NOAA Data Report OMPA-11

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STAX-II

FINAL ACOUSTICAL DATA REPORT

John R. Proni
Donald J. Walter
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Boulder, Colorado
January 1982

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UNITED STATES DEPARTMENT OF COMMERCE
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Office of Marine Pollution Assessment
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Abstract. High frequency acoustic systems (20 and 200 KHz) have been used successfully in the detection and tracking of sewage sludge in a dumping zone in the New York Bight Apex. Observations made with these systems indicate that particulate distribution of a dumped artificial tracer is highly dependent on changes associated with the vertical density structure in the water column.

1. Introduction

During the period of July 11 through July 16, 1976, members of the Ocean Acoustics Laboratory of NOAA's Atlantic Oceanographic and Meteorological Laboratory participated in the Second Sludge Tracking Acoustical Experiment (STAX-II) in the New York Bight. The present report deals only with the acoustical measurements made in this multi-disciplinary experiment. Three publications (Proni et al. a, b, c (1981)) have thus far resulted from the work performed in this experiment and it is likely that additional publications will result.

The first Sewage Sludge Tracking Experiment (STAX-I) carried out in September 1975 clearly demonstrated that acoustical detection, tracking, and concentration mapping of at least the particulate phase of ocean dumped sewage sludge was indeed possible (Proni et al. (1976)). No samples of dumped material were obtained in that first experiment. After the successful completion of the STAX-I experiment several questions arose. Some of those questions were:

1) How complete a picture of the particulate distribution is presented by the acoustical data?

2) What size range and concentration levels may be detected acoustically?

3) What relationship does the distribution of the dissolved phase of sewage sludge bear to distribution of the solid phase which is acoustically detected?

4) Can a particulate or mass budget for the dump material be derived from acoustical data?

5) Can a correlation between acoustical back scattered sound intensity and particulate concentration be established?

6) Over what period of time after a dump may dumped sewage sludge be detected acoustically?

7) Assuming that sewage sludge may be detected for a period of at least 72 hours after a dump, can anything be established about the long term (weeks, months, years) fate of the sludge?

8) What influence is the water column structure likely to have upon sludge dispersion?

9) Does the sewage sludge penetrate the pycnocline rapidly, slowly, or not at all?

10) Does the sewage sludge fractionate, i.e. divide into different components at different depths within the water column?

At the time the STAX-II experiment occurred there were two difficult problems facing the scientists involved. These problems both bore upon the subject of the comparison of acoustical concentration estimates with chemical concentration estimates. The first of these problems was that no clearly defined chemical indication of sludge concentration was available. The second of these problems was that the acoustical system was not calibratable; that is, fundamental electronic difficulties existed in the acoustical system for which neither the funds nor the time were available to correct the system. In spite of these difficulties significant scientific results were obtained in the experiment as will be seen presently.

2. Objectives

Formally, two fundamental objectives were set forward for the acoustical effort in the STAX-II Experiment. These were:

1) To use acoustical echo-sounder systems, shown to be useful in the detection of sewage sludge in STAX-I, to guide chemical sampling in STAX-II.

2) To use acoustical echo-sounder systems to study the spatial and temporal dispersion of dumped sewage sludge.

In order to accomplish these objectives it was decided that two acoustical platforms (i.e. ships) were necessary; one to come on station to allow chemical sampling and one to continue in a roving pattern permitting continuous mapping of the subsurface sewage plume.

3. Methods

Acoustical data were collected from the Kelez on the 11th, 12th, 14th, and 16th of July 1976; and from the Johnson on the 11th. The Johnson subsequently broke down on the 12th and was replaced by the Black Coral from which data were collected on the 14th, 15th, and 16th of July. The Kelez served as the chemical sampling vessel and the Johnson/Black Coral served as the roving platform to delineate the plume boundaries.

Two acoustic systems were used on the Kelez (20 and 200 KHz) and one on the Johnson/Black Coral (200 KHz), each with real time strip chart output as well as an analog tape recorder for data processing in the laboratory. The acoustic transducers were towed separately between 0-4 knots in tow bodies designed to alleviate noise and movement in the water.

Generally temperature profiles were obtained before or after each station. The analog temperature trace was used in conjunction with the analog acoustic trace as a guideline for locating desired chemical sampling depths.

During the study the Kelez monitored a total of three planned dumping events and the Black Coral monitored a total of two planned events and one unplanned event. Schematics of the sludge cloud as transposed from the acoustic traces are contained in Appendix A.

4. Observations

One of the most important features of the oceanic water column at the New York Bight sewage sludge dumpsite - south and east of 40^{0} 23' 30" N, and 73^{0} 43' 45"W - in July 1976 was its characteristic density stratification. Typical water column density and temperature profiles are shown in Figures 1 and 2 respectively. The importance of this feature upon sewage sludge dispersal is quite evident in acoustical data such as that shown in Figure 3. In this Figure are shown two consecutive passes over a sewage sludge spot dump. The ship reversed course (approximately) between 10:15 and 10:25 local time (L.T.). The following key observation may be made from Figure 3:

1) A portion of the dump material rapidly penetrates the thermocline and reaches the bottom.

2) Much of the material penetrating the thermocline is in the form of "chunks" sufficiently discreet and separated so as to be detected individually acoustically.

3) Another portion of dump material does not initially penetrate the thermocline and "surges" horizontally along the "top" of the pycnocline.

4) Internal oscillations are produced by the dump material as it impacts the pycnocline.

5) There exists a vertical current shear whose critical point appears to be at a depth of about 8 meters. This shear was observed on several other occasions during the course of the experiment and generally appeared to be near the top of the pycnocline.

6) The particle surge does not appear to be spreading isotropically about the point of injection.

Additional acoustic data are contained in Appendix B. This data shows representative samples of the lowering of a chemical sampling system (INTER OCEAN ROSETTE) vertically in the water column. It can clearly be seen that the acoustic trace shows an object in the acoustic beam being lowered deeper in the water column as time progresses. The object in this case is the Rosette system.

5. Acknowledgments

The authors wish to thank the NOAA/MESA office for the contractural support to maintain this study and also the crew members of the NOAA ship George B. Kelez for their assistance and support during this study.

The authors also wish to express their appreciation to Charles Lauter for his diligent efforts involved in preparing the equipment for use and continued flawless operation at sea during some difficult situations.

6. References

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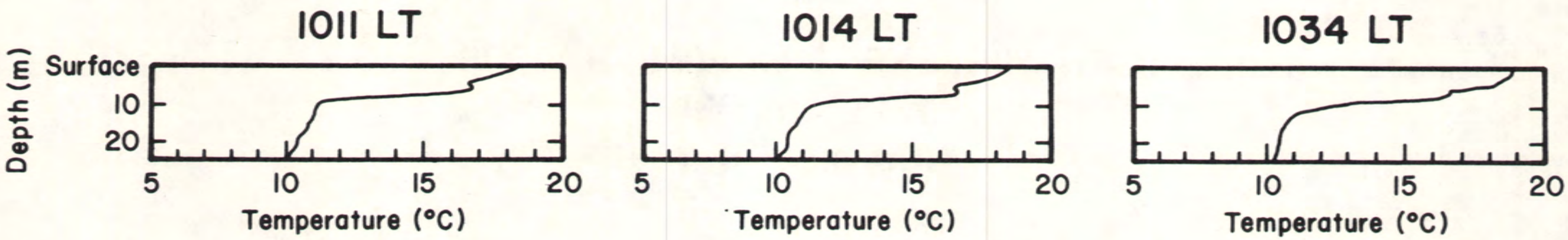
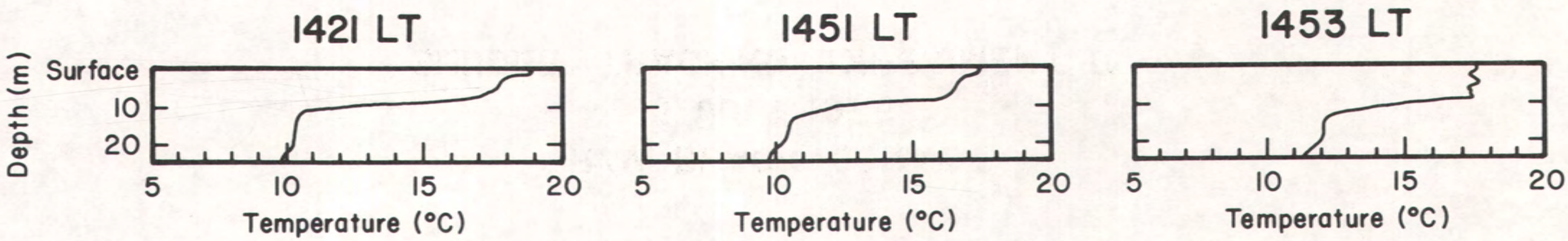


R/V BLACK CORAL
15 JULY 1976
SLUDGE TRACKING EXPERIMENT II

Figure 1. Three representative temperature versus depth traces from the Sewage Sludge Disposal Sight in the New York Bight. Acoustic data obtained in conjunction with these traces are contained in figure 3.



R/V BLACK CORAL
15 JULY 1976
SLUDGE TRACKING EXPERIMENT II

Figure 2. Three additional temperature versus depth traces which in comparison to figure 1 show the consistency of water column temperature structure on July 15, 1976.

RV BLACK CORAL
JULY 15, 1976
SLUDGE TRACKING EXPERIMENT II

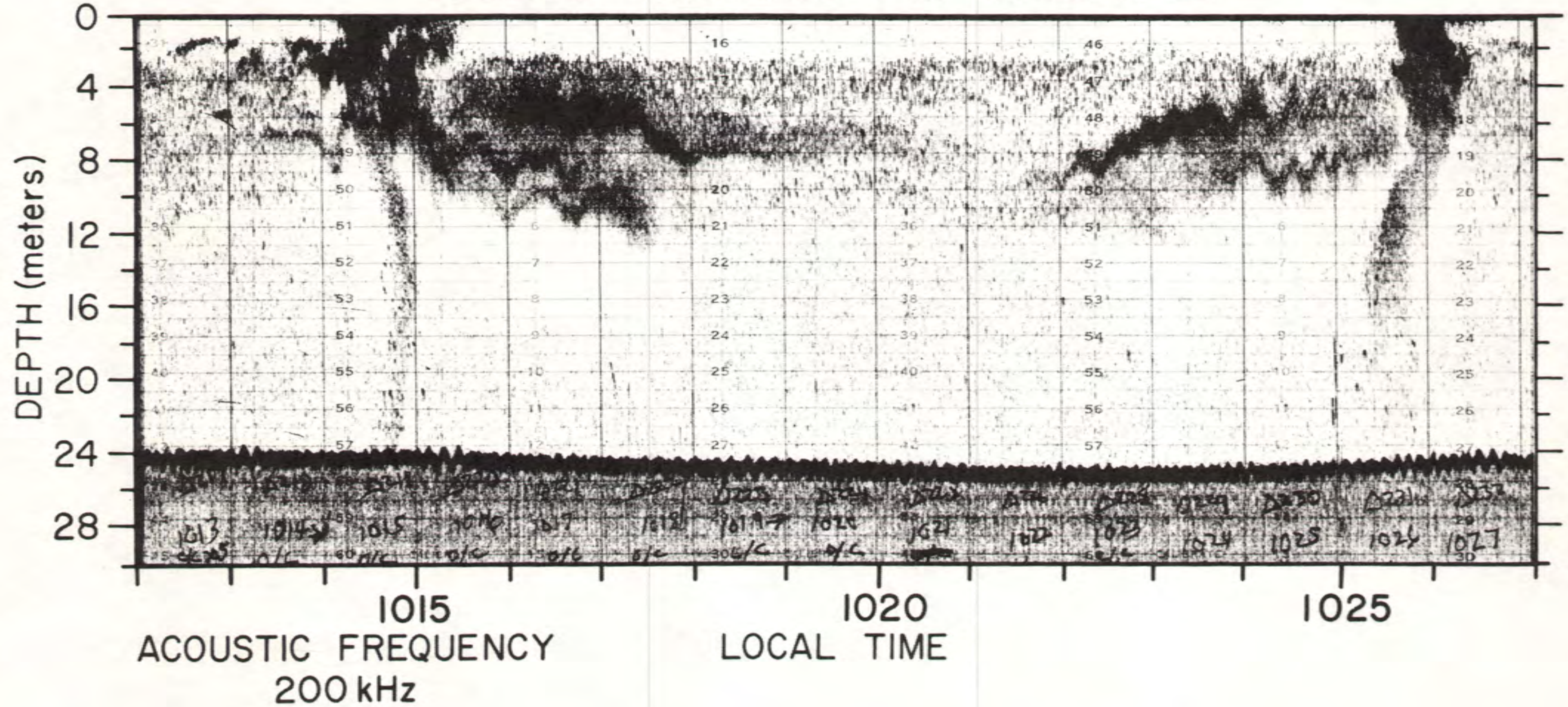
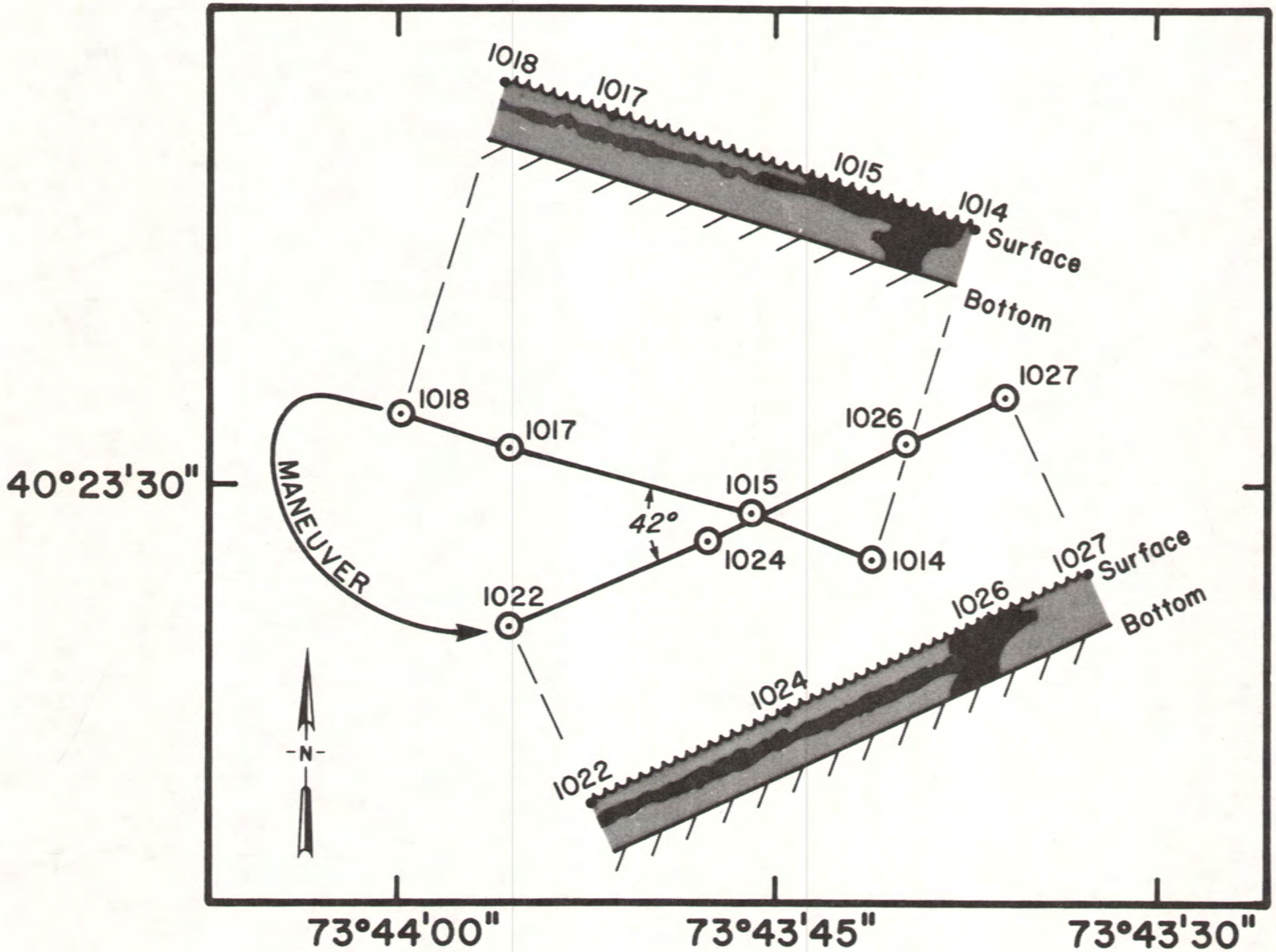


Figure 3. Acoustic data obtained during two consecutive passes over a Sewage Sludge Dump on July 15, 1976 by the R/V Black Coral. Note the particles falling to the bottom at approximately 1015 and 1026. Also note the oscillatory particle surges to the side of each plume.

APPENDIX A

SLUDGE CLOUD SCHEMATICS

Ship's tracklines with overlays of sludge cloud cross sections. These cross sections were transposed from the acoustical data in figure 3.



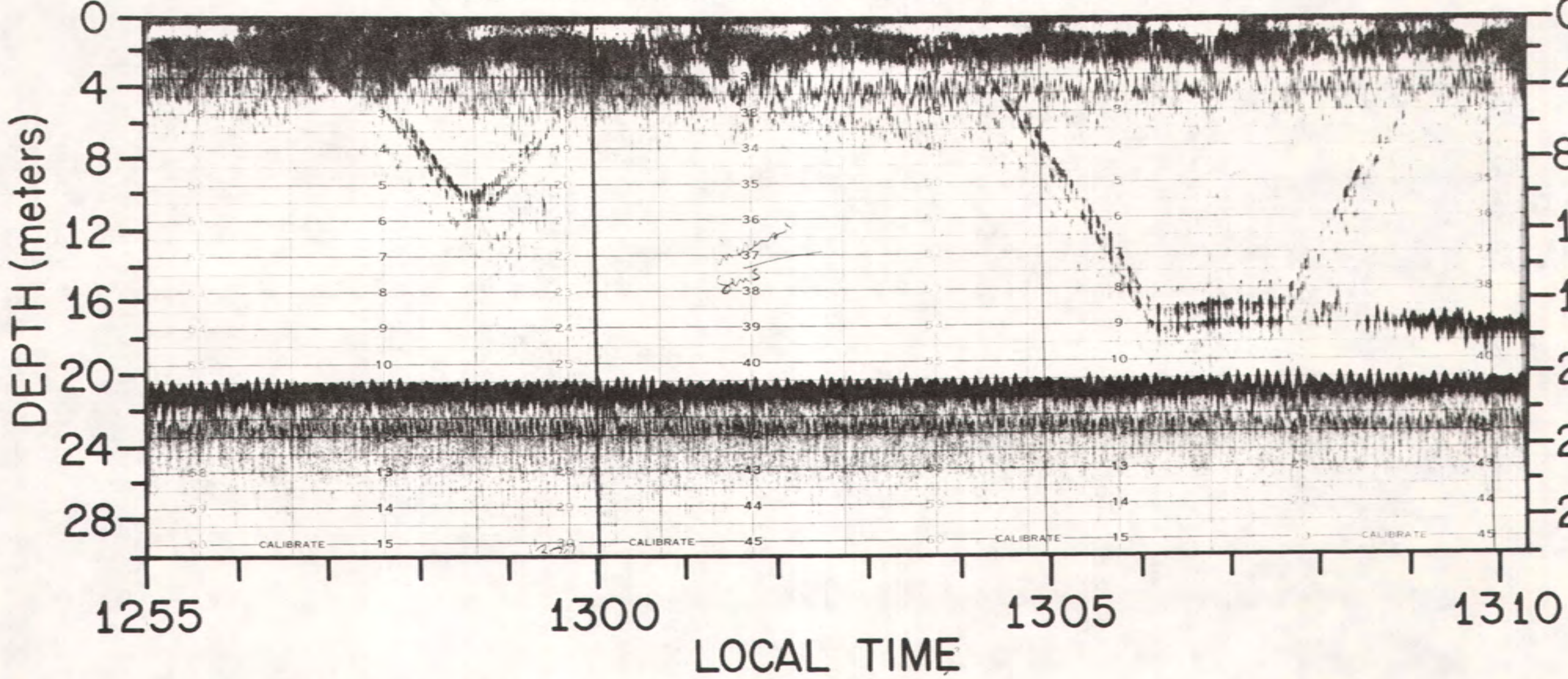
R/V BLACK CORAL
15 JULY 1976
SLUDGE TRACKING EXPERIMENT II

APPENDIX B

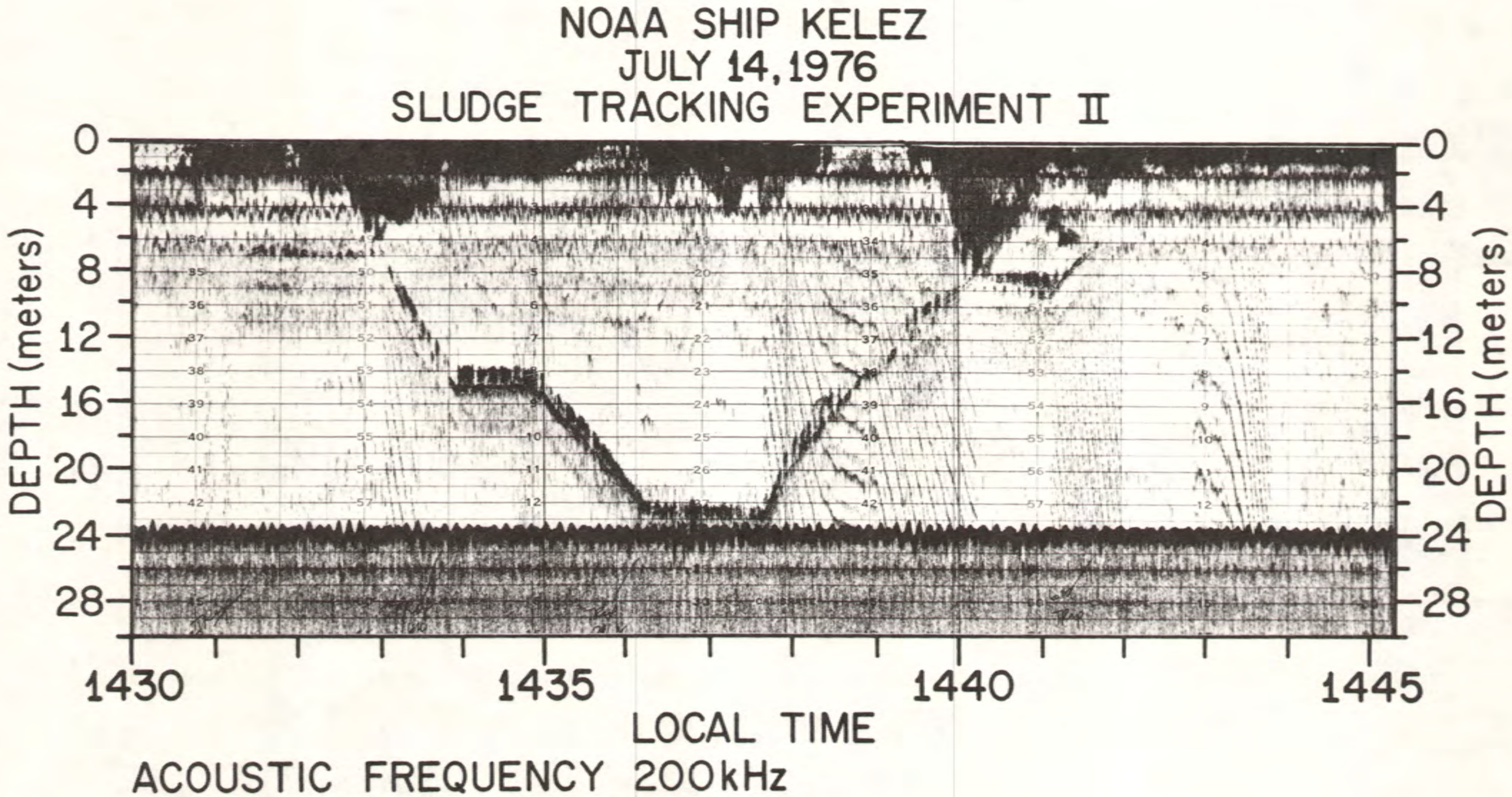
ACOUSTIC STRIP CHART DATA

Acoustic data photos showing representative traces of the lowering of a rosette sampler in the water column.

NOAA SHIP KELEZ
JULY 11, 1976
SLUDGE TRACKING EXPERIMENT II



ACOUSTIC FREQUENCY 200kHz



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