means that there is a loose or leaky connection causing a ground loop. In any case, the most bothersome interference was from the screws. About midnight I decided that we were unlikely to solve this problem in the middle of the night, so we shortly thereafter replaced the Alpine array. The whole system, including the magnetometer, was back at work by 0034.

The experience with the Chesapeake array does not fit the reports I have had from Knott and Bunce. All the noise appears to be generated by the ship or else by the power line. The worst offenders are the propellors: their noise completely dominates the 100 to 200 cps band, although it seems not to be recorded in the 20 to 50 cps band we are using on PGR 2. I plan to proceed on the notion that the propellor noise arises from distortion of high frequencies, which is emphasized in the array's response peak in the region 4 to 5 kcps. We will attempt to filter this out.

The results have been generally good despite the evening's failure with arrays. The abyssal plain south of Rhodes appears to be a sediment pond with sediments to about 1 second of travel time beyond the bottom echo and possibly deeper. South of the plain on course 200 we encountered seamounts rising to depths of slightly less than 1000 fathoms. We passed beyond these just as day ended.

Sam Pierce, the steward, staged a steak cookout on the boat deck for supper. It was a fine affair, now a firmly established part of the life of this ship.

22 June, Monday. Today started with underway echo sounding, gravity, magnetic, and seismic observations and continuous recordings of surface temperature. I have been attempting to use the Chesapeake array, hoping to find out whether it can be properly tuned geometrically for towing at speeds of 7 to 8 knots at least. As noted above, we have been prevented from useful experimentation by power-line pickup and surprisingly high-level sounds timed with the screw beats of CHAIN. Both sources of noise proved to be due to a ground loop completed by a ground lead in the head of the array, which was accidentally bare and touching the metal case of the front end of the array. Apparently, large electrical transients are generated by the rotation of the propellor shaft. These couple with a ground loop and can make overwhelmingly loud signals in the CSP receiving system. When the ground loop is gone, the noise with screw beat rhythm completely disappears. Eventually, the Chesapeake array was completely without noise from this source, whereas the Alpine was hopelessly noisy, probably because of a ground loop in it as well.

The ground loop cleared, the Chesapeake array was streamed and towed for a time, while we attempted to use pingers in array and generally to become accustomed to using the Chesapeake array. Through a misinterpretation of the pinger circuits and their output we logged considerable misinformation about the depth of the array. About 2100 we discovered that the array depth could best be had by filtering 4800 cps high pass in the PGR and reading the delay between the direct bottom echo and its surface reflection.

Meantime, we had connected the array cable to the 85-foot chain by means of our new fairings, designed to incorporate the cable as part of the fin structure. In the past we have lashed the cable alongside the chain, thereby causing a poor towing shape and poor towing performance, and it has long been obvious what was needed to correct this situation. I am glad that at last it has been done. The chain, fish, and cable combination tows well but has a tendency to ride into the wake, unless a fin near the hoist is pulled toward the ship by a shock cord at its top. This device readily steers the cable, so that it tows either straight aft or slightly outboard.

When the tow point of the cable was 10 feet or less below the surface, the array seemed to tow deep at 3 knots and came to about 30 feet at 7.5 to 8 knots. This means that the array is considerably too heavy, which may account for its high towing noise level. Qualitatively, I can hear engine room sounds distinctly at 3 to 4. 5 knots, but not at faster speeds and, presumably, this means that towing noises start to dominate at about 6 knots or maybe slightly less. Unfortunately, we are unable to measure the depth or attitude of the array, because we have not been able to understand what comes out of it when we are using the pingers. Part of the difficulty is that all five hydrophones are in parallel and cannot be separated. We badly need five independent circuits, to know how the array is behaving.

At 4. 5 knots the output of the array seemed almost too good to be true, there being long prominent echo sequences across the full width of the paper on the 1000-fathom sweep in the 15 to 50 cps band. At 6 knots this beautiful performance completely disappeared, and echoes could be distinguished through noise only with difficulty - and with a vivid imagination. Much of the detailed experimentation from this point on was completed during the early morning watch of Tuesday.

Early this morning the seas, set up by a west wind, were rolling the ship, and we reduced speed to 6 knots so that gravity observations could be continued. Later the wind and sea abated, and our accustomed good weather set in again.

The broken helix drive shaft of PGR 1 was gradually repaired and was in full operation by nightfall. No progress today on the pinger fish: too many other problems to cope with.

The CSP results show the region of fine- and coarse-textured topography to be as complex below the bottom as the bottom shape suggests. In many places one is tempted to interpret the mass of crescentic echo sequences as topographic, but they clearly aren't all so. Some sequences seem to be from highly irregular, deeper reflectors. Occasionally there are small sediment ponds, frequently less than a mile across, with evidence of layered sediments down to nearly 1 sec below bottom. One might be able to describe the tectonic history of the whole region by supposing a complex fracture and differential movement, largely vertical, beneath much of the "cobblestone" bottom. There are some places where an extensive sedimentary deposit (20 to 40 miles across) seems to lie over a deeper rougher surface, although both are now complexly distorted. These may once have been basins with ponded sediments such as those in the modern pond southeast of Rhodes. If so, one might well be able to deduce much about the tectonic history of the region if one had a good chart based on seismic reflections. Such a chart should be made by CSP, not by shooting, and in as much detail as possible, since the region seems far too complex for sweeping generalizations. Magnetic anomaly data obviously, and perhaps gravity data as well, will be important aids in the interpretation of the CSP picture.

23 June, Tuesday. During the early hours of the morning the tests of the Chesapeake array were completed, largely determining its depth as a function of towing speed, as noted above. Good records were obtained at 4.5 knots, poor to worthless ones at 6 knots, and rather good one at 7.5 knots, but the fact that the noise increased with speed clearly shows the Chesapeake to be inferior to the Alpine in this respect. We don't know how the Alpine array tows; it may be more nearly neutrally buoyant than the Chesapeake, and we might find that both would show comparable performances if they both had neutral buoyancy.

By 0330 it became obvious that the performance of the Chesapeake at 7.5 knots truly could not be made as good as that of the Alpine. I therefore requested the watch to go back to using the Alpine and continue to record CSP data on course 270 (we changed course from 245 to 270 at 0220). They found the Alpine hopelessly loaded with power-line pickup which they could not readily find, so they swapped back to the Chesapeake again and continued to record CSP data until 1000. At 0940 we altered course from 270 to 298.

Soon after 1000 we increased speed to 11 or more knots (usually close to 12 knots) and headed for the location of a coring, sounding, and CSP program designed by Bill Ryan. During this passage we are echo sounding and measuring gravity, magnetics, and surface temperature. The 85-foot chain has been altered for use with the array cable, so for the moment at least I am not recording temperature at the end of it.

Yates and Winfree, both of whom are interested in the scattering layers, are now familiar enough with the ship and many of the instruments to make meaningful and perhaps even significant observations. PGR 1 was altered to two-channel operation for recording scattering layers on one channel and bottom on the other. Either 400- or 500-fathom sweeps are being used, as suits the depth of the water. We got some excellent records of the scattering layer as well as of the bottom.

Wilharm and Johnston have tested the pinger-and-receiver combination on the Schlumberger cable. The cable seems not to introduce any serious problems, but we do hear the multivibrator of the pinger unit extraordinarily well. Wilharm plans to try moving it away from the receiver by mounting it higher up the cable.

During the evening the west wind picked up, causing some pitching. As a result the gravity meter operated improperly, but it worked fairly well after our speed as reduced to 10 knots.

24 June, Wednesday. We continued underway at high speed, echo sounding and taking gravity, magnetic, and surface-temperature measurements, until we reached a point slightly east of the first coring station. At 1801 the ship slowed to 2 knots for rigging of the Sparker and Chesapeake array. There followed four hours of frustrating and largely futile attempts to make good CSP recordings. At 2300 we stopped at Station 80 to attempt to take a 50-foot core. This stations was near the eastern edge of an abyssal plain whose echo soundings show the persistent layering described as sediment ponding. The first subbottom layer is about 40 feet below bottom; hence our interest in taking a 50-foot core.

A handsome record of the dawn migration of the scattering layer was obtained today.

Later in the day we held a thorough housecleaning of PGR 1 and readjusted all cams, commutators, and switches; greatly improved performance. Gravity and magnetic recordings seem to have been successful. The magnetic field in the eastern basin exhibits considerable variation on a scale of miles to tens of miles in the range of 10 to 100 gammas.

25 June, Thursday. By 0226 the first 50-foot core barrel was on deck after an operationally successful lowering. Mud was on the outside of the barrel to about 43 feet, but on the inside there were only 33 feet of core. Five members of the scientific party, the boatswain, and the winch operator did the whole job; undoubtedly fewer persons would have sufficed, but the work of these men was well disciplined and sensible, and I am pleased with their performance.

After the coring station we decided to rig only the magnetometer for the run to the next coring station. Thus, between 0300 and 0700 we proceeded toward core Station 81 making echo, gravity, magnetic, and surface-temperature measurements. Station 81, another 50-foot core barrel station, was occupied from about 0700 to 1020 at 36°03.5'N, 18°12.0'E.

At 1020 we were underway on course 086, to define the eastern boundary of the sediment pond in which we are coring. Having found the edge of the pond somewhat farther west than anticipated, we altered course to 254 at 1434.

Because of our very shortened cruise (four days lost) Bill Ryan decided to cancel two of the six cores he had planned. Accordingly, we headed for a part of the abyssal plain near the point where a submarine canyon feeds it from the Strait of Messina. Since the coring station we have been making echo soundings, mostly on the sediment pond, using a 100-fathom sweep and a short pulse for high resolution. Several subbottom echoes have been recorded on the echo sounder everywhere on this plain, but the first one, about 40 feet below the bottom, is consistently the strongest. We have recorded gravity, magnetics, surface temperature, and seismic reflections (CSP). The CSP has been very poor at frequencies below 100 cps, but rewarding at higher frequencies. Throughout the day we have had only faint hints from the Chesapeake array of what the deep structure beneath the plain may be. We thought to better our situation by changing to the Alpine array. It appeared to be much quieter, but at less than 100 cps we could record virtually no echoes from it, scarcely even the bottom! The other recordings seem to be quite satisfactory.

The Alpine array definitely has a 150,000-ohm leak in its metal case, caused by the instrument ground. In contact with sea water, the leak immediately creates a strong ground loop. Rather than repair it, which appeared difficult to do because the watertight outer cylinder would not come apart, we have waterproofed the whole assembly, using much rubber and Scotch electrical tape. This expedient has been successful, for the time being at least.

<u>26 June, Friday.</u> Changed course from 086 to 074 at 0024 and speed from 8 knots to 4 knots at 0025, in preparation for Station 82 (core and heat flow). The station was occupied at 35°47.2' N lat., 17°28.7'E long from 0135 to 0636, when a core 25' long and a usable heat flow record were pulled on board. At 0636 we took course 303 at a speed of 4 knots, to stream the magnetometer, array, and Sparker; we increased speed to 7 knots at 0700.

For the balance of the day, until 1730, echo sounding, gravity, magnetic, surface temperature, standard weather observations, and seismic reflection measurements were recorded. The ship held a steady course but ran at various speeds, to fit our attempts to improve the CSP recordings. All other observations were routine and gave no special trouble. For the past two days the CSP recordings, as noted above, have been very poor in frequency bands below 100 cps, but they have been fair to good in the bands 100 to 200 cps, 300 to 600 cps, or higher. We have had persistent difficulty in recording even the bottom echo in our favorite low-frequency band, 15 to 50 cps. We have been making systematic changes in the depth of the Alpine array, to achieve the best possible low-frequency recording. Since each change must be followed by a long period of recording, else its effect cannot be judged, the tests required the whole afternoon, until about 1615 or so. The arrangement on the 85-foot chain continued to work very well, and it was easy to use. We started with about 10 feet of array cable in the water and, by a series of observations, first at slow speed (4. 5 knots) and then at fast speed (8 knots), determined that a consistent strong bottom echo could be recorded in the band 18. 75 to 75 cps. There are hints of reflections to slightly more than 1 sec beyond the bottom echo. I now believe that there is little, if any, persistent reflecting surface, the sound seeming to be a disorganized reverberation even when the ship is well out over the smooth abyssal plain where we have been working. This fact suggests that the reverberation comes from below the bottom or else from a rough surface revealed persistently on the record in any band between 100 and 1000 cps. We have some recordings obtained from the Chesapeake array just before it was retrieved, which contain sequences that may be echoes from layers deep below the abyssal plain. By the time we had tuned the Alpine array we were no longer passing over the abyssal plain, so I have no way of knowing whether the new rig (Alpine and holding cable on the 85-foot chain) would have improved the low-frequency recordings there. Our biggest lack remains specific reliable data about depth of source and depth of receiver. The experiments of this afternoon suggest that tuning for the best depth is both necessary and critical when signal-to-noise ratios are poor.

After 1730 we decided to make a small survey of the canyon or pond where we intended coring. The survey was most rewarding, enabling us to find an excellent location fairly in a deep channel that had previously been described by Ryan as probably continuous up the slope to the vicinity of the Strait of Messina. Several course changes were made during this survey, which should be read from the top-lab log (typewriter).

At 2035 the ship stopped for Station 83 (core and heat flow) near 36°33'N, 16°33'E. This station was successfully completed just after midnight. The core length was 22 feet; the heat flow data appear satisfactory.

27 June, Saturday. At 0055 after a short run eastward from the core station we stopped to prepare for a camera lowering. This lowering was designed to take the camera down a steep slope, about 1100 feet horizontally and about 240 feet vertically, to the canyon floor near where the core had been taken. The operation took until 0355, and then we were off again. The approximate position of this station is 36°36'N, 16°40'E.

The remainder of the day until evening we had a beautifully scenic trip along the east coast of Sicily, past Mt. Aetna (covered by clouds), past Messina, and through the Strait of Messina to the vicinity of Stromboli. Since we had a functioning heat flow apparatus on board and only a few hours' available working time, I decided to take a heat flow measurement as close as possible to the base of Stromboli; we made the measurement, with the gravity corer, just over six miles southwest of the island (Station 85). The work was accomplished between 1942 and 2116; the approximate location was 38°47'N, 15°03'E.

Next we proceeded on course 293 toward the western part of the Tyrrhenian Sea.

28 June, Sunday. Today was devoted entirely to a speed run at about 14 knots across the Tyrrhenian Sea and north between Elba and Corsica. The seas were completely calm, as they have been most of the time since we left Beirut for the first time. The program of observations included gravity, magnetic, surface-temperature, and echo-sounding measurements.

In the morning I held a meeting of the scientific party to talk over preparing the ship for the port call and to review the scientific program of the past two weeks; this I did with the help of Bill Ryan. Dave Fahlquist gave a brief description of our plan for the work between La Spezia and Monaco.

Toward midnight it appeared that we had about three or four hours of working time before a nine o'clock arrival on Monday morning in La Spezia, and I decided to do three hours of CSP, beginning where we reached the latitude of Elba, about 2345.

The students, mostly under Colin Waldon, did an excellent job of straightening our gear on the afterdeck and in the lower lab; the ship as a whole is cleaner and neater than I have ever known her to be on entering port.

29 June, Monday. The session of CSP recording lasted until 0400, and we achieved possibly as much as three hours of actual observations. The record is striking. We towed the array 200 feet aft of the fantail, of course at an unknown depth. The cable was fastened to the 85-foot chain by means of the modified fairings, and the tow point was about 18 to 20 feet below sea level. The water depth was 200 fathoms (±30 fathoms) and the record was very clear at speeds of up to 9 knots. The chain did not tow well, tending to kite outboard, perhaps because we hadn't enough fairings on the chain and the cable was attached too close to the fish; these are points to be tested when we go to sea again. At 9 knots intense transient sounds were received by the array. They did not obscure the recording, but they were worrisome because they sounded as though the array might be breaking down in some way. At 8 knots the transients ceased. These may have been cavitation sounds, or possibly the higher speed was critical in causing some slap under water. I hope we can find this noise and eliminate it, as then we might be able to do the shallow-water work at 10 knots or faster.

After retrieving gear we continued at high speed toward La Spezia.

29 June - 2 July. The ship entered La Spezia about 1020 on 29 June. We expect to be here until 2 July. Jonathan Leiby met us and delivered the new crane for the stern. It was St. Peter's Day, a major Italian holiday. No business was transacted except for two phone calls, one to Rather in Houston and one to Beckerle in Woods Hole, both of which concerned use of the thermistor tows. No one visited us, and we had a blessed day of rest. The younger members of the party scattered.

On 30 June and 1 July we exchanged visits with scientists from the SACLANT Research Center, they coming to CHAIN for the most part on 30 June and the morning of 1 July. Fahlquist and I gave a seminar at the Center, reviewing the scientific program of WHOI in the Mediterranean. In the evening the officers and scientists of the ship were entertained at cocktails by Dr. and Mrs. Wineland and other families at the Center. The ship reciprocated by entertaining those of the party who could be present at a dinner in Lerici following the cocktail party. The guest list is recorded in CHAIN's guest book. We and three younger members - Ryan, Aldrich, and Salisbury - visited the Center on 2 July in the morning for technical discussions and a general view of the Center. The Director, Dr. Notvedt, then entertained all five of us at lunch at the Jolly Hotel.

We left the Molo Italia about 1600 and immediately proceeded out of the harbor and to the beginning of the projected grid of tracks, to measure subsurface geologic structures off western Italy between La Spezia and Elba. All of the underway observations were started by 1840 or so, and we were on a southerly course recording gravity, magnetic field, echo soundings, seismic reflections, and surface temperature. The recordings were made on a generally southerly or southeasterly course until the end of the day, but there were several interruptions due to malfunctions of the tape recorders and the Sparker (mainly, the Sparker intermittently missed firing).

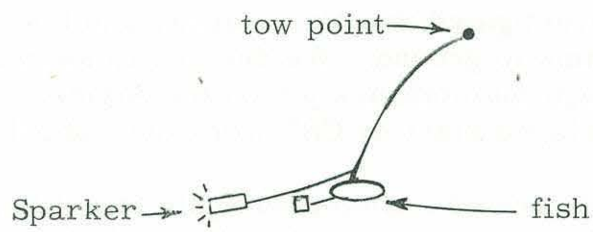
3 July, Friday. We continued underway observations all day, following the grid of tracks laid out by Dave Fahlquist. The continuity of CSP observations was considerably marred by the intermittent missing of the Sparker, a fault which still appears to be caused by conduction by the ignitrons during the charging cycle following a discharge. Thus, the missing occurs never more often than every other trigger cycle and usually not that often, but it is serious and we have tried to correct it by installing a new set of ignitrons.

Today Tasko discovered that we had not received, or perhaps had misplaced, his shipment of cable connectors and T-sections for the towed thermistors. I have sent out a series of radiograms trying to round them up and get them shipped to La Spezia, hoping that we can stop there and pick them up before we work too far to the west for this to be practical. Meanwhile we are searching the ship exhaustively.

Leiby has been finishing up the odds and ends of installing the A-frame and outboard working platforms on the stern. They should be excellent when completed. The basic installation of the A-frame and its hydraulic system was made by a shipyard crew from La Spezia under Leiby's direction, while CHAIN was tied up at Molo Italia. Thus, the work was a very smooth operation, although it involved considerable maintenance and repair, particularly of the 85-foot-chain winch and of the other A-frame already installed on the starboard side. We also engaged a large crane to shift the Schlumberger winch to the port side of the ship's deck so that its lead goes straight from the boat deck to the stern A-frame. The trailer lab containing the photographic darkroom and the Mercedes generator (which powers the Sparker) were shifted from the port side to the center of the ship, to make place for the crane. All these moves should improve greatly the general operability of the fantail.

In the afternoon Leiby and I toured part of the ship, reviewing in detail the sort of changes that are needed during the next yard overhaul.

During early evening, while the ignitrons of the Sparker were being changed, we changed the rigging on the array, placing its tow point 34 links below the surface and moving the tow point of the Sparker from near the wake on the stern, where it has been since our coring program of last week, to the starboard side where it originally was just after Beirut. We also rerigged to make the canvas fairing tow in better form for streaming. Later, when the ship was proceeding at 7.5 knots (nominal speed), I estimated that the Sparker electrode was about 4 feet aft of the after end of the new stern working platforms, and measured it to be 24 feet aft of the shackle fastening its tow cable to the hook of the hydrocrane. The shackle is about 2 feet above the water and we have three 9-foot fairings on the cable. In the absence of more accurate measurements I estimate the cable is 4 or 5 feet longer than the fairings, or a total of 31 or 32 feet. The cable clearly looks as if it were towing like this:



The various changes made today seem to have improved the PGR records considerably, in both the low and the high frequency bands (15 to 50 cps and 75 to 200 cps).

4 July, Saturday. Gravity, magnetic, CSP, echo sounding, surface temperature, and weather observations were continued underway throughout the day, with only minor interruptions for maintenance. We continued to follow the north-south grid lines of the Ligurian Sea survey. Most of the day our speed was 7.5 knots, but toward the end of the day as the water became deeper (as we worked farther and farther from Italy) the record became poorer at this speed and eventually, when the records seemed improved, I slowed ship to 5.5 knots. Soon we must recover the array and do maintenance on it: its output seems to contain faint beginnings of ground loop troubles, which may be caused by wetting through the out layer of rubber that was supposed to keep the metal case from grounding to seawater.

We had a fine picnic of steak, baked potatoes, and other victuals in honor of the Glorious Fourth. Weather mild, light airs; a thoroughly pleasant affair it was. During the evening the wind has freshened somewhat, but the weather remains mild.

5 July, Sunday. Today has been partly cloudy or overcast, with a light west wind and numerous thunder showers about. Underway observations were continued most of the day.

At about 0400 the set of north-south grid lines of the Ligurian Sea survey was completed and a series of east-west lines was begun. During the first half of the day the sea was mildly choppy, enough to affect one or two of the students but not any of the scientific programs. In the afternoon the winds abated, and toward late afternoon the wind dropped and the sky cleared.

About 1430 we slowed, to stream the array farther aft and reduce noise. We also investigated the Alpine array and found it to be slightly wet and 700,000 ohms to ground. We decided to swap to the Chesapeake array and do a thorough maintenance job on the Alpine. These changes and other minor troubles delayed starting CSP work until about 1930.

Winfree and I attempted again to record the scattering layer via the Edo transducer in the fish. Although the apparatus could be made to work, the recording appears not to be very successful, and I don't know why. The fish still has serious 60 cps pickup, which we will try to eliminate today. We made recordings of the spark and its reverberation and echoes on the Dimock analyzer; the records show 0. 1 to 0. 2 sec of low-frequency reverberation following the spark, but I cannot be sure how much of this is acoustic and how much electrical. In any event, none of this is like what we were able to do in 1961 with essentially identical equipment.

Magnetic disturbances apparently caused by the local thunderstorms are being recorded by our magnetometer. They appear as spikes on the paper record, each 100 to 300 gammas high.

6 July, Monday. The combined gravity, magnetic, and seismic reflection survey of the shallow water area off the western coast of Italy was completed today between 2300 and midnight by virtue of completing the series of east-west profiles that were commenced yesterday. Underway observations of surface temperature and weather were also continued.

All equipment operated satisfactorily, except the Sparker, which has continued to miss badly except when it is set for about 7.0 kv of tension. We decided to complete the shallow-water work and the first leg of the deep-water recordings farther west in the Ligurian Sea before stopping the Sparker and altering its program to eliminate the missing (all missing is due to failure of the condensers to charge, not to failure to fire).

Feverish outside painting of the superstructure has gone on for the past two days. It is necessary to watch out that you don't encounter a spray gun at point-blank range. The ship is looking far more spruce with each passing hour.

Removed the fish circuit from the echo-sounder connection box in the lower lab; this nearly cured the 60 cps pickup problem and makes it possible to hear water noises over the fish-suitcase combination. The large problem now remaining appears to be a general insensitivity of the system combined with the overwhelmingly loud acoustical or electrical signal from the Sparker, which causes saturation and, ultimately, paralysis of the receiving electronics for 0.2 to 0.3 sec after the Sparker is discharged.

We have been trying, via radio messages to Woods Hole and to the ship's agents in La Spezia and Beirut, to locate the electrical cables and other fittings shipped to Beirut for Tasko. Also missing is a box or two of gravimeter and PGR spares. Messages started to come in today, telling of three boxes received at Livorno; on the darker side, there is little hope of replacement from Woods Hole if the shipment is irrecoverably lost.

I have been trying to interest someone in taking a look at the surface temperatures; they might make an interesting and significant pattern over the grid we have just executed. The magnetometer shows such large anomalies that we have kept the recorder on the 1000-gamma scale steadily during this survey. The CSP recordings are both good and bad. We continue to be hampered by not knowing the depth of the array. Many of the reflectors at shallow depth in this area are so strong that we record many multiples, making interpretation very difficult indeed. In deeper water this problem will vanish, but for this area we will need energy from the Sparker and quietness in the array and all the other help we can get.

7 July, Tuesday. The usual underway observations (gravity, magnetics, surface temperature, CSP, and echo sounding) were carried out until 0820, when the Sparker was secured for repair, to remove the causes of the

intermittent charging. The repairs were completed about 1330, and CSP was continued with the Chesapeake array as receiver. The weather recorder is not working, having developed an electronic programming fault. While echo sounding we are recording the scattering layer, always in phase 1 of the left-hand channel of PGR 1. When the depth is greater than 400 fathoms, the bottom echo is recorded on channel 2: the programming is supposed to be altered with water depth such that bottom echoes will never appear in phase 1 when the depth is greater than 400 fathoms.

For the balance of the day underway observations were carried out along refraction profile 3 of CHAIN Cruise 7 (1959).

8 July, Wednesday. The geophysical observations along refraction profile 3 (CHAIN 7) were completed, and the ship ran the short distance to St. Lucia Bank. Underway observations (except weather observations) were continued until about 0230, when preparations were made to dredge the side of the bank. Rock dredging was successful there, netting a variety of igneous, metamorphic, and sedimentary rocks, as well as bottom sediment and several living animals. Also Bob Feden was quite happy; so was I.

The remainder of the day was spent following Dave Fahlquist's planned line of profile, but with some difficulties and interruptions both in gravity and seismics. Something went wrong with the gravimeter; it was fixed in about an hour early in the afternoon.

A loud transient noise, which had previously shown up in the Alpine array as an intermittent problem, became a full-time feature just after Station 86 (dredge). We reinstalled the Chesapeake array and continued our work through the rest of the day at 5.5 knots.

The plan of the survey was altered somewhat during the evening because of unanticipated results, but we arranged projected profiles to bring us to a promising dredging and camera site where the CSP records from CHAIN Cruise 21 suggest an outcrop.

The thermistor in the 85-foot chain was rehabilitated by Bob Tasko and is now recording again. Its lead on the fish had been completely mashed. Tasko is guiding Art Winfree along various electronic pathways hopefully leading to successful broad-band recording of the scattering layers with the Sparker as source and the Edo transducer in the fish as receiver. Thus far they have encountered mainly the results of neglect. The first job will be to replace the electric cabling in the 85-foot chain.

9 July, Thursday. Shortly after 0200 the CHAIN slowed for recovery of the towed gear (magnetometer, array, and Sparker fish), in preparation for Station 87 (camera). The station was made by 0600 near 43°23'N, 8°44'E and was completely successful. The location was selected by means of the CSP at a major fault that appears to place the underlying rough reflecting surface at the bottom and makes it form an abrupt steep slope. Photographs show rocks and some benthic life. This seems to be a significant find, but a decision was made not to dredge because of inadequacies in the lead for running the wire through the A-frame on the stern.

We are now too far behind in our program to make further CSP recordings and carry out the schedule we have laid out. We plan to visit the Monegasque manned spar buoy, which is 60 or 70 miles to the southwest of the camera station, and carry out a local CSP recording there. We are now committed to appearing in La Spezia at 1100 on 10 July. Reluctantly we recovered the array and Sparker and headed for the buoy at 9.5 knots. By 1500 we were within about 10 miles east of the buoy's position with two radar targets to the west at about the right range. Seven miles east of the buoy, on an otherwise flat featureless bottom, there is a small bump about 40 fathoms above the plain, around which Cousteau has asked us to make a survey with CSP to serve as a reference for the work of his own seismic group. We prepared to do this at 1500.

While we were running from the camera station we struggled with a dilemma: the Alpine, which has been our quietest array and has permitted speeds to 8 knots, is now noisy for a mysterious reason which seems to be mechanical and within the array itself. The Chesapeake behaves well at speeds as high as 6 knots, but is obviously limited to this speed by a noise that is not from the ship and dominates only at speeds greater than 6 knots. Might not this noise be generated by friction between the tubing of the array and the water? The tubing is rough to the touch and has on it ridges caused by the construction of the tube; this roughness may create the bothersome noise. A smooth paint might reduce both friction and noise. The tubing is neoprene, which seems not to be attacked by paints. About 1300, after some preliminary tests, I decided to take the plunge: we painted the sections of the array within 3 or 4 feet of each detector, and they were almost dry by 1500.

Speed-noise tests of a strictly qualitative nature quickly demonstrated that the surmise about flow noise and roughness was correct. The Chesapeake could now be towed at 9.5 knots without any burdensome noise at all. Even at this speed we could still distinguish the diesel engine sounds of the ship.

Just to make sure, we slowed to 7 knots, made three crossings over Cousteau's bump, and circumnavigated the buoy while recording CSP. Attempts at radio communications with the buoy failed, but there was an enthusiastic tooting of whistles. The weather was rather nasty, having been making up all day, so we had no thought of going on board the buoy; there would not have been time in any case.

After the visit to the buoy a course to La Spezia was laid, which would give new information about the fault zone where the camera lowering (Station 87) had been made. This zone has been traced somewhat speculatively, and seems to extend along a nearly north-south line across four of our survey lines.

10 July, Friday. The weather worsened through the night, but it comes from the southwest and puts us in a following sea, so we are quite comfortable. About 0400 we came upon the edge of the abyssal plain at the fault zone at about the time the Mercedes generator decided to quit. Sparker was reconnected to ship's power. CSP observations were continued until about 0700, when the Sparker was secured and its fish put on deck.

We proceeded as fast as possible to La Spezia, arriving there about 1230. Our shipments were ready for us on the dock, but we realized that it was useless to return to the heavy seas we had left outside the harbor. After some delay I learned that rough weather was expected to continue through the night. We decided to depart at 0800 on 11 July. This accident of schedule permitted several of the scientific party to confer with members of the SCALANT staff who had been away on a cruise at the time of our last visit.

11 July, Saturday. We left La Spezia shortly after 0900 and prepared to take all of the usual geophysical observations underway, down the continental slope southwestward from La Spezia and onto the abyssal plain of the Ligurian Sea. The abyssal plain starts as a distinct physiographic province marked by an abrupt change from steep slopes of several degrees to a fraction of a degree, as shown by echo sounding. CSP shows this same boundary to be structural (as mentioned earlier in this journal), with seamounts that rise several hundred fathoms above both slope and plain along a north-south trend. In places the seamounts adjoin the plain; elsewhere they stand a few miles to the east of it, with gentler slopes and subbottom evidence of somewhat irregular stratification. We planned to zigzag along this boundary, hoping to define its shape, and then to dredge on one of the steep slopes, maybe where the camera had shown coral and rock cropping out above the sediment.

During the remainder of the day we did just exactly as planned, and in addition made speed tests with the Alpine array coated with silicone grease. Like the coat of paint on the Chesapeake array, the grease permitted us to take good data at much higher speeds than formerly - up to 13 knots. There still remains the usual set of uncertainties and questions of the data's significance. (1) How much effect did the local geologic structure have on the success of the tests, was the bottom an especially good reflector (it was), and how about the subbottom reflectors? (2) To what extent was the flow noise limiting as compared with the ship's noise? (3) How well was the combination of Sparker depth and array depth tuned for optimal reception of echoes?

My own estimate of these factors is that the flow noise had been much reduced and was not very evident, whereas the ship's noise, such as that of the diesel engines, could plainly be heard. Screw beats were not prominent, however.

The bottom is a very good reflector; it is so good that quite possibly it seriously reduces the energy available for deeper reflectors. Over the abyssal plain where these tests were made we almost always heard three distinct bottom reflection - in 1400 fathoms of water and even during towing at 13 knots.

After zigzagging along the north-south boundary of the plain we selected a dredge location for Station 88. Dredging was accomplished between 2230 and 0030. There were several sizeable fragments, obviously freshly broken-off corals which were later identified as Desmophyllum cristagalli by Dr. Carpine of the Musée Océanographique of Monaco. The corals were dead and were covered by a black deposit. We do not know whether this deposit is manganese oxide.

12 July, Sunday. We decided to try another dredge lowering in the hope of taking some igneous rock from one of the seamounts. It was made (Station 89) without benefit of the tensiometer (which had been damaged at Station 88). The dredge was on deck about 0350 with only a touch of mud to show that it had been dredging.

Underway geophysical observations were started, and we proceeded easterly on course 095 for the southeastern end of refraction profile 2 of CHAIN Cruise 7. At 0730 we started running along this profile on course 287, recording CSP from the Chesapeake array.

About 0940 we sighted whales. By spout count there must have been at least five in the pod. They appear to be black and to have a small dorsal fin. The spout is vertical and estimated to be 10 feet high. The sounding interval between groups of spouts is about 6 to 8 minutes. The whales were in the vicinity of our line of seamounts, if this fact has any significance. They were observed for about an hour, the last sighting being made about 1100 near 43°25'N, 8°30'W.

We continued along the refraction profile to its end, which came just before 1700. All towed instruments were retrieved in preparation for the first test of the new thermistor tow.

After supper 50 meters of the new fairings were clamped onto 50 meters of the Schlumberger line. Several confusions and minor problems to be solved before the Schlumberger winch was operational were well handled by the crew. The new fairings, without instruments in them, were tow-tested at speeds of 2 to 13 knots. The wire angles were between 18° and 50° for speeds between 6.2 and 13.0 knots. Radical turns were executed both to port and to starboard. The tow appeared to behave very well in these tests. The tests were completed at 2045.

We set up the underway geophysical observations with the plan of making a more detailed study of the area of the abyssal plain near Monaco.

At about midnight the computer collapsed; it cowered in a corner, not operational, for the remaining nine hours before our arrival in Monaco. If such had to happen, this was a good time and place for it.

<u>13 July, Monday to 15 July Wednesday.</u> Gravity and magnetic observations were discontinued when the computer collapsed. CSP might almost as well be said to have collapsed, too, because the morning hours were engulfed in a-c power-line pickup problems. Some recordings were made, but most of the night's work was a disappointment.

We entered the harbor at Monaco about 0900 13 July and made a Mediterranean mooring at a brand-new dock in the center of the harbor. The next three days (until our departure on 16 July) were crowded with entertaining many visitors to the ship and with visits to the Museum of Oceanography at Monaco. We were entertained most handsomely by the museum staff at a reception on 13 July, and we reciprocated by inviting the entire staff of the museum as well as other guests to one of Sammy Pierce's steak cookouts on the fore deck of CHAIN. It was a fine party - and what a setting!

It is quite impossible to capture the complexity or the worth of such a mingling of two scientific groups. That Prince Albert's collection of oceanographic instruments would have a broadening effect on our group should be obvious to anyone who has seen that collection. On the other hand, we have more deliberately approached oceanography with the technical tools of the present age than have most of our counterparts in the world, and a good leisurely inspection of our ship and its program is bound to be thought-provoking to an oceanographer unfamiliar with such a program. I feel that a most valuable communication has been made in these few days.

Biologists helped us by identifying our corals dredged at 1200 fathoms, and a carbon-14 dating specialist has taken samples for an age determination of them. We in turn provided the seismologists at Monaco with records of seismic reflection observations made near the spar buoy.

16 July, Thursday. We departed Monaco about 1030 and started streaming gear, with the intention of running along refraction profile 1 of CHAIN Cruise 7. Magnetic and gravity observations were quickly started, but not the CSP, as we had great trouble with power-line pickup: the Alpine array gave us an excessive pickup that we could not locate. We switched to the Chesapeake shortly after 1415 and finally began the work. We started along the refraction profile at 1746 on course 124. These observations continued through the rest of the day, although with many interruptions because of pickup problems, Sparker generator problems, and several attempts to return to the Alpine array so that we could achieve higher speed.

While still close to Monaco, about 1130, we observed a school of small fish making a stir at the surface about a mile from the port quarter. They were being fished by gulls in the air and by some sort of larger fishes in the water.

17 July, Friday. The underway geophysical observations along refraction profile 1 of CHAIN Cruise 7 were completed about 0430, and we headed for the Buoy Laboratoire of Monaco and started to survey with the same methods on a grid of profiles near it.

About 0900 the air conditioning and, hence, the gravity and magnetics operation shut down and stayed shut down until about 1620. CSP did, too, but for different reasons (power-line pickup), until 1740, when this fact was recognized and we broke off further attempts to retrieve the day.

We proceeded to the bump 7 miles east of Buoy Laboratoire, first to photograph it and later to dredge.

For this operation we rigged the fifty-foot booms and their Edo transducers. After a great confusion of attempts to use suitcase amplifiers for listening to the Edos, we found they worked very well when paralleled with those on the bow at the input to the Gifft transceiver. Considerable time was lost, however, in making this discovery. The camera lowering was started about 2300 and terminated about 0140A on 18 July. We later found that, apparently because of moisture, both cameras had jammed and taken no pictures.

18 July, Saturday. After the camera lowering of yesterday, two dredgings were made with both pinger and directional receiving array. Both netted only mud but were successful in that we had demonstration that the dredge towed astern and went directly over the intended feature on the bottom (Stations 93 and 94).

The remaining daylight hours were spent in mechanical towing tests with the wire on the Schlumberger winch and the Commercial Engineering fairings. Speeds of up to 12 knots were used to measure vertical wire angles as a function of towing speed for 150, 300, and 600 meters of Mark V fairings. The tests were successful, and various data on towing characteristics and rigging times were taken.

Between 1900 and 2000 it was necessary to shut off the air conditioning for maintenance. Consequently, the computer was unavailable until about midnight. It was possible to conduct CSP observations, however, and the other geophysical observations were resumed by the end of the day.

There was one brief whale sighting today, but no estimates of the characteristics of the whale were reported.

19 July, Sunday. We were underway all day making gravity, magnetic, seismic-refraction, and surface-temperature observations. Various adjustments were made in speed as well as in depth of the array and Sparker, in an attempt to improve CSP records. Generally we saw few reflections beyond 0. 5 sec until after we had altered course from 200 to 243 at 1430 in order to head for Gibraltar. Within a few hours of this time we were recording reflections that indicated a persistent layer 0. 3 to 0. 5 sec below the bottom. All along the track today we have been recording the same sort of shadow interruptions

of the shallow subbottom layers that are represented bythe bump seven miles east of the Buoy Laboratoire. These interruptions do seem to come in groups, and some of them break through the surface and form bumps. Their depth below sea level appears to lie within 100 fathoms of each other and the bottom. Occasionally we see evidence of the rough surface from which these structures appear to protrude. It seems to have a somewhat more variable depth, taking the average height of crescents, which lies between 0. 75 sec and more than 1. 0 sec after the onset of the bottom echo. We have recorded this deep, rough surface so intermittently here that I feel we know little about it. Minor instrumental difficulties, including residual power-line pickup and lack of time, are preventing us from learning much about the Algiers-Provencal Basin. Anyone with a 9000-joule Boomer and a good receiving system, however, could do a very worthwhile geological investigation just be charting the occurrence of these interrupting and protruding structures.

Throughout the day Tasko, Rather, and others have been designing, testing, and assembling an upside-down pinger to mount on the fish (2500 pounds and painted bright orange) which is used to hold down the thermistor tow. This is an adaptation of the Edgerton pinger and allows it to be triggered by the PGR; it also incorporates a separate receiver on the fish. Both trigger and receiver connections from fish to ship are to be made through the logging cable on the Schlumberger winch. By nightfall the system had been completed and tested functionally on deck, but a series of technical mishaps in assembly prevented its being tested in the water immediately and kept a few of us working at it until about three hours beyond midnight.

20 July, Monday. We made the three underway geophysical observations (gravity, magnetics, and CSP) nearly all day long, as well as echo-sounding and temperature measurements at the bow and in the thermistor fish. The IIOE automatic weather station has been out of operation, since we did not receive any replacement parts for it in Monaco. The track for the day was along 242 about midway between the Balearics and North Africa and in water about 1150 to 1450 fathoms deep. A complex reflection was recorded off and on during the day, lying between 0. 25 and maybe 1. 0 sec below bottom. There are hints of deeper reflections. We have been increasingly beset by precision power pickup and don't seem to be able to find it.

Tasko and others have worked all day to make the upside-down echo sounder on the thermistor fish work. About 1930 it did. We tested it in the water with 120 meters of Mark V fairings on the Schlumberger. At first it worked well; then it seemed to give up completely. We decided to assume that its reason for failing was trivial and left it for the morrow, continuing with underway observations through the night.

21 July, Tuesday. Underway observations were continued until about nine o'clock in the morning. They were spiced by a visit at 0215 from several porpoises who played about the bow for some minutes. CHAIN was on course 244 heading toward Gibraltar, generally at a speed of 10 knots. The Sparker was stopped at 0952 and brought aboard, but the magnetometer and array were left streaming astern.

By 1000 a tow test of empty Mark IV fairings was underway. The inverted echo sounder on the fish worked well throughout the test, which was conducted at speeds of 4, 6, 8, and, for 150 meters of fairings, 10 knots. Fairings were installed in cable segments 150, 300, and 450 meters long, each of which was tow-tested. The tests were successfully completed at 1544, but during recovery of the gear the drive shaft of the Schlumberger winch broke (for the third time). This was an operator failure and not due to excessive load (the total tension observed during high-speed towing was just greater than 2 tons).

Repairs were finished by 1800; in the meantime we rigged the Sparker and made underway geophysical observations while headed for Gibraltar. The thermistor fish was aboard by 1949.

For the balance of the day we headed by Gibraltar on 280 and, most of the time, at full two-engine speed (10 knots) while recording gravity, magnetics, CSP, echo-sounding, and surface-temperature measurements.

22 July, Wednesday. Underway geophysical observations were continued through the morning watches until 0718 on course 277° at full two-engine speed (about 10 knots). At that time the Sparker was stopped so that the thermistor tow could be lowered. We attempted to lower the entire string complete with sensors and electronics. After a hard day's work with many frustrations it became obvious that the line had a few faults in it, which we planned to correct the following day. The Sparker was started again just before 1700 for sound-scattering observations during the passage through the Strait of Gibraltar. We also tried recording CSP. There seem to be a few pockets of layered rock or sediments 10 or 20 miles from the Strait, but the bottom along most of the passage is rugged and looks bare.

The air was hazy at best, and the visibility was often as low as 1 mile in light fog. The watch officers and Captain Davis had an anxious time passing through the Strait because of the heavy traffic. We cleared the Strait about dusk, between 2000 and 2100. The first steady course beyond the Strait was 280. About 2200 a little excitement was caused by the Schlumberger winch brakes slipping slightly and allowing about 16 meters of wire to go out. This was probably an operator error, as we found the hand brake slightly loose. Nevertheless, leaving such a heavy tow on a hand brake is a poor way to operate. We tied a white rag onto the wire to help monitor further slippage. Later (23 July) Dick Nowak rigged a light in the top lab so that the slipping would turn out the light, warning of trouble.

Many sightings of porpoises were made today, as well as of other fish. The display of scattering layers through the Strait was, as usual, magnificent. No evidence of internal waves was found, either in slicks and white water on the surface or in waviness of the scattering layers.

23 July, Thursday. Underway geophysical observations were continued through the morning along the southern coast of Spain and Portugal. We stayed in water several hundred fathoms deep both because of the thermistor tow and because our purpose in crossing this area was to search for major structural breaks that would reflect sound and could be traced to outcrops on the continental slope. The bottom profile was uneven or rugged all the way. In places there seemed to be both folded layers and layers that may have been sediment deposited in relatively small local basins. These recordings, which are similar to many just completed in the western Mediterranean, have a suspiciously regular geometrical look about them. Characteristically, many layers are nearly parallel to each other but curving as though to fit a space between two high parts of the bottom profile. They are recorded up to 0. 25 to 0. 50 sec beyond the bottom and spaced at most about 0. 02 sec apart. In some places each successively deeper layer seems to assume the shape, though slightly exaggerated, of the one above it. In others this does not appear to be the relationship. Possibly these are some sort of multiple internal reflection in thinly bedded sediments; possibly they truly present the profile of deposits of layered rock. Their travel-time pattern does appear to be related to some dimension of the geologic structure and not merely to an instrumental oscillation.

At 1025 the Sparker was stopped and we slowed to 4 knots to make repairs to the thermistor tow. This became somewhat of a bear-by-the tail, since sequential failures twice required that we raise the cable nearly its full 200 meters. The last thermistor was put on the line at 1632, and at that point all of them were sound. The Sparker was warmed up and we soon resumed 10-knot speed and the full program of underway observations.

Bob Tasko had learned by this time that the electrical radiation from the Sparker gave him a gratuitous pulse that would initiate his reed switch sequence. He was busily trying to measure this effect and to devise a way of circumventing it. By midnight, however, we knew from checks of the cable that the mechanical construction of the electrical cable was not up to towing at 10 knots, since in these few hours three cable faults had developed.

To add to the joy of the occasion, the seismic reflection recordings were most disappointing for the rest of the day; at least, we found that where we were there just did not seem to be subbottom reflectors deeper than a few tenths of a second. A compensating joy was that the Chesapeake array, which had been installed during the day, performed well at 10 knots and was quiet at frequencies of above 100 cps. In the band of 15 to 50 cps it appears to be 4 decibels noisier at 10 knots than it is at 4 knots. This rather surprising result, which should be checked, is to be explained by the prominence of the engine room sounds, which are observed at all speeds. Except for failures that were quickly repaired, the computer and the gravity, magnetics, water-temperature, and echo-sounding measurements went on without a hitch.

<u>24 July, Friday.</u> Proceeded over rugged topography most of the day. At 0928 we diverted from a course of 344 (heading for Galicia Bank) to 307, which would take us over a corner of an abyssal plain. CSP showed only 0. 2 to 0. 3 sec penetration, but we paralleled the edge of the basin and were close to it. Later results were uniformly disappointing and, on top of this, the quality of the received sound was poor. At 1127 the Alpine was streamed. Its signal was obviously weak. After several fake starts a corroded plug in the deck connections aft was found to be the culprit; it was replaced, and the subsequent results were much better. Still no substantial subbottom echoes except at very short delays after bottom. This situation prevailed all day.

Early this morning CSP was interrupted for Tasko to make measurements on the thermistors without interference from the Sparker. In the afternoon the whole thermistor tow was recovered on deck in one hour.

Today the main lab watch told me that they had recently become keenly interested in the bow and fish temperature measurements. Could they be combined and put in one place? We discussed this, and plan to record them on Rustrak in the main lab. We must measure the depth of the fish better, if past data are to be retrieved and our future work improved. I propose that this be done by measuring the depth of the water simultaneously on the bow and on the fish: the difference plus 2. 5 fathoms is the depth of the fish.

25 July, Saturday. Underway observations were made all day except for the hours between 1446 and 2100, during which we measured the tow angle and depth of the fish for the Schlumberger cable without fairings. Bob Tasko made a series of tests on thermistor elements attached to the cable in Mark IV fairings, and he attached an experimental string of nine thermistors to the line, to be towed for the night, to discover whether simple means of strengthening the connectors would make the system work. We got an answer to that by midnight, as one cable failure seemed to have occurred, within an hour of going to 10-knot speed. The triggering system still seemed to be actuated by the Sparker, although it had not been so actuated when tested at the fantail by a special tester that eliminated the top-lab apparatus. This made me suspect the cable, which is run inside the ship from the stern to the top lab and so through the Sparker compartment. Tests made on Sunday with a separate line outside the ship eliminated the Sparker actuations. The outside line could be used without any Sparker-actuated triggerings. Now if we can conquer the plug failures we can find out what other defects remain!

All observations except CSP went as well as usual, and the CSP recordings were much better than yesterday. About suppertime we started climbing Galicia Bank, arriving at soundings less than 500 fathoms at 1900. Between thermistor tests we managed short sequences of CSP recordings, which show that the very shallowest part of the bank over which we went (less than 400 fathoms) consists of nearly horizontally layered rock which must crop out at the edges of the banks. Below the shallowest portion is a slope starting at about 1000 fathoms and sloping downward to about 1500 fathoms. This slope is underlain by a layer that slopes somewhat more rapidly, since it appears about 0. 5 sec after the bottom at 1000 fathoms and about 0. 75 sec from 1200 fathoms on down. Recordings of this reflector were quite good even at 11 knots nominal speed. At Galicia Bank at 1920 we changed course from 348 to 036, heading for the southern end of the seismic reflection line for Whittard south of Penzance Point in Cornwall.

It is now apparent that we will have to make 11 knots, if we are to reach Plymouth in time for the trip through the lock.

26 July, Sunday. Underway geophysical observations were made all day at speeds of 10 to more than 11 knots, except during a brief period after 1600, when the final thermistor tow tests were made and the cable and fish were finally put on deck.

In the early morning hours we were descending the northern slope of Galicia Bank to the abyssal plain of the Bay of Biscay. During much of the descent the subbottom reflection observed yesterday was recorded at a delay of approximately 0. 75 sec. In depths between 1500 and 2000 fathoms this reflection was lost in noise or the reflector terminated. For several hours after, the low-frequency bottom reflection was very faint, maybe because our speed of 11 knots caused the array to stream too close to the surface. We slowed to 4 knots and let the 85-foot chain out 10 feet. Immediately the bottom echo and two or three others up to 0. 25 sec later were recorded rather well above background. There is no time to slow the ship again, or make careful measurements of this effect, or find out whether the signal could be further enhanced by such means. We also deepened the Sparker as much as possible at this same time. In any event, we recorded at least 0. 25 sec penetration the remainder of the day, and we may be detecting deeper layers at considerably greater delays, up to about 1. 25 sec, which are very weak compared with the background of a 10-knot tow.

There was minor trouble with the magnetometer for a time, but in other respects the recording program was complete and trouble-free throughout the day.

We had one last fling with the towed thermistor chain, during which we mounted seven new thermistors in the hope of achieving a small operational test. Even at slow ship speeds, one or two cable faults developed within a half-hour of installation. We decided to give up completely. The cable and fish were stowed about 2100.

We now must return to 11 knots speed to reach Plymouth by 0700 on Tuesday. I believe we can do so without serious harm to the scientific program, but we would have to reschedule completely our arrival there, say by three to five days, for us to do our work materially better.

About ten o'clock this morning a large school of tuna was sighted about a mile off our port bow, and just before midnight four or five porpoises played about the bow.

27 July, Monday. Underway geophysical observations at 11 knots all day. The high continuous speed is designed to bring us to the pilot station at Plymouth tomorrow at 0700. Recordings were made across the continental slope during the early morning hours. The CSP records were not good and probably are not indicative of what the method can do in this place.

Over the edge of the shelf several subbottom reflectors were recorded; they disappeared beneath the strong second echo from the bottom as the water shoaled. One subbottom reflector remained; it seemed to shoal gradually until it finally formed the sea floor. Some time later we appreciated that the 1000-fathom scale of the PGR is too compressed and long pulse we have been using in deep water is just too long for studying the shelf. We first tried reducing the voltage. This proved ineffective, so we cut out three of the four condensers in the Sparker. The latter change cut the pulse width in half and permitted us to use a repetition rate of one spark per four seconds instead of one per ten. At the same time we shifted to the 400-fathom sweep (one spark in four recorder sweeps) much clearer records resulting. Subsequently, several reflecting surfaces were detected and traced from the beginning of the second bottom reflection to the bottom echo. Thus, all the reflectors on this line appear to be dipping to the south rather than forming a syncline, as they do farther east, in the English Channel.

The magnetic field showed large local variations over the abyssal plain and after we crossed the shelf edge as well. At least one magnetic high over Parson's Bank agrees with that reported by T. D. Allen, of SACLANT. I do not know whether a large high in the abyssal plain is known of from previous work.

28 July, Tuesday. Observations with towed gear were terminated just before 0600 after we had passed the Eddystone abeam. All gear was retrieved on deck by 0630, and by 0800 we were tied up in Millbay Dock.

Plymouth, England to Woods Hole, Massachusetts
31 July - 21 August, 1964

by Richard L. Chase

30 July, Thursday. The ship lay in Willoughby's Docks, Plymouth, at the berth usually occupied by RRS DISCOVERY.

Dr. J. B. Hersey left the ship at 2300 hours to take the night sleeper for London.

During the day technicians from Decca Ltd. completed the installation of the new Decca radar on the ship and checked the Decca Navigation.

Personnel who left the ship at the completion of the Monaco-Plymouth leg were Drs. J. B. Hersey and Davis Fahlquist, Messrs. Roy and Randy Rather, Dr. William Ryan, Mr. Robert Whitmarsh, Capt. David Scott, and Mr. Robert Tasko.

Dr. R. L. Chase arrived to take over as Chief Scientist. Mr. John Jones, of the Department of Geology and Geophysics, Cambridge University, also joined.

31 July, Friday. The ship moved from Willoughby's Docks to Sutton Harbor for fuelling at 0915. Fuelling was completed at 1600, and at 1615 the ship cast off and moved out of Plymouth Sound, passing many small sailing craft with brightly colored sails.

Watches were set: Top Lab

0000-0400 1200-1600	0400-0800 1600-2000	0800-1200 2000-2400
Halunen	Waldon	Feden
Jones	Friedberg	Campbell
Carlisle	Salisbury*	Porter
	Yates	Winfree

Gravity Lab

Goulet	Vogt*	Aldrich

* Salisbury and Vogt exchanged watches 10 August.

The scientific party is as follows:

Chase, Richard, Chief Scientist

Aldrich, Thomas
Birch, Francis
Campbell, J. Frisbee
Carlisle, Donald
Feden, Robert
Friedberg, Jeffrey
Goulet, Julien
Halunen, John
Jones, John
Nowak, Richard
Porter, Charles
Powers, Patrick (IBM)
Salisbury, Matthew
Vogt, Peter
Waldon, Colin
Winfree, Arthur

Half an hour was spent in testing the ship's radar, after the Sound had been cleared. Thereafter we commenced a survey in the coastal waters between Plymouth and Land's End. A course was set a mile outside British Territorial water, about four miles offshore, following the coast westward in 30 to 40 fathoms of water. The Alpine hydrophone array was towed 200 feet behind the ship, and only one of the four capacitor banks of the Sparker was used to produce sound for seismic profiling. The object of the survey was to seek evidence for the existence of buried submarine valleys or canyons cut during Pleistocene low sea level into the Paleozoic rocks. We expected to find canyons off shore from present-day rivers such as the Plym and the Fal. The survey failed because of insufficient resolution of the seismic profiler. The Sparker wavetrain was some 200 feet long, whereas the buried Pleistocene surface we sought is probably located considerably nearer than this beneath the seafloor. Echo soundings with the impulse pinger also failed to reveal subbottom surfaces, probably because the sandy bottom is acoustically unsatisfactory.

1 August, Saturday. On completion of the coastal survey off Cornwall, the ship began a survey of the continental shelf and slope off England and Brittany. The survey has six legs.

The first leg was south from Land's End to a point off Brittany. A syncline in the subbottom was passed over in this leg. Magnetic-field intensity anomalies lie over the points where major subbottom reflectors delineating the syncline come nearest to sea bottom.

On the second leg the ship passed southwestward over the shelf-slope margin. Near the edge of the shelf, subbottom reflectors dip oceanward but, surprisingly, appear to flatten out as the actual margin of the shelf is approached. The slope in this area is very rugged, and little information was obtained about the subbottom acoustic characteristics because of the steep slopes and side echoes of the bottom itself.

The third, or northward, leg of the shelf survey was commenced at 2322 hours.

During the day the Decca radar and Decca Navigator gave some trouble, and we were unable to locate ourselves accurately by using Decca cross-chain fixing.

Evidence of a concentration of marine life at the edge of the continental shelf was obtained on the two-channel precision graphic recorder used for echo soundings.

The Alpine hydrophone array was towed at a distance of 200 feet behind the ship for the shelf work, and the 100,000-joule Sparker was used at low power. This arrangement proved unsatisfactory for work over the slope, so during the second (southwestward) leg the array was let out to 600 feet behind the ship and the Sparker used at full power.

The bow thermistor continuously recorded sea temperature. A short circuit in the stern thermistor (mounted in a towing fish attached to the 85-foot faired chain) prevented its operation.

Wind and sea were moderate and sky clear during the day.

2 August, Sunday. At the beginning of the day the ship was over the continental slope, proceeding northward. The boundary of the continental shelf was crossed during the morning, and for the remainder of the day continuous seismic profiles were made over the shelf, except for a time in the morning when CSP gear was overhauled. An overcast sky necessitated reliance on the Decca Navigator for positioning the ship. Readings from the Southwest British Chain of stations seemed fairly accurate.

The Alpine hydrophone array was streamed from the stern unattached to a fish and gave good results. Meanwhile the stern thermistor mounted in the fish usually used to stream the array was made to function again.

Little information on subbottom structure was discernible in the seismic reflection records over the continental slope, except at the uppermost part of the slope, where relatively steeply dipping reflectors are almost parallel with the present bottom and seem to flatten with it as the slope gives way to the continental shelf.

Penetration of 0. 25 to 0. 33 second was achieved beneath the continental shelf. Structural features observed were broad anticlines with very low amplitude in the subbottom, in places, but not everywhere, coinciding with rises or sags in the sea bottom.

The bow thermistor, magnetometer, and gravimeter were operative, and echo soundings of bottom and scattering layers were obtained continuously.

3 August, Monday. The first part of the day the ship completed the survey of the continental shelf and slope: at 0545 the third and last crossing of the boundary of the continental shelf and continental slope was made, in a southerly direction; at 1552, over the continental rise, the survey was completed and the ship turned westward towards the mid-oceanic ridge and Woods Hole. The narrow abyssal plain which lies at the foot of Europe in these latitudes was crossed between 1725 and midnight, and at the end of the day we were steaming over abyssal hills.

The bearings of one of the magnetic disk packs used for the storage of data fed into the IBM 1710 computer became noisy and were replaced by a new set from the engine room.

Both bow and stern thermistors and gravity, magnetics, and echo sounding data were recorded continuously through the day.

The Alpine hydrophone array was streamed again from the 85-foot chain when the continental slope was reached, and the Sparker, which had been operating on one capacitor bank over the shelf, was now operated on four. The sky was overcast and the seas light to moderate.

Seismic reflection profiles very similar to yesterday's were obtained over the continental shelf. Over the northern side of a canyon, crossed near the outer margin of the shelf, southward-dipping subbottom reflectors appeared on the seismic reflection records. The dips of these reflectors steepen under the canyon's north slope, and some appear to outcrop there at depths between 160 and 240 fathoms. Little penetration was achieved over the remainder of the continental slope and rise or even over the abyssal plain. The surface of the last is a very good reflector: two multiples of the bottom echo could be heard.

The transition between the continental slope and the continental rise was crossed at 1130. Here the shape of the magnetic profiles changed from a relatively steep westward slope of about 3 milligauss per mile to a wavy trace, the waves having an amplitude of about 80 milligauss and a length of 14 miles.

4 August, Tuesday. The ship continued westward toward the Mid-Atlantic Ridge over rugged terrain at the eastern extremity of the east flank of the ridge.

Two velocimeter lowerings were completed and a third was started during the day. Velocity minima were found at about 60 and 740 fathoms, and zones of irregular gradient at 450 to 650 fathoms and 740 to 850 fathoms. The two completed profiles, made about 28 miles apart, show minor differences as far down as 1100 fathoms, but become identical at greater depths. The first lowering was delayed two hours when the Markey winch brake gave trouble.

Seismic reflection profiles were poor for the first part of the day, with considerable 60 cps interference. Seismic profiling gear was not streamed between the second and third velcoimeter lowerings, while Richard Nowak worked at isolating and eliminating the causes of the background in the records.

Seas were light. An overcast day and a too great distance from Decca transmitting stations made exact determination of the ship's position impossible.

5 August, Wednesday. The ship continued westward. Four velocimeter lowerings spaced about 28 miles apart were completed. The third of these (Station 98) was marred by pinger and electronic malfunctioning, and the instrument was brought to the surface from about 600 fathoms.

Colin Waldon and Robert Feden renewed the Sparker electrode tip, and the seismic profiling gear was streamed and tested after the third velocimeter lowering.

The topography continued rough. We are in the southern flanks of Rockall Rise or over the lower step of the east flank of the Mid-Atlantic Ridge. Seismic reflection profiles made after the last velocimeter station (Station

100) show about 0.25 second of penetration to one subbottom reflector. Since Dick Nowak put a shielded transformer into the electronics in the top laboratory, the background noise due to 60 cps interference on our reflection records has gone down 11 decibels.

The stern thermistor was out of action again because of a short circuit.

A big sea bird examined us as we took a bathythermograph after Station 100, then flew off.

Art Winfree scooped up some transparent plankton about 3 cm long and put them in formaldehyde. These animals emit flashes of light at night.

Dolphins were sighted and their noises taped.

6 August, Thursday. The weather was clear again in the morning, with moderate seas from the west. Because we had made only 8 knots during the night, speed was increased to 11 or 12 knots to make up time. Even at this speed we continued to get 0.25-second penetration below the bottom on our reflection records, and the gravimeter was not much affected because of the diminished seas.

We seem to have passed over the southern part of Rockall Rise during the night. The bottom rose to 2000 fathoms and appears made of a series of faulted blocks. In the morning more abrupt scarps were crossed, and depth increased to 2500 fathoms. This means that the Rockall Rise should be extended farther south than indicated on Heezen's physiographic diagram.

Sea gulls were sighted. The ship is equidistant from the Azores, northwest Iberia, and southwest Ireland (about 525 nautical miles in each case). Porpoise noises were taped and three scattering layers seen on echo sounding records.

7 August, Friday. The day dawned foggy, and the sky was generally overcast but with some sun later.

Continuously recording echo soundings, strength of gravitational and magnetic fields, sea temperature from the bow thermistor, and seismic reflection, the ship finished the course westward from the European continental rise to the Mid-Atlantic Ridge. The east side of the central zone of the latter was reached at 1100, at a point within the area surveyed by DISCOVERY II in 1960. Streamed gear was hauled in over a hill which rises to a depth of 786 fathoms, and Station 101, a lowering of the deep-diving magnetometer, was begun. The hill has over it a positive magnetic anomaly, and it was our aim to measure the vertical variation in the earth's magnetic field between sea level and the top of the hill.

John Jones and Chuck Porter readied the instrument while we maneuvered after lunch. The rig consists of a proton magnetometer, a recorder mounted in a 4-foot long pressure case, and a lead weight. The weight is secured below the magnetometer by a light line about 50 feet long and acts as a stabilizer during lowering. The magnetometer in turn is secured to the recorder by 50 feet of line, along which is taped the conducting cable connecting the recorder and the coil within the magnetometer. The recorder is attached to the Fiege fitting at the end of the half-inch wire on the trawl winch. All three parts of the rig were lowered over the stern A-frame. An estimated eastward set of 1 knot made maintenance of the ship's position over the center of the magnetic anomaly difficult, because we had no buoy or other marker as a reference point. The gear was eventually pulled to the surface at 1615, and it was found that salt water had shorted a circuit in the recorder so that incomplete records were obtained.

Seismic profiling gear was streamed, and the ship moved due south down the east side of the median valley, then west across it. The valley here is filled with hills, but the sides are higher than the central hills and so are fairly evident.

We attempted to put the heat probe down into a narrow valley within the main valley (Station 102). The probe went 11 feet into clay or ooze, then apparently struck rock, whereupon the paper reel in the recorder came adrift and spoiled the record.

Magnetic anomalies over the central valley are high - several hundred to more than a thousand milligauss.

8 August, Saturday. A second crossing of the median valley of the mid-oceanic ridge was made 20 miles south of the first, and a second narrow deep valley within the central valley was chosen as a heat probe site. Again the probe hit rock or gravel, smashing the lower thermistor, nose cone, and core catcher. Volcanic glass fragments were caught around the recorder.

After this disaster we went east and dredged (Station 104) a mountain 890 fathoms below surface on the east side of the central valley. The west-facing slope between 1440 and 1350 fathoms was dredged as the ship drifted east. About one hundred pounds of rock were recovered, almost entirely finely crystalline basalt with 1 mm vesicles. One limestone glacial erratic, some porous clay fragments, and tests of thin-shelled pelagic organisms in the bale sampler formed the remainder of the haul.

During the station a log, covered with gooseneck barnacles, crabs, sea slugs, eggs, brown algae and isopods (?), drifted by the ship, was hauled aboard, sampled, and thrown overboard. A sea turtle about two-feet long seen feeding on the log's creatures swam away.

Camera gear was lowered over the area dredged, and although one camera did not function, the other obtained good pictures of both rocky and sandy or muddy bottom with organisms.

Dick Nowak put together another pinger while heat probers Birch and Halunen licked their wounds.

A third crossing of the median valley, 20 miles south of the second, was made toward the end of the day.

Sea temperature (19.8°C) and weather were warmer today. The hoist thermistor continued to give trouble because of short-circuiting and was inoperative. Gravimeter hams gave trouble during the day.

9 August, Sunday. Sunny and mild with light wind and sea. The central valley was crossed three times in search of a valley suitable for heat probing. The crossings were 5 miles apart. On the third crossing a small valley was found, and the ship maneuvered back over it and put down the heat probe (a piston coring rig and 400-pound weight were used). The shock of the impact caused a leak in the recorder case; thus no record was obtained. A 9-foot core was taken, of cream-colored ooze with sandy interbeds. White and black grains in the ooze are presumably tests and volcanic glass fragments, respectively. The sand probably results from turbidity currents when sediment and volcanic debris slough off the sides of local hills.

More damage was sustained by the nose cone and corer barrel of the heat probe.

A conversation with Don Carlisle has led me to the belief that basalt obtained from the very center of the median valley should be fresher than that from its flanks. This follows from the convective spreading hypothesis, and is supported by a yield of at least incipiently weathered basalts from the valley's east wall but of fresh glass from a heat probe in its center.

At the completion of Station 106, the sheave on the starboard A-frame was changed in readiness for a lowering on the trawl wire through the stern A-frame. The Second Mate estimated that the ship drifted northeast at about 0. 8 knots during the heat probe station. During Station 107, a lowering of a rock dredge, the ship drifted north-northeast over the west-facing slope of the valley of the last heat probe, towing the dredge. The haul was several fragments of basalt (one with a glassy sheath), a striated facetted limestone glacial erratic, and several other fragments.

A cookout was then held on the port boat deck, after which the ship proceeded south-southeast and then west across the median valley again.

The wind rose to 30 knots and seas became heavier as night fell.

<u>10 August, Monday.</u> A stream of troubles fell into my lap today. At 0230, as we readied for a heat probe, it was found that the heat probe recorder bridge would not balance. This was rectified three hours later when Birch found that a resistance had been misplaced in the bridge circuit. At the same time it was found that the half-inch trawl wire was jammed in the sheave of the stern A-frame. After the wire was freed, the wiring in the trawl winch remote control box failed, preventing any lowerings on the trawl winch until it was repaired. The electricians had not got the winch in working order at the end of the day.

Since lowerings were not feasible for several hours at least, I turned the ship southward toward the area marked on various British and American charts as Chaucer Knolls or Banks, supposedly a group of hills coming within one hundred fathoms of the sea surface. I hoped that by the time we reached the area the trawl winch would be operable once again. We turned southwest at 1500 so that we should cross to the west side of the median valley. Thence we steamed for Chaucer Knolls.

The 85-foot hoist was lowered so that the array cable streamed from a point about 20 feet below surface. This was done to get reinforcement of 120 cps echoes.

Peter Vogt and Matthew Salisbury exchanged watch duties today, and will keep their new posts for the rest of the cruise.

Brenda, a moderate tropical storm, moved north from Bermuda. Gear on the fantail was secured as a precaution against her turning our way.

11 August, Tuesday. In the early hours of the morning the ship maneuvered in the area marked as Chaucer Knolls on sounding charts (see Figure 7). The minimum depth sounded was 600 fathoms. A buoy was laid down in the vicinity, anchored by quarter-inch polypropylene line to a Danforth anchor and 150 pounds of weights. Two radar reflectors were put atop the buoy, with an orange flag and a small light.

A grid of three and a half east-west traverses about 18 miles long and 2 miles apart was made about the buoy, the ship going 13 knots and recording echo sounding, gravity, and magnetic field intensity. A fresh northwest wind blew, and swells of six to eight feet from the same direction made the buoy difficult to detect with the ship's radar.

The trawl winch was finally pronounced in working order during the morning. The radar broke down at 1700, as the ship was heading for a site selected for a heat probe station, delaying the latter somewhat.

The main features of the area surveyed around the buoy are a north-trending ridge rising to 600 fathoms below the surface, and a comparatively flat area to the east of the ridge with a floor between 1350 and 1380 fathoms. The latter was chosen for the heat probe.

The gravity coring rig used for the heat probe fell on its side on coming to the bottom, retrieving only 1 foot of core. The ship then went west to dredge the north-trending ridge.

12 August, Wednesday. A productive day indeed, our best in the Mid-Atlantic Ridge survey. The day started badly. The first station of the day was a dredge lowering. With Feden at the controls, the ship drifted east toward the north-trending ridge located the previous day, dragging the dredge up

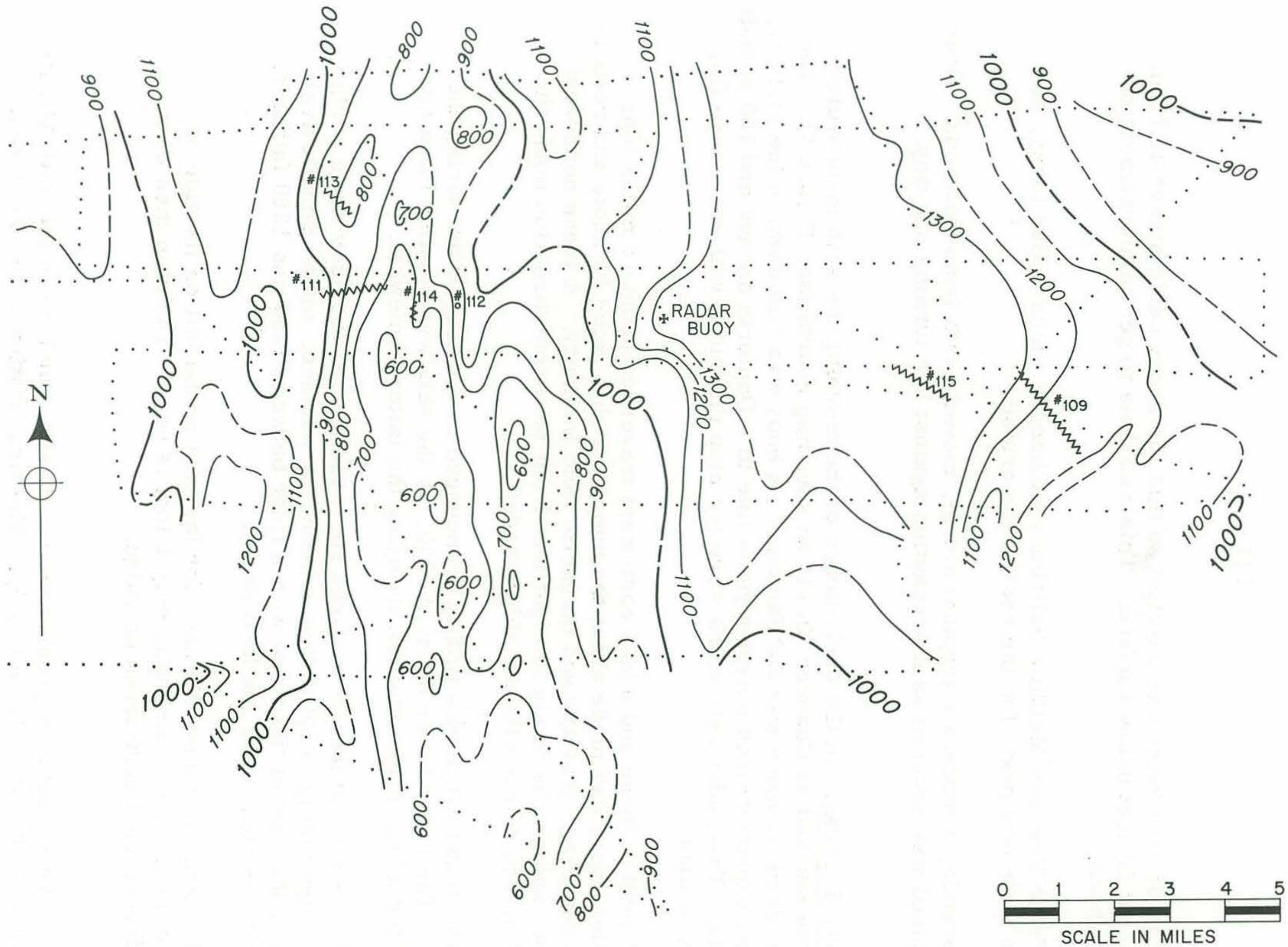


FIGURE 7. Chaucer Knolls area, Mid-Atlantic Ridge survey. Bathymetry (uncorrected) in fathoms; contour interval, 100 fathoms; radar buoy located at 28°54'W, 42°39'N. Zigzag lines indicate ship's position during station.

up slope. Feden became impatient at getting no bites and added 1.5 knots to the 1-knot set. The pinger, mounted 75 fathoms above the dredge, caught on a steep slope, was ripped from its clamp on the wire and fell to the bottom. The dredge was also lost, only its safety chains remaining forlornly on the end of the wire.

The camera rig (built-in pinger and two cameras with black-and-white film mounted 5 feet apart and focussed for 14 feet) was lowered by Fris Campbell over the top and upper west side of the north-trending ridge, as the ship made 30 to 40 turns at a heading of 300° to compensate for the 1-knot set. Excellent pictures resulted, forming practically a continuous mosaic and showing a series of sandy shelves or steps in the bottom, broken by steeper areas of outcrop and talus.

Two more dredge lowerings were made after the camera station, the first on the upper eastern slope of the ridge and the second on the lower western slope. Both lowerings were made as the ship steamed west-northwest against the set. Two cobbles, one of limestone and the other of weathered basalt (?) encrusted with manganiferous oxides and porous limestone, were retrieved by the dredge in the first lowering. The second haul consisted of about one hundred pounds of rock, mainly porous coralline limestone, with living sponges, worms, and other organisms attached, and several glacial erratics.

The penultimate station of the day was a lowering of John Jones' deep-diving magnetometer, during which the ship was kept within 0.2 of a mile of the center of a large negative magnetic anomaly over the north-trending ridge. The magnetometer recorder appeared to function well.

The final station in the area was a second lowering of a heat probe in the flat valley east of the ridge. This time a piston coring rig was used, an 11-foot core of sandy ooze was obtained, and a preliminary value of 1.3 μ cal/cm^{2}sec was obtained for the heat flow. Because this, the only successful probe of the Mid-Atlantic Ridge survey, was made in a valley which proved to be outside the median valley of the ridge, the major aim of the survey, to test the heat flow within the median valley, was not achieved. The median valley in the area we surveyed appears to be almost devoid of thicknesses of fine-grained sediment suitable for heat flow measurements with our present instrument. Detailed surveys such as we made in the Chaucer Knolls area, however, may reveal suitable spots for heat probing.

The ship steamed northeast away from the heat probe station at 13 knots, with magnetometer streamed, and extended the area surveyed around the buoy to the west and south. The position of the buoy was fixed by stars and several sun lines, and is right among the mythical Chaucer Knolls or Banks shown on sounding charts. The north-trending ridge was found to extend farther south without diminution of height or magnetic anomaly. The valley in which the heat probe was made is closed to the north.

Seismic profiling gear was streamed just before midnight, in preparation for a run down the axis of the flat-bottomed valley within the survey area.

A moderate-to-heavy swell from the north gradually subsided during the day, making radar detection of the buoy progressively easier. We achieved a maximum range of 10 to 11 miles under good conditions.

13 August, Thursday. The ship steamed south-southeast down the long axis of the flat valley east of the radar buoy. Less than 0.125 second penetration was obtained, showing that the sediment cover of the valley is thin. This and a subsequent east-west track completed the radar buoy survey in the Chaucer Knolls area. We have disproved the existence of the Knolls in this area. The ship steamed westward during the first third of the day, passing over the median valley for the last time. The valley here has a high broad magnetic anomaly over its center. The flanking ridges have sharper high anomalies. A depression in the Bouguer anomaly profile over the ridge on the eastern flank, i. e. the one surveyed, may be caused by a cap of limestone, specimens of which we obtained in abundance in our dredge haul of Station 113.

The day began overcast, and wind freshened until gusts of up to 55 knots were recorded. Wind direction shifted from southwest to northwest. Gear on the fantail was secured, ship's speed was reduced at times to 6 knots, and the gravimeter and computer memory discs were shut down during the latter half of the day.

Seismic reflection records obtained west of the median valley were good and show 0.25 second of penetration through sediment to a reflector which is presumably the volcanic surface exposed on the flanking ridges of the valley, and which continues to come to the surface when peaks are passed. At 2000 hours we crossed a seamount or ridge whose crest was 1005 fathoms and whose base was 1600 fathoms deep. A magnetic anomaly is associated with this feature.

Tom Aldrich streamed a new magnetometer because the old one seemed to have a signal-weakening short somewhere in its connections. The new fish is a Varian with a WHOI cable, the old one a WHOI fish with a WHOI cable.

The bottom records show a change from mountainous to more gently rolling topography as we passed from the mid-oceanic ridge center to its lower flanks.

14 August, Friday. The ship continued westward over the western flank of the Mid-Atlantic Ridge. Weather was unsettled, with moderate seas and some rain. Members of the scientific party were engaged in writing reports on various aspects of the work of the cruise.

The seismic reflection records made at 9 knots are much superior to those at 13 knots, but to keep on schedule most steaming has to be done at the latter speed. Only one 4-hour period at 9 knots was steamed (1330 to 1730 hours), the remainder of the day being at 13 knots, except for a time after supper when it was found that the array cable had partially detached itself from the hoist chain. The tape used to lash the cable to the chain had become unwound because of the high speeds during the last two days.

Somebody put PGR records of velocimeter lowerings on the floor of the drafting room and they were wet and one became almost useless as a result. Birch festooned them about the drafting room to dry them.

Sam Pierce, Chief Steward, requested that scientists move forward from the snake pit to the forward cabins. Winfree, Salisbury, and Carlisle will move, leaving Goulet alone in the snake pit.

The topography passed over today appears to be a series of fault blocks whose tops lie between 2000 and 2500 fathoms deep, with overall diminution in height from east to west. The blocks are 5 to 15 miles wide.

The bow thermistor recorded sea temperatures in the range 21.0 to 22.3°C; the hoist thermistor range was 20.3 to 23.2°C.

15 August, Saturday. A time zone change took place last night, the fourth of this leg. We have one more to bring us to Eastern Summer Time.

The ship steamed at 9 knots from 0400 to 0840 and at 12 to 13 knots at other times. Seismic reflection records show much noise at the higher speed but, when run through Dave Caulfield's correlator, quite deep reflectors may well be revealed; there are hints of this in the records.

Birch just came in and made a lurid graph in my presence, purporting to show that the 12-foot piston coring rig is superior, for heat probing, to the 12-foot gravity rig and the large (1200-pound) piston coring rig.

The high speed and heavy seas have been hard on streamed gear. The canvas sheathing around the Sparker cable above the fish had to be retied with line, and the array cable above its fish became unfastened when tape bindings unwound. The tape fastenings were replaced with six-thread line. Bolts holding the elbow joint of the array cable to the 85-foot hoist chain came loose and were tightened. Much noise in seismic reflection records at high speed was traced to flapping Scotch electric tape unwound from the fore end of the array.

The mid-ocean "canyon" was crossed in the evening. It is 50 fathoms deep, and the seismic records clearly show it to be an erosional feature, with flat-lying beds outcropping on its gently sloping sides. Coring and dredging of the sides of the canyon may well result in the recovery of interesting older deep-sea sediment; a radar buoy would have to be laid near-by so that a coring ship could accurately position itself over the banks.

Engine troubles at suppertime slowed the ship briefly to 6 knots. During this time we retaped part of the array connections. A birthday party for Pat Powers, IBM customer engineer, aged twenty-nine, was held in the forward hold at night.

West of the mid-ocean canyon we passed over a flat, almost featureless, bottom which rose gradually as we approached the southern extension of the continental rise south of Grand Banks.

A sudden 1°C fall in sea temperature was indicated by both bow and hoist thermistors at about 2330 hours. Sea temperature has been rising for the past few days, is now 23 or 24°C.

The gravimeter and computer memory discs were out of action for most of the day because of unsuitable ship motions due to sea state, speed, and course.

16 August, Sunday. Weather warmed this morning, the sun shone and the sea was blue and contained Sargasso weed and sea turtles. The ship slowed to 9 knots during the morning for engine repair. Full speed was resumed before lunch. An easterly set of 2 knots makes full speed necessary to make 11 knots over the ground, the average speed required if we are to reach Woods Hole on schedule. We are in eddies of the Gulf Stream. Evidence for this is plain on the sea-temperature thermistor records, which show considerable temperature fluctuation during the day.

The high speed again resulted in poor seismic reflection records and damage to streamed gear. The six-thread line used to lash the array cable to the hoist chain was torn off by the sea. Waldon and Nowak replaced it by steel bands.

Weather worsened and we had rain in the afternoon.

The IBM 1710 computer was secured for two hours because of a breakdown in the air conditioning unit.

Ocean depth decreased steadily to 1400 as we passed over a projection of the continental rise, then increased irregularly as we approached the Sohm Abyssal Plain.

17 August, Monday. We are crossing the Sohm Abyssal Plain. Seismic reflection records are mediocre because of ship's high speed.

A steering failure at 0330 lost us some time. Engine no. 3 had to be taken off the line during the morning. An adverse set of 2 knots continues. The precision graphic recorder used for echo sounding broke down early in the morning, Nowak found a short circuit to ground in the solenoid which lifts the blade when the "motor on - standby" switch is operated. Echo soundings were recorded on the main-laboratory recorder while the top-laboratory recorder was under repair.

Loose tape around the array receiving Sparker echoes caused low-frequency noise and had to be removed and replaced. The day is overcast, wind and sea are following. Light rain fell at night.

The line lacing the canvas sheathing of the sparker cable had to be replaced again.

Water depth, Bouguer, and free-air anomaly profiles were flat and featureless all day. The profile of total magnetic field, however, shows broad sinusoidal wave structure, presumably caused by volcanic rocks buried beneath the abyssal plain.

Sea temperature fluctuated between 22° and 25°C during the day.

A copper tube in the ship's air conditioning unit broke in the evening and put the unit out of action for a short while.

18 August, Tuesday. The sea bottom beneath us rose steadily today as the Sohm Abyssal Plain merged into the continental rise.

The Sparker gave trouble early in the day. The symptoms were low voltage and erratic firing. Nowak and Waldon discovered the trouble to be in the leads to the transformer in the circuit controlling the charging current. One lead had failed and arcing took place across it. One phase of the current from the charging generator was cut out. New and more rugged leads were installed by Nowak and Waldon by 1100.

Radio contact was made with R/V CRAWFORD during the day.

Two engines were taken off line at 1700 for replacement of injectors. For the rest of the day the ship steamed at full speed.

The sea temperature fluctuated between 18° and 25°C during the day as we steamed on the northern margin of the Gulf Stream.

19 August, Wednesday. Calm seas, overcast skies, little wind as we steamed westward towards Nantucket over the continental rise and the lower part of the continental slope.

We had to bring the array in during the morning to investigate the source of low-frequency noise. Waldon has evolved a cunning technique for obviating the need to detach the array cable from the hoist chain. The ship slows to 3 knots, Waldon stands on a platform at the stern of the ship and flings a small anchor on a line into the water, hoping its prongs will grip the array cable as it is hauled back aboard. The technique works if done with patience. Flapping Scotch electrical tape was again the source of array noise.

Waldon and Nowak washed affected parts forward of the array with a solvent, then filled in a neck in front of the array connection cylinder with Scotch fill tape, over which was bound Scotch TR tape and Scotch electric. Finally Scotch-kote was applied. The array was then restreamed. Remaining at low speed we hauled in the proton magnetometer fish in fifty-foot stages as the ship steamed west, then repeated the procedure as the ship steamed toward magnetic north. This was done at Peter Vogt's request, to test the effect of the ship's magnetic field on the magnetometer readings. Little effect was found until the fish was about 330 feet from the ship.

As soon as magnetometer testing was completed we began to increase speed gradually to 9.8 knots, receiving bottom echoes on both hoist and bow transducers and recording them on channels 1 and 2 of the echo-sounding recorder. By this means we estimated the depth below the bow transducer, at various speeds, of the hoist fish and hence of the hoist thermistor and of the array cable tow point.

The sea temperature recorders show great fluctuation today, a low of 16° and a high of 25°C being the extremes.

Captain Davis conducted a preliminary examination of our goods to see whether any declarable items had been left off customs declarations sheets.

Aldrich, Waldon, Birch, and others prepared a pennant for our homecoming, on which was painted "Homebound from Indian Ocean, February 16 - August 21".

20 August, Thursday. Early in the morning the ship changed course and went north over the continental slope and the outer parts of the shelf. Speed was kept down to 7 knots so that good seismic profiling records could be obtained. Thence the ship went west above the shelf, then south again to a point over the base of the slope. From here course was made for Nantucket Shoals lightship, the ship steaming at 11 knots obliquely across the slope. At 1730, over the shelf once again, seismic profiling gear was hauled aboard for the last time on the cruise. The magnetometer also was reeled in, and echo sounding and gravity measurements ceased soon after 1800.

After laboratories had been put in order and equipment switched off, Chuck Porter and Dick Nowak made some calibrations on seismic profiling electronics in the top laboratory. These had been requested by John Cook earlier in the cruise.

Logs were collected together, but no electronic gear was dismantled because dockside calibrations of the latter were anticipated.

The ship passed Nantucket Shoals lightship at about 2130.

The day was foggy to begin with, then turned sunny and cool later. Sea temperatures fluctuated greatly throughout the day.

The scientific party, relieved of watch duties after supper, celebrated the end of their six months' endeavour together.

21 August, Friday. The ship berthed at Woods Hole in bright sunshine at about 0800. An impromptu band on the dock welcomed us with "Dixieland" and other selections. Bandsmen were Dave Caulfield, piano, Hoyt Watson, accordion, J. B. Hersey, trumpet, Sam Raymond and Joe Chase, clarinets, and Ace Wing, drums.

APPENDIX A

CHAIN 43 - STATION LOG

Station	Date	Type	Latitude	Longitude	Depth (fathoms)	Time Start	Time End	Physiographic Position	Remarks
1	4 Mar.	Velocimeter	40°29.5N	2°37'E	1037	1000	1125	Medit. Sea	Test lowering.
2	6 Mar.	Velocimeter	43°01.6'N	7°23'E	1380-1387	1641	1845	Medit. Sea	Test lowering.
3	25 Mar.	Rock dredge 1	20°59'N	38°10'E 38°15'E	1100-800	0920	1037	Red Sea - Median valley	No rocks, but some sediment scraped from dredge contained glob. ooze 70%, clay 25%, mineral grains 5%.
4	26 Mar.	Heat Flow Meas. 1 Gravity corer	17°39'N	40°10'E	673	1454	1615	In valley or hole in deep part of Red Sea	No value
4a	26 Mar.	Rock dredge 2	17°39'N	40°10'E	800-600	1654	1745	Red Sea: SW wall of hole or valley, in zone of parallel linear magnetic anomalies mapped by Allen.	Lost dredge when it bacame caught, broke both weak link and safety chain.
5	26 Mar.	Heat Flow Meas. 2 Gravity corer	17°39'N	40°10'E	775	1915	2030	In valley of deep part of Red Sea.	No heat flow value.
6	26 Mar.	Rock dredge 3 Magnet	17°38'N	40°08'E 40°11'E	715-620	2153	2253	Red Sea as for station 4a.	One good bite on dredge, but no rocks recovered. Magnet picked up about 5 gms material including minute spheroids.
7	4 Apr.	Heat Flow Meas. 3 Piston corer	05°52'N	53°51'E	2702-2705	0439	0750	Indian Ocean-On plain NW of Mistaken Mountain alias Owen Ridge	About 20' core. Heat probe recorder did not work. Damaged cable from thermistor recorder while bringing in corer.
8	4 Apr.	Rock dredge 4 Magnet Camera	5°35.5'N	54°03'E 54°01'E	2500-1750	1310	1539	Owen Ridge or Mistaken Mountain, E. Slope	Lost magnet. No pictures due to camera failure. 30 lbs rocks: gabbro and Mn-coated porous white clay. 25 fragments, largest of which weighs about 7 lbs. Towed NW at 2 knots. Summit of ridge in this locality at about 1500 fms.
9	7 Apr.	Heat flow Meas. 4 Gravity corer	0°55'N	51°38'E	2709	1555	1816	Somali Abyssal plain	About 57 inch core recovered. Preliminary value of heat flow 1.06 (2)
10	8 Apr.	Heat flow Meas. 5 Gravity corer	0°22'S	54°33'E	2580	0940	1155	Off E edge Somali Abyssal plain	Preliminary value 1.34. 8' core.
11	9 Apr.	Rock dredge 5 Magnet Bail sampler	1.37'S	53°21'E 53°29'E	2539-2176	0814	1310	W slope of ridge NNW of Seychelles Platform	Manganese nodules with green and white clay nuclei. Mud in bail sampler. Small spherules and crystals magnetite on magnet. Dredged W upslope.
12	9 Apr.	Heat flow Meas. 6 Gravity corer	1°38'S	53°20'E	2540	1430	1637	On plain W of slope dredged on station 11.	10' core, red at top, then gray. Preliminary value 0.86.
13	10 Apr.	Heat flow Meas. 7 Gravity corer	2°41'S	53°59'E	2234	0852	1110	On abyssal plain	No core. 1st thermistor only went in. Preliminary value: at least 0.2.
14	10-11 Apr.	Rock dredge 6 Magnet Bail sampler	3°18'S 3°15'S	54°36'E 54°41'E	2100-1600	2255	0310	Lower of two steps of continental slope north of Seychelles Platform	No rocks. No bites on tensiometer. Small piece mud in bail sampler. Dredged eastward up lower step of continental slope.
15	11 Apr.	Heat flow Meas. 8 Gravity corer	2°55'S	55°43'E	1971-	1505	1650	On gently undulating bottom 45 mi. N of N slope of Seychelles Platform.	10' core pale brown glob. ooze. Heat flow value 0.88.
16	12 Apr.	Camera 2	3°37'S 3°40'S	55°41'E 55°42'E	1540-800	1628	1912	NNE of Dennis Is. Cont. slope of Seychelles Platform.	One camera operated. Film transport mechanism on 2nd camera failed. Sand, Cobbles, a few animals recorded.
17	12 Apr.	Pipe dredge 1	3°37'S	55°42'E	about 1400	2038	2139	NNE Dennis Is. Cont. slope of Seychelles Platform.	Mud, coarse coral sand, some pebbles of soft, weathered black and gray rocks.
18	16 Apr.	Rock dredge 7 Bail sampler Magnet	6°49'S	57°22'E 57°24'E	1483-1510	1508	1650	S. of Seychelles Platform. Western edge of Seychelles-Mauritius ridge or southern edge of complex of seamounts south of Seychelles Platform.	Came across mountains up to 770 fms deep after crossing plain 1500 fms deep at 090°. No yield. Slope fell away instead of rising-must have lost hills while maneuvering. Magnet came up clamped to bail. Inferred that hills were to north of place dredged, and that ship was set south by NE wind.
19	16 Apr.	Heat flow Meas. 9 Gravity corer	6°51'S	58°00'E	825	2155	2315	On Seychelles-Mauritius ridge	Corer came up sideways: no core. No heat flow value.

NOTE: 1. Where two latitudes and/or longitudes are given for one station, they represent start and end points.
(2.) Heat flow units are microcalories/cm^2sec.

20	17 Apr.	Rock dredge 8 Magnet	7°02'S	59°22'E	1670-1594	1304	1554	E edge of N part Sey.-Maurit. ridge	V. Small pinch white sand in bail sampler. Magnet had flipped into dredge and closed chain bag. Dredge lost initial load mud or sand on way up. Dredged NW at 2-2.5 knots, 1 knot set to S. Many cusps on E/S record as slope is passed over may indicate rugged topog. covered by ooze.
21	18 Apr.	Camera 3	6°56'S 6°55'S	60°16'E 60°19'E	2091	0130	0413	Abyssal Plain	2 black and white films. Mud bottom, animal tracks, holothurians.
22	18 Apr.	Heat flow Meas. 10 Piston corer	6°54'S	60°21'E 60°24'E	2090±	0534	0800		3-10' barrels. Penetration about 23'. Core catcher broke off ring, found at base of 2nd barrel. Much core lost. Glob. ooze forms, few inches remaining. No penetration acoustically at this site using impulse pinger. No heat flow value; one probe leaked.
23	23 Apr.	Heat flow Meas. 11 Gravity corer	17°27'S	58°5.5'E	2148-2150	0845	1044	Basin or valley W of S end of Sey.-Maurit. ridge	About 4' core. Glob. ooze. Black specks in top section of core. Broken when retrieved - top probe not in. Prelim. value 0.82.
24	24 Apr.	Rock dredge 9 Magnet	17°22.5'S	59°11'E	450-350	0029	0115	Steep west edge of Sey.-Maurit. ridge 37 mi. S of Albatross Is.	Lost dredge and magnet-caught on steep slope about 380 fms deep. Probably caught on huge chunks reef rock which tumbled down from a reef at edge of flat top of the feature, which now lies at about 210 fms.
25	24 Apr.	Rock dredge 10	17°22.5'S	59°11'E	510-350	0140	0320	As above	As Above. Lost dredge, although apparently it hung onto wire until pinger was removed, then fell off.
26	24 Apr.	Rock dredge 11	17°22.5'S	59°10'E	440-420	0411	0551	As above	Damaged dredge - lost lead weight tore chain-bag. 1 piece limestone with worm tests, Mn-coating. Hung dredge up at 400 fms, had to bring ship around more than 180° before could get dredge loose.
27	24 Apr.	Heat flow Meas. 12 Gravity corer	17°22'S	60°24'E	2065	1935	2145	Foot of E slope of Sey.-Maurit. ridge SE of Cargados Carajos	4' glob. ooze, drifted 1 mi. W. No heat flow value.
28	27 Apr.	Heat flow Meas. 13 Gravity corer	14°15'S	62°51'E	2034	0425	0630	Abyssal plain E of Sey.-Maurit. ridge.	3' core of ooze, reddish clay. Preliminary value 1.89.
29	28 Apr.	Pipe dredge 2	12°50'S	60°43'E No celestial fix dead reckoning	215	0955	1120	Flat top of Sey.-Maurit. ridge N of Nazareth bank	On way up wire went under ship and fouled starboard screw - had to cut wire. Lost dredge, pinger, and 100 fm of wire.
30	30 Apr.	Heat flow Meas. 14 Gravity corer	11°30'S	58°24'E	2180	0917	1135	Abyssal plain W of Sey.-Maurit. ridge.	8' core, creamy - glob. ooze. Preliminary value 0.9. No penetration acoustically with echo-sounder.
31	1 May	Heat flow Meas. 15 Gravity corer	14°25.1'S 14°23'S	58°25'E	2212	1546	1747	Basin W side of Sey.-Maurit. ridge	No results - recorder quit, no core.
32	2 May	Camera 4	18°11'S 18°06'S	57°41'E 57°40'E	2220-2260	1943	2309	Gentle westward slope, W side of S end of Sey.-Maurit. ridge	Modified camera, 18' focus, T-shaped frame. Cameras flooded, no photos.
33	2-3 May	Heat flow Meas. 16 Gravity corer	18°04'S	57°38'E	2062	2320	0115	As for station 32	5' core. Preliminary value about 0.98.
34	9-10 May	Heat flow Meas. 17 Gravity corer	15°25'S	58°30'E	2153	2350	0159		Very flat bottom. Corer hit sideways, no core, no value.
35	10 May	Rock dredge 10 with canvas liner	14°34'S 14°38'S	60°21'E	31	2040	2106	Nazareth Bank	No pinger. Some coral rock, calcareous sand, some live specimens. Canvas bag fitted inside chain bag of rock dredge.
36	11 May	Camera 5	13°40'S 13°37'S	61°20'E 61°14'E	1160-1054	1425	1718		Both cameras failed.
37	11 May	Rock dredge 11 with canvas liner	13°35'S 13°34'S	61°12'E 61°09'E	1140	1836	2005	East of Nazareth Bank	Fine calcareous sand, with spicules.
38	11 May	Camera 6	13°24'S 13°23'S	61°01'E 60°58'E	770	2320	0055		Both cameras worked. Sandy bottom photographed.
39	12 May	Rock dredge 12 with canvas liner	13°22.5'S 13°21'S	60°57'E 60°57.5'E	775	0127	0230	Top of Sey.-Maurit. ridge	Small pieces of calcareous sandstone, coated with Mn.
40	12 May	Rock dredge 13	12°47'S 12°45.5'S	60°33.0'E 60°25'E	1250	1055	1520	W of Sey.-Maurit. ridge, N of Nazareth Bank	Two bites while dredging. Caught in the "V" between the blades of the stbd. screw. It later sprang loose, but many fms. of wire had piled upon the bottom, resulting in breaking of strands. Pinger came up, but no dredge. Chain attached to wire showed severe strain. 715 fm of damaged trawl wire cut off.
41	12 May	Camera 7	12°48'S 12°45'S	60°27.5'E 60°21.5'E	1240-1543	1915	2222	W. of Sey.-Maurit. ridge N of Nazareth Bank	Came down cliff during lowering. 2 sudden jumps in topography noted. Limestone and sand bottom recorded.

42	13 May	Camera 8	10°56'S	60°12'E	710-540	1958	2209	W of Saya de Malha Bank	Ship drifted without screws during station. Limestone (?) and rippled sand photographed.
43	13 May	Rock dredge 14 with canvas liner	10°54'S	60°10'E	880	2340	0110	W of Saya de Malha Bank	Nothing brought up.
44	14 May	Rock dredge 15 with canvas liner	10°50.5'S	60°08.0'E	705	0203	0600	As above	Some live black coral, limestone with coral and 3 small arthropods. Demolished pinger frame, bent dredge
45	15 May	Rock dredge 16 with canvas liner	08°34'S	58°51'E	1050	1425	1720	W slope of Saya de Malha Bank	Lost dredge - 10,000 lb bite - evidence that dredge was hung up from time it hit bottom to loss.
46	15 May	Camera 9	8°33'S	58°51'E	1100	1820	2122		Ship drifting, no power on screws; good pictures showing mostly sand but one good rock outcrop.
47	15 May	Rock dredge 17 with canvas liner	08°35.5'S	58°54'E	1100	2307	0118	W slope of Saya de Malha Bank	Recovered dredge - empty. Dredge at about 1100 fm, away from W slope of Sey.-Maurit. Ridge NW of Saya de Malha Bank - Cameras had shown rocks - no bites.
48	16 May	Rock dredge 18 with canvas liner	08°30'S	58°55'E	1070	0223	0520	W slope of Saya de Malha Bank	Nothing in dredge, but damaged pinger frame. Bites of 5500 and 5000 lbs.
49	16 May	Rock dredge 19	08°36.6'S	58°54'E	about 650	0544	0820	W slope of Saya de Malha Bank	No bites, nothing brought up in dredge
50	16 May	Camera 10	08°21.2'S 08°20.1'S	59°15'E 59°12'E	about 650	1343		Top of Sey.-Maurit. Ridge N of Saya de Malha.	Both cameras worked. Pictures of muddy bottom with pebbles.
51	16 May	Rock dredge 20	08°19.8'S 08°18.7'S	59°10.6'E 59°9.8'E	about 650	1710	1831	Scarp on E side of Sey.-Maurit. Ridge, NE of Saya de Malha	No results.
52	17 May	Rock dredge 21 with canvas liner	07°36.3'S 07°34.8'S	60°12.3'E 60°06.4'E	1760	0753		E slope Sey.-Maurit. Ridge	4 small pebbles; oolitic limestone, fragmental limestone, sandy limestone and basalt (?).
53	17 May	Heat flow Meas. 18 Gravity corer	07°16.4'S 07°13.2'S	60°32'E 60°28'E	2020	1609	1820	Flat bottom of plain NE of Saya de Malha	43" core, heat flow value at least 0.66.
54	17 May	Heat flow Meas. 19 Gravity corer	06°49'S	60°50'E	2120	2329	0140	E of Sey.-Maurit. Ridge	No core, no value, corer hit sideways.
55	18 May	Heat flow Meas. 20 Gravity corer	05°59'S	60°14'E	2165	0923	1138	Flat-bottom plain E of Sey.-Maurit. Ridge	Corer hit sideways, no core, no value.
56	18 May	Inverted Pinger	05°59'S	60°13'E	about 2165	1156	1237	As above	Cook's measurements of strength of front and back lobes of regular Edgerton Pinger.
57	18 May	Heat flow Meas. 21 Piston corer	05°58'S 05°59.4'S	60°13'E 60°11'E	2165	1540	1802	Plain E of Sey.-Maurit. Ridge	20' large piston corer, 9' core, recorder malfunction, no value.
58	19-20 May	Pipe dredge 3	05°49.5'S	57°24.5'E	570	2305	0015	S.E. of Seychelles Platform.	Dredge empty.
59	20 May	Piston corer	05°49'S	57°23'E	580	0117	0145	as above	Empty - few small grains.
60	20 May	Pipe dredge 4	06°04'S	57°07'E	1020	0545	0659	SE of Seychelles Platform	4 pebbles of limestone and coral, and one small pebble of granite.
61	20 May	Rock dredge 22 with canvas liner	6°00'S	57°05'E	943	0725		As above	Dredge empty.
62	20 May	Camera 11	6°00'S	57°05'E	910-1050	1050	1400	As above	Left hand camera had P-X film, 20' focus. Right hand camera had X-R film (test for EG&G) 20' focus. Center camera had P-X, 6' focus. Left camera ran 3/4 way, center didn't run. Bottom of rocks, sand and pebbles.
63	21 May	Rock dredge 23	05°14'S 05°13'S	55°19.5'E 55°21.5'E	800	2050	2280	South of Mahe	Limestone and coral rocks obtained.
64	21-22 May	Rock dredge 24	05°17'S	55°16'E	1320-1360	2328	0220	As above	Few bites. Pinger came up lying horizontally and knotted in trawl wire This explains very weak bottom echo during lowering. No rocks.
65	22 May	Camera 12	04°52.5'S	55°31'E	27	0547	0742	6 mi. from Mahe Island	Camera started with no delay - flashes visible from deck. Pictures overexposed due to sunrise.
66	22 May	TV camera	04°41.7'S	55°36.3E	20	1012	1048	Seychelles Platform	Station was successful. Could see bottom in clear focus, with adequate light. An auxiliary light attached to camera did not seem to have any effect on available light. Camera & light were mounted on an old sparker fish, and let down on trawl wire, while electric cables were paid out by hand.
67	26 May	TV camera 2	03°50.1'S 03°49.2'S	55°34'E	30	1443	1630	Northern Seychelles Platform	Device rigged as for station 66. This time sky was cloudy with squalls and not enough light was available to see bottom because auxiliary light shorted.
68	28 May	Heat flow Meas. 22 Piston corer	01°02.5'S 01°00.8'S	61°12'E 61°15'E	2425	1905	2259	West flank of Carlsberg Ridge	Obtained 10' brown core. Heat flow about 1.6 (very questionable).
69	30 May	Heat flow Meas. 23 Piston corer	02°49'N	59°41'E	2240	0915	1215	West flank of Carlsberg Ridge	Obtained 11' light brown core. No heat flow value.
70	5 June	Rock dredge 25 with canvas liner	16°04'N	41°25'E	610-590	0028	0137	Red Sea	Limestone with fossils, wormtubes. Possibly just a hard crust.

71	5 June	Rock dredge 26 with canvas liner	16°04'N	41°25'E	590	0202		Red Sea	Aborted - pinger stopped.
72	5 June	Rock dredge 27	17°29'N	40°20'E	770	1350	1503	Red Sea	Lost bottom - forced to return to surface.
73	5 June	Rock dredge 28	17°50'N	40°12'E	625	1850	2115	Red Sea	Three small fragments, probably slag.
74	7 June	Velocimeter 3	23°45.3'N 23°43.3'N	36°21.5'E 36°25.1'E	680	0800	1140	Near St. John's Is., Red Sea	Lowering to test inverted E/S and to break in the operators for next leg. The signal became weak at the end. Found that receiver batteries were very weak due to switch inside having been left on the "ON" position the previous night. Otherwise ok.
75	8 June	Heat flow Meas. 24 Piston corer	25°22'N	36°11'E	1140	0045	0245	Near S entrance to Suez Canal	12' piston corer, heat flow value 2+. Thermistor smashed.
76	9 June	Rock dredge 29 with canvas liner	28°53'N	32°58'E	27	0102	0235	Northern end of Gulf of Suez	Mud and animals.
77	16 June	Camera 13	33°55.0'N 33°53.6'N	35°23.6'E 35°23.3'E	at start 682	0103	0300	Eastern Mediterranean.	"T" camera rig with 3 cameras center camera didn't run. Changed to 6 sec rep rate and steamed at 2 knots. Over-lap on pictures shows that we could have steamed slightly faster. Pictures of muddy bottom.
78	17 June	Rock dredge 30	33°24.5'N 33°22.7'N	35°12'E 35°11.7'E	27	1015	1100	Shelf off Beirut	Fossils, sand, mud, shells.
79	17 June	Rock dredge 31	33°23.0'N	35°07'E		1205	1323		2 quarts sandy mud.
80	24-25 June	Piston corer	35°49'N	18°33'E	2120	2300	0226	Abyssal plain SE of Straits of Messina	A 50' piston coring tube.
81	25 June	Piston corer	36°04'N	18°11.3'E		0704	0953	As above	Penetration achieved.
82	26 June	Heat flow Meas. 25 Piston corer	35°47.2'N	17°28.7'E	2112	0249	0625	Messina Abyssal Plain	Heat flow about 0.6. 4 barrels on large corer. 25' core.
83	26 June	Heat flow Meas. 26 Piston corer	36°34.2'N	16°33.7'E	1750	2100	2320	Near mouth of Messina canyon, SE of Strait of Messina.	4 barrels on large corer, no heat flow result. 22' core showing graded bedding in top section, and good pilot core showing same. One thermistor cable cut.
84	27 June	Camera 14	36°35.5'N 36°37'N	16°43.3'E 16°39.2'E		0103	0400	as above	Camera on at 0200. Both cameras operated. Muddy bottom photographed.
85	27 June	Heat flow Meas. 27 Gravity corer	38°47.3'N	15°03'E		1941	2114	Near Stromboli	About 1' ash core. Heat flow about 0.9.
86	8 July	Rock dredge 32	43°33'N 43°36'N	09°24'E	at start 500	0400	0535	Santa Lucia Bank, NE of Corsica	Used new stern A frame for first time. Damaged pinger, lost pressure case with battery, mangled frame. Serpentine, coral, brachiopods and metamorphic rocks brought up.
87	9 July	Camera 15	43°24'N	08°42'E 08°46'E	1250-1294	0305	0548	Scarp in Liguvian Sea, NW of Corsica.	Camera set to start at 0335, water depth at start 1250, camera started about 500 fms off bottom. Camera on bottom at 0407 at 1282 fms. Bottom dropped to 1294 fms then rose to 1279 near the end of the lowering. Mud and coral in pictures.
88	11 July	Rock dredge 33	43°22'N 43°22.6'N	08°37.2'E 08°42.2'E	1300	2237		Scarp NW of Corsica	Coralline limestone with possibly Mn coating.
89	12 July	Rock dredge 34	43°21.1'N 43°21.4'N	08°38.3'E 08°40.8'E		0115	0350	As above	No rocks recovered.
90	12 July	Thermistor fish	43°33'N	07°55'E		1707	2110		
91	12 July	Scattering layer pinger	43°27'N	07°43'E		2107	0015		
92	17 July	Camera 16 with booms	42°46.5'N 42°46.7'N	07°38.5'E 07°37.8'E	1400	2255	0143	Over hill rising 40 fm above flat plain. Liguvian Sea.	Near Cousteau's buoy. Used 50' booms to either side of the ship for positioning. Neither camera worked.
93	18 July	Rock dredge 35 with booms	42°46.6'N 42°46.3'N	07°37.5'E 07°40'E		0237	0505	As above	No rocks - ship drifted away from hill during lowering. Small mud sample containing pteropods obtained.
94	18 July	Rock dredge 36 with booms	42°46.5'N 42°47.8'N	07°38'E 07°40.6'E		0625	0948	As above	Dredge came up empty.
95	4 Aug.	Velocimeter 4	46°37'N	15°09'W	2500	0940	1517	Lower step of Mid-oceanic ridge, Eastern North Atlantic	Two velocity minimums at 60 and 850 fms. Trouble with brake of Markey winch, which had been standing un-used for some time and had rusted. Autodepths intermittently functioning. Good BT (#6) before lowering.
96	4 Aug.	Velocimeter 5	46°35.8'N	15°40.2'W 15°41.4'W	1640	1800	2115	As above	BT #7 before lowering.
97	4-5 Aug.	Velocimeter 6	46°32.8'N	16°21.5'W	2400	2330	0335	As above	BT #8 after lowering (0335). Intermittent operation of pinger. Lowered to 2400 fm. Winch troubles on way up restricted speed.

98	5 Aug.	Velocimeter 7	46°29.8'N	17°02.7'W	1290	0644	0915	Lower step of E flank of Mid-Atlantic Ridge	BT #9 before station.
99	5 Aug.	Velocimeter 8	46°27'N	17°46'W	2120-545	1140	1316	As above	Battery trouble. BT #10.
100	5 Aug.	Velocimeter 9	46°24'N	18°15'W	1450	1730	2022	As above	No trouble. All stations agree below 1100 fms. Sofar channel axis between 800 and 900 fms on all lowerings. BT #11.
101	7 Aug.	Deep-diving magnetometer	45°50.3'N 45°49.8'N	27°38.9'W 27°39.2'W		1403	1546	E side of Median Valley, Mid-Atlantic Ridge. Ship hove to over hill with positive magnetic anomaly charted by DISCOVERY II in 1960.	Station marred by 1 knot drift eastward. Saltwater entered recorder pressure case and shorted out batteries, thus only partial records obtained.
102	7 Aug.	Heat flow Meas. 28 Piston corer	45°30'N	27°50'W	1610	2228	0042	Median Valley Mid-Atlantic Ridge	Core of about 9' of grey mud; recorder malfunction - take-up spool jarred loose on impact - no value.
103	8 Aug.	Heat flow Meas. 29 Piston corer	45°07.5'N	28°02.5'W	1487	0743	1002	As above	Core-catcher, nose cone and lower probe smashed on bottom. Volcanic glass caught around recorder. No core, no heat flow value.
104	8 Aug.	Rock dredge 37	45°11'N	27°56'W 27°52'W	1440-1350	1301	1442	Mid Atlantic Ridge W-facing slope of hill forming E side of Median valley	Electric tensiometer used. Bites seen well on PGR record and poorly on tensiometer. Did no steaming on line, but drifted east over first or lower part of slope. Haul of 100 lb rock, chiefly vesicular basalt; also fragments of porous clay, glacial erratics, and pteropod tests.
105	8 Aug.	Camera 17	45°11'N	27°53.9'W 27°50.9'W		1630	1910	Median Valley Mid-Atlantic Ridge	Right camera didn't advance, left camera only went half way. About 2 dozen excellent pictures of rocks and sand. Steamed east up west slope.
106	9 Aug.	Heat flow Meas. 30 Piston corer	44°36'N	28°10'W	1720	0955	1205	As above	Core. 9' of ooze. Thermistor and pressure case flooded. Core cutter sheared off. Barrel flattened. General disaster. No heat flow value.
107	9 Aug.	Rock dredge 38	44°34'N 44°36.4'N	28°09.2'W 28°06.8'W		1347	1535	W-facing slope of 1740 fm valley over which last station (106) was occupied.	Several fragments basalt, one with glassy sheath, one striated facetted cobble of limestone, and other fragments. Ship drifted NNE pulling dredge up slope.
108	10 Aug.	Heat flow Meas. 31						Median valley, Mid-Atlantic ridge	Winch troubles caused this lowering to die in embryonic stage.
109*	11 Aug.	Heat flow Meas. 32 Gravity corer	42°37.1'N	28°44.8'W	1356	1924		Flat valley several miles east of eastern edge of Median valley, Mid-Atlantic Ridge	One foot core only. No value. Many pteropod tests around pressure case.
110*	11-12 Aug.	Rock dredge 39	42°38.4'N 42°38.3'N	29°02.7'W 28°59.7'W	1000-600	2336	0133	Ridge forming E side of Median Valley, Mid-Atlantic Ridge	Dredged up west slope of the ridge. Steamed eastward at 1 1/2 knots + 1 knot drift. Lost pinger but not clamp dredge but not safety chains.
111*	12 Aug.	Camera 18	42°39.6'N 42°39.4'N	29°00.7'W 29°02.5'W	780-1000	0251	0450	As above	Photographed west slope of ridge. Bottom appeared to drop off in steps. Excellent pictures of outcrops talus and sand. Ship steamed against easterly set of 1 knot with turns increased until ship went very slowly West with reference to buoy. Stern A-frame used. No pictures from left camera.
112*	12 Aug.	Rock dredge 40	42°39.3'N	28°59.1'W	870	0605	0708	Eastern slope of ridge of station 110.	Ship steamed dead slow westward against easterly drift of 1 knot. 2 small cobbles, one limestone, one basalt, were recovered.
113*	12 Aug.	Rock dredge 41	42°40.9'N 42°42.4'N	29°01.6'W 29°01.5'W	900-1000	0730	0842	Western slope of ridge of Station 110.	Load of 100 lbs of coral, erratics, sponges, limestone, and animals. Ship steamed west against set, pulling dredge downslope below area photographed in Station 111.
114*	12 Aug.	D. D. Magnetometer	42°39'N	29°00.0'W		1052	1215	Over high magnetic anomaly on ridge of Station 110.	Ship steamed 300° at 1 knot against easterly set, maintaining position over starting point to within about 1/10 mi. (Ref. to buoy). No instrumental failure.
115*	12 Aug.	Heat flow Meas. 33 Piston corer	42°38.1'N 42°37.4'N	28°48.4'W 28°46.4'W	1372	1340	1530	As for Station 109	Preliminary value of 1.3. Eleven feet of calcareous mud recovered in the corer. This spot is out of the Median valley.

* Position of Radar buoy 42°39'N, 28°54'W. This position is accurate to within less than 1 mile. Positions of stations 109-115 are in relation to above buoy position, and accuracy between these stations is within less than 1/4 mile.

APPENDIX B: EXCERPTS FROM RESEARCH PROPOSAL AND CRUISE PLANS

Research Proposal Submitted to the National Science Foundation (Nov. 3, 1961): Excerpt from WHOI Tech. Memo. #1-64.

The Institution proposes to investigate the structure of the earth's crust in the northwestern part of the Indian Ocean during the period March - June 1964. The area in which such investigations will take place is that north of 25°S, west of 80°E, and includes the Arabian Sea. This area and the subjects for investigation are too large to be completely covered in these proposed cruises. However, new and important information about the area can be obtained by selecting certain problems discussed below and concentrating much of the effort on them. While this cruise is primarily planned to solve these problems, there are certain oceanographic and geophysical measurements that can be taken almost continuously while the ships are in the area. These measurements include meteorological observations, precision echo sounding, near surface temperature and water shear velocity data. Study of the bottom substructures with the Continuous Seismic Profiler, magnetic field and gravity field measurements will be undertaken whenever feasible.

The principal subjects to be investigated in the Indian Ocean are:

(1) Areal extent of Seychelles granite

(2) Relationship of the Seychelles (continental crust?) to the surrounding ocean basin

(3) Relationship of the Seychelles to the ridge extending to the south and east toward the Mascarene Islands

The basin located between Africa and the Seychelles will be studied by the Cambridge University Geophysical Group. We plan to supplement their geophysical study of this area with a seismic reflection and gravity profile across the basin; but the most intensive geophysical activity will be concentrated in the area surrounding the Seychelles and extending south to Madagascar and southeastward along the ridge to the Mascarene Islands. This work will be planned to supplement previous research there by several geophysical groups that have visited the region in the recent past.

The area of the Carlsberg Ridge would be investigated less intensively en route to the Seychelles.

These subjects will be investigated by means of seismic refraction and reflection profiles, bottom sampling by dredging and coring, bottom photography, heat flow measurements, magnetic, and gravimetric measurements.

The structure and petrology of the island of Madagascar indicate that continental type crust underlies the island. Isolated patches of continental crust of this size are unusual and warrent detailed study in an effort to determine the nature and extent of the crust beneath these features. Oceanic depths surround Madagascar essentially on three sides, and on the fourth side a shallower channel links the island to the African continent. We propose to make seismic refraction and reflection profiles in the channel and in the ocean basins bordering Madagascar, in order to determine the crustal structure in these regions. Gravity measurements, taken at the same time in the areas around the profiles, will permit extension of the seismic results to a larger area and will assist in determining locations of different crustal types.

Continental-type crust may also underlie the Seychelles Islands; a conclusion based on reports of Pre-Cambrian granite outcropping in the island group. Steep submarine scarps border the island of Madagascar on the east; a northern extension of these features appear to border the western edge of the Seychelles group some 600 miles away. The structural and tectonic relationships of this area will be studied. During the program it is proposed to detail the topography, to study some of the sections by seismic means, to conduct heat flow measurements across the ridges, and to make magnetic and gravimetric measurements over the ridge system.

The ridge system defines ocean basins that are essentially isolated from each other. Studies of sediments in these basins by coring and continuous seismic profiling will be made. The deeper substructure will be investigated by refraction and reflection seismic techniques.

Several programs in physical oceanography will be pursued by means of continuous underway observations and special observations as follow:

(1) Surface water temperature will be measured down to approximately 600 feet by means of the towed thermistor chain. Horizontal fluctuations of the water temperature will be studied along with the vertical

temperature gradients and inversions. The temperature gradient in the mixed layer will permit determination of the stability of the surface water. These temperature measurements will also permit a study of the internal waves. One problem of especial interest is the understanding of small thermal fronts which have been the object of study for several years under Contracts Nonr-4029 and Nonr-2866 with the Office of Naval Research. These are rapid steplike changes in near-surface temperature, which have been found in the vicinity of 30°N, 70°W (southwest of Bermuda). On every occasion that temperature profiles have been recorded there (five occasions since 1959), the change has always been found to be one wherein water warmer by 1.5° - 3.0°C exists on the southern side of the front which is only 2 to 5 miles wide. Since the recordings were made at quite different times of the year the occurrence does not seem to be seasonal, but there may be seasonal effects now unknown. The front extends at least through the mixed layer, which is usually isothermal to within 0.1 to 0.2°C at any one location there. The horizontal temperature gradient can be as high at 1°C per mile. A few current measurements made be means of von Arx's GEK during CHAIN Cruise 34 indicated northeastward flows along the front, of nearly 1 knot which is about 10 times the noise background. Druing the same cruise one front was traced for a distance of about 40 miles and was found to trend east-west through the position cited above. Later when the GEK measurements were made the orientation of the front was ENE - WSW. At the present time we do not know whether these fronts are permanent or recurring. Possibly similar thermal fronts are to be found elsewhere in the oceans. As opportunity affords throughout this expedition we propose to seek clues leading to general understanding of small thermal fronts in the ocean. For example, in the parts of the Indian Ocean that will be visited for the geophysical program, especially the broad area south of the equator and east of Madagascar, we shall try to discover the frequency and location of thermal fronts.

(2) Sound velocity profiles will be made from surface to bottom in the areas of special interest. It is expected that a shipboard digital computer will be available for converting the data continuously to sound velocity versus true depth.

(3) Other studies will include recordings of ambient noise, measurements of the acoustic properties of the bottom, and observations of the scattering layers. These studies are of particular interest for evaluation of the acoustic properties of the Indian Ocean.

Throughout our scientific program the fullest possible use will be made of an on-line computer which has been in use in the Geophysics Department for slightly over a year.

Cruise Plans for R/V CHAIN Cruise #43, Indian Ocean Expedition: Excerpt from WHOI Tech. Memo. #1-64, by E. T. Bunce

R/V CHAIN will depart from Woods Hole February 15, 1964 en route to the Indian Ocean via the Atlantic Ocean, Mediterranean Sea, and Red Sea. It is proposed that the first section of the cruise be concerned with routine observations that can be made underway during the transit of the Atlantic Ocean. The crossing will be made along latitude 28'N, from 64°W longitude to 28°W longitude, enabling observations of a section across the mid-Atlantic Ridge not yet surveyed in detail.

The underway observations to be conducted continuously on this and on all other sections are: measurements of gravity field and of magnetic field, temperature structure of the ocean water to a depth of 600 feet, surface temperature, bathymetry, and sub-bottom structure with the continuous seismic profiler.

A stop will be made at Ceuta, Morocco, to fuel the ship. From Ceuta the ship will cross the western Mediterranean Basin en route to visit La Spezia, Italy, and part of the eastern Mediterranean Basin en route to Port Said, Egypt. As in the Atlantic Ocean, only underway observations will be made in the Mediterranean Sea.

Detailed studies will commence in the Red Sea. A chart is attached (CHART I) showing the proposed tracks. These are laid out to intercept and cross the seismic refraction profiles made by R/V ATLANTIS and R/V VEMA in 1958, to study the relations of the sub-bottom structures using the continuous seismic profiler. Additionally, we plan to make 4 or 5 heat flow measurements along the Red Sea track and possibly to land on Zebirget, (St. John's Island) to investigate its geological structure.

Chart II shows the proposed areas of investigation in the Indian Ocean.

Following a visit to Aden, Aden Protectorate, for the purpose of exchanging members of the scientific party and for supplies, we will investigate in detail an area of the Somali Abyssal Plain before proceeding to the Seychelles Islands (Area I of Chart II). Two recent E-W crossings of this plain by R/V VEMA have produced profiler records showing a thick layer or series of layers of sediments above a deep reflecting horizon. At some places there are peaks apparently thrusting through the sediment cover. We hope to dredge one or two of these peaks for rock samples, and to core sediments if the peaks are sediment covered. If topographic and profiler studies of the eastern side of the Abyssal Plain indicate scarps and possible rock outcrops we plan to dredge this area. The surface of the plain, the seamounts, and the eastern slope will also be photographed. We plan to make oblique reflection profiles, using the acoustic telemetering buoys, in a small section of the Abyssal Plain. This will enable us to determine the compressional wave velocity in the shallow sedimentary layers.

In the Seychelles area we will make a detailed survey north and east of the island to investigate the areal extent of the Seychelles granite and the relationship of the Seychelles structure to the surrounding ocean basin. This portion of the work will be conducted mainly by underway observations, but time is allowed for dredging and coring if suitable locations are found.

From the Gulf of Aden to the Seychelles a number of heat flow measurements will be made, their exact locations being dependent upon locations of recent RRS DISCOVERY stations not available at this writing. A stop will be made at Port Victoria in the Seychelles Islands at the conclusion of this phase of the program.

Departing Port Victoria, we will continue the detailed survey to the south and east across the Seychelles-Mauritius Ridge, then proceed to the location of Vema Trench, approximately 09°08'S latitude, 67°15'E longitude. This contains the greatest known depth in the Indian Ocean, 3501 fm, (6402 m). It is a narrow trench, cutting across the axis of the mid-oceanic (Carlsberg) ridge. The steep-walled trench trends 055°T, its depth below 3000 fm extending for 60 miles. We plan a detailed study of this feature, to include heat flow measurement and coring, underwater photography of the trench floor, and dredging with associated photography of the walls.

From Vema Trench to Mauritius the work is planned to study further the Seychelles-Mauritius Ridge area using both underway observations and lowerings designed to obtain photographs and bottom samples. The island of Mauritius will be visited at the conclusion of this section of the cruise; there will be changes in the scientific party at this time.

The next area of operation is shown in Section III of Chart II. We will investigate the relationship of Madagascar with the Seychelles-Mauritius Ridge and the ocean basin between, and the apparent fault zone extending along the east coast of Madagascar through the Seychelles Islands. Broad-scale under-way survey work will alternate with more closely spaced survey tracks and with core sampling and heat flow measurements. Of specific interest in this region is a small arcuate trench to the southwest of the Amirante Islands. It is planned to investigate this feature with dredging and photography.

A second stop will be made at Port Victoria for supplies. This will mark the conclusion of the detailed scientific investigation of this relatively small area of the Indian Ocean. The ship will proceed from the Seychelles to Beirut, Lebanon, via the Red Sea. The return track to the Gulf of Aden will cross the Somali Abyssal Plain, or will be located east of the plain, dependent upon the observations made on the initial passage southwards.

Cruise Plans for R/V CHAIN Cruise #43, Beirut, Lebanon, to Woods Hole, Massachusetts.

Excerpt from <u>WHOI Tech. Memo. #7-64, by J. B. Hersey</u>

Beirut, Lebanon to La Spezia, Italy

This portion will be devoted in large part to geophysical and geological investigations of basins, and the sediment ponds in them, situated south of Cyprus, Crete, the Peloponnesus, and southern Italy. A short period will also be devoted to geophysical investigation, particularly seismic-reflection and magnetic-field measurements, over a portion of the passage between Elba and Corsica and the area off the western coast of Italy between Elba and La Spezia.

In the basins, the extent, both horizontally and in depth, of sediment ponding will be surveyed by echo-sounding and seismic-reflection profiling.

Cores will be taken along profiles planned to determine the relationship between the thickness of individual coarse-grained layers and possible routes of turbidity currents. The state of the edges of ponds, having been outlined by geophysical methods, will be inspected by means of bottom cameras and dredges where appropriate. Gravity profiles will be recorded continuously throughout these surveys so as to develop an appreciation for the probable thickness of the Earth's crust beneath the eastern Mediterranean. Suitable profiles will be laid out so as to chart changes in gravity across the whole basin.

During this portion of the cruise it is anticipated that CHAIN will keep rendezvous with CALYPSO at a position yet to be determined south of Greece for cooperative observations and exchange of information on the basins marginal to southern Greece and Crete.

La Spezia, Italy to Monaco

Gravity, magnetic, and seismic reflection data will be taken in a pattern over the Ligurian Sea and the Algiers Provencal Basin designed to elucidate the relationship between the continental platforms of southern Europe, Corsica, and the Balearics in relation to the intervening basins. Seismic refraction measurements, completed in 1959 and since analyzed by Fahlquist (1962, MIT thesis), show that the intervening basins are underlain by a crust that is thin compared with the nearby continent, but somewhat thicker than that of the open ocean. The relationship between structures of the basin and the continent and islands is doubtless complex; but it probably can be mapped effectively by the combination of geophysical methods on board.

Monaco to Plymouth, England

Seismic reflection and gravity profiles from the shelf into deep water along the western European coast from Gibraltar to Plymouth is a primary objective of this portion of the cruise. A second primary objective is to complete the rigging of a new thermistor tow and to use it to observe water structure at shallow depth in deep water between Gibraltar and Plymouth. These somewhat competing programs will be merged by making the thermal observations and the deep-water reflection profiles simultaneously; geophysical observations across the shelf and slope will be carried out separately. A straight passage including only underway observations will be made between Monaco and Gibraltar.

Plymouth, England to Woods Hole, Massachusetts

Seismic, magnetic, and gravity profiles and thermal tows will be made from Plymouth to the mid-Atlantic ridge just south of 50° north. At this point the thermal tow will be secured while a series of heat-flow measurements will be made in a southerly direction in and near the median rift. Rock dredging and photography will be done when appropriate, and bathymetry and seismic profiling will be carried out between heat flow or dredging stations. At the conclusion of the heat-flow profile, which will be made in an area previously surveyed by Hill and others, the underway observations made on the first part of this leg will be resumed at least onto the Grand Banks, and as much farther towards Cape Cod as time allows.

APPENDIX C: SCIENTIFIC AND TECHNICAL BRIEFS

Velocimeter Stations (Francis S. Birch)

Nine velocimeter stations were made.

The first two were made in the Mediterranean Sea by Willy Dow and Steve Stillman, to test the computer program and velocimeter system. Both worked well.

A third station was occupied near St. John's Island in the Red Sea when most of the scientific party was ashore on geologic reconnaissance. The purpose was to train new people to operate the system.

The remaining six stations were made on the Plymouth to Woods Hole leg on a line between 46°37'N, 15°09'W (Station 4) and 46°25'N, 18°17.5'W (Station 9). They were to depths of 2460, 1640, 2490, 1290, 545, and 1450 fathoms, respectively. All except the next to last, which was stopped by battery failure, went beyond the sofar channel into a region of constant velocity gradient. These stations all show an isovelocity surface layer about 5 fathoms thick overlying a region of rapid velocity decrease that goes to a local minimum at about 80 fathoms. The velocity increases to a local maximum at about 550 fathoms. The axis of the sofar channel, where the velocity is least, is at about 800 fathoms. Below 1100 fathoms the velocity gradient is constant, about 0.014 meters per second per meter, and the velocity is the same for all the stations.

The Dow-Stillman inverted echo sounder was used for depth measurement. It performed very well except for high thyratron consumption.

The Markey acoustic winch worked well, although a major overhaul of the slip rings and electric brake was necessary.

A Daystrom V-10 velocimeter, similar to the early NBS model, was used for the first three stations. The last six were made with an ACF model TR-4-B. This instrument has a temperature-compensated sound path, but BT's and bucket temperatures were taken from force of habit.

To accomodate the computer, the time of ten periods of the velocimeter output was measured. These periods, together with depths from Wilharm automatic depth device, were stored in the IBM computer. Because the inverted echo sounder is not synchronized with the PGR, which controls the autodepth device, large depth errors sometimes occur. For this reason and because the computer samples the data infrequently, the computer was not used for the last three stations. The computer was used on the earlier lowerings to test the program; it was not used after its inadequacy was shown.

The PGR record and counter output tape were marked simultaneously by the remains of the Erlanger automarker of 1961. This fine machine should be put into perfect condition again.

Heat Flow Stations (Francis S. Birch)

Of thirty-two stations made, eighteen yielded useful data on heat flow and some of the others yielded only sediment cores or rocks. The rest revealed weaknesses in the recorder and coring gear.

Many stations were failures because of poor penetration of the corer; a small piston corer was more successful than the gravity corer. The large piston corer, with 1200-pound weights and a 20- to 40-foot barrel, was not very successful and also was extremely dangerous and difficult to use. The present heat probe is very accurate and, in suitable places, has been very successful (in rough topography and on hard bottoms it is too fragile).

No extraordinary values were found. The Indian Ocean values roughly compare to values found on previous expeditions, but the stations are too far apart for true comparisions. One value near the median rift of the Mid-Atlantic Ridge was about normal, rather than high as expected. A value in the north end of the Red Sea was a little high; this was expected because of high values in the southern Red Sea and in the Gulf of Aden. The Mediterranean values are rather low. Some explanation of the individual values may be possible because of the relative wealth of other geophysical data.

Camera Stations (J. Frisbee Campbell)

Eighteen camera stations were made on this cruise, of which twelve were in the Indian Ocean, four in the Mediterranean Sea, and two in the Atlantic Ocean. Fifteen of the eighteen stations were successful to some extent; that is, enough pictures were obtained to give an idea of what the bottom looked like. It is estimated that from 6,000 to 10,000 pictures were taken, many of them stereo pairs. A number of the lowerings produced overlapping pictures that can be made into photo mosaics.

The first lowering was made with the dredge camera attached to the wire above the dredge. This method was abandoned because of the possibility of damaging the camera if the dredge were to get a good bite. Two lowerings were made with the dredge camera and no dredge, but the camera was so light that it kited, so the cameras were moved to the heavier T-frame, and this was used in all subsequent lowerings. In the first twelve lowerings the cameras were set for a 12-sec repetition rate and the ship drifted while the cameras were on the bottom. This proved to be a satisfactory method, as good mosaics were produced. To shorten the time on station and increase the area covered, the repetition rate was speeded up to 6 sec for the last six stations. With the repetition rate doubled, the cameras were towed at various speeds so that we could see what speed would produce the best results. Unfortunately, the bottoms covered were generally mud and not very good for producing mosaics, so no conclusive results have been obtained yet.

Aside from mechanical problems, such as broken lines and loose connections, only one problem bothered us. When the cameras were loaded and left on deck for more than an hour or two before being lowered, condensation tended to form in the pressure cases, causing the film to get sticky and jam. This can be prevented by either mounting a silica gel capsule in the camera or taking a few extra minutes to load and test the cameras after definitely getting on station.

<u>Dredging Stations</u> (Richard L. Chase and Robert H. Feden)

Forty-six dredge stations were made during the cruise, in the Indian Ocean, Red Sea, Mediterranean Sea, and the Atlantic Ocean. Of these, twenty-one were successful. Seven dredges and three pingers were lost. Dredging stations accounted for better than one-third of all stations during the cruise.

Of twenty-seven dredges taken in the Indian Ocean, eleven yielded rocks. Gabbro from a ridge trending across the north part of the Somali Abyssal Plain was perhaps the most interesting rock obtained in the Indian Ocean. Manganese nodules were taken off a seamount north of the Seychelles Islands. The nuclei of selected cut samples were all composed of clay.

Limestone was recovered from eight places on the Seychelles-Mauritius Ridge. Small pebbles of altered crystalline rock were recovered from the base of the northern part of the Seychelles Platform.

Operations in the Indian Ocean were hampered because we had to dredge from the starboard side of the ship. Dredging in this manner made it necessary for the wind always to be on the starboard beam. This often rendered impossible dredging of the most favorable sites. Of the five dredges lost in the Indian Ocean, three were lost when the trawl wire fouled in the ship's screws. Poor navigational control in the Indian Ocean also made sites, once discovered, difficult to find again.

Seven stations were made in the Red Sea, two of which were successful. One dredge was lost in a valley in the south. Mud and beasts, with some rock fragments, were recovered south of the mouth of the Suez Canal. Limestone was recovered in the dredge north of the Gulf of Aden.

Seven stations were made in the Mediterranean. Four yielded rocks and one pinger was lost. A detailed bathymetric survey was run off the Lebanese coast. Upon completion of this survey two sites were dredged, one in shallow water and the other in deeper water. Sand and shells were obtained in the shallow dredge and mud in the deep. Metamorphic rocks and limestone were taken from Santa Lucia Bank, northwest of Corsica. Northeast of Corsica, coralline limestone coated with manganese was obtained from a scarp at about 1300 fathoms.

The acquisition of a stern A-frame in La Spezia gave us freedom of movement. We could then dredge in practically any direction.

Basalt, limestone, and glacial erratics were dredged from the Mid-Atlantic Ridge on the homeward crossing. Of five dredge hauls made all but one were successful. One dredge and pinger were lost. Dredge prospects are so good in this part of the world that even the heat-probe recorder managed to obtain fragments of basaltic glass. Control of the speed and direction of the dredge over the ground was greatly facilitated by dredging over the stern and by using a radar buoy for determination of set.

A-frame Construction (Jonathan Leiby)

Removal of the thermistor winch from the ship in Beirut gave rise to a need of some method of handling other gear over the stern, both to permit use of the substitute thermistor fairing and for such tasks as dredging, which are better handled from the stern.

A hydraulic A-frame much like the one at the side of the ship, with the addition of stern platforms, was considered the best choice from the point of view of past experience with that type of equipment, the current plans, and the installation requirements.

In the time available for the change the most realistic approach was to have the equipment built at a port-of-call of the ship and to install it within the scheduled two or three days in port. The prime necessity for such a project was contact with knowledgeable people for advice on commercial facilities and equipment availability at the scheduled ports-of-call. Since the American Bureau of Shipping, with which most commercial United States vessels and many foreign ships are classed, maintains surveyors in ports outside the United States, it was felt that an ABS office in a port would be an indication of good shipyard facilities there. Reference to the Bureau's bulletin showed that they maintain an office in La Spezia with a staff of three surveyors. Through our contact with John Ennis of the Boston office, we learned that Mr. B. A. McLean, senior vice president in New York, had recently been for 15 years past the principal surveyor for the Mediterranean area in Genova and therefore would be able to advise us of the possibilities of undertaking such a job in La Spezia. By telephone Mr. McLean informed us that there should be no problem whatsoever, that there were many adequate and good yards available for the work, and that he would write a note to the surveyor in La Spezia, Mr. L. De Simoni, and also to the present principal surveyor in charge of the Mediterranean area, Mr. V. Van Riper in Genova, requesting that they give us all required assistance. Mr. McLean stated that, regardless of the fact that the CHAIN was not classed with the ABS (being a Navy-owned ship), the ABS has always been interested in the work of Woods Hole and wished to help in any way possible.

On 17 June I visited Van Riper at the ABS office in Genova. He telephoned De Simoni in La Spezia to inform him of my arrival and assisted greatly with advice about train travel between Genova and La Spezia (no small matter, I found).

On the morning of the 18th, after a brief discussion of the project with De Simoni, he took me in his car to four shipyards and requested bids on the plans I had brought with me, modified with metric dimensions. All conversations were in Italian, and without De Simoni it would have been impossible to have covered as much so adequately in so short a time. By the next afternoon (the 19th) three bids had been reported to De Simoni's office and he drove me to the low bidder to discuss the project and be certain that everything was correct. Upon such assurance we asked them to start the job and De Simoni called the others to thank them and inform them that they were unsuccessful. The bids were (in lira):

1. Ferronavale:	L 2,850,000	complete; 10 days
2. Second Bidder:	L 2,700,000	complete; less cylinders,
(approx.)	750,000	2 weeks
	L 3,450,000	
3. Sgorbini:	L 2,375,000	A-frame, cylinders, paint;
	750,000	10 days
	50,000	
	L 3,175,000	

A private contract was drawn up by Ferronavale and signed on the 23rd after I had gone over it with De Simoni. They desired 50% as down payment and 50% upon completion. I established that the letter of credit from the State Street Bank and Trust Company, Boston, would be honored by the Credito Italiano, and on the 23rd I went to the bank with Mr. Bosero, owner and manager of Ferronavale, and paid him L 1,425,000. The Credito Italinao is the bank used by Ferronavale, and this aided the acceptance of my letter of credit.

None of the management at Ferronavale spoke English, but the yard electrician did and I communicated through him, relieving De Simoni from the burden of interpretation after award of the job. De Simoni and the others of his office, Mr. G. Cuneo and Mr. G. Mazzella, stopped at the yard from time to time to check on the work, however, and from the start of the work on the 19th until delivery on the 29th I stopped at the yard each morning and afternoon to answer questions, prepare further drawings for the stern platforms and other attachments, and to inspect the progress of the work in the shops. The yard included the hydraulic cylinders in their price for the

A-frame, but it was necessary to spend further time with an industrial supply firm (Coprobit), ordering the hydraulic hose, operating valve, and fittings necessary to connect the new A-frame into the existing hydraulic system on the ship. Some more time was required, to make contact by telephone (no mean feat in Italy) with the Dimetcote agent in Genova to order that material.

The yard lofted the A-frame, burned the steel, welded it together, and bent the plate - all within their own well-equipped shops. Their machine shop did all the machine work. All pins are of stainless steel and the bronze bushings are as shown on the drawings. A four-way manual valve with a center open return was obtained from Coprobit, and a stainless-steel through-deck operating handle was built by the yard. Hydraulic hose fittings of 1/2 inch and 3/4 inch size turned out to be the same standards as American pipe threads.

As the job neared completion the yard worked two nights straight through to get finished with the welding, sandblasting, and Dimetcoting. They worked all day Sunday and delivered everything on Monday, 29 June, which was a national holiday. With the ship due at 10 a. m. on the 29th, the yard loaded all the parts on a small barge and towed it to the ship at about 11 a. m. , even though our contract called for delivery on the 30th! Yard personnel assisted the ship in loading the material on deck before dinner and then left for the holiday. In the afternoon I set up the A-frame with bolts, with the help of one or two of the ship's personnel.

The following day (the 30th) a welder and some fitters from the yard were employed to weld the unit to the deck and install the stern platforms and hydraulic piping. The yard was also asked to construct two hinged platforms (one for each A-frame) for working on the block and other gear hung on the A-frame. These have proven very valuable additions. Ladder rungs up the foreward leg of the existing A-frame were added.

A floating crane arrived at 6 p. m. on 1 July to move the winch to port to give a fair lead to the A-frame from the Schlumberger winch. The drive chain of that winch was found upon test to be cracked in a number of links (old rusted cracks) so a new chain and a spare were obtained through the yard. Moreover, the 85-foot hoist had almost run away owing to the absence of any lining on its brake drum, so the winch was sent to the yard for overhaul relining and Dimetcoting. This job was done with too little time and the Dimetcote will not hold up as it should, but it can be redone in Woods Hole. The ship's crew had disassembled the hoisting sheaves of the hydrocrane, and they also were sent to the yard for sandblasting and Dimetcoting.

The workers from the yard remained with us until 2:30 a. m. on the 2nd, to finish all jobs. At 10 a. m. I went to the bank with Mr. Bosero and paid the remainder of our bills, including the extras. I then visited the ABS office to thank De Simoni for his help, stopped at the yard and thanked the workers and directors (with the ship's doctor as interpreter) and, after a short wait to receive the new movies, the ship sailed at 4 p. m.

Prior to sailing, the new A-frame was tested by lifting 11 tons clear of the water with the trawl winch on a two-part fall.

CSP Equipment (Richard T. Nowak)

Sparker

Upon our arrival in La Spezia it was found that the Sparker was misfiring at random times and that only three ignitrons were in operation. The misfiring was at first attributed to aging of the ignitrons. These were exchanged for a set of four new Westinghouse tubes. The misfiring disappeared for about a day and then returned. It was observed to be of the following nature. When the capacitor bank charged up to the level for which the voltage relay was set, the power supply would shut off. The PGR would then trigger a discharge and the bank would dump. At this point a built-in time lag would keep the power supply relay open for another 100 msec, until the ignitrons had a chance to deionize. It was found that, when the power relay subsequently came to supply current to the capacitors again, the ignitrons would be conducting at random times and so preventing the charging of the bank.

The time delay was lengthened to about 500 msec, but this did not cure the trouble. It was then found that the thyratrons were sometimes double-pulsing. The second pulse occurred at the time of the closing of the power relay and was triggering the ignitrons just as, or slightly after, voltage was being applied to them. The double-pulsing was traced to the relay in the delay-time flip-flop. The negative pulse, which was normally obtained when this relay was turned on to energize the power relay, was ringing positive, owing to the inductance of the relay coil, and was triggering the thyratrons. This fault was corrected by placing a 0.001 μf capacitor across the relay coil, and no further misfirings of this type were encountered.

Another type of misfiring was found somewhat later. For a time only ignitrons 1, 3, and 4 were being used. It was found that ignitron 1 tended to carry most of the current, thus becoming overheated and misfiring as the bank was being charged. The layout of the ignitron cabinet suggested that this was happening because ignitron 1 has a much shorter current path than ignitrons 3 and 4. The cause of the malfunction in ignitron 2 turned out to be a burnt feed-through connector on the trigger lead from the thyratron cabinet. No spare for this could be found, so a direct connection was made.

Even with all four ignitrons operative it seemed that one of them was preferred. This was surmised from the movement of the anode leads during a discharge. No more misfiring was observed after these repairs.

One other major malfunction was discovered. One morning the power supply decided not to put out more than 1.5 amp. One of the terminal lugs on a primary of transformer T_3 had overheated and arced. The arc destroyed the solder lug and burned the mounting board. The transformer, however, was undamaged. A new terminal was mounted, all solder lugs were replaced with ones of larger size, and the unit was reassembled and put back in operation.

Recommendations for the Sparker

1. Permanent cabinets should be kept stocked with spares; there are too many of some things scattered all over the lower lab, and none of others.

2. Fans should be installed in the thyratron and ignitron cabinets.

3. Heaters should be installed for keeping the circuits warm and dry during long shutdowns.

4. The electrode assemblies should be standardized; some spares for this did not fit.

5. The entire unit should have a thorough overhaul.

Arrays.

Since the Alpine array was preferred because of its lower towing noise at high speed, it is the only one that will be reported on. This array was plagued with noise troubles for some time. These were of two types, motional and 60-cycle. Some of the motional noise seemed to be due to a gradual loosening of the hydrophone elements in the Tygon housing. This was attributed to a flattening of the cross section from a circular shape to an elliptical one. An unsuccessful attempt was made to lessen this noise by wedging the units in the housing with small pieces of plastic sponge. The noise was finally eliminated by additing about 30 feet of 3/4-inch manila line to the trailing end, to stabilize the array.

Other two noise was encountered and found to be due to loosening and slipping of the plastic tape around the two cable connection and electrical connector housing. The tape would slip back along the array until it tangled along the Tygon tubing; the resulting turbulence and flapping tape raised the noise level. The solution was to tape thoroughly and coat the tape with Scotch-kote.

The 60 cps noise problem in the Alpine array had two sources, the array itself and the connecting cables and junction box. The 60 cps due to the array itself arose because the fluid in the array was a conductor. Electrical connection to the array was made through a two-conductor shielded cable. The shield originally had been insulated from this fluid by rubber tape, but a high-resistance (500,000-ohm) leakage path developed, probably because of seepage. The aluminum end caps provided a connection to the sea water and so caused a ground loop with the hull of the ship. This was cured for a while by taping the aluminum end caps, but the final cure was to fill the array with No. 10 motor oil.

The multichannel cable running from the afterdeck to the top lab and the junction box in the top lab were found to be introducing some hum. A quieter arrangement consisted of using one of the hydrophone patch cables. This was run to a small aluminum box containing a matching transformer. The box was fixed directly to the suitcase amplifier cabinet. The only apparent source of 60 cps pickup with this arrangement was magnetic pickup in the transformer used.

Recommendations for the Arrays.

If the Alpine array is to be used any more, the connectors should be redesigned to eliminate the jury rig now in use.

Amplifiers

The five-channel suitcase in general gave good service with only minor component troubles. It was found, however, that when channels 4 and 5 were spliced together at the inputs and at the outputs used to drive separate PGR's there was set up some sort of a ground loop, which introduced 60 cps into the suitcase amplifiers along with quite a bit of scale-line generator signal. This was reduced by using only one amplifier to drive two cathode followers. The noise was reduced further by running the output of the amplifier to the cathode follower in a lead which was grounded only at the amplifier.

Filters

No problems.

PGR

Routine maintenance.

Tape recorders

Quite a bit of trouble was experiences with the relays in the control system of the four-channel Crown recorders. Sticking contacts and unreliable operations were the major complaints. There also seems to be quite a bit of variation between amplifiers and amplifier-head combinations. The manual for these machines is very inadequate.

Further recommendations

There should be a way to synchronize PGR's but have different sweep speeds and scale-line combinations. The humidifiers need more work. There should be a maintenance log with each PGR, as sometimes extensive modifications are made.

CSP Towing Methods (Colin Waldon)

Array-towing procedures

The prodecures for towing continuous seismic profiling gear on CHAIN Cruise 43 have varied widely. In previous seismic work speed was restricted to less than 6 knots, the records suffering from extreme noise level problems due primarily to towing.

The first array-towing arrangement was similar to what is now used with the Sparker. A heavy wire rope with fire hose fairings and a 450-pound tow fish were used to sink the array cable and the hydrophones. The fairings were 9 feet long and split up the back and were laced when the cables (both suspending and conductor) were installed. This assembly was suspended by a boom-and-mast arrangement mounted just forward of the 85-foot hoist.

For streaming and retrieving gear the fish and installed fairings were raised off the fantail by a line running from the capstan to the fairleads, up to the boat deck's after davit, and down to the fish. Once over the rail, the fish was lowered to the water, and the retrieving line was slackened so as not to impair the fish's towing qualities. The array and remaining cable was then streamed over the fantail and released. The array could be adjusted to desired depths by raising or lowering the boom. With this method the array was towed at any depth from 25 to 40 feet and from 200 to 1300 feet aft.

The procedure was extremely difficult to carry out, besides being somewhat dangerous, because the entire rig had to be pulled forward and up, and so past the port screw. Moreover, four to six people were needed to stream it. There was also much towing noise caused by the cable, the fairings and, most of all, the line used for streaming. Since the line had to be slackened, it vibrated extensively. All these noises were picked up by the hydrophones and recorded.

In the second arrangement the same fairings were used but the suspending cable was mounted on their trailing edges. The chain, with fairings and cable, was streamed over the fantail by means of a pulley incorporated on the thermistor winch and a cable and drum installed on the deck. For streaming, the fairings had to have the hydrophone cable laced inside and then connected with shackles and pins to the suspending cable (Figures 8 and 9). For holding the fairings up, a 3/4-inch line was attached to the top fairing and secured to a cleat on the thermistor winch.

As was found in the use of the previous system, there was much tow noise, but this time it was greater because of the fairings' position, which was in the screw-turbulence area. The procedure also was quite time-consuming.

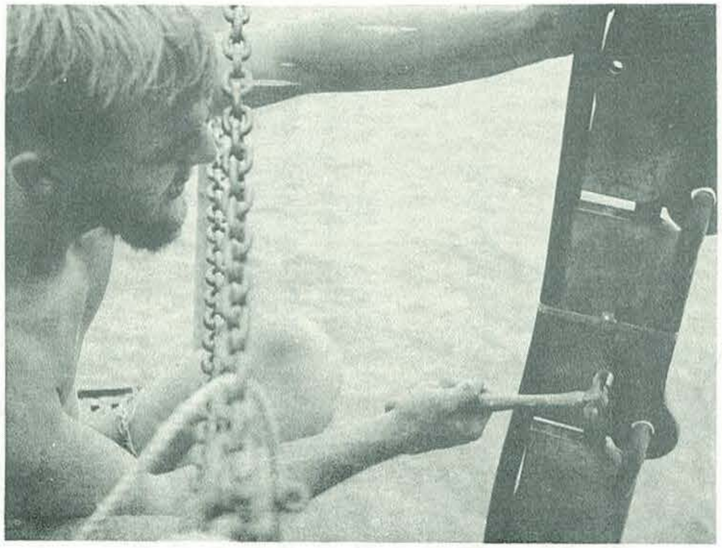


FIGURE 8. Banding on cable.

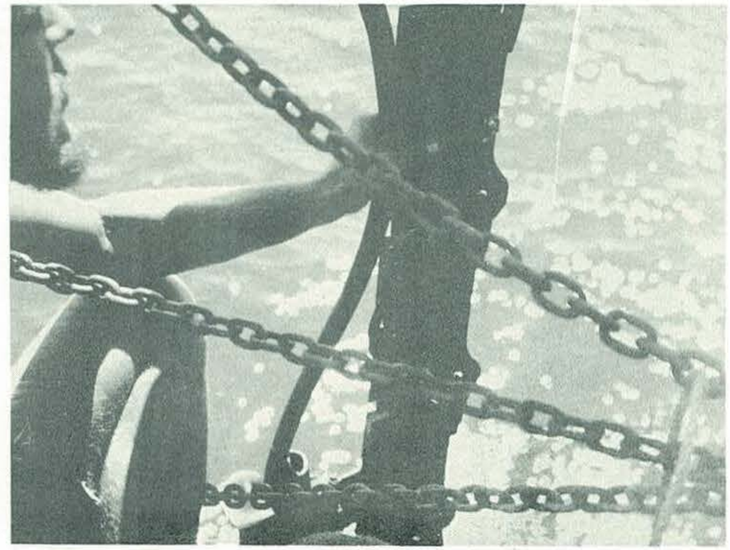


FIGURE 9. Bandit hold-on.

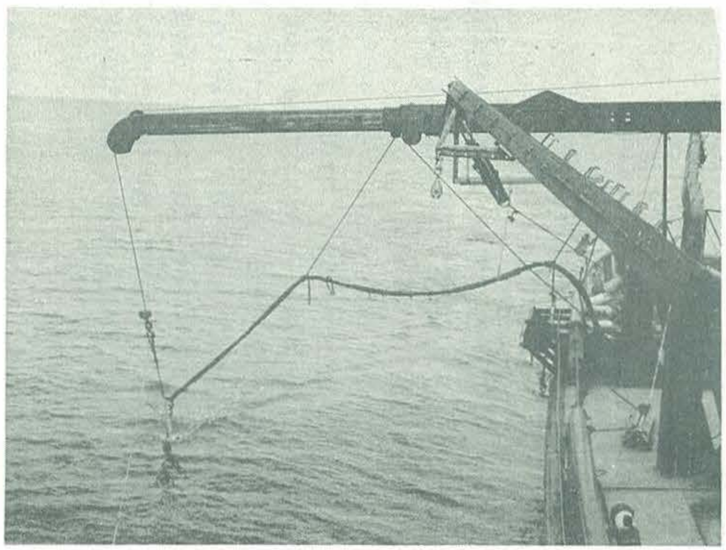


FIGURE 10. Sparker streamed at 4 knots.

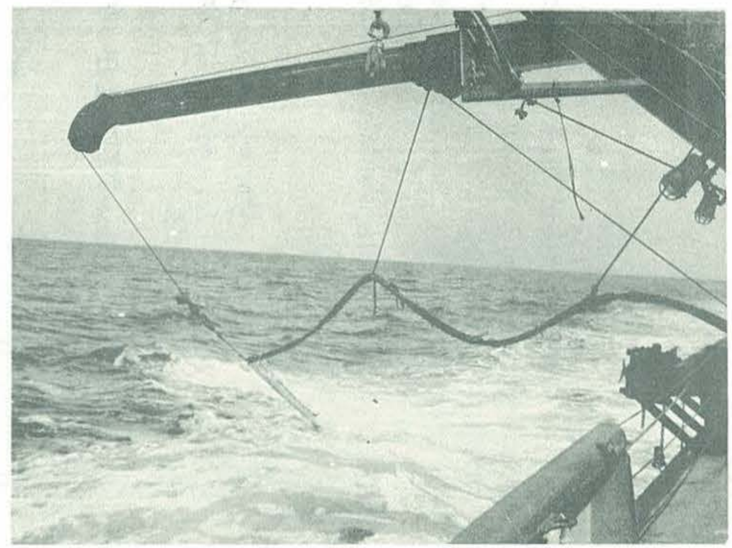
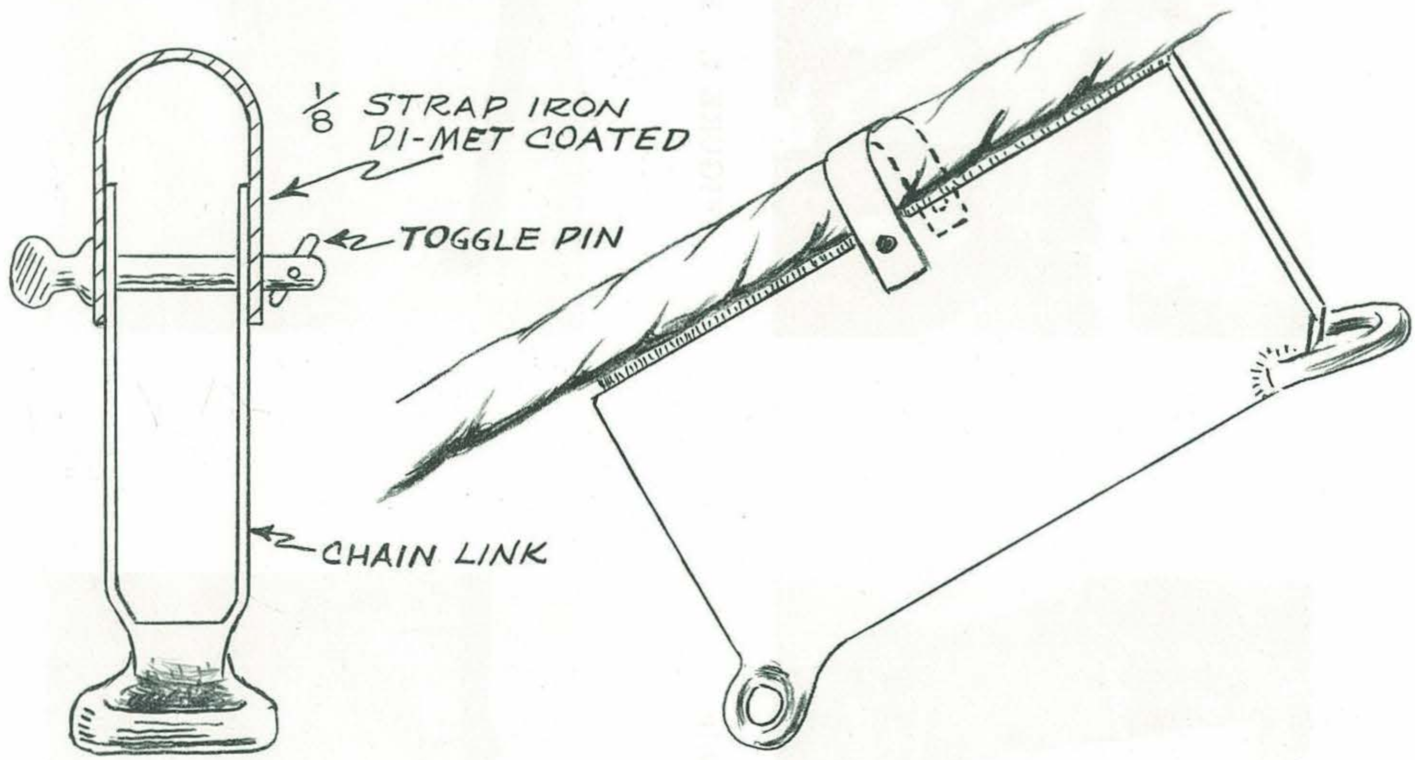


FIGURE 11. Sparker streamed at 10 to 12 knots.

This system was used from La Spezia to the northern area of the Indian Ocean, where very calm sea conditions permitted us to use sash weights taped and tied with marlin to the hydrophone cable. These were secured about 200 feet aft of the ship. The noise level was reduced greatly, and very good records were got at speeds of up to 7 knots. The method was used for all the Indian Ocean CSP.



THIS TYPE OF ARRANGEMENT SHOULD WORK BETTER THAN THE EXISTING TYPE OF HOLD-DOWN

At Mauritius we received a new array that produced better records at higher speeds with the same towing arrangement. In this new array the Alpine eel and same cable and connector are used, but a preamplifier is not needed. A special connector, however, that contains an impedance-matching transformer must be installed between the top-lab hydrophone connector and the suitcase chassis. Both arrays were used as far as Beirut, with frequent changes, so that experiments could be run over similar topography and under the same conditions and the two arrays could be compared.

After Beirut the 85-foot hoist was utilized by removing about two thirds of the fiberglass fairings from the chain and milling the trailing edges so that they would accept the hydrophone cable. To connect the cable, first a steel elbow is installed to act as lower clamp of the cable and is bolted to the fourteenth and fifteenth chain links up from the fish. Then the hydrophone is made to hold in place with the modified fairings as far as the surface. The only problem that came up was that the brass clips parted after flexing while being installed or removed from the chain. Tape was then tried, and it held quite well at the lower speeds but came loose at the higher ones. Six-thread was tried, but it also parted at speeds higher than 9 knots. The most recent and also most enduring method tried has been the use of Band-it straps. The only trouble with this arrangement is that, if the array is to be brought on board for repairs or to be changed, either the entire rig must be removed from the hoist or a grappling hook must be used to snag the cable. The hook in turn is hauled on board, and the remaining hydrophone is brought aboard with the tugger and is figure-eighted on deck.

The method has many advantages: (1) the array, once streamed, can be raised or lowered by one person, (2) towing noise is at a minimum, and (3) the array is towed out and below the screw-turbulence area.

Towing procedures for the Sparker

The Sparker is towed much as were the hydrophones at the beginning of the cruise. A 1/2-inch wire cable is used for suspending the fire hose fairings, double conductor cable, and weight. The Sparker is suspended from the hydrocrane, which is pinned in a starboard position. To prevent the crane wire from chafing on the pulley cheeks, a forward stay is shackled to the suspending wire rope and is lead forward of the starboard lifeboat davit, where it is secured to a cleat. Until recently a 450-pound fish was used as depressor, but this has been replaced by a modified coring weight that has a towing tail added. This improvised fish allowed the Sparker electrode to tow deeper in the water (See Figures 10 and 11).

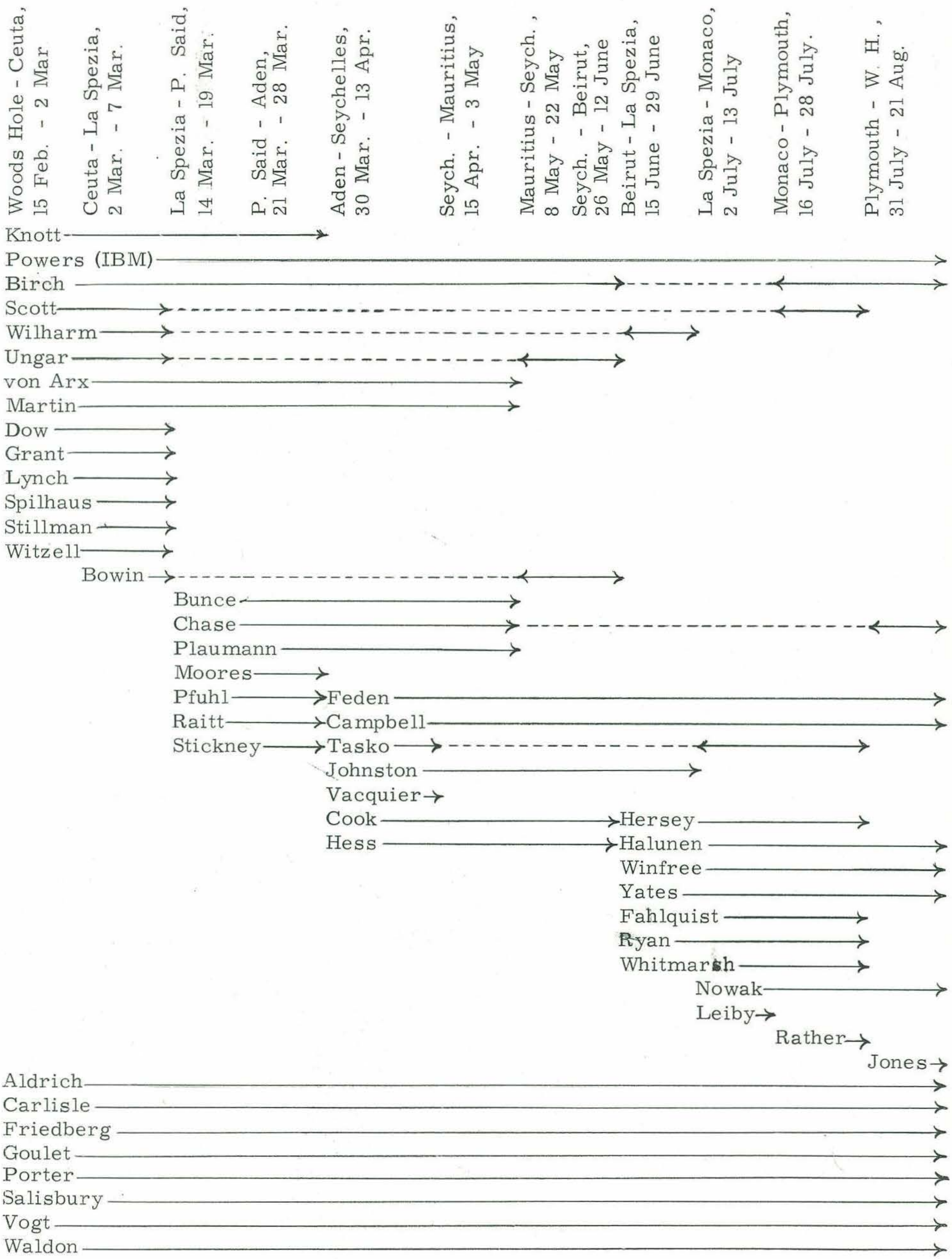
Handling of this gear is quite simple, only two scientists and one crane operator being needed to stream it in average seas. More persons should be available when seas are rough, for the rig weighs upwards of 1500 pounds when out of water.

Sparker maintenance

Replacing the Sparker electrode is very easy but takes about one half-hour. The procedure is explained by John Hall in the Sparker handbook.

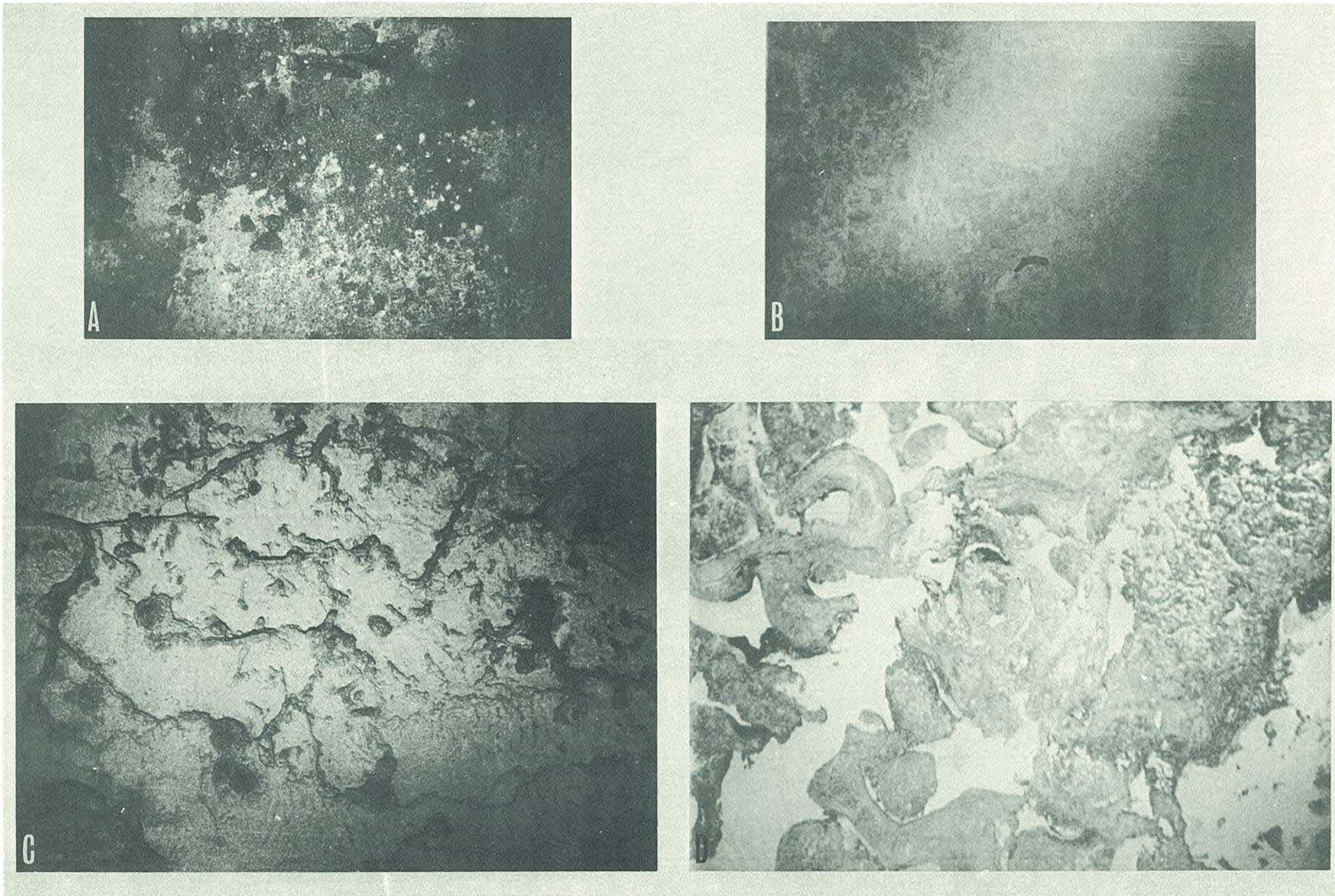
The top-lab watches should set up a routine of checking on such fantail conditions as (1) any signs of chafing on either array or sparker parts, (2) Sparker towing angle, (3) forestay, (4) tag lines and, most of all, (5) safety lines around Sparker cables. The electrode should be checked, as well as the fire hose fairings, every time the Sparker is brought aboard. It has been found that the tip lasts about 40,000 sparks before it needs replacing.

APPENDIX D: TABLE OF PERSONNEL

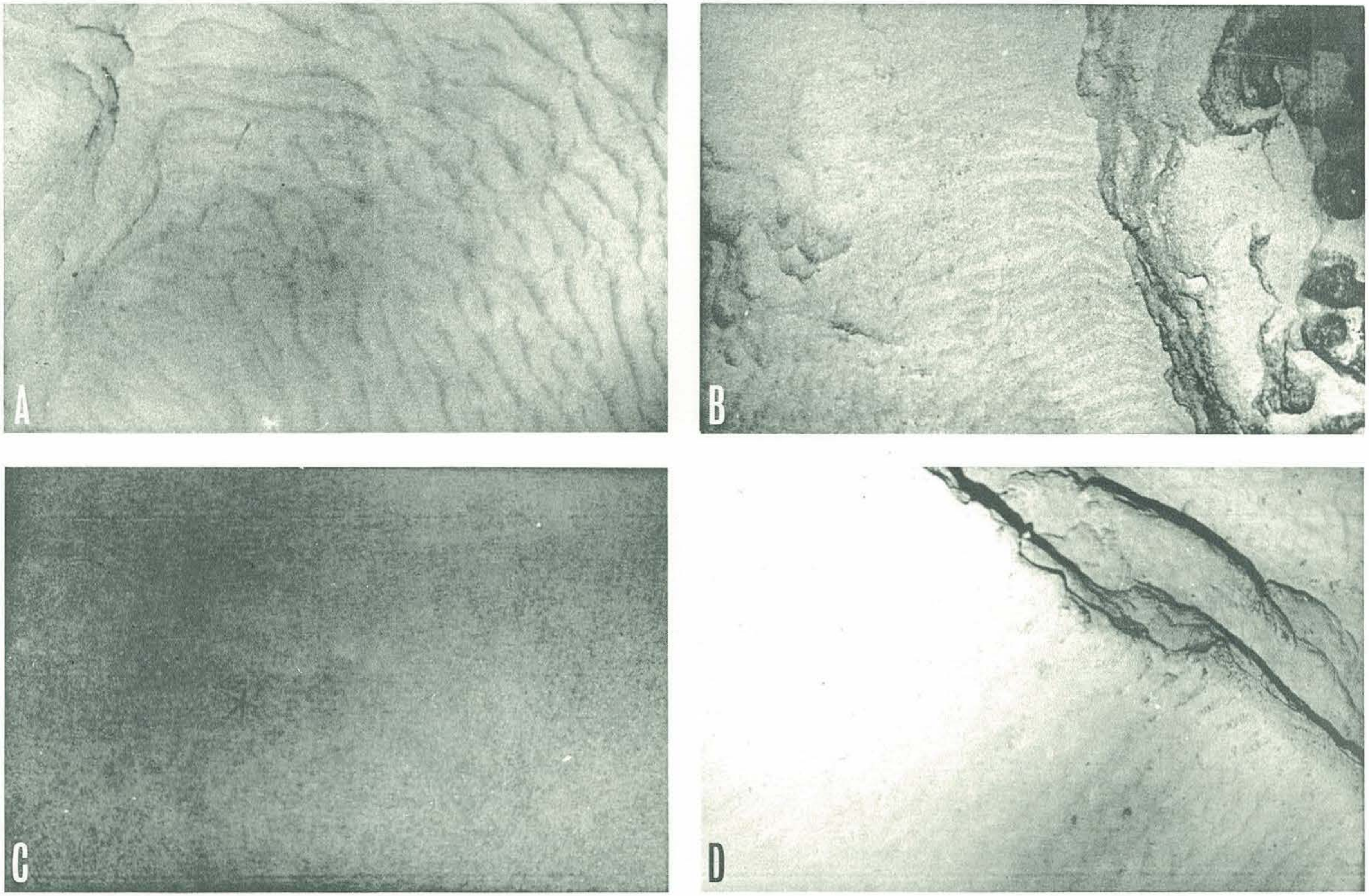


APPENDIX E

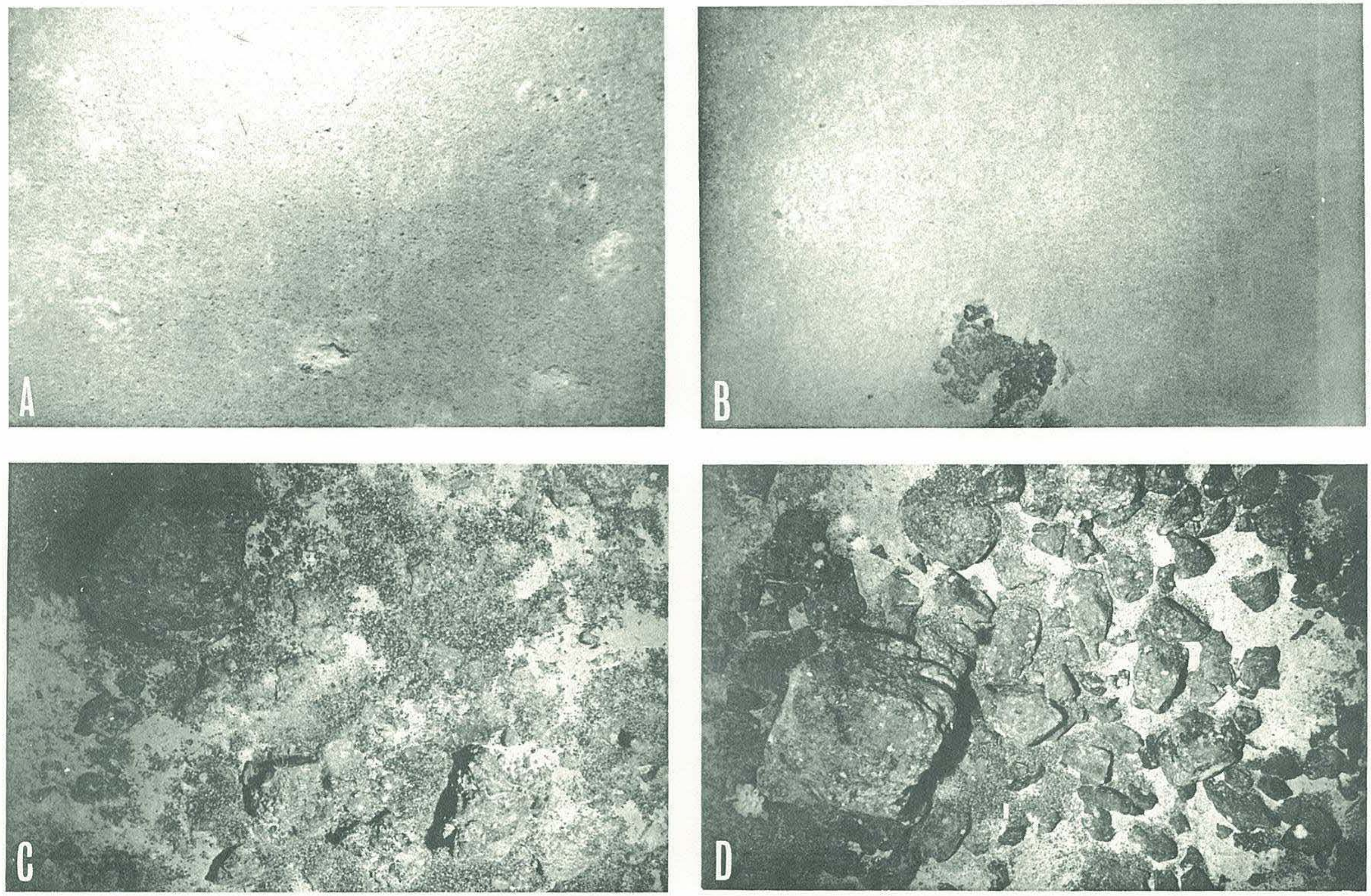
Selection of Bottom Photographs



(A) Station 111, in 950 fathoms; sand and cobble bottom with fish. (B) Station 21, in 2090 fathoms; mud bottom with animal tracks and holothurian. (C) Station 38, in 770 fathoms; coral and sand bottom. (D) Station 41, in 1275 fathoms; sand bottom and rock (?).



(A) Station 42, in 650 fathoms; limestone and rippled sand. (B) Station 46, in 1100 fathoms; coral, limestone, and rippled sand. (C) Station 50, in 650 fathoms; sand bottom with echinoid. (D) Station 62, in 1010 fathoms; rippled sand bottom and limestone ledge.



(A) Station 84, in 1760 fathoms; mud bottom with animal borings. (B) Station 87, in 1290 fathoms; sand bottom with coral outcrop. (C) Station 105, in 1320 fathoms; sand and loose rock bottom, with animals (?). (D) Station 111, in 820 fathoms; sand, cobbles, and boulders; note animals (?).

DISTRIBUTION LIST

	No. of Copies
Bell Telephone Laboratories, Inc. Whippany, New Jersey Attn: Mr. C. F. Wiebusch, Div. 54	1
Chief, Bureau of Ships Department of the Navy Washington 25, D. C. Attn: Code 335	1
Code 341	1
Code 631	1
Code 689B	1
Oceanographer (RU222) Bureau of Naval Weapons Department of the Navy Washington 25, D. C.	1
Director Hudson Laboratories 145 Palisade Street Dobbs Ferry, New York	1
Oceanographer U. S. Naval Oceanographic Office Washinton 25, D. C.	2
Library Lamont Geological Observatory Columbia University Palisades, New York 10964	1
Systems Analysis Group Undersea Warfare Research and Development Council Room 5-224 USNOL White Oak Silver Spring, Maryland	1

	No. of Copies
Bureau of Naval Weapons Department of the Navy Washington 25, D. C.	1
Office of Naval Research Department of the Navy Washington 25, D. C. Attn: Code 468	1
Code 416	1
Code 418	1
Code 466	2
Director Defense Research Laboratory University of Texas Austin, Texas	1
Commander Submarine Development Group TWO c/o Fleet Post Office New York, New York	1
Director Department of Oceanography Texas A and M University College Station, Texas	1
Director Marine Laboratory University of Miami 1 Rickenbacker Causeway Virginia Key Miami 49, Florida	1
Director Narragansett Marine Laboratory University of Rhode Island Kingston, Rhode Island	1

	No. of Copies
Librarian U. S. Naval Postgraduate School Monterey, California	1
U. S. Naval Ordnance Test Station Pasadena Annex 3202 East Foothill Boulevard Pasadena 8, California Attn: Pasadena Annex Library	1
Commander (Code 753) U. S. Naval Ordnance Test Station China Lake, California Attn: Technical Library	1
Commanding Officer U. S. Naval Underwater Ordnance Station Newport, Rhode Island	1
Office of Naval Research Project Officer U. S. Navy Sofar Station APO 856 c/o Postmaster, New York	1
Office of Naval Research 495 Summer Street Boston, Massachusetts	1
Commanding Officer U. S. Navy Mine Defense Laboratory Panama City, Florida	1
Air Force Missile Test Center Technical Library, MU-135 Patrick Air Force Base, Florida	1

	No. of Copies
U. S. Navy Research Laboratory Washington, D. C. Attn: Code 2021	1
Code 5500	1
Code 5510	1
Commanding Officer and Director U. S. Navy Underwater Sound Laboratory Fort Trumbull New London, Connecticut	2
Commanding Officer U. S. Naval Ordnance Laboratory White Oak, Silver Spring Maryland	2
Commanding Officer and Director (Code 560) David Taylor Model Basin Washington 25, D. C.	2
Applied Physics Laboratory University of Washington 1013 East 40th Street Seattle 5, Washington	1
Director U. S. Naval Air Development Center Johnsville, Pennsylvania	1
Force ASW Officer Commander, Submarine Force U. S. Pacific Fleet c/o Fleet Post Office San Francisco, California	1

	No. of Copies
Anti-Submarine Defense Force U. S. Atlantic Fleet U. S. Naval Base Norfolk, 11 Virginia	1
National Academy of Sciences National Research Council 2101 Constitution Avenue Washington, D. C. Attn: Dr. William Rainey	1
ONR Liaison Officer Woods Hole Oceanographic Institution Woods Hole, Massachusetts	1
Dr. G. P. Woollard, Director Hawaii Institute of Geophysics University of Hawaii Honolulu, Hawaii	1
Daystrom Electric Division of daystrom, Inc. 753 Main Street Poughkeepsie, New York	1
Fluid and Solid Mechanics Laboratory Institute of Science and Technology Post Office Box 618 Ann Arbor, Michigan	1
Ordnance Research Laboratory Pennsylvania State University University Park, Pennsylvania	1
Pacific Oceanographic Group Nanaimo, British Columbia	1

	No. of Copies
Defense Documentation Center Cameron Station Alexandria, Virginia 22314	20
Chief of Naval Operations Op-07T Washington 25, D. C.	1
Commanding Officer and Director U. S. Navy Electronics Laboratory San Diego 52, California	2
Commanding Officer and Director ASW Tactical School U. S. Atlantic Fleet Norfolk, Virginia	1
Director Marine Physical Laboratory of the Scripps Institution of Oceanography San Diego 52, California	1
Anti-Submarine Warfare Research Center La Spezia, Italy	1
Commander Destroyer Development Group TWO c/o Fleet Post Office New York, New York	1
Commander Destroyer Flotilla THREE c/o Fleet Post Office San Francisco, California	1

	No. of Copies
Commanding Officer Anti-Submarine Defense Force U. S. Pacific Fleet Fleet Post Office San Francisco, California	1
Institute of Defense Analyses Communications Research Division Von Neumann Hall Princeton, New Jersey	1
Chief of Naval Operations (Op03EG) Department of the Navy Washington 25, D. C.	1
Seyir ve Hidrografi Dairesi Cubuklu-Istanbul, Turkey Via: ONR Branch Office London	1
National Institution of Oceanography Wormley Godalming, Surrey, ENGLAND Attn: Library	1
Advanced Research Projects Agencies Pentagon Washington 25, D. C. Attn: Nuclear Test Detection Office	1
Director Bureau of Commercial Fisheries Biological Laboratory U. S. Fish and Wildlife Service Woods Hole, Massachusetts	1
Bermuda Biological Station St. George's West, Bermuda Attn: Mrs. Leida Piip, Librarian	1

	No. of Copies
Institute for Defense Analysis 1666 Connecticut Avenue Washington 9, D. C. Attn: Classified Library	1
Mr. R. H. Wilcox Information Systems Branch Mathematical Sciences Division Office of Naval Research (Code 437) Department of the Navy Washington 25, D. C.	1
U. S. Naval Applied Science Laboratory Code 9360 Naval Base Brooklyn 1, New York	1
Water Quality Section Basic Data Branch Division of Water Supply and Pollution control Department of Health, Education, and Welfare 1014 Broadway Cincinnati 2, Ohio	1

Woods Hole Oceanographic Institution
Reference No. 65-9

NARRATIVE OF CHAIN CRUISE #43, February - August 1964, by S. T. Knott, E. T. Bunce, C. O. Bowin, J. B. Hersey, and R. L. Chase, 146 pp, 11 figs., and Appendices, February 1965.

Unclassified

On CHAIN Cruise 43, 15 February to 21 August 1964, geophysical and geological observations were made in the North Atlantic Ocean, the Mediterranean and Red Seas, and the Western part of the Indian Ocean, along the track Woods Hole - Ceuta (Spanish Africa) - La Spezia - Port Said - Aden - Victoria (Seychelles Islands) - Port Louis (Mauritius) - Victoria (Seychelles Islands) - Port Said - Beirut - La Spezia - Monaco - Plymouth (England) - Woods Hole. This report contains (1) a narrative of the cruise, (2) a list of stations, (3) statements of the scientific objectives of the cruise, (4) a summary of the geological and geophysical observations, (5) end-of-cruise reports on equipment and some phases of the research program, and (6) a selection of bottom photographs. WHOI Ref. No. 64-51 contains a detailed navigational plot of the entire cruise, including soundings and the locations of other observations.

1. Gravity
2. Magnetics
3. Reflection Seismology
4. Bathymetry

I. Knott, S. T.
II. Bunce, E. T.
III. Bowin, C. O.
IV. Hersey, J. B.
V. Chase, R. L.

1. Woods Hole Oceanographic Institution

This card is UNCLASSIFIED

Woods Hole Oceanographic Institution
Reference No. 65-9

NARRATIVE OF CHAIN CRUISE #43, February - August 1964, by S. T. Knott, E. T. Bunce, C. O. Bowin, J. B. Hersey, and R. L. Chase, 146 pp, 11 figs., and Appendices, February 1965.

Unclassified

On CHAIN Cruise 43, 15 February to 21 August 1964, geophysical and geological observations were made in the North Atlantic Ocean, the Mediterranean and Red Seas, and the Western part of the Indian Ocean, along the track Woods Hole - Ceuta (Spanish Africa) - La Spezia - Port Said - Aden - Victoria (Seychelles Islands) - Port Louis (Mauritius) - Victoria (Seychelles Islands) - Port Said - Beirut - La Spezia - Monaco - Plymouth (England) - Woods Hole. This report contains (1) a narrative of the cruise, (2) a list of stations, (3) statements of the scientific objectives of the cruise, (4) a summary of the geological and geophysical observations, (5) end-of-cruise reports on equipment and some phases of the research program, and (6) a selection of bottom photographs. WHOI Ref. No. 64-51 contains a detailed navigational plot of the entire cruise, including soundings and the locations of other observations.

1. Gravity
2. Magnetics
3. Reflection Seismology
4. Bathymetry

I. Knott, S. T.
II. Bunce, E. T.
III. Bowin, C. O.
IV. Hersey, J. B.
V. Chase, R. L.

1. Woods Hole Oceanographic Institution

This card is UNCLASSIFIED

Woods Hole Oceanographic Institution
Reference No. 65-9

NARRATIVE OF CHAIN CRUISE #43, February - August 1964, by S. T. Knott, E. T. Bunce, C. O. Bowin, J. B. Hersey, and R. L. Chase, 146 pp, 11 figs., and Appendices, February 1965.

Unclassified

On CHAIN Cruise 43, 15 February to 21 August 1964, geophysical and geological observations were made in the North Atlantic Ocean, the Mediterranean and Red Seas, and the Western part of the Indian Ocean, along the track Woods Hole - Ceuta (Spanish Africa) - La Spezia - Port Said - Aden - Victoria (Seychelles Islands) - Port Louis (Mauritius) - Victoria (Seychelles Islands) - Port Said - Beirut - La Spezia - Monaco - Plymouth (England) - Woods Hole. This report contains (1) a narrative of the cruise, (2) a list of stations, (3) statements of the scientific objectives of the cruise, (4) a summary of the geological and geophysical observations, (5) end-of-cruise reports on equipment and some phases of the research program, and (6) a selection of bottom photographs. WHOI Ref. No. 64-51 contains a detailed navigational plot of the entire cruise, including soundings and the locations of other observations.

1. Gravity
2. Magnetics
3. Reflection Seismology
4. Bathymetry

I. Knott, S. T.
II. Bunce, E. T.
III. Bowin, C. O.
IV. Hersey, J. B.
V. Chase, R. L.

1. Woods Hole Oceanographic Institution

This card is UNCLASSIFIED

Woods Hole Oceanographic Institution
Reference No. 65-9

NARRATIVE OF CHAIN CRUISE #43, February - August 1964, by S. T. Knott, E. T. Bunce, C. O. Bowin, J. B. Hersey, and R. L. Chase, 146 pp, 11 figs., and Appendices, February 1965.

Unclassified

On CHAIN Cruise 43, 15 February to 21 August 1964, geophysical and geological observations were made in the North Atlantic Ocean, the Mediterranean and Red Seas, and the Western part of the Indian Ocean, along the track Woods Hole - Ceuta (Spanish Africa) - La Spezia - Port Said - Aden - Victoria (Seychelles Islands) - Port Louis (Mauritius) - Victoria (Seychelles Islands) - Port Said - Beirut - La Spezia - Monaco - Plymouth (England) - Woods Hole. This report contains (1) a narrative of the cruise, (2) a list of stations, (3) statements of the scientific objectives of the cruise, (4) a summary of the geological and geophysical observations, (5) end-of-cruise reports on equipment and some phases of the research program, and (6) a selection of bottom photographs. WHOI Ref. No. 64-51 contains a detailed navigational plot of the entire cruise, including soundings and the locations of other observations.

1. Gravity
2. Magnetics
3. Reflection Seismology
4. Bathymetry

I. Knott, S. T.
II. Bunce, E. T.
III. Bowin, C. O.
IV. Hersey, J. B.
V. Chase, R. L.

1. Woods Hole Oceanographic Institution

This card is UNCLASSIFIED

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Woods Hole Oceanographic Institution Woods Hole, Massachusetts	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

NARRATIVE OF CHAIN CRUISE #43
February - August 1964

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Summary

5. AUTHOR(S) *(Last name, first name, initial)*

Knott, S. T. , Bunce, E. T. , Bowin, C. O. , Hersey, J. B. , and Chase, R. L

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
February, 1965	178	3

8a. CONTRACT OR GRANT NO. Nonr-4029(00)NR 260-101 b. PROJECT NO. NSF Grant GP-2370 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) Reference No. 65-9 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*

10. AVAILABILITY/LIMITATION NOTICES

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Office of Naval Research (Code 466) Washington, D. C.

13. ABSTRACT

On CHAIN Cruise 43, 15 February to 21 August 1964, geophysical and geological observations were made in the North Atlantic Ocean, the Mediterranean and Red Seas, and the Western part of the Indian Ocean, along the track Woods Hole - Ceuta (Spanish Africa) - La Spezia - Port Said - Aden - Victoria (Seychelles Islands) - Port Louis (Mauritius) - Victoria (Seychelles Islands) - Port Said - Beirut - La Spezia - Monaco - Plymouth (England) - Woods Hole. This report contains (1) a narrative of the cruise, (2) a list of stations, (3) statements of the scientific objectives of the cruise, (4) a summary of the geological and geophysical observations, (5) end-of-cruise reports on equipment and some phases of the research program, and (6) a selection of bottom photographs. WHOI Ref. No. 64-51 contains a detailed navigational plot of the entire cruise, including soundings and the locations of other observations.

DD FORM 1 JAN 64 1473

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2*a*. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2*b*. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7*a*. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7*b*. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8*a*. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8*b*, 8*c*, & 8*d*. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9*a*. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9*b*. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through ______________."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through ______________."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through ______________."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS)*, *(S)*, *(C)*, or *(U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, roles, and weights is optional.